THE
ANATOMY AND PHYSIOLOGY
OF THE
HUMAN BODY.

BY

JOHN AND CHARLES BELL.

THE WHOLE MORE PERFECTLY SYSTEMATIZED AND CORRECTED
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TO THE ROYAL COLLEGE OF SURGEONS OF LONDON; AND
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IN TWO VOLUMES.

THE SIXTH AMERICAN,
FROM THE LAST LONDON EDITION.
WITH VARIOUS IMPORTANT ADDITIONS, FROM THE WRITINGS
OF SOEMMERING, BICHAT, BECLARD, MECKEL,
SPURZHEIM, WISTAR, &c.

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PREFACE

TO

THE FIRST EDITION.

To those who are at all acquainted with books on anatomy, the appearance of a new one on the subject will not be surprising. To those who are not yet acquainted with such writings, I have only to say, that I have written this book because I believed that such a one was needed, and must be useful. I have endeavoured to make it so plain and simple as to be easily understood; I have avoided the tedious interlarding of technical terms, (which has been too long the pride of anatomists, and the disgrace of their science,) so that it may read smoothly, compared with the studied harshness, and, I may say, obscurity, of anatomical description. If an author may ever be allowed to compare his book with others, it must be in the mechanical part; and I may venture say, that this book is full and correct in the anatomy, free and general in the explanations, not redundant, I hope, and yet not too brief.

If, in the course of this volume, I shall appear to have given a place and importance to theories far higher than they really deserve, my reader will naturally feel how useful they are in preserving the true balance between what is amusing and what is useful; between the looser doctrines of functions and the close demonstration of parts. He will be sensible, how much more easily these things can be read in the closet than taught in any public course; he will, I think, be ready to acknowledge, that I introduce such theories only as should connect the whole, and may be fairly distinguished as the physiology of facts; and he will perceive that, in this, too, I feel a deference for the public opinion, and a respect for the established course of education, which it is natural to feel and to comply with.

Thus, perhaps, it is less immodest for an author to put down what he thinks he may honestly say concerning his own book, than to omit those apologies which custom requires, which give assurance, that he has not entered upon his task rashly, nor performed it without some labour and thought, and which are the truest signs of his respect for the public, and of his care for that science to which he has devoted his life.

With these intentions and hopes, I offer this book to the public; and more particularly to those in whose education I have a chief concern; not without a degree of satisfaction at having accomplished what I think cannot fail to be useful, and surely not without an apprehension of not having done (in this wide and difficult subject) all that may be expected or wished for.

Every book of this kind should form a part of some greater system of education: it should not only be entire in its own plan, but should be as a part of some greater whole; without which support and connection, a book of science is insulated and lost. This relation and subserviency of his own particular task to some greater whole, is first in an author's mind: he ventures to look forward to its connection with the general science, and common course of education; or he turns it to a correspondence and harmony with his own notions of study; and if these notions are to give the complexion and character to any book, it should be when it is designed for those entering upon their studies, as yet uncertain where to begin, or how to proceed.

Hardly any one has been so fortunate as to pursue the study of his own science under any regular and perfect plan; and there are very few with whom a consciousness of this does not make a deep and serious impression at some future period, accompanied with severe regret for the loss of time never to be retrieved. In medicine, perhaps, more than in any other science, we begin our studies thoughtless and undecided, following whatever is delightful, (as much is delightful,) neglecting the more severe and useful parts: but as we advance towards that period in which we are to enter upon a most difficult profession, and to take our place and station in life, and when we think of the hesitation, anxiety, and apprehension with which we must move through the first years of practice, we begin to look back with regret on every moment that is past; with a consciousness of some idle hours; and (what is more afflicting still) with an unavailing sense of much ill-directed, unprofitable labour:—for there is no study which a young man enters upon with a more eager curiosity; but, not instructed in what is really useful, nor seriously impressed with the importance of his future profession, he thinks of his studies rather as the amusement than as the business of life; slumbers through his more laborious and useful tasks, and soon falls off to the vain pursuit of theories and doctrines.

If I were not persuaded of the important consequences, of the infinite gain or loss, which must follow the first steps in every profession, I should not feel, but, above all, I should not venture to show, an anxiety, which may be thought affected by those who cannot know how sincere it must be; for, in our profession, this is the course of things, that a young man, who, by his limited fortune, or the will of his friends, by absence from his native country, or by the destination of his future life, is restricted to a few years of irregular, capricious, ill-directed study, throws himself at once into the practice of a profession, in which, according to his ignorance or skill, he must do much good or much harm. Here there is no time for his excursions into that region of airy and fleeting visions, and for his returning again to sedate and useful labour: there is no time for his discovering, by the natural force of his own reason, how vain all speculations are:—in but a few years, at most, his education is determined; the limited term is completed, ere he have learnt that most useful of all lessons—the true plan of study: his opportunities come to be valued (like every other happiness) only when they are lost and gone.

Of all the lessons which a young man entering upon our profession needs to learn, this is, perhaps, the first,—that he should resist the fascinations of doctrines and hypotheses, till he have won the privilege of such studies by honest labour, and a faithful pursuit of real and useful knowledge. Of this knowledge, anatomy surely forms the greatest share. Anatomy, even while it is neglected, is universally acknowledged to be the very basis of all medical skill. It is by anatomy that the physician guesses at the seat, or causes, or consequences, of any internal disease: without anatomy, the surgeon could not move one step in his great operations; and those theories could not even be conceived, which so often usurp the place of that very science, from which they should flow as probabilities and conjectures only, drawn from its store of facts.

A consciousness of the high value of anatomical knowledge never entirely leaves the mind of the student. He begins with a strong conviction that this is the great study, and with an ardent desire to master all its difficulties: if he relaxes in the pursuit, it is from the difficulties of the task, and the seduction of theories too little dependent on anatomy, and too easily accessible without its help. His desire for real knowledge revives, only when the opportunity is lost; when he is to leave the schools of medicine; when he is to give an account of his studies, with an anxious and oppressed mind, conscious of his ignorance in that branch which is to be received as the chief test of his professional skill; or when, perhaps, he feels a more serious and manly impression, the difficulty and importance of that art which he is called to practise.

Yet, in spite of feeling and reason, the student encourages in himself a taste for speculations and theories, the idle amusements of the day, which, even in his own short course of study, he may observe sinking in quick succession into neglect and oblivion, never to revive; he aspires to the character of a physiologist, to which want of experience and a youthful fancy have assigned a rank and importance which it does not hold in the estimation of those who should best know its weakness or strength. The rawest student, proud of his physiological knowledge, boasts of a science and a name which is modestly disclaimed by the first anatomist, and the truest physiologist of this or any age. Dr. Hunter speaks thus of

his physiology, and of his anatomical demonstration:—" Physio-
" logy, as far as it is known or has been explained by Haller, and
" the best of the moderns, may be easily acquired by a student
" without a master, provided the student is acquainted with phi-
" losophy and chymistry, and is an expert and ready anatomist;
" for with these qualifications he can read any physiological book,
" and understand it as fast as he reads.

" In this age, when so much has been printed upon the subject,
" there is almost as little inducement to attend lectures upon phy-
" siology as there would be for gentlemen to attend lectures upon
" government or upon the history of England. Lectures upon
" subjects which are perfectly intelligible in print, cannot be of
" much use, except when given by some man of great abilities,
" who has laboured the subject, and who has made considerable
" improvements either in matter or in arrangement.

" In our branch, those teachers who take but little pains to de-
" monstrate the parts of the body with precision and clearness,
" but study to captivate young minds with ingenious speculations,
" will not leave a reputation that will outlive them half a century.

" I always have studied, and shall continue my endeavours, to
" employ the time that is given up to anatomical studies as usefully
" to the students as I can possibly make it,—and, therefore, shall
" never aim at showing what I know, but labour to show and de-
" scribe, as clearly as possible, what they ought to know. This
" plan rejects all declamation, all parade, all wrangling, all subtil-
" ty: to make a show, and to appear learned and ingenious in
" natural knowledge, may flatter vanity; to know facts, to sepa-
" rate them from suppositions, to range and connect them, to make
" them plain to ordinary capacities, and above all, to point out
" the useful applications, is, in my opinion, much more laudable,
" and shall be the object of my ambition."*

* Introductory Lecture published by Dr. Hunter.

Edinburgh, Sept. 1793.

PREFACE

TO

THE SIXTH EDITION.

In giving this edition of the Anatomy of the Human Body to the public, I have recast and arranged the whole, and have added several subjects to the original work. I have been careful to revise the descriptions, and have made some additions to them ; so that I hope these volumes will be found to have fewer errors, and to present a more perfect system.

Of the first part of the work by my brother, I may speak more freely. And I may recommend it to those who superintend the education of students, to consider whether they have not in it a work calculated to open the minds of the pupils to the right understanding of the important subjects of their studies, and to give them correct and liberal views of their profession. It will not soon be surpassed in correctness and minuteness of description.

I have not dared to touch the History of the Arteries, as delivered by my brother: the rapid improvement in the surgery of the arteries, which followed as a consequence of the first publication of this part of the Anatomy, has, with me, made it sacred. The nervous system is given here as I have taught it in my lectures of late years. And the discoveries which I have made in this department being now acknowledged, I have thought myself at liberty to incorporate the new views of the nervous system with this edition of the System of Anatomy of the Human Body. I have also introduced, in their proper places, the substance of such essays or observations as I have published from time to time, when they have seemed to deserve this by the interest they have excited.

CHARLES BELL.

Soho-Square, London,
Oct. 1826.

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INTRODUCTION.

Human anatomy is a part only of a more general science, which embraces the knowledge of the structure of all classes of animals, from the most simple to the highest; but it is by far the most important part. It should be kept before the anatomist and naturalist, as a subject of suitable dignity and usefulness, not only to animate their endeavours, but to give them a direction, and to prove a criterion of their success in the pursuit of useful knowledge. On the other hand, human anatomy cannot be highly cultivated without the assistance of what is called comparative anatomy. It cannot be considered a liberal study, nor properly preserved in relation to general science, without a continual reference to natural history, and the chain of animal existence.

Whether there be a perfect chain and gradation of existence, some will doubt; that is to say, when the naturalist has arranged animals according to their exterior appearance, the anatomist deranges his ideas, by exhibiting, in the internal structure, transitions and gradations which he did not contemplate, and principles of arrangement which he had not foreseen. But this does not controvert the general principle, that there is a chain of existence through the whole of nature. It only throws us back, mortified that we do not perfectly comprehend the whole system; a conclusion which, however humbling, is exactly what man experiences in the pursuit of every other department of knowledge, whether the subject of his contemplation be the earth he inhabits, the creatures which partake it with him, or his own faculties and nature, and his condition in creation. And let us make the best of this truth; let us view it as promising to us an inexhaustible field for enquiry, and an ever new hope of discovery.

In respect to animals, there are principles in operation, and a structure or organization, which extend, with a certain resemblance, through the whole. There is a system of parts to give form; there is a substance the seat of irritability; there are parts the seat of sensibility and enjoyment; and the powers or endowments of those parts, however different, are supplied through the same means. They have a circulation of fluids more or less perfect (as we use the expression); they receive new matter under the influence of the same appetites; and they perfect or animalize it, and appropriate it, by similar organs.

In all the more perfect animals we have a texture of bones, constituting the skeleton, and giving form and stature; both bearing up the soft parts and protecting them, and at the same time receiving the influence, and adjusting the effects, of the contractile parts of the body: for the bones are moulded with a regard to the motions to be performed, and their shapes give a direction to the efforts of the muscles.

The muscles constitute, properly, the fleshy part of the body. They consist of a fibrous texture, and are possessed of a peculiar animal and living power of contraction: in them, motion is originated by the influence of nerves; and by their operation on the bones, the motions and agency of the body are produced.

The nerves are like white cords, which are every where traceable through the body, where sensibility and motion can be perceived. They extend betwixt the brain and the muscular frame, combine the muscles in their actions on the bones and joints, and convey to them the influence of the will.

But these muscles and nerves have powers peculiar to them as living parts. All living properties are continued and propagated through the influence of the circulating blood: so that, although in the nerves, muscles, and bones, we see all that is necessary to the mechanism of the frame, we find every where accompanying them, arteries, veins, and lymphatics, which are necessary to their constitution as living parts.

To knit the bones together, and form the articulations, to be a bed and proper support for the muscles, to constitute a general bond of union betwixt bones, muscles, nerves, and blood-vessels—a certain cellular texture is necessary. This common cellular substance extends over the whole frame, unites the rudest parts, as the bones, and sustains the most delicate vessels, and such as are not visible to the naked eye; it constitutes, therefore, a very large proportion of the body, and is common to all animals.

Still, in what is here described, we have only the common textures of the frame of animal bodies; and, suppose them so constituted and possessed of their endowments, to feel or suffer, to re-act and to move symmetrically, how are these powers to be continued, and the delicate textures to be preserved? This consideration leads to the second division of the Anatomy, the VISCERA; the organs which are for the reception and assimilation of new matter.

To the circumstances of volition and locomotion, is owing the necessity for an alimentary canal. The vessels of vegetables, extended in their roots, draw nourishment from the soil; but animals must have these vessels and absorbing mouths internal, and the nutritious matter conveyed to them through an intestinal canal. In this canal, various processes are performed, suiting the contained matter to its new condition, and fitting it to be received into the living vessels, and gradually assimilating it to the condition of the circulating blood. In man, the food requires no preparation but of mastication, and is directly carried into a digesting stomach. Digestion is the first and the most essential change wrought upon the food: after that it is sent into the intestines, and subjected to the operation of certain secreted fluids, which separate, and, as it were, refine off the pure and nutritious fluid. It is then subjected to the absorbent mouths of the lacteals of the intestines, by a process as curious as any to be observed in the animal functions, and incapable of being explained on the common principles of fluids acting on dead matter out of the body. By the lacteals, the fluid destined to supply the waste of the body is carried into the circulating system.

The CIRCULATING SYSTEM consists of heart, arteries, and veins, a set of tubes continuous throughout, which transmit the blood through the whole body. The blood is sent outward by the arteries, and returns by the veins, and thus moves in a continual stream, urged on by the contraction of the containing tubes and cavities.

In animals which have a circulation, the blood is a vehicle which is constantly receiving from the alimentary canal, what it furnishes to all parts of the body for their growth. It is in its distribution to the extremities of the arteries that it effects those purposes of nutrition. In the very lowest animals, some physiologists have persuaded themselves that the vessels carry the fluid directly from the stomach to the parts of the frame, to nourish them. But in the more perfect animals, we know that it is not so.

The new fluid which has come from the organs of digestion and assimilation, is not fit for the purposes of nutrition until it has suffered the influence of the lungs. Nor is the blood which returns from the body by the veins, capable of sustaining the endowments or properties which distinguish the different textures as living parts, until it be submitted to the same operation.

LUNGS, therefore, are an essential part of the organic functions of all living beings. Vegetables, and those animals which have no true circulation, respire through the whole of their surface, or they have the air admitted into the interior of their bodies through different foramina, and by air-vessels, which accompany the blood-vessels in their distribution to the body. It is a beautiful display, to see minute tubes distributing air and mingling with those carrying blood, as if they were as necessary to the health and exercise of the living properties, as the blood-vessels themselves. And so it is proved by the survey of animated nature, to be in some way essential to the existence of life, that the blood and the pure air shall mutually influence each other.

In the more perfect animals, the lungs admit the air into contact with the blood. They consist of innumerable cells, having connexion with the windpipe or trachea, and by the muscular apparatus of the chest or thorax, these cells are expanded and compressed alternately; so that the atmospheric air is permitted to press or sink into these cells in inspiration, and is again discharged in expiration. To the cells of the lungs, a grand division of the circulating system of vessels is transmitted: arteries carrying the blood to them, and veins returning that blood again to the heart. And by means of these vessels the blood in the lungs is exposed to the influence of the atmospheric air, and through its influence it is purified.

This is the meaning of what is termed the double circulation, and the double heart; for in the higher and warm-blooded animals, there is a heart, consisting of two cavities, for receiving the blood from the body and transmitting it to the lungs, and there is another heart of two cavities for receiving the blood from the lungs and transmitting it to the body. These four cavities are tied together by the interlacement of their muscular fibres; and their walls, being animated by the same nerves, are in every respect combined, and subject to the same excitement: so that as the principal force of circulation is in the heart (for so we call the union of the four cavities), the circulation in the body and the circulation in the lungs are regulated by the heart's excitement, and always correspond.

The air respired must contain oxygen, or vital air; the air returned from the lungs is loaded with carbonic acid gas. The blood which had received the operation of the oxygen upon it was venous, dark-coloured, and unfit for the offices of life; but, on returning from the lungs, it has parted with its carbon,—it has become purer in colour; it is the bright vermilion-coloured blood which, from its being transmitted through the body by the arteries, is called arterial blood.

No animals respire by a particular organ except those that have a real circulation of the blood; because, in them, the heart and vessels are so ordered, that no blood is transmitted to the body, unless the whole or part has been subjected to the offices of the lungs and purified, and made capable, not merely of conveying the nutriment and material of the bodily frame, but also of supporting the vital energies, whatever these may be. Whether it is the nerve which has to feel, or the muscle to contract, no quality of life can be long supported in the organ without the supply and actual contact of the pure or arterial blood.

In this introductory survey of the animal œconomy, we perceive that the functions may be divided into three distinct orders.

We perceive that if animals required no supply, and if they held an independent existence, the faculties of sensation and motion would suffice, and nerves and muscles would constitute the whole active frame. These are the functions which anatomists call the animal functions, by which we might suppose the lower properties of our nature were meant; but the term is used in contra-distinction to vegetable life, which enjoys neither sense nor motion.

In opposition to the animal functions, are the vital functions, by which are meant, those which serve for the preservation and renovation of the machine; such as the offices of digestion, absorption, circulation, respiration, and the excretions.

Finally, the duration of each individual is defined and limited. There is a continual change and renovation of the frame, an intestinal or internal motion, a separation and an absorption of its particles, by which the body is ever new; but the life, the active principle, suffers change in infancy, youth, maturity, and the debility of age and death. Such is the law of animal existence. By which we see the necessity of a system of superadded parts, and a third order of functions: organs of generation, by which the individuals that perish, are replaced by others, and by which the existence of each species of animals is maintained.

On the whole, and surveying what is common to all animals, we perceive,—and all men who do not allow their passions to interfere with their philosophical opinions must acknowledge,—that there is a principle of life which hold those bodies that enjoy it, subjected to a law different from that which governs inanimate matter; and that the principal character of this power is to withdraw the bodies it animates, from the influence of those mere chemical affinities, to which, from the multiplicity of their component parts, their mixture, moisture, and temperature, they would have a strong tendency, and to which they are immediately exposed on death, and whereby their textures* are reduced to their original elements.

* Bichat, the illustrious founder of the science of General Anatomy, classified the elementary *tissues*, from which all the TEXTURES of the body are formed, in the following manner:

General or Primitive Tissues.	*Special or Secondary Tissues.*
1 Cellular,	8 Osseous,
2 Nervous of animal life	9 Medullary,
3 Nervous of organic life,	10 Cartilaginous,
4 Arterial,	11 Fibrous,
5 Venous,	12 Fibro-cartilaginous,
6 Exhalants,	13 Muscular of animal life,
7 Absorbents and their glands.	14 Muscular of organic life,
	15 Mucous
	16 Serous,
	17 Synovial,
	18 Glandulous,
	19 Dermoid,
	20 Epidermoid,
	21 Pilous.

The defect of this classification is obviously that of making too many tissues, since several of those above specified are but modifications of the same. Various writers on the subject have proposed new classifications. We do not think it necessary to give any other than those of Beclard and J. F. Meckel.

Beclard divides the tissues into 11 classes:—1. *cellular and adipous*; 2. *serous membranes*; 3. *tegumentary membranes*; 4. *vascular system*; 5. *glands*; 6. *ligamentous tissue*; 7. *cartilages*; 8. *osseous system*; 9. *muscular system*; 10. *nervous*; 11. *accidental productions*.

Meckel makes ten elementary tissues:—1. *the mucous*; 2. *the vascular*; 3. *nervous*; 4. *osseous*; 5. *cartilaginous*; 6. *fibrous*; 7. *fibro-cartilaginous*; 8. *muscular*; 9. *serous*; 10. *dermoid*.—J. D. G.

SUPPLEMENTARY INTRODUCTION.

BY THE AMERICAN EDITOR.

The sentiment expressed by the Author, in the preceding paragraph, is entirely accordant with the definition given by Bichat, in his immortal Treatise on Life and Death. From this work we shall here condense the excellent observations made in relation to the two remarkable modifications of life, termed by him, animal and organic.

Life is the sum of the functions which resist death. The measure of life being in general the difference which exists between the effort of external agents, and that of the internal resistance ; the excess of the former announces the feebleness of life ; the predominance of the latter is the index of its strength.

Such is life considered in the aggregate ; but examined in detail, it exhibits two remarkable modifications ; one of which is common to vegetables and animals, the other belonging exclusively to animals. The vegetable exists only from within, having no relation with surrounding bodies, except those of nutrition ; it commences, grows, and perishes, fixed to the soil that first received the germ. The animal has connected with this internal life, which it enjoys in the highest degree, an external life, which establishes numerous relations between it and surrounding objects, unites its existence with that of all other beings, separates or approaches them according to its fears or necessities, and seems, in appropriating to itself every thing in nature, to refer the whole to its peculiar existence. Hence animal functions form two very distinct classes ; one concerned in the actions which assimilate extraneous materials to the sustenance of the body, and reject matters which have become effete, constituting the internal life. The other which enables it to perceive surrounding objects, reflect upon its sensations, move voluntarily according to their influence, and most commonly express by the voice, its desires, fears, pleasures or pains.

The sum of the first *class* of functions, may be called ORGANIC LIFE : that of the second we name ANIMAL LIFE, because it is the exclusive attribute of the animal kingdom.

Generation does not enter into the series of phenomena of either of these modifications of life, which relate to the individual ; while generation refers to the species, and is but indirectly connected with most of the other functions ; commencing long after the other functions have been in operation, and ceasing long before they are discontinued.

Animal and organic life are both composed of two *orders* of functions, succeeding and connected with each other in an inverse manner. The *first* order in animal life, is established from the exterior of the body towards the brain. The second from that organ towards those of locomotion and voice. The impression of objects successively affects the senses, nerves, and brain. The senses receive, the nerves transmit, and the brain perceives the impression, which being thus received, transmitted, and perceived, constitute our sensations.

A very exact proportion exists between these two orders of functions; the developement of one being attended by increased energy of the other: vividness of sensation being always allied with vivacity of motion.

A double movement also is in operation in organic life; one of which incessantly composes, and the other decomposes the animal. Hence the *elements* are continually changing, though the organization remains the same. The nutritive molecules are successively absorbed, rejected, pass from the animal to the plant, thence to dead matter, again return to the animal, and are again reabsorbed. To this constant circulation of matter, organic life is adapted by two orders of functions. 1st. The *assimilative*, consisting of digestion, circulation, respiration, and nutrition. 2d. The *dis-assimilative*, absorption, circulation, exhalation, and secretion.

The sanguineous system occupies a middle rank, having the molecules which are to be assimilated, circulating along with those which have already been employed. This system constitutes the *centre* of *organic*, as the brain is of *animal* life. There is not the same relation existing between the two orders of functions of organic life, as is found between those of animal life: the feebleness of assimilation does not necessarily cause diminution of the dis-assimilating actions.

The marks which essentially distinguish the organs of animal from those of organic life, are 1st. *The regularity of the organs of animal life.*

The sense of sight is derived from two globes corresponding precisely in character; the sense of hearing from two organs in all respects correspondent; and that of smell from an organ of which one portion is throughout a copy of the other. The organ of taste is symmetrical, being separated by a median line, although covered by an undivided membrane; and the skin, although extended universally over the surface, is not deficient in traces of separation, which show that the organ of touch is formed in an analogous manner. The depressions below the nose, middle of the lips and chin; the navel, raphe of the perineum, projection of the spinous processes, and hollowing of the middle of the back of the neck, serve to indicate the fact.

The nerves of the organs of sense, excepting that of touch, are evidently arranged in symmetrical pairs. The nerves of locomotion, the muscles, bones, and their dependences, the larynx and its accessaries, have all a regularity which is never to be mistaken.

The brain, the organ which receives impressions, is remarkable for the regularity of its forms. The parts which are in pairs resemble each other exactly, while the central parts are separated by a median line, and are perfectly symmetrical. Symmetry is, in fact, so peculiarly the characteristic of animal life, that the moment the muscular and nervous systems become irregular, they no longer pertain to the animal functions. The muscular fibres of the heart and intestines, and the irregular distribution of the trisplanchnic or ganglionic nerve, may suffice in proof of this statement.

2d. The irregularity of the Viscera of organic Life.

The viscera of organic life are of an entirely opposite character. Of the digestive system, the stomach, intestines, spleen, liver, &c. are all irregularly disposed. In the circulatory system, the heart, great vessels, such as the arch of the aorta, the venæ cavæ, azygos, vena portæ, and arteria innominata offer no trace of symmetry. Continual varieties present themselves in the vessels of the extremities, and what is remarkable, is, that the irregularities of arrangement on one side are not necessarily accompanied by irregularity on the other.

The respiratory apparatus at first sight appears exactly regular. Yet the right bronchus differs in length, diameter, and direction from the left; the right lung has three, while the left has but two lobes. There is an obvious difference in volume between the right and left lung. The pulmonary arteries are unlike in their courses and diameters: the mediastinum upon which the median line falls, deviates sensibly to the left; all of which circumstances show, that the common law of irregularity suffers no exception in relation to the respiratory organs.

The organs of exhalation, absorption, the serous membranes, thoracic duct, the great lymphatic vessels, the secondary absorbents of all parts, have throughout an unequal and irregular distribution. In the glandulous system, we see the crypts or mucous follicles distributed irregularly in their respective membranes. The pancreas, liver, and even the salivary glands, although at first sight more symmetric, are not found to be so exactly beneath the median line. The kidneys differ from each other by their position, the number of their lobes in the child, the length and size of their arteries and veins, and especially by their frequent varieties.

From all the foregoing observations, it is evident that animal life is double; that its phenomena, executed at the same time on both sides, form on each of these sides a system independent of the opposite system, one of which may exist, although the other has ceased to act, being, doubtless, destined reciprocally to supply each other's place. This we see occur in common morbid affections, where the animal sensibility and mobility being weakened or entirely suspended in one of the symmetric halves of the body, does not preserve any relation with surrounding objects. In this case the individual is on one side nothing better than a vegetable, while on the other he preserves all the characters of animality, by the sense and motion which remain.

Organic life, on the contrary, forms a single system, where all is allied and co-ordinate, where the functions of one side cannot be interrupted without necessarily extinguishing those of the other. Disease of the left side of the liver, influences on the right, the state of the stomach; if the colon on one side cease its action, the opposition portion must also suspend its movements; the same stroke which arrests the circulation in the great venous trunks and right side of the heart, must also check it in the left portion and the great arteries. Should all the viscera of organic life have their actions suspended on one side, death must inevitably follow. Nevertheless, this assertion is general, and relative to the aggregate of organic life, and not to all the insulated phenomena; some organs of this system being actually double, and like the lungs and kidneys, being able on one side to supply the place of the other.

The viscera of organic life are not only subject to individual irregularities, but frequently the whole of the organs within the chest and abdomen have been found transposed; those of the right being found on the left side, and the contrary. It is in the viscera of organic life that we find by far the greatest number of deviations from the normal structure.

The actions of the functions of animal life, are characterized by a harmony, equal to their perfect symmetry; while the actions of organic life are as discordant as the vicera belonging thereto are irregular in their conformation.

The precision of sensation appears to be in proportion to the exact similarity of the two impressions, of which each is the collection. The right is imperfect, when one eye being stronger than the other is more vividly affected, and transmits a stronger image to the brain. It is to avoid this confusion, that we close one eye when the other is artificially increased in power by a convex glass, which interrupts the harmony of the two organs. We have the same effect produced naturally, when in squinting we turn the weaker eye from the object, while the stronger is fixed upon it, and thus avoid the inequality of impression.

The same sort of observation may be extended to all the organs of sense; acccording to their peculiar characters, the harmony of action of two symmetric organs, or of two similar halves of single organs, being essential to the perfection of sensations. The perfection of the *internal senses*, derived immediately from external sensations, the memory, imagination, and judgment, depend on the harmony existing between the two portions of the brain, in which the nerves of sense terminate.

Should one hemisphere of the brain be more perfectly organized than the other, more developed at all points, and therefore more susceptible of vivid impressions, the perception will be confused, for the brain is to the intellect what the senses are to the brain. Thus, if the want of harmony in the external sensitive system disturbs the perception of the brain, why will not the intellect perceive confusedly when two hemispheres of unequal force do not reduce to one, the double impression they have received?

The opposite of all this harmony of action is to be observed in the functions of organic life, and it is sufficient to refer to those of respiration, circulation, and secretion, to supply multitudes of examples of the truth of the statement.

In the organs of animal life, we see throughout regular alternations of activity and repose. The organic functions are continued without interruption throughout life, or if at all suspended, at the hazard of its immediate destruction. All the secretions are performed without interruption, and if some periods of remittance are observed, as in the bile during digestion, or the saliva during mastication, these periods refer to the intensity and not to the entire exercise of the function. Exhalation and absorption incessantly succeed each other;—nutrition is never inactive; the double movement of assimilation and disassimilation from which it results has no other limit than that of life.

The difference between organic and animal life is still farther shown by their difference of duration. The functions of organic life commence the first actions of the embryon. Animal life cannot be said to begin until after birth, unless we suppose that some indistinct sensation of touch is caused by the striking of the fœtus against the sides of the womb. The organic actions, though differing in force and activity from what they become at a more advanced age, are nevertheless in constant operation, and require but a short time after birth to attain their entire perfection. The organs of animal life, after birth, are but just commencing their actions, and require a long continued education to arrive at their greatest degree of excellence.

The distinction between the two modifications of life continues to be kept up in their different periods of decline and extinction. Natural death terminates the animal life, nearly altogether, before organic life is much impaired. The animal functions fail successively. Sight grows feeble, indistinct, and is lost. Sounds affect the ear but slightly and confusedly until the function is entirely lost. The skin withers, wrinkles, has little circulation, and becomes obtuse in its sensibility. Smelling is no longer performed, and taste, although it lingers to the last, is at length altogether extinct. With the senses the understanding disappears—perception, imagination, memory fade away. Memory, however, faithful to the vividness of early impressions, remains capable of recalling the past, even when the senses no longer are capable of exciting ideas of the present. The aged differ from infants in this; the latter judge according to immediate sensations, the former from those heretofore experienced. Both conditions are liable to great errors, since both the present and past are equally necessary in our sensations, to the correctness of judgment; when either is wanting they cannot be compared, and the judgment cannot be correct.

We thus readily perceive, that the external functions, or of animal life, are necessarily extinguished in the old man, while the functions of organic life continue in activity. In this respect, the state of an animal dying a natural death, approaches the state of one in the maternal womb, and even to that of a vegetable, which only lives internally, and to which all nature is in silence.

If we now recollect, that sleep retrenches more than one third of the duration of animal life, and add to its entire inaction during the first nine months, the almost total inactivity to which it is reduced during the last period of existence, it will be easy to see how great is the disproportion existing between the duration of animal and organic life.

The idea of our last hour is only painful, because, in terminating our animal life, it arrests all the functions which place us in relation with surrounding objects. It is the privation of these functions that scatters fear and dread upon the borders of the grave. It is not pain that we fear: for how many dying persons would purchase a continuance of existence at the price of uninterrupted sufferings? Observe the animal that lives but little, except within, and whose external relations have reference solely to his material wants; the immediate approach of death is accompanied by no uneasiness.

If it were possible to suppose a man in whom death affecting only the internal functions, as circulation, digestion, secretion, &c. would leave the whole functions of animal life untouched; such an individual would behold with indifference the approach of the end of organic life; because he would be sensible that the good of existence is not attached thereto, and that after such a death he would be in condition to feel and enjoy nearly all that previously constituted his happiness.

If animal life cease by degrees, if each of the ties which connect our lives with pleasure are successively broken, we relinquish our enjoyments without perceiving the loss, and have already forgotten their value when we yield to the stroke of death. Thus, the decay of the old man resembles the perishing of a vegetable, which without external relations, and having no consciousness of life, is equally free from the consciousness of death.

OF THE SKELETON.

The skeleton is the assemblage of bones which sustains the soft parts, and gives form to the human body. The bones may be contemplated in their three offices :—1. As columns under the weight of the parts ;—2. As levers on which the muscles act, to give activity and locomotion ;—and, 3. As a covering and protection to the softer and more delicate organs. In all the higher links of the chain of animal existence, there is a texture resembling the composition of bone, to sustain or protect the soft parts. In the corals, we may see a skeleton common to the whole family. In *testacea* it is an external shell, a calcareous foliated texture for their protection. In creatures that creep, the muscles are attached to their skin; while in the *crustacea* there is a calcareous crust, which is at once skin and skeleton, since the shell is in distinct parts, and articulated, and these parts have the muscles inserted into them. In reptiles and fishes, there is an internal system of bones, or a true skeleton. The peculiarity of their skeleton is not merely in the form and arrangement of the bones, but in their possessing more elasticity than belongs to the skeleton of birds and quadrupeds.

The thing most admirable in the composition of the skeleton, is the relation of its parts; the manner in which all its parts are cast at once, forming a system which, in our methods of proceeding, we are apt to forget. For, studying the individual bones with great minuteness, we neglect the relation which is established betwixt all the parts of the skeleton of any one animal.

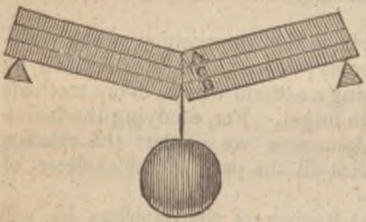
If the reader turn to the Review of the Skeleton, he will perceive that a system pervades all animated nature; but in the mean time it may be more proper for him to consider the structure of one of the long bones.

That the bones, which form the interior of animal bodies, should have the most perfect shape, combining strength and lightness, ought not to surprise us, when we find this in the lowest vegetable production.

In the sixteenth century, an unfortunate man who taught medicine, philosophy, and theology, was accused of atheistical opinions, and condemned to have his tongue cut out, and to suffer death. When brought from his cell before the Inquisition, he was asked if he believed in God. Picking up a straw which had stuck to his garments, "If," said he, "there was nothing else in nature to teach me the existence of a Deity, even this straw would be sufficient!"

A reed, or a quill, or a bone, may be taken to prove that in Nature's works strength is given with the least possible expence of materials. The long bones of animals are, for the most part, hollow cylinders, filled up with the lightest substance, marrow; and in birds the object is attained by means (if we may be permitted to say so) still more artificial. Every one must have observed, that the breast-bone of a fowl extends along the whole body, and that the body is very large compared with the weight: this is for the purpose of rendering the creature specifically lighter and more buoyant in the air; and that it may have a surface for the attachment of muscles, equal to the exertion of raising it on the wing. This combination of lightness with increase of volume, is gained by air-cells extending through the body, and communicating by tubes between the lungs and cavities of the bones. By these means, the bones, although large and strong, to withstand the operation of powerful muscles upon them, are much lighter than those of quadrupeds.

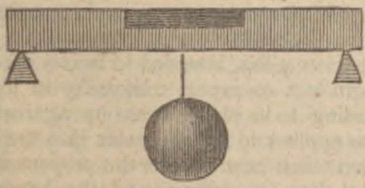
The long bones of the human body, being hollow tubes, are called cylindrical, though they are not accurately so, the reason of which we shall presently explain; and we shall, at the same time, show that their irregularities are not accidental, as some have imagined. But let us first demonstrate the advantage which, in the structure of the bones, is derived from the cylindrical form, or a form approaching to that of the cylinder. If a piece of timber supported on two points, thus —



bear a weight upon it, it sustains this weight by different qualities in its different parts. For example, divide it into three equal parts (A, B, C): the upper part A supports the weight by its solidity and resistance to compression; the lowest part B, on the other hand, resists by its toughness, or adhesive quality. Betwixt the portions acting in so different a manner there is an intermediate neutral, or central part, C, that may be taken away without materially weakening the beam, which shows that a hollow cylinder is the form of strength. The author lately observed a good demonstration of this:—a large tree was blown down, and lay upon the ground; to the windward, the broken part gaped; it had been torn asunder like the snapping of a rope: to the leeward side of the tree, the fibres of the stem were crushed into one another, and splintered; whilst the central part remained entire. This, we presume, must be always the case, more or less. And here we may take the opportunity of noticing why the arch is the form of greatest strength. If this transverse piece of timber were in the form of an arch, and supported at the extremities, then its whole thickness, its centre, as well as the upper and lower parts, would support weight by resisting compression. But the demonstration may be carried much farther to show the form of strength in the bone. If that part of the cylinder which bears the pressure be made more dense, the power of resistance will be much increased; whereas, if a ligamentous covering be added on the other side, it will strengthen the part which resists extension: and we observe a provision of this kind in the tough ligaments which run along the vertebræ of the back.

When we see the bone cut across, we are forced to acknowledge that it is formed on the principle of the cylinder; that is, that the material is removed from the centre, and accumulated on the circumference, thus*—

We find a spine, or ridge, running along the bone, which, when divided by the saw in a transverse direction, exhibits an irregularity, as at A. The section of this spine shows a surface as dense as ivory, and it is, therefore, much more capable of resisting compression than the other part of the cylinder, which is common bone. This declares what the spine is; and those anatomists must be wrong who imagine that the bone is moulded by the action of the muscles, and that the spine is a mere ridge, arising by accident among the muscles. It is, on the contrary, a strengthening of the bone in the direction on which the weight bears.† If we resume the experiment with the piece of timber, we shall learn why the spine is harder than the rest of the bone. If a portion



of the upper part of the timber be cut away, and a harder wood inserted in its place, the beam will acquire a new power of resisting fracture, because, as we have stated, this part of the wood does not yield but by being crush-

* See Munro's Works, p. 45. "Since the united force of all the fibres is to be regarded as resisting at a distance from the centre of motion equal to the semi-diameter, it follows that the total resistance of all these fibres, or the strength of the bone, is proportional to its semi-diameter, and consequently to its diameter." This proposition has been demonstrated mathematically, by Dr. Porterfield, in the Medical Essays of Edinburgh, vol. i. art. 10.

† As the line A B extends farther from the centre than B C, on the principle of a lever, the resistance to transverse fracture will be greater in the direction A B than B C.

ed, and the insertion of the harder portion of wood increases this property of resistance. With this fact before us, we may return to the examination of the spine of bone. We see that it is calculated to resist pressure, first, because it is farther removed from the centre of the cylinder; and, secondly, because it is denser, to resist compression, than the other part of the circumference of the bone.

This explanation of the use of a spine upon a bone gives a new interest to osteology. The anatomist ought to deduce from the form of the spine the motions of the limb; the forces bearing upon the bone, and the nature and the common place of fracture: while, to the general enquirer an agreeable process of reasoning is introduced in that department, which is altogether without interest when the "*irregularities*" of the bone are spoken of, as if they were the accidental consequences of the pressure of the flesh upon it.

Although treating of the purely mechanical principle, it is, perhaps, not far removed from our proper object to remark, that a person of feeble texture and indolent habits has the bone smooth, thin, and light; but that Nature, solicitous for our safety, in a manner which we could not anticipate, combines with the powerful muscular frame a dense and perfect texture of bone, where every spine and tubercle is completely developed. And thus the inert and mechanical provisions of the bone always bear relation to the muscular power of the limb, and exercise is as necessary to the perfect constitution of a bone as it is to the perfection of the muscular power. Jockies speak correctly enough, when they use the term "*blood and bone,*" as distinguishing the breed or genealogy of horses; for blood is an allowable term for the race, and bone is so far significant, that the bone of a running horse is remarkably compact compared with the bone of a draught horse. The reader can easily understand, that the span in the gallop must give a shock in proportion to its length; and, as in man, so in the horse, the greater the muscular power, the denser and stronger is the bone.

The bone not being as a mere pillar, intended to bear a perpendicular weight, we ought not to expect uniformity in its shape. Each bone, according to its place, bears up against the varying forces that are applied to it. Consider two men wrestling together, and then think how various the properties of resistance must be: here they are pulling, and the bones are like ropes; or again, they are writhing and twisting, and the bones bear a force like the axle-tree between two wheels; or they are like a pillar under a great weight; or they are acting as a lever.

To withstand these different shocks, a bone consists of three parts, the *earth* of bone (phosphate of lime) to give it firmness; *fibres* to give it toughness; and *cartilage* to give it elasticity. These ingredients are not uniformly mixed up in all bones; but some bones are hard, from the prevalence of the earth of bone; some more fibrous, to resist a pull upon them; and some more elastic, to resist the shocks in walking, leaping, &c. But to return to the forms:—Whilst the centre of the long bones is, as we have stated, cylindrical, their extremities are expanded, and assume various shapes. The expansion of the head of the bone is to give a greater, and consequently a more secure surface for the joint, and its form regulates the direction in which the joint is to move. To admit of this enlargement and difference of form, a change in the internal structure of the bone is necessary, and the hollow of the tube is filled up with *cancelli*, or lattice-work. These *cancelli* of the bone are minute and delicate, like wires, which form lattice-work, extending in all directions through the interior of the bone, and which, were it elastic, would be like a sponge. This texture of the bone permits the outer shell to be very thin, so that whilst the centres of the long bones are cylinders, their extremities are of a uniform cancellated structure. But it is pertinent to our purpose to notice, that this minute lattice-work, or the cancelli which constitute the interior structure of bone, have still reference to the forces acting on the bone; if any one doubts this, let him make a section of the upper and lower ends of the thigh-bone, and let him inquire what is the meaning of the difference in the *lay* of these minute bony fibres, in the two extremities? He will find that the head of the thigh-bone stands obliquely off from the shaft, and that the whole weight bears on what is termed the *inner trochanter*; and to that point, as to a buttress, all these delicate fibres converge, or point from the head and neck of the bone.

There is another circumstance of more practical importance, connected with the difference of texture of the bone in its diaphysis and epiphysis, that is, in its centre and its extremities, Different effects will be produced by violence; for example, by gun-shot. A musket-ball will sink into the head of the bone and lodge there, or pass quite through it; whereas if it strike the centre, it will split it up and break it into twenty pieces. Of this the reader may find examples in the Museum of the College of Surgeons of Edinburgh, which specimens I took from the wounded at Corunna and at Waterloo. It is probably owing to the looser texture of the extremities of the long bones that true necrosis does not take place in them, but only in the diaphysis.

Some, with a singular unhappiness of disposition, will contemplate the chain of animal existence, and see in it only a mechanical principle of adherence to a certain original type or model; and they have more gratification in giving a catalogue of things useless (that is to say, of parts, the beauty or usefulness of which they do not comprehend,) than of contemplating the whole, and allowing their minds to receive that natural influence which the system of nature is calculated to produce.

The four divisions of the upper extremity exist in all the anterior extremities of the class mammalia. A curious inspection of the gradations will prove that parts dissimilar in form, are a new appropriation of the same bones. In the fin of a whale we may recognize the bones of the human hand. Strip the integuments off the anterior fin of the dolphin or porpoise, and we recognize, somewhat disordered, a scapula, humerus, fore-arm, and carpus, metacarpus, and finger bones. It should surprise us less, that in the wing of a bird we should see the bones of the anterior extremity of a quadruped; or recognize, in the fine bones which stretch the membraneous wing of a bat, the phalanges of the fingers. Although there be no resemblance betwixt the outer form of animals that walk, and those that fly, and those that creep, yet in all of them the skeleton is recognizable as the same system of bones, variously modified.

But the question returns upon us,—can there be an adaptation of parts better calculated to their end, or more obviously designed, or better evidence of a system pervading all nature, and that the whole has been cast out at once from a power omnipotent?

There is not a more curious proof of adaptation of the texture of the skeleton to the condition and habits of animals, than we have in the bones of birds and fishes. In the former, as we have said, the dimensions, and consequently the strength, are increased without adding to the weight, by admitting a communication betwixt the lungs and the cavities of the bones, by which air is admitted into them. In fishes, the bones are light, not only by having a lesser quantity of earth in their composition, but by having spermaceti or oil deposited in their cavities. In the spermaceti whale, the head is kept buoyant, and the blow-holes above the water, by a large quantity of the spermaceti lodged in the head.

The bones of the human skeleton have been divided into the flat and cylindrical bones. It is incorrect, and therefore unscientific. Their forms are too much varied to admit of this sort of arbitrary division. There can be no other division of the skeleton, than into, 1. The bones of the trunk. 2. The bones of the extremities. 3. The bones of the head.

Immobilis junctura sive synarthrosis; viz. 1. Sutura. 2. Harmonia. 3. Sutura Squamosa. 4. Gomphosis. 5. Synchondrosis. 6. Diarthrosis sive mobilis junctura.

The bones are united in a manner varying with their forms and uses. They are immoveably joined together, by having their processes fixed into corresponding cavities, like cabinet-work; or, where the texture of bone is delicate, they are simply laid together, and a line marks their union; or they are laid over each other, and spliced together; or conical processes are, in a manner, inserted into corresponding cavities, like a nail; or the bones are firmly joined, yet so as to give some elasticity, and to take off the jar of contact, by intermediate cartilage. Finally, the bones are constituted with a relation to free motion at their articulation: for which purpose their extremities are covered with smooth cartilage, and joined by ligaments.

It is an interesting subject of study, to consider the uses of the parts, and to observe with what felicity and curious skill (so would we express ourselves of things of human invention) the strength, forms, and processes of the bones are adapted.*

OF THE TRUNK.

THE BONES OF THE SPINE, PELVIS, AND THORAX.

THE demonstration of the bones should begin with those of the spine, as it is the centre of muscular action, and the part of most common relation; for the spine is placed upon the arch of bones which form the pelvis, and supports the head, and is at the same time the bond of union of the bones of the thorax or chest.

The bones of the trunk consist of these: the chain of bones forming the vertebral column or spine; the bones of the pelvis; the ribs; and the sternum or breast-bone.†

OF THE SPINE.

Uses of the spine.

THE spine is so named from certain projecting points of each bone, which, standing outwards in the back, form a continued ridge; and the appearance of continuity is so complete, that the whole ridge is named spine, which, in common language, is spoken of as a single bone. This long line consists of twenty-four distinct bones, named vertebræ, from the Latin vertere, to turn. They conduct the spinal marrow, secure from harm, the whole length of the spine, and support the whole weight of the trunk, head, and arms; they perform,

* The young student, before entering on the demonstration of the bones, should make himself familiar with the meaning of such terms as the following: *Fovea*, *Fossa*, *Cella*, *Sinus*, *Fissura*, *Sulcus*, *Foramen*, *Meatus*, *Cervix*, *Condylus*, *Apophysis*, *Spina*, *Crista*, *Stylus*, *&c.* Let him look up these words in his dictionary. For although this anatomy is written with a desire to substitute the full and pure English description for the barbarism of the terms used in anatomical works, it is not always possible to avoid the use of such terms, in describing the infinite varieties in the form of bones. Indeed, the student ought to know these terms; and yet in communication and consultation it shews a better educated man to prefer the English language, if it can be made sufficiently descriptive.

† The reader may peruse the dissertation *on the formation and growth* of bone, before studying the forms and processes of the skeleton. But as the subject is abstruse, it has been (in this edition) introduced at the end of the anatomy of the bones.

at certain points, the chief turnings and bendings of the body; and do not suffer under the longest fatigue, or the greatest weight which the limbs can bear. Hardly can any thing be more beautiful or surprising than this mechanism of the spine, where nature has established the most opposite and inconsistent functions in one set of bones; for these bones are so free in motion, as to turn continually, yet so strong, as to support the whole weight of the body; and so flexible, as to turn quickly in all directions, yet so steady withal, as to contain and defend the most material and the most delicate part of the nervous system.

Classification of the 24 vertebræ. Five of the loins.

The vertebræ are arranged according to the neck, back, and loins, and the number of them corresponds with the length of these divisions. The vertebræ of the LOINS are five in number, very large and strong, and bearing the whole weight of the body. Their processes stand out very wide and free, not entangled with each other, and performing the chief motions of the trunk. The vertebræ of the BACK are twelve in number. They also are big and strong, yet smaller than those of the loins; their processes are laid over each other; each bone is locked in with the next, and embarrassed by its connexion with the ribs: this is, therefore, the steadiest part of the spine; a very limited motion only is allowed. The vertebræ of the NECK are seven in number; they are more simple, and like rings; their processes hardly project; they are very loose and free; and their motions are the widest and easiest of all the spine.

Twelve of the back.

Seven of the neck.

The seven vertebræ of the neck, twelve of the back, and five of the loins, make twenty-four in all, which is the regular proportion of the spine. But the number is sometimes changed, according to the proportions of the body; for, where the loins are long, there are six vertebræ of the loins, and but eleven in the back; or the number of the pieces in the back is sometimes increased to thirteen; or the neck, according as it is long or short, sometimes has eight pieces, or sometimes only six. However, these varieties are very rare.

General description of a vertebra.

The general form, processes, and parts of the vertebræ are best exemplified in a vertebra of the loins; for in it, the body is large, the processes are right-lined, large, and strong; the joint is complete, and all its parts are very strongly marked. Every vertebra consists of a body, which is firm, for supporting the weight of the body, and hollow behind, for transmitting the spinal marrow: of two articulating processes above, and two below, by which it is jointed with the bones which are above and below it: of two transverse processes, which stand out from either side of the bone, to give hold and purchase to those muscles which turn the spine; and of one process, the spinous process, which stands directly backwards from the middle of the bone: and these processes being felt in distinct points all the way down the back, give the whole the appearance of a ridge; whence it has the name of spine.

The BODY of the VERTEBRA is a large mass of soft and spongy bone; it is circular before, and flat upon the sides. It is hollowed into the form of a crescent behind, to give the shape of that tube in which the spinal marrow is contained. The body has but a very thin scaly covering for its thick and spongy substance. It is tipped with a harder and prominent ring above and below, as a sort of defence; and within the ring, the body of the vertebra is hollowed out into a sort of superficial cup, which receives the ligamentous substance, by which the next vertebra is joined to it; so that each vertebra goes upon a pivot, and resembles the ball and socket joints. And in many animals it is distinctly a joint of this kind.

Particular description of the body. Shape.

The harder ring; hollowed above and below.

On the fore and back part of the body of the vertebra are several holes, which are for the transmission of blood-vessels and for the attachment of ligaments.*

Foramina.

The BODY is the main part of the vertebra, to which all the other processes are to be referred: it is the centre of the spine, and bears chiefly the weight of the body: it is large in the loins, where the weight of the whole rests upon it, and where the movements are rather free: it is smaller in the vertebræ of the back, where there is almost no motion and less weight; and in the vertebræ of the neck, there is hardly any body, the vertebræ being joined to each other chiefly by the articulating processes.

The ring or circle of bone, or the arch which, together with the body itself, forms this circle, next attracts our notice; for the arches of the vertebræ, forming a continued tube, give passage to the spinal marrow. We observe a notch on each side of the arch for transmitting the nerves which go out from the spinal marrow.

The arch.

The notch.

The ARTICULATING PROCESS is a small projection, standing out obliquely from the body of the vertebra, with a smooth surface, by which it is joined to the articulating process of the next bone; for each vertebra has a double articulation with that above and with that below. The bodies of the vertebræ are united to each other by a kind of ligament, the intervertebral substance, which forms a more fixed, and rather an elastic joining; and they are united again by the articulating processes, which make a very moveable joint of the common form. The articulating processes are sometimes named oblique processes, because they stand rather obliquely. The upper ones are named the ascending oblique processes, and the two lower ones are named the inferior or descending oblique processes.

The articulating process,

called also oblique.

The SPINOUS PROCESSES are those which project directly backwards, whose points form the ridge of the back, and whose sharpness gives the name to the whole column. The

The spinous processes.

* These foramina enlarge in the beginning of the scrofulous inflammation of the bone.

body of each vertebra sends out two arms, which, meeting behind, form an arch or canal for the spinal marrow; and from the middle of that arch, and opposite to the body, the spinous process projects. Now the spinous, and the transverse processes, are as so many handles and levers, by which the spine is to be moved; which, by their bigness, give a firm hold to the muscles, and, by their length, give them a powerful lever to work their effects by. The spinous processes, then, are for the insertion of these muscles, which extend and raise the spine, and for the attachment of a ligament which runs from point to point in the whole length of the spine, and which checks the bending of the trunk forward.

Transverse processes.

The TRANSVERSE PROCESSES stand out from the sides of the arms or branches (named *crura*) which form this arch. They stand out at right angles, or transversely from the body of the bone; and they also are as levers, and long and powerful ones, for moving and turning the spine. Perhaps their chief use is not for turning the vertebræ, as there is no provision for much lateral motion in the lower part of the spine; but the muscles which are implanted into these are more commonly used in assisting those which extend and raise the spine.

These, and all the processes, are more distinct, prominent, and strong, more direct, and larger in the loins, and more easily understood, than in the vertebræ of any other class. But this prepares only for the description of the individual vertebra, where we find a variety proportioned to the various offices and to the degrees of motion which each class has to perform.

Peculiarities of a lumbar vertebra.

Of the VERTEBRÆ OF THE LOINS.—I have chosen to represent the general form of a vertebra, by describing one from the loins, because of the distinctness with which all its parts are marked. In the lumbar vertebræ, the perpendicular height of the body is comparatively less, the intervertebral substance is thicker than in the other parts of the spine, and the several processes stand off from each other distinct and clear; all which are provisions for a freer motion in the loins. The arch of the lumbar vertebra is wider than in the back, to admit the looser texture of the spinal marrow.

Spinal canal larger.

The body large and broad.

The BODY of a lumbar vertebra is particularly large, thick, and spongy, and its thin outer plate is perforated by many arteries going inwards to nourish this spongy substance of the bone. The length of the body is about an inch, and the intervertebral cartilage is very considerable; so that the vertebræ of the loins present to the eye, looking from within the body, a large, thick, and massy column, fit for supporting so great a weight.

The spinous process short.

The SPINOUS PROCESS is short, big, and strong. It runs horizontally and directly backwards from the arch of the spinal marrow. It is flattened, and about an inch in breadth; and it is commonly terminated by a lump or knob, indicating the great strength of the muscles and ligaments which belong to it, and the secure hold which they have.

The TRANSVERSE PROCESS is longer and firmer than in the other vertebræ; it goes out laterally and horizontally, and is provided for the origins of powerful muscles. We find the spinous process divided into two unequal parts by a spine running from the inferior articulating process; in the same manner we see the transverse process divided by a ridge extending from the superior articulating process. *Transverse process direct.*

The ARTICULATING PROCESSES of the lumbar vertebræ stand so directly upwards and downwards, that the name of oblique processes cannot be applied here. They are tuberculated and strong, partaking of the peculiarity which marks the general form of those vertebræ of the loins. *Articulating process perpendicular.*

Of the VERTEBRÆ OF THE BACK.—The character of the vertebræ of the back is directly opposite to that of the loins. *Of the dorsal vertebra.* The BODIES of the vertebræ are smaller, though still large enough to support the great weight of the trunk; but they are much deeper, proportionably, than those of the loins, and their intervertebral substance is thin, for there is little motion here. *Body deep.* The SPINOUS PROCESSES in the vertebræ of the back are very long and aquiline. They are broad at their basis, and very small or spinous at their further end; and in place of standing perpendicularly out from the body, they are so bent down, that they do not form a prominent nor unsightly spine, but are ranged almost in a perpendicular line, that is, laid over each other, like the scales of armour, the one above nearly touching the one below, by which the motions of these vertebræ are abridged; and the further to sustain the column, there is a groove on the under surface of the spinous process, which receives the superior edge of the one below. *Spinous process long, oblique, grooved.* The TRANSVERSE PROCESSES are short and knobby: in place of standing free and clear out, like those of the loins, they stand obliquely backward, are trammelled and restricted from motion, by their connection with the ribs; for the ribs are not merely implanted upon the bodies of the dorsal vertebræ, but they are further attached firmly by ligaments, and by a regular joint, to the transverse process of each vertebra. *Transverse processes directed backwards.* *Impression on the transverse process.* Now the rib being fixed to the body of one vertebra, and to the transverse process of the vertebra below, the motions of the vertebræ are much curbed. We get another mark by which the dorsal vertebræ may be known: for each vertebra bears two impressions of the rib which was joined to it, one on the flat side of its body, and the other on the fore part of its transverse process. *Two impressions on the body.* On the extremity of each of these transverse processes, a tubercule projects backward, giving advantage for the attachment of muscles. The articulating processes are so short, that they can hardly be described as distinct projections, and they stand out so directly from the transverse process, appearing as parts of it. *Articulating processes.* The surfaces of these processes present more obliquity, and they are simpler in form, and smoother, than those of the loins. *More oblique.*

We may distinguish the first vertebra of the back, by its *The first* and last dorsal vertebra distinguishable. having the whole of the head of the rib impressed upon its side.

The 12th, or lowest dorsal vertebra, has also the entire head of the rib impressed upon it, and it has no articulating surface on the extremity of the transverse process.

Cervical vertebræ. Their bodies small. Of the VERTEBRÆ OF THE NECK.—The vertebræ of the neck depart still farther from the form of those of the loins. The BODY is very small in all the vertebræ of the neck. In the uppermost of the neck there is absolutely no body; and the next to that has not a body of the regular and common form. There is not in the vertebræ of the neck, as in those of the loins, a cup or hollow for receiving the intervertebral substance; but the surfaces of the body are flat or plain, and the articulating processes are oblique, and make, as it were, one articulation with the body; for the lower surface of the body being not hollow, but plain, and inclined forwards, and the articulat- Articulating processes oblique. ing processes being also inclined backwards, and oblique, the two surfaces are opposed to each other; the one prevents the vertebræ from sliding forwards, and the other prevents it from sliding backwards, while a pretty free and general motion is Spinous process bifurcated, short, and horizontal. allowed. The SPINOUS PROCESSES of the neck are short, and project directly backwards; they are for the insertion of many muscles, and therefore they are split, and have small tubercles on their extremities. This bifurcation of the spinous process is not absolutely peculiar to the cervical vertebræ; for sometimes, though rarely, the others are so: and it is only in the middle of the neck that even they are forked; for the first vertebra is a plain ring, with hardly any spinous process, because there are few muscles attached to it; and the process of the last vertebra of the neck is not bifurcated, so that it approaches Lower vertebra of the neck, the *vertebra prominens.* to the nature of the dorsal vertebræ; the spinous process is long and aquiline, is depressed towards the back, and is so much longer than the others, as to be distinguished by the name of VERTEBRA PROMINENS.

Transverse process bifurcated; The TRANSVERSE PROCESSES of the neck are grooved and bifurcated, because there are a great many small muscles attached to them. But the most curious peculiarity of the perforated. transverse processes is, that each of them is perforated for the transmission of the great artery, which is named VERTEBRAL ARTERY, because it passes through these holes in the vertebræ which form altogether a bony canal for the artery.

General character. So that the character of these cervical vertebræ is, that they are calculated for much free motion; and the marks by which they are distinguished are, that the bodies are particularly small, the articulating processes oblique, with regard to their position, and almost plain on their surface. The spinous process, which is nearly wanting in the uppermost vertebræ, is short and forked in all the lower ones; the transverse process also is forked; and the transverse processes of all the vertebræ, except sometimes the first and last, are perforated near their extremities with the large hole of the vertebral artery.

ATLAS AND VERTEBRA DENTATA.—But among these vertebræ of the neck, two are to be particularly distinguished, as of greater importance than all the rest; for though the five lower vertebræ of the neck be ossified and fixed, if but the two uppermost remain free, the head, and even the neck, seem to move with ease.

The first vertebra is named ATLAS, perhaps because the globe of the head is immediately placed upon it; the second is named DENTATA or axis, because it has an axis or tooth-like process upon which the first turns. **Atlas.**

The ATLAS has not the complete form of the other vertebræ of the neck, for its processes are scarcely distinguishable: it has no body, unless its two articulating processes are to be reckoned as a body: it is no more than a simple ring; it has hardly any spinous process; and its transverse process is long and perforated, but not forked. On the upper margin of the ring may be observed the mark of the ligament, which unites it to the margin of the occipital bone; and on the lower margin of the ring the mark of attachment of a similar ligament, which attaches it to the circle of the dentata. The BODY is entirely wanting: in its place, the vertebra has a flat surface looking backwards, which is smooth and polished for the rolling of the tooth-like process; there is also a sharp point rising perpendicularly upwards towards the occipital bone, and this point is held to the edge of the occipital hole by a strong ligament. The smooth mark of the tooth-like process is easily found; and upon either side of it, there projects a small point from the inner circle of the ring: these two points have a ligament extended betwixt them, called the transverse ligament, which, like a bridge, divides the ring into two openings; one the smaller, for lodging the tooth-like process, embracing it closely; the greater opening is for the spinal marrow: the ligament confines the tooth-like process; and when the ligament is burst by violence (as has happened,) the tooth-like process, broken loose, presses upon the spinal marrow; the head, no longer supported by it, falls forward, and the patient dies. On the inside and lateral part of the circle, the origin of the lateral ligaments of the processus dentatus may also be observed. **Wants the body.** **Spinous process short.** **Has a sharp point or process.** **Articulating surface of the processus dentatus.** **Points of attachment of the transverse ligament.** **Origin of the lateral ligament.**

The ARTICULATING PROCESS may be considered as the body of this vertebra; for it is at once the only thick part, and the only articulating surface. This broad articulating substance is in the middle of each side of the ring: it has two smooth surfaces on each side; one looking upwards, by which it is joined to the occiput; and one looking directly downwards, by which it is joined to the second vertebra of the neck. The two upper articulating surfaces are oval, and slightly hollow to receive the occipital condyles: they are also oblique, for the inner margin of each dips downwards; the outer margin rises upwards, and the fore end of each oval is turned a little towards its fellow. Now, by the obliquity of the condyles, and **Articulating surfaces.** **The upper hollow oblique.**

this obliquity of the sockets which receive them, all rotatory motion is prevented, and the head performs, by its articulations with the first vertebra or atlas, only the nodding motions; and when it rolls, it carries the first vertebra along with it, moving round the tooth-like process of the dentatus. The articulation with the head is a hinge joint, in the strictest sense: it allows of no other motion than that backwards and forwards; the nodding motions are performed by the head upon the atlas, the rotatory motions are performed by the atlas moving along with the head, turning upon the tooth-like process of the dentatus as on a centre.

Forming with the condyles a hinge joint.

Now the upper articulating surfaces of the atlas are hollowed, to correspond with the condyles of the occipital bone, and to secure the articulation with the head; but the lower articulation, that with the vertebra dentata, being secured already by the tooth-like process of that bone, no other property is required in the lower articulating surfaces of the atlas, than that they should glide with perfect ease; for which purpose they are plain and smooth; they neither receive nor are received into the dentata by any hollow, but lie flat upon the surfaces of that bone. It is also evident, that since the office of the atlas is to turn along with the head, it could not be fixed to the vertebra dentata in the common way, by a body and by intervertebral substance; and since the atlas attached to the head moves along with it, turning as upon an axis, it must have no SPINOUS PROCESS; for the projection of a spinous process must have prevented its turning upon the dentatus, and would even have hindered, in some degree, the nodding of the head; therefore the atlas has a simple ring behind, and has only a small knob or button where the spinous process should be, which is somewhat irregularly notched. The TRANSVERSE PROCESS is not forked, but it is perforated with a large hole for the vertebral artery; and the artery, to get into the skull, makes a wide turn, lying flat upon the bone, by which there is a slight hollow or impression of the artery, which makes the ring of the vertebra exceedingly thin. Sometimes, instead of the groove for the artery, there is a perforation in the ring.

The lower surface plain, smooth. **Turning on the dentata.** **No spinous process.** **Transverse process perforated for the artery.** **Impression of the artery.**

But the form of the vertebra dentata best explains these peculiarities of the atlas, and this turning of the head.

Dentata, general form.

The VERTEBRA DENTATA, ODONTOIDES, or AXIS, is so named from its projecting point, which is the chief characteristic of this bone. When the dentata is placed upright before us, we observe, 1. That it is most remarkably conical, rising all the way upwards by a gradual slope to the point of its tooth-like process. 2. That the ring of the vertebra is very deep, that is, very thick in its substance, and that the opening of the ring for transmitting the spinal marrow is of a triangular form. 3. That its spinous process, though short and thick, yet projects beyond the level of the three spi

Spinous process short, and strong.

nous processes immediately below it; and that it is turned much downwards, so as not to interfere, in any degree, with the rotation of the atlas. 4. That its tooth-like process, from which the bone is named, is very large, about half an inch in length; very thick, like the little finger; that it is pointed; and that from this rough point a strong ligament goes upwards, by which the tooth is tied to the great hole of the occipital bone. We also observe a neck or collar, or smaller part, near the root of the tooth-like process, where it is grasped by the transverse ligament of the atlas; while the point of the process swells out a little above. We find this neck particularly smooth; for it is indeed upon this collar that the head continually turns. And we see on each side of this tooth-like process a broad and flat articulating surface. These articulating surfaces are placed like shoulders; and the atlas, being threaded by the tooth-like process of the dentata, is set flat down upon the high shoulders of this bone, and there it turns and performs all the rotatory motions of the head.

Its tooth-like process.

Neck of the process.

Articulating surfaces.

On the side of the tooth-like process we may observe the roughness for the insertion of the lateral ligaments, and its point is irregular where it is grasped by the perpendicular ligament which comes down from the occipital bone.

Insertion of the lateral ligaments.

We may observe, that while the superior articulating processes are horizontal, answering the purpose of a body, the lower surface of this vertebra is in all respects like the other vertebræ of the neck.

Articulating surface horizontal.

Of the SPINE generally.

All the vertebræ conjoined make a large canal of a triangular or roundish form, in which the spinal marrow lies, giving off and distributing its nerves to the neck, arms, and legs; and the whole course of the canal is rendered safe for the marrow, and very smooth by lining membranes, the outermost of which is of a leather-like strength and thickness, and serves this double purpose; that it is at once a hollow ligament to the whole length of the spine upon which the bones are threaded, and by which each individual bone is tied and fixed to the next. Within this there is the proper vagina or sheath which contains the spinal marrow, and which is bedewed on its internal surface with a thin exudation, keeping the sheath moist and soft, and making the enclosed marrow lie easy and safe.

All down the spine, this spinal medulla is giving off its nerves: one nerve passes from it at the interstice of each vertebra; so that there are twenty-five nerves of the spine, or rather fifty nerves, twenty-five being given towards each side; these nerves pass each through an opening or small hole in the general sheath; there they pass through the interstice of each vertebra; so that there is no hole in the bone required, but the nerve escapes by going under the articulating process.

This, indeed, is converted into something like a hole, when the two contiguous vertebræ are joined to each other.

The bodies of the vertebræ are somewhat peculiar in structure, being light and spongy bones, covered with a thin cortex: and it is from these circumstances that they are very liable to scrofulous caries.

The INTERVERTEBRAL SUBSTANCE.—The intervertebral substance is that which is interposed betwixt the bodies of two adjoining vertebræ, and which is (at least in the loins) nearly equal in thickness to the body of the vertebra to which it belongs. We give it this undefined name, because there is nothing in the human system to which it is entirely similar; for it is not ligament, nor is it cartilage, but it is commonly defined to be something of an intermediate nature: it is a soft and pliant substance, which is curiously folded and returned upon itself, like a rolled bandage with folds, gradually softer towards the centre, and with the rolled edges as if cut obliquely into a sort of convex. The cut edges are thus turned towards the surface of the vertebra, to which each intervertebral substance belongs: it adheres to the face of each vertebra, and it is confined by a strong ligament all round; and this substance, though it still keeps its hold on each of the two vertebræ to which it belongs, though it permits no true motion of one bone on another, but only by twisting of its substance, yields, nevertheless, easily to whichever side we incline, and it returns in a moment to its place by a very powerful resilience. This perfect elasticity is the chief character and virtue of this intervertebral substance, whose properties indeed are best explained by its uses; for, in the bendings of the body, it yields in a very considerable degree, and rises on the moment that the weight or the force of the muscles is removed. In leaping, in shocks, or in falls, its elasticity prevents any harm to the spine, while other less important joints are luxated and destroyed; and it gives to the whole column that fine elasticity which guards the head from sudden shocks, and the brain from vibration.

Since pressure, in length of years, shortens the fore part of the column of the spine, and makes the body stoop, any undue inclination to either side will cause distortion: the substance yields on one side, and rises on the other; and at last the same change happens in the bones also, and the distortion is fixed, and not to be changed but with great difficulty and by exercises continued for a long time: this distortion is peculiarly apt to happen with children whose bones are growing, and whose gristles and intervertebral substances are peculiarly soft; so that a tumour on the head or jaw, which makes a boy carry his head on one side, or constant stooping, such as is used by a girl in working at the tambour, or the carrying of a weakly child always on one arm by a negligent or awkward nurse, will cause in time a distortion.

We are now qualified to understand the motions of the vertebræ, and to trace the degree of motion in each individual class. The degrees of motion vary with the forms of the vertebræ, in each part of the spine: the motion is freest in the neck, more limited in the loins, and in the back (the middle part of the spine) scarcely any motion is allowed: the head performs all the nodding motions upon the first vertebra of the neck: the first vertebra of the neck performs again all the quick and short turnings of the head, by moving upon the dentatus: all the lower vertebræ of the neck are also tolerably free, and favour these motions by a degree of turning; and all the bendings of the neck are performed by them. The dorsal vertebræ are the most limited in their movements, bending chiefly forwards by the yielding of their intervertebral substance. The vertebræ of the loins again move largely, for their intervertebral substance is deep, and their processes less entangled. To perform these motions, each vertebra has two distinct joints, as different in office as in form: first, each vertebra is fixed to those above and below by the intervertebral substance, which adheres so to each that there is no true motion: there is no turning of any one vertebra upon the next; but the elasticity of the intervertebral substance allows the bones to move a little, so that there is a general twisting and gentle bending of the whole spine. The second joint is of the common nature with the other joints of the body, for the articulating processes are faced with cartilage, surrounded with a capsule, and lubricated with synovia. And I conceive this to be the intention of the articulating processes being produced to such a length, that they may lap over each other to prevent luxations of the spine; and they must, of course, have these small joints, that they may yield to this general bending of the spine.*

RIBS AND STERNUM.

Of the ribs.—The ribs, whose office it is to give form to the thorax, and to cover and defend the lungs, also assist in breathing; for they are joined to the vertebræ by regular hinges, which allow of short motions, and to the sternum by cartilages, which yield to the motion of the ribs, and return again when the muscles cease to act.

Each rib, then, is characterised by these material parts: a great length of bone, at one end of which there is a head for articulation with the vertebræ, and a shoulder or knob for articulation with its transverse process; at the other end there is a point, with a socket for receiving its cartilage, and a cartilage joined to it, which is implanted into a similar socket in the side of the sternum, so as to complete the form of the chest.

The ribs are twelve in number, according to the number of the vertebræ in the back, of which seven are named true Classification of the ribs;

* See further of the Spine, in the Review of the Skeleton.

Seven true. ribs, because their cartilages join directly with the sternum, and these are the preservers, the *custodes*, as protecting the heart; and five are named false ribs, because their cartilages are not separately nor directly implanted into the sternum, but are joined one with another; the cartilage of the lower rib being joined and lost in that of the rib above, so that all the lower ribs run into one greater cartilage. But there is still another distinction, viz. that the last rib, and commonly also the rib above, are not at all implanted in the sternum, but are loosely connected only with the muscles of the abdomen, whence they are named the loose or floating ribs.

Five false.

Two floating ribs.

Their form flat. The ribs are, in general, of a flattened form, their flat sides being turned smooth towards the lungs. But this flatness of the rib is not regular; it is contorted, as if the soft rib had been seized by either end, and twisted betwixt the hands: the meaning of which is, to accommodate the flatness of the rib to the form which the thorax assumes in all its degrees of elevation; for when the rib rises, and during its rising through all the degrees of elevation, it still keeps its flat side towards the lungs. Though of a flattened form, the rib is a little rounded at its upper edge, is sharp and cutting at its lower edge; and its lower edge seems double; for there is a groove, which in some measure gives security to the intercostal artery and nerve.

Twisted.

Upper edge rounded.

A groove on the lower edge.

The head having two articulating surfaces. On each rib we find the following parts: 1. The HEAD, or round knob, by which it is joined to the spine. The head of each rib has indeed but a small articulating surface; but that smooth surface is double, or looks two ways. For the head of the rib is not implanted into the side of one vertebra, it is rather implanted into the interstice betwixt two vertebræ; the head touches both vertebræ; all the vertebræ, except the first and last, bear the mark of two ribs, one above, and one below. The mark of the rib is on the edge of either vertebra, and the socket may be said to lie in the intervertebral substance betwixt them.

Cervix. 2. The NECK of the rib is a smaller part, immediately before the head. Here the rib is particularly small and round.

Tubercle. 3. About an inch from the head, there is a second rising, or bump, the articulating surface by which it touches and turns upon the transverse process of the vertebra below. These two articulations have each a distinct capsule or bag: each is a very regular joint; and the degree of motion of the rib, and direction in which it moves, may be easily calculated from the manner in which it is jointed with the spine; for the two articulating surfaces of the rib are on its back part: the back of the rib is simply laid upon the side of the spine; the joints, with the body of the vertebra, and with its transverse process, are in one line, and form as if but one joint; so that the rib being fixed obliquely, and at one end only, that end continues firm, except in turning upon its axis: the two heads roll upon the body of the vertebræ, and upon the transverse process; and so its upper end continues fixed, while its lower end rises

Articulating with the transverse process.

or falls; and as the motion is in a circle, the head being the central point, moves but little, while the lower end of the rib has the widest range.

4. Just above the second articulating surface there is a second tubercle, which has nothing to do with the joints, but is intended merely for the attachment of the ligaments and muscles from the spine which suspend and move the rib, and for the attachment of the anterior slips of the longissimus dorsi muscle. **A second tubercle.**

5. The angle of the rib is often mentioned, being a common mark for the place of surgical operations. There is a flatness of the thorax behind, forming the breadth of the back; the sharpness where this flatness begins to turn into the roundness of the chest is formed by the angles of the ribs. Each rib is round in the place of its head, neck, and tubercles: it grows flatter a little, as it approaches the angle: but it is not completely flattened till it has turned the angle which is the proper boundary betwixt the round and the flat parts of the rib; into these angles of the ribs the sacro-lumbalis is inserted. This anatomy of the ribs is sufficiently simple, but it is not equally easy to observe how it bears on the practice of surgery. It is in some degree useful in the more advanced parts of anatomy, to remember the names; and it is necessary, even in speaking the common language of surgeons, to know these parts, viz. the head of the rib; the tubercle, or second articulating surface; the angle, or turning forward of the rib; the upper round, and the lower sharp edge; and especially to remember the place and the dangers of the intercostal artery. It is, however, more important to consider the connections of parts; as the seat of the artery, the manner in which the ribs are lined with the pleura, and their nearness to the surface of the lungs. The ribs increase in the obliquity of their position from the highest to the lowest, and their anterior extremities expand, and are more distant from each other. There are some peculiarities in individual ribs, the chief of which are these: the length of the rib is increasing from the first to the seventh, but again decreases from the seventh to the twelfth; the curve of the ribs gradually decreases from the first to the last, the first being exceedingly short and circular, the lower ones longer, and almost right lined, making a small portion or segment of a large circle; so that the thorax is altogether of a conical shape, the upper opening so small, as just to permit the trachea, œsophagus, and great vessels to pass; the lower opening so large, that it equals the diameter of the abdomen: the first rib is consequently very short; it is thick, strong, and of a flattened form; of which flatness one face looks upwards, and another downwards, and the great axillary artery and vein lie upon its flat upper surface. We do not see any groove on the lower surface for the intercostal artery. It is also particularly circular, making more than half a circle from its head to the extremity where it joins the sternum; it

The angle. **Recapitulation of the anatomy of the rib.** **Peculiarities of individual ribs.**

has, of course, no angle, and wants the distorted twisting of the other ribs: the second rib is also round, like the first rib. The eleventh and twelfth, or the floating ribs, are exceedingly small and delicate, and their cartilage terminates in an acute point, unconnected with the sternum: and, lastly, the heads of the first, and of the twelfth ribs, are rounder than any of the others; for these two have their heads implanted into the flat side of one vertebra only, while all the others have theirs implanted betwixt the bodies of two vertebræ. And there is this further difference, that in the eleventh and twelfth ribs there are no tubercles for the articulation with the transverse processes. The cartilages of the ribs become longer as they descend and approach nearer to each other; they complete the form of the thorax, and form all the lunated edge of that cavity; and it is from this cartilaginous circle that the great muscle of the diaphragm has its chief origin, forming the partition betwixt the thorax and the abdomen. The farther end of each rib swells out thick and spongy, and has a small socket for lodging the cartilage; for these cartilages are not joined, like the intervertebral substances, with their bones: but there is a sort of joint, very little moveable indeed, but still having a rude socket, and a strong capsular ligament, and capable of luxation by falls and blows; the implantations into the sternum are evidently by fair round sockets, which are easily distinguished upon the two edges of that bone. These cartilages may be enumerated thus: The cartilages of the first and second ribs descend to touch the sternum. The cartilage of the third rib is direct. The cartilages of the fourth, fifth, and sixth ribs rise upwards, in proportion to their distance from this central one. The first five ribs have independent cartilages. The eighth, ninth, and tenth ribs run their cartilages into the cartilage of the seventh rib. And the eleventh and twelfth ribs have their cartilages small, unconnected, and floating loose.

Socket in the anterior extremity of the rib, and of the cartilage.

Motion of the ribs.

By the motion of the ribs, the thorax is alternately dilated and diminished in capacity, the lungs thereby having their play. A rib has two motions: 1. Its sternal end rises and falls, the centre of motion being in the articulation with the spine. 2. It moves on its own axis; a line drawn through the two extremities is the centre of this motion. The former motion enlarges and diminishes the diameter of the thorax, from the spine to the sternum; this enlarges the lateral diameter of the thorax. The importance of attending to the motion of the ribs is obvious in practice; for when the rib is broken, the ends jar and rub against each other, in consequence of the anterior extremity moving through a greater space than the posterior; and the business of the surgeon is to interrupt this. Besides, the fracture of the rib, most commonly of little consequence, is sometimes attended with the most serious symptoms, and even death; for if the fractured extremity punctures the membrane of the lungs, the air is drawn into the cavity of the chest, and from thence is pressed into the cellular substance, and the man is blown up in a prodigious degree.

THE STERNUM.—The sternum is that long and squared bone, which lies on the fore part of the breast over the heart, and which being joined by the cartilages of the ribs, completes the cavity of the chest; it is for completing the thorax, and defending the heart, for a medium of attachment to the ribs, and for a fulcrum or point, on which the clavicles may roll. **Situation.**

We find the sternum consisting in the child of eight distinct pieces, which run together in the progress of life, and which, in old age, are firmly united into one; but in all the middle stage of life, we find three pieces in the sternum, two of which are properly bone, the third remains a cartilage till very late in life, and is named the ensiform cartilage, from its sword-like point. **In the child eight pieces. In middle age three.**

It is found to have eight pieces, even in the child of six years old: some years after, it has but five or six; and the salient white lines which traverse the bone, mark where the intermediate cartilages have once been.

1. The upper piece of the sternum is very large, roundish, or rather triangular, resembling the form of the heart on playing-cards: it is about two inches in length, and an inch and a half in breadth; and these marks are easily observed. The APEX, or point of the triangle, is pointed downwards, to meet the second bone of the sternum. The BASE OF THE TRIANGLE, which is uppermost, towards the root of the throat seems a little hollowed, for the trachea passing behind it. On each upper corner, it has a large articulating hollow, into which the ends of the collar bones are received (for this bone is the steady fulcrum upon which they roll.) A little lower than this, and upon its side, is the socket for receiving the short cartilage of the first rib; and the second rib is implanted in the interstice betwixt the first and second bone of the sternum; so that one half of the socket for its cartilage is found in the lower part of this bone, and the other half in the upper end of the next. **Triangular portion. Apex. Base upwards, hollowed for the throat. Articulates with the clavicle. Socket for the first rib. Part of the second rib touches this.**

2. The second piece of the sternum is of a squared form, very long and flat, and composing the chief length of the sternum: for the first piece receives only the cartilage of the first rib, and one half of the second; but this long piece receives, on each side or edge of it, the cartilages of eight ribs; and as three of the lower cartilages are run into one, there are but five sockets or marks. The sockets for receiving the cartilages of the ribs are on the edges of the sternum; they are very deep in the firm substance of the bone, and large enough to receive the point of the finger with ease: and whoever compares the size and deepness of these sockets with the round heads of the cartilages which enter into them, will no more doubt of distinct joints here than of the distinct articulation of the vertebræ with each other. **Central portion oblong. Five pits for the attachment of eight ribs.**

3. This is, in truth, the whole of the bony sternum; and what is reckoned the third piece, is a cartilage merely, and **The third piece.**

Cartilago ensiformis.

continues so down to extreme old age. This cartilage, which ekes out, and lengthens the sternum, and which is pointed like a sword, is thence named CARTILAGO MUCRONATA, the pointed cartilage; or CARTILAGO ENSIFORMIS, or XIPHOIDES, the sword-like cartilage. One half of the pit for the attachment of the seventh rib is on this portion. This cartilaginous point, extending downwards over the belly, gives a sure origin and greater power to the muscles of the abdomen, and that without embarrassing the motions of the body; but this cartilage, which is commonly short and single-pointed, is sometimes forked, sometimes bent inwards, so (it has been thought) as to occasion sickness and pain; and once was produced to such a length, as to reach the navel, and ossified at the same time, so as to hinder the bending of the body, and occasion much distress.

Sometimes forked.

Surgical remarks.

The sternum and the ribs, and all the chest, stand so much exposed, that did we not naturally guard them with the hands, fractures must be very frequent; but indeed when they are broken, and beaten in, they hurt the heart or lungs, and not unfrequently the most dreadful consequences ensue. The sternum is, like the body of a vertebra, spongy and covered with a thin cortex of bone, and sheathed with ligaments; and being exposed, it is very subject to scrofulous inflammation.

The fracture of the sternum is a most serious accident; for when there is not death in consequence of the injury of the heart, there is a grating and rubbing of the broken surfaces: for the lower extremity of the sternum is carried forward in inspiration; and therefore, when there is a fracture, the lower part moves upon the upper part, and if not restrained, it will cause inflammation and suppuration beneath.

PELVIS.

To give a steady bearing to the trunk, and to connect it with the lower extremities by a sure and firm joining, the pelvis is interposed; which is a circle of large and firm bones, standing as an arch betwixt the lower extremities and the trunk. Its arch is wide and strong, so as to give a firm bearing to the body; its individual bones are large, so as to give a deep and sure socket for the implantation of the thigh bone; its motions are free and large, bearing the trunk above and rolling upon the thigh bones below; and it is so truly the centre of all the great motions of the body, that when we believe the motion to be in the higher parts of the spine, it is either the last vertebra of the loins bending upon the top of the pelvis, or the pelvis itself rolling upon the head of the thigh bones.

Pelvis consisting in the child of many pieces, in the adult of four

The PELVIS is named from its resembling a basin in its form; or, perhaps, from its office of containing the urinary bladder, rectum, vagina, and womb: it consists in the child of many pieces, but in the adult it is formed of three large bones and a smaller one; viz. the sacrum, and ossa innominata, and os coccygis.

Os SACRUM.—The names, os sacrum, os basilare, &c. seem to relate rather to its greater size than to its ever having been offered in sacrifice. This bone, with its appendix, the os coccygis, is called the false spine, or the column of the false vertebræ: authors making this distinction, that the true vertebræ are those of the back, neck, and loins, which possess motion, a column which grows gradually smaller upwards; the false vertebræ are those of the sacrum and coccyx, which are conical, with the apex or point downwards, and the base, viz. the top of the sacrum, turned upwards to meet the true spine, and which have no motion like the pieces of the spine. The sacrum. The false vertebræ.

The bones of which the sacrum is composed had originally the form of distinct, small vertebræ. These distinctions are lost in the adult, or are recollected only by the marks of former lines; for the original vertebræ are now united into one large and firm bone. The sacrum originally distinct pieces or vertebræ.

We can recognize the original vertebræ, even in the adult bone; for we find it regularly perforated with holes, for the transmission of the spinal nerves: we find these holes regularly disposed in pairs: we see a distinct white and rising line, which crosses the bone, in the interstice of each of the original vertebræ, and marks the place where the cartilage once was; and by these lines, being five in number, with generally five pair of holes, we know this bone to have consisted once of five pieces, which are now joined into one. The remains of former processes can also be distinguished, and the back of the bone is rough and irregular from the projection of the spinous processes. Which we recognise in the adult bone.

The os sacrum, thus composed, is among the lightest bones of the human body, with the most spongy substance, and the thinnest tables; but then it is a bone the best cemented, and confirmed by strong ligaments, and the best covered by thick and cushion-like muscles. The os sacrum is of a triangular shape; the base of the triangle turned upwards to receive the spine; its inner surface is smooth, to permit the head of the child in labour to glide easily along; and its outer surface is irregular and rough, with the spines of former vertebræ, giving rise to the great glutæi muscles, (which form the contour of the hip,) and to the strong muscles of the back and loins, the longissimus dorsi and sacro-lumbalis, which are for raising the spine and sustaining the body. Substance spongy. Form triangular. Concave within. Irregular on the back part.

It has in it a triangular cavity under the arch of its spinous processes; which cavity is continued from the canal in the vertebræ of the spine; and this cavity of the sacrum contains the continuation and the end of the spinal marrow, which being, before it descends to this place, divided into a great many thread-like nerves, has altogether the form of a horse's tail, and is therefore named cauda equina. Its cavity. Triangular.

From this triangular cavity the nerves of the cauda equina Foramina.

go out by four, sometimes five, great holes on the fore part of the sacrum, holes large enough to receive the point of the finger: grooves are seen running from these holes, for the passage of the sacral nerves. The first three nerves of the sacrum joining with the last two nerves of the loins, form the sacrosciatic nerve, the largest in the body, which goes downward to the leg, while the two lower nerves of the sacrum supply the contents of the pelvis alone.

The back of the sacrum is also perforated with four holes, whose size is nearly equal to those on its fore part: these transmit no great vessel nor nerve, and seem to be merely for diminishing the weight and substance of the bone.

Base articulated with the vertebra. All the edges of the sacrum form articulating points, by which it is joined to other bones. The base, or upper part of the sacrum, receives the last vertebra of the loins on a large broad surface, which makes a very moveable joint; and, indeed, the joining of the last true vertebra with the top of the sacrum, is a point where there is more motion than in the higher parts of the spine. **Articulating processes.** The sacrum has two articulating surfaces, which stand perpendicular, and correspond with those of the lower lumbar vertebra. **Apex with the os coccygis.** The apex, or point of the sacrum, has the os coccygis joined to it; which joining is moveable till the age of twenty in men, and till the age of forty-five in women; and the meaning of its continuing longer moveable in women is very plain, since the lower point of the coccyx in women is felt yielding in the time of labour, so as to enlarge greatly the lower opening of the pelvis. **Lateral articulating or scabrous surface.** The sides of the os sacrum form a broad, rough, and deeply indented surface, which receives the like rough surface of the haunch bones, by that sort of union which is called synchondrosis: but here the surfaces are so rough, and the cartilage so thin, that it resembles more nearly a suture; and by the help of the strong ligaments, and of the large muscles which arise in common from either bone, makes a joining absolutely immoveable, except by such violent force as is in the end fatal.

Thus the original state of this bone is easily recognized and traced by many marks; it stands in a conspicuous place of the pelvis, and its chief office is to support the trunk: to which we may add, that it defends the cauda equina, transmits its great nerves, forms chiefly the cavity of the pelvis, and that it is along the hollow of this bone that the accoucheur calculates the progress of the child's head in labour.

Os coccygis an appendix to the sacrum; in the child cartilage. The os COCCYGIS, so named from its resemblance to the beak of a cuckoo, is a small appendage to the point of the sacrum, terminating this inverted column with an acute point, and found in very different conditions in the several stages of life. In the child it is merely cartilage, and we can find no point of bone; **Moves on the sacrum.** during youth it is ossifying into distinct bones, which continue moveable upon each other till manhood; then the separate bones gradually unite with each other, so as to form one conical bone, with bulgings and marks of the pieces of which it was originally composed; but still the last bone continues to move upon the joint of the sacrum, till, in advanced years, it is at last firmly united, later in women than in men, with whom it is often fixed at twenty or twenty-five. The first bone is flat, with two transverse processes; the others become gradually of a roundish form, convex without, and concave inwards, forming, with the sacrum, the lowest part of the pelvis behind. It has no distinct holes, but the last sacral hole is frequently completed by a groove on the upper surface of the first bone; it has no communication with the spinal canal, but points forwards to support the lower part of the rectum. The prolongation of this appendix to the spine by a succession of additional bones, forms the tail in quadrupeds; while, in man, the coccyx is turned in to support the parts contained in the pelvis, and to afford an elastic extremity to the spine, on which, in some measure, we rest in sitting: in women it continues so moveable as to recede in time of labour, allowing the child's head to pass. This bone is apt to be dislocated by our falling with the breech on a projecting corner, or, more ignominiously, by kicks in the same place. When dislocated, it gives rise to very considerable distress, and to disorder of the function of the rectum and neck of the bladder.

In advanced years united to it.

It has no cavity.

The OSSA INNOMINATA are the two great irregular bones forming the sides of the pelvis, which have a form so difficult to explain by one name, that they are called ossa innominata, the nameless bones. But these bones having been in the child formed in distinct and separate pieces, these pieces retain their original names, though united into one great bone: we continue to explain them as distinct bones, by the names of os ilium, os ischium, and os pubis. The os ILIUM, the haunch-bone, is that broad and expanded bone on which lie the strong muscles of the hip, and which forms the rounding of the haunch. The os ISCHIUM, the hip-bone, the lowest point of the pelvis, that on which we rest in sitting. The os PUBIS, or share-bone, on which the private parts are placed. All these bones are divided in the child; they are united in the very centre of the socket for the thigh-bone; and we find in the child a thick cartilage in the centre of the socket, and a prominent ridge of bone in the adult; which ridge, far from incommoding the articulation with the thigh-bone, gives a firmer hold to the cartilage which lines that cavity, and is the point into which a strong ligament from the head of the thigh-bone is implanted.

Os Innominatum.

Divided into three.

The os ILIUM, or haunch-bone, is named from its forming the flank. It is the largest part of the os innominatum. It rises upwards from the pelvis in a broad expanded wing, which forms the lower part of the cavity of the abdomen, and supports the chief weight of the impregnated womb (for the womb commonly inclines to one side.) The os ilium is co-

Os ilii.

vered with the great muscles that move the thighs, and to its edge are fixed those broad flat muscles which form the walls of the abdomen. This flat upper part is named the ALA, or WING; while the lower, or rounder part, is named the BODY of the bone, where it enters into the socket, and meets the other bones.

Ala.

The ALA, or flat expanded wing, has many parts, which must be well remembered, to understand the muscles which arise from them. 1. The whole circle of this wing is tipt with a ridge of firmer bone, which encircles the whole. This is a circular cartilage in the child, distinct from the bone, and is ossified and fixed only at riper years. All this ridgy circle is called the spine, and is the origin for several muscles. The external oblique muscle of the abdomen is inserted into the outer edge or labrum, and from this margin the gluteus maximus and medius arise. The internal oblique arises from the middle rough line, and the transversalis from the inner edge of the spine. 2. The two ends of this spine are abrupt, and the points formed upon it are consequently named spinous processes, of which there are two at its fore and two at its back end. The two POSTERIOR SPINOUS PROCESSES are close by each other, and are merely two rough projecting points near the rough surface by which the os ilium is joined to the os sacrum: they jut out behind the articulation, to make it firm and sure; and their chief uses seem to be the giving a firm hold to the strong ligaments which bind this joint. Where the spine terminates in this process the great muscle of the hip, the gluteus maximus, takes its rise. 3. The two anterior spinous processes are more distinct, and more important marks; for the ANTERIOR SUPERIOR SPINOUS PROCESS is the abrupt ending of the spine, or circle of the ilium, with a swelling out: from which jutting point the sartorious muscle, the longest, and amongst the most beautiful in the human body, goes obliquely across the thigh, like a strap, down to the knee; another, which is called the tensor vaginæ femoris, also arises here; and from this point departs the ligament, which, passing from the os ilium to the pubis, or fore point of the pelvis, is called Poupart's ligament. The LOWER ANTERIOR spinous process is a small bump, or little swelling, about an inch under the first one, which gives rise to the rectus femoris muscle, or straight muscle of the thigh, which lies along its fore part; and upon the inside of the process there is a depression lodging the iliacus internus and psoas magnus.

Spine. Spinous processes. Posterior, superior, and inferior. Anterior superior. Anterior inferior.

Dorsum.

The back, or DORSUM of the os ilium, is covered with the three great glutæi muscles. We remark in a strong bone a semicircular ridge, which runs from the upper part of the anterior inferior spinous process to the lower part of the notch, and which marks the place of origin of the gluteus minimus. The inner surface is hollowed, so as to be called the cup or hollow, or sometimes the venter.

Cup.

Articulation with the sacrum.

This bone (the os ilium) has a broad rough surface, by which it is connected with the os sacrum at its side; the very form of which declares the nature of this joining, and is sufficient argument and proof that the joinings of the pelvis do not move. Scabrous surface.

The acute line, which is named LINEA INNOMINATA, is seen upon the internal surface of the bone, dividing the ala, or wing, from that part which forms the true pelvis. This line composes part of the brim of the pelvis, distinguishes the cavity of the pelvis from the cavity of the abdomen, and marks the circle into which the head of the child descends at the commencement of labour. This bone enters into the composition of the socket for the thigh-bone, in a manner to be presently explained. Linea innominata. Acetabulum.

In many parts of the bone we see holes for transmitting vessels; we find one particularly large in the cup.

The OS ISCHIUM, or hip-bone, is placed perpendicularly under the os ilium, and is the lowest point of the pelvis upon which we sit. It forms the largest share of the socket, whence the socket is sometimes named acetabulum ischii, as peculiarly belonging to this bone. The bump or round swelling upon which we rest is named the tuber ischii; and the smaller part which extends upwards to meet the os pubis, is named the ramus, or branch, which meets a similar branch of that bone to form the thyroid hole. Os ischii.

The BODY is the uppermost and thicker part of the bone which helps in forming the socket; and among the three bones, this one forms the largest share of it; nearly one half. From the body, a sharp-pointed process, named SPINOUS PROCESS of the ischium, is projected backwards; which, pointing towards the lower end of the sacrum, receives the uppermost of two long ligaments, which, from their passing betwixt the ischium and sacrum, are named sacro-sciatic: by this ligament a semi-circle of the os ilium, just below the joining of the ilium with the sacrum, is completed into a large round hole; which is in like manner named the sacro-sciatic hole, and gives passage to the pyramidalis muscles, and to the great nerve of the lower extremity, named the great sacro-sciatic nerve. Body. Spinous process. Notch of ilium.

From the TUBER, or round knob, being the point upon which we rest, this bone has been often named OS SEDENTARIUM. The bump is a little flattened where we sit upon it. It is the mark by which the lithotomist directs his incision, cutting exactly in the middle betwixt the anus and this point of bone. It is remarkable as being the point towards which the posterior or lower sacro-sciatic ligament extends, and as a point which gives rise to several of the strong muscles on the back of the thigh, and especially to those which form the hamstrings, semi-tendinosus, semi-membranosus, and long head of the biceps cruris. Tuber.

Between the scabrous surface on the tuber, and the edge of the acetabulum, there is a smooth surface, rather depressed, Cervix. which is called the CERVIX. It is covered with a cartilage which allows the tendon of the obturator internus to move easily.

Ramus. The RAMUS, or branch, rises obliquely upwards and forwards, to join a like branch of the pubis. This branch, or arm, as it is called, is flat, and its edges are turned a little forwards and backwards; so that one edge forms the arch of the pubis, while the other edge forms the margin of the thyroid hole.

Os Pubis. The OS PUBIS, or SHARE-BONE, is the last and smallest piece of the os innominatum, and is named from the mons veneris being placed upon it, and its hair being a mark of puberty. It forms the upper, or fore part of the pelvis, and completes the brim; and, like the ischium, it also is divided into three parts, viz. the BODY, ANGLE, and RAMUS.

Body. The BODY of the os pubis is thick and strong, and forms about one fifth of the socket for the thigh-bone. It is not only the smallest, but the shallowest part of the socket. The bone grows smaller, as it advances towards its angle; it again grows broad and flat, and the two bones meet with rough surfaces, but with two cartilages interposed. Over the middle of this bone, two great muscles, the iliac and psoas muscles, pass out of the pelvis to the thigh; and where they run under the ligament of the thigh, the pubis is very smooth. On the

Crest. angle or crest there is a process which is frequently called tuberous angle: from this process there are two ridges traced;

Linea ileo pectinea. one goes to meet the line on the ilium, forming the brim of the pelvis, and forms the linea ileo pectinea, or linea innominata; the other goes down towards the edge of the acetabulum: between these two ridges there is a flat surface giving origin to

Ramus. the pectineus. The RAMUS, or branch, is that more slender part of the pubis, which, joining with the branch of the ischium, forms with it the arch of the pubis, and the edge of the

Groove of the os pubis. thyroid hole. Just under the body of the bone, there is a groove, which forms that part of the thyroid hole which transmits the obturator nerve and artery.

This completes the strict anatomy of the pelvis; but when we consider the whole, it is further necessary to repeat, in short definitions, certain points which are oftener mentioned as marks of other parts.

Promontory of sacrum. The PROMONTORY of the sacrum is the projection formed by the lowest vertebra of the loins, and the upper point of that

Hollow. bone. The HOLLOW of the sacrum is all that smooth inner surface which gives out the great nerves for the legs and pel-

Lesser angle. vis. The LESSER ANGLE, in distinction from the greater angle or promontory of the sacrum, is a short turn in the bone near

Crest of pubis. where it is joined with the os coccygis. The CREST of the PUBIS is a sharper ridge or edge of the bone over the joining or

Symphyses. symphysis pubis. The POSTERIOR SYMPHYSIS of the pelvis is the joining of the sacrum with the ilium, while the symphysis pubis is distinguished by the name of ANTERIOR SYMPHYSIS of the pelvis. The SPINE, the TUBER, and the RAMUS of the ischium are sufficiently explained. The ALA, or wing, the SPINE, the SPINOUS PROCESSES, and the LINEA INNOMINATA of the ilium, have been already sufficiently explained. The ACETABULUM, so named from its resemblance to a measure which the ancients used for vinegar, is the hollow or socket for the thigh-bone, composed of the ilium, ischium, and pubis; the ridge in its centre shows the place of its original cartilage, and points out what proportion belongs to each bone; that it is made, two fifths by the os ilium, two fifths by the os ischium, and one fifth only by the os pubis; but the ischium has the greatest share; the ischium forming more than two fifths, and the ilium less. On the lower part of the margin there is a deficiency of bone; which, however, is made up by a ligament, and yet not so perfectly, but that dislocation of the head of the femur sometimes takes place in this direction. Acetabulum ischii.

The BRIM of the PELVIS is that oval ring which parts the cavity of the pelvis from the cavity of the abdomen: it is formed by a continued and prominent line along the upper part of the sacrum, the middle of the ilium, and the upper part or crest of the pubis. This circle of the brim supports the impregnated womb, keeps it up against the pressure of the labour pains; and sometimes this line has been "as sharp as a paper-"folder, and has cut across the lower segment of the womb;" and so, by separating the womb from the vagina, has rendered the delivery impossible; and the child escaping into the abdomen among the intestines, the woman has died.* The OUTLET of the PELVIS is the lower circle again, composed by the arch of the pubis, and by the sciatic ligaments, which is wide and dilatable, to permit the delivery of the child, but which being sometimes too wide, permits the child's head to press so suddenly, and with such violence upon the soft parts, that the perineum is torn. The THYROID HOLE is that remarkable vacancy in the bone which perhaps lightens the pelvis, or perhaps allows the soft parts to escape from the pressure, during the passage of the head of the child. Brim of the pelvis. Outlet. Thyroid hole.

The marks of the female skeleton have been sought for in the skull, as in the continuation of the sagittal suture; but the truest marks are those which relate to that great function by which chiefly the sexes are distinguished: for while the male pelvis is large and strong, with a small cavity, narrow openings, and bones of greater strength, the female pelvis is very shallow and wide, with a large cavity, and slender bones, and with every peculiarity which may conduce to the easy passage of the child. And this occasions that peculiar form of the body which the painter is at great pains to mark, and Peculiarities of the female pelvis.

* This condition of the brim is exhibited in a skeleton distorted by ricketts, in my collection, now in the possession of the College of Surgeons of Edinburgh. The woman died in child-bed, and it was found that the arm of the child had escaped from the womb, at the place where it was cut by the sharp spine of bone.

which is indeed very easily perceived; for the characteristic of the manly form is firmness and strength; the shoulders broad, the haunches small, the thighs in a direct line with the body, which gives a firm and graceful step. The female form again is delicate, soft, and bending; the shoulders are narrow; the haunches broad; the thighs round and large; the knees, of course, approach each other, and the step is unsure: the woman even of the most beautiful form, walks with a delicacy and feebleness, which we come to acknowledge as a beauty in the weaker sex.

The bones of the pelvis compose a cavity which cannot be fairly understood in separate pieces, but which should be explained as a whole. Though perhaps its chief office is supporting the spine, still its relation to labour deserves to be observed; for this forms at least a curious inquiry, though it should not be allowed a higher place in the order of useful studies.

We know, from much experience, that where the pelvis is of the true size, we have an easy and natural labour: that where the pelvis is too large, there is pain and delay; but not that kind of difficulty which endangers life; that where, by distortion, the pelvis is reduced below the standard size, there comes such difficulty as endangers the mother, and destroys the child, and renders the art of midwifery still worthy of serious study, and an object of public care.

Of the change in the joining of the pelvis.

There was a time when it was universally believed, that the joinings of the pelvis dissolved in every labour; that the bones departed, and the openings were enlarged; that the child passed with greater ease; and "that this opening of the basin "was no less natural than the opening of the womb." By many accidents, this opinion has been often strengthened and revived; and if authority could determine our opinion, we should acknowledge, that the joinings of the pelvis were always dissolved as a wise provision of nature for facilitating natural, and preventing lingering labour, compensating for the frequent deviations, both in the head and pelvis, from their true and natural size. This unlucky opinion has introduced, at one time, a practice the most reprehensibly simple, as fomentations to soften these joinings of the pelvis in circumstances which required very speedy help; while, at another time, it has been the apology for the most cruel unnatural operations of instruments, not merely intended for dilating and opening the soft parts, but for bursting up these joinings of the bones. And those also, of late years, who have invented and performed (too often, no doubt,) this operation of cutting the symphysis pubis to hasten the labour, say, that they do not perform an unnecessary cruel operation, but merely imitate a common process of nature.

How very far nature is from intending this, may be easily known from the very forms of these joinings, but much more from the other offices which these bones have to perform; for if the pelvis be, as I have defined it, an arch standing betwixt the trunk and the lower extremities on which the body rolls, its joinings could not part without pain and lameness, perhaps inability for life.

One chief reason drawn from anatomy is this: that in women dying after labour, the cartilages of the pelvis are manifestly softened; the bones loosen; and though they cannot be pulled asunder, they can be shuffled or moved upon each other in a slight degree: all which is easily accounted for. The cartilage that forms the symphysis pubis is not one cartilage only, as was once supposed, but a peculiar cartilage covers the end of each bone, and these are joined by a membraneous or ligamentous substance: this ligamentous substance is the part which corrupts the soonest: it is often spoiled, and in the place of it, a hollow only is found; that hollow of the corrupted ligament may be called a separation of the bones; but it is such a separation "as equals only the back of a common "knife in breadth, and will not allow the bones to depart from "each other;" the joining is still strong, for it is surrounded by a capsular ligament, not like the loose ligament of a moveable joint, but adhering to every point of each bone; and this ligament does perform its office so completely, that while it remains entire, though the bones shuffle sideways upon each other, no force can pull them asunder: "Even when the fore-"part of the pelvis is cut out, and turned and twisted betwixt "the hands, still, though the bones can be bent backwards and "forwards, they cannot be pulled from each other the tenth "part of an inch." These enquiries were made by one, who, though partial to the other side of this question, could not allow himself to disguise the truth, whose authority is the highest, and by whose facts I should most willingly abide.

Now, it is plain, that since a separation, amounting only to the 12th part of an inch, occasions death, this cannot be a provision of nature; and since the separation in such degree could not enlarge the openings of the basin, there again it cannot be a provision of nature. I know that tales are not wanting of women whose bones were separated during labour; but what is there so absurd, that we shall not find a precedent or parallel case in our annals of monstrous and incredible facts? Or, rather, where is there a fact of this description which is not balanced and opposed by opposite authorities and facts? I have dissected several women who have died in lingering labour, where I found no disunion of the bones. I have seen women opened, after the greatest violence with instruments, and yet found no separation of the bones. We have cases of women having the mollities ossium, a universal softness and bending of the bones, who have lived in this condition for many years, with the pelvis also affected; its openings gradually more and more abridged; the miserable woman suffering lingering labour, and undergoing the delivery by hooks, with all the violence that must be used in such desperate cases, and still no separation of the bones happening. How, indeed, should there be such difficult labours as these, if the separation of the bones could allow the child to pass?

If it be said, "the joinings of the pelvis are sometimes "dissolved,"* I acknowledge that they are, just as the joint of the thigh is dissolved, that is, sometimes by violence, and sometimes by internal disease; but if it be affirmed that "the join-"ings of the pelvis are dissolved to facilitate labour," I would observe, that wherever separation of the bones has happened, it has both increased the difficulties of the labour, and been in itself a very terrible disease; for proofs of which, I must refer to Hunter, Denman, and others, to whose peculiar province such cases belong. But surely these principles will be universally acknowledged; that the pelvis supporting the trunk is the centre of its largest motions: that if the bones of the pelvis were loosened such motions could no longer be performed: that when, by violence or by internal disease, or in the time of severe labour, these joinings have actually been dissolved or burst, the woman has become instantly lame, unable to sit, stand, or lie, or support herself in any degree; she is rendered incapable of turning, or even of being turned in bed; her attendants cannot even move her legs without intolerable anguish, as if torn asunder†: there sometimes follows a collection of matter within the joint (the matter extending quite down to the tuber ischii), high fever, delirium, and death‡; or, in case of recovery (which is indeed more frequent,) the recovery is slow and partial only; a degree of lameness remains, with pain, weakness, and languid health: they can stand on one leg more easily than on both; they can walk more easily than they can stand; but it is many months before they can walk without crutches; and long after they come to walk upon even ground, climbing a stair continues to be very difficult and painful. In order to obtain even this slow re-union of the bones, the pelvis must be bound up with a circular bandage very tight; and they must submit to be confined long: by neglect of which precautions, sometimes by the rubbing of the bones, a preternatural joint is formed, and they continue lame for years, or for life§; or sometimes the bones are united by ossification; the callus or new bone projects towards the centre of the pelvis, and makes it impossible for the woman to be again delivered of a living child.||

Now this history of the disease leads to reasons independent of anatomy, which prove, that this separation of the bones

* I have known the synchondrosis pubis burst by straining. The man stood over the weight which he strained to lift, and felt something give way. The case terminated in suppuration around the joint and caries of the ossa pubis. See my Collection.

† Denman.

‡ Dr. Hunter, Med. Observ. and Enquir. Vol. ii. p. 321.

§ Denman says twenty-five or thirty years.

|| Spence's cases.

(an accident the existence of which cannot be questioned) is not a provision of nature, but is a most serious disease. For if these be the dreadful consequences of separation of the bones, how can we believe that it happens, when we see women walking during all their labour, and, in place of being pained, are rather relieved by a variety of postures, and by walking about their room? who often walk to bed after being delivered on chairs or couches? who rise on the third day, and often resume the care and fatigues of a family in a few days more? or can we believe, that there is a tendency to separation of the bones in those who, following the camp, are delivered on one day and walk on the following? or in those women who, to conceal their shame, have not indulged in bed a single hour? or can we believe, that there is even the slightest tendency to the separation of the bones in those women whose pelvis resists the force of a lingering and severe labour, who suffer still further all the violence of instruments, who yet recover as from a natural delivery, and who also rise from bed on the third or fourth day? I have only to add to this catalogue of evils attending the separation of the symphysis or sychondrosis in the female pubis, that I have known the bones separated by violence in man, and the accident was attended with tedious suppuration and hectic.

BONES OF THE THIGH, LEG, AND FOOT.

The THIGH-BONE is the greatest bone of the body, and needs to be so, supporting alone, and in the most unfavourable direction, the whole weight of the trunk; for though the body of this bone is in a line with the trunk, in the axis of the body, its neck stands off almost at right angles with the body of the bone; and in this unfavourable direction must it carry the whole weight of the trunk, for the body is seldom so placed as to rest its weight equally upon either thigh-bone, as commonly it is so inclined from side to side alternately, that the neck of one thigh-bone bears alone the whole weight of the body and limbs, or is loaded with still greater burdens than the mere weight of the body itself.

Femur; general form cylindrical, The thigh-bone is one of the most regular of the cylindrical bones. Its BODY is very thick and strong, of a rounded form, swelling out at either end into two heads. In its middle it bends a little outwards, with its circle or convex side turned towards the fore part of the thigh. **curved.** This bending of the thigh-bone has been a subject of speculation abundantly ridiculous, viz. whether this be an accidental or a natural arch. There are authors who have ascribed it to the nurse carrying the child by the thighs, and its soft bones bending under the weight.

There is another author, very justly celebrated, who imputes it to the weight of the body, and the stronger action of the flexor muscles, affirming, that it is straight in the child, and grows convex by age. This could not be, else we should find this curve less in some, and greatest in those who had walked most, or whose muscles had the greatest strength: and if the muscles did produce this curve, a little accident giving the balance to the flexor muscles would put the thigh-bone in their power, to bend it in any degree, and to cause distortion. But the end of all such speculations is this, that we find it bended in the fœtus, not yet delivered from the mother's womb, or in a chicken while still enclosed in the shell; it is a uniform and regular bending, designed and marked in the very first formation of the bone, and intended, perhaps, for the advantage of the strong muscles in the back of the thigh, to give them greater power, or more room.

Head being more than half a circle. The HEAD of the thigh-bone is likewise the most perfect of any in the human body, for its circumference is a very regular circle, of which the head contains nearly two thirds: it is small, neat, and completely received into its socket, which is not only deep in itself, and very secure, but is further deepened by the cartilage which borders it, so that this is naturally, and without the help of ligaments, the strongest joint in all the body; but among other securities which are superadded, is the round ligament, the mark of which is easily seen, being a broad dimple in the centre of its cavity. In the surface of the head or ball we observe a small pit for the attachment of the round ligament of the hip-joint.

Pit.

Neck. The NECK of this bone is the truest in the skeleton; and indeed it is from this neck of the thigh-bone, that we transfer the name to other bones, which have hardly any other mark of neck than that which is made by their purse-like ligament being fixed behind the head of the bone, and leaving a roughness there. But the neck of the thigh-bone is more than an inch in length, thick, and strong, yet hardly proportioned to the great weights which it has to bear; long, that it may allow the head to be set deeper in its socket; and standing wide up from the shoulders of the bone, to keep its motions wide and free, and unembarrassed by the pelvis; for without this great length of the neck, its motions had been checked even by the edges of its own socket.

Trochanter. The TROCHANTERS are the longest processes in the human body for the attachment of muscles, and they are named trochanter (or processes for turning the thigh,) from their office, which is the receiving those great muscles which not only bend and extend the thigh, but turn it upon its axis; or these processes are oblique, so as to bend and turn the thigh at once.

Major. The TROCHANTER MAJOR, the outermost and longer of the two, is that great bump which represents the direct end of the thigh-bone, while the neck stands off from it at one side;

therefore the great trochanter stands above the neck, and is easily distinguished outwardly, being that great bump which we feel so plainly in laying the hand upon the haunch. On the upper and fore part of this great process, are two surfaces for the insertion of the gluteus medius and minimus.

The extremity of the great trochanter hangs over a pit into which principally the small rotator muscles of the thigh are inserted, viz. the pyriformis, the gemini, the obturator internus and externus. On the lower part there is a very strong marked ridge, which is for the insertion of the gluteus maximus.

Tr. minor. The TROCHANTER MINOR, or lesser trochanter, is a smaller and more pointed rising on the inner side of the bone, lower than the trochanter major, and placed under the root of the neck, as the greater one is placed above it. It is directed backwards, so that the muscles inserted into it turn the toe outwards at the same time that they raise the femur. It is deeper in the thigh, and never to be felt, not even in luxations. Its muscles, also, viz. the flexors of the thigh, by the obliquity of their insertion into it, turn the thigh, and bend it towards the body, such as the psoas and iliacus internus, which, passing out from the pelvis, sink deep into the groin, and are implanted into this point. On the neck of the thigh-bone there is a very conspicuous roughness, which marks the place of the capsule or ligamentary bag of the joint; for it encloses the whole length of the neck of the thigh-bone.

Inter-trochantral line. Betwixt the greater and lesser trochanters, there runs a rough line, the *inter-trochantral line*, to which the capsular ligament is attached, and into which the quadratus femoris is inserted.

Linea aspera. The LINEA ASPERA is a rising or prominent line, very rugged and unequal, which runs all down the back part of the thigh: it begins at the roots of the two trochanters, and the rough lines from each trochanter meet about four inches down the bone; thence the linea aspera runs down the back of the bone a single line, and forks again into two lines, one going towards each condyle, and ending in the tubercles at the lower end of the bone, so that the linea aspera is single in the middle, and forked at either end. **Double above, and below.**

Condyles. The CONDYLES are the two tubers, into which the thigh-bone swells out at its lower part. There is first a gentle and gradual swelling of the bone, then an enlargement into two broad and flat surfaces, which are to unite with the next bone in forming the great joint of the knee. The two tuberosities, which, by their flat faces, form the joint, swell out above the joint, and are called the CONDYLES. The INNER CONDYLE is larger, to compensate for the oblique position of the thigh-bone; for the bones are separated at their heads by the whole width of the pelvis, but are drawn towards a point below, so as to touch each other at the knees. On the fore part of the bone, betwixt the condyles, there is a broad smooth surface **The inner largest.**

upon which the rotula, patella, or pulley-like bone glides. The outer side of this trochlea is the largest and most prominent. On the back part of the thigh-bone, in the middle betwixt the condyles, there is a deep notch, which gives passage to the great artery, vein, and nerve, of the leg.

Trochlea.

Notch.

Nutritious artery.

The great nutritious artery enters below the middle of this bone, and smaller arteries enter through its porous extremities; as may be known by many small holes near the head of the bone.

Review of the principal points of demonstration.

The HEAD of the thigh-bone is round, and set down deeply in its socket, to give greater security to a joint so important, and so much exposed as the hip is. The NECK stands off from the rest of the bone, so that by its length it allows a free play to the joint, but is itself much exposed by its transverse position, as if nature had not formed in the human body any joint at once free, moving, and strong. The neck is not formed in the boy, because the socket is not yet deep, nor hinders the motions of the thigh, and the head is formed apart from the bone, and is not firmly united with it till adult years, so that falls luxate or separate the head in young people, but they break the neck of the bone in those that are advanced in years. The TROCHANTERS, or shoulders, are large, to receive the great muscles which are implanted in them, and oblique, that they may at once bend and turn the thigh. The SHAFT or BODY is very strong, that it may bear our whole weight, and the action of such powerful muscles; and it is marked with the rough line behind, from which a mass of flesh takes its rise, which wraps completely round the lower part of the thigh-bone, and forms what are called the vasti muscles, the greatest muscles for extending the leg. The CONDYLES swell out to give a broad surface, and a firm joining for the knee. But of all its parts, the great trochanter should be most particularly observed, as it is the chief mark in luxations or fractures of this bone: for when the greater trochanter is pushed downwards, we find the thigh luxated inward; when the trochanter is higher than its true place, and so fixed that it cannot roll, we are assured that it is luxated: but when the trochanter is upwards, with the thigh rolling freely, we are assured its neck is broken, the trochanter being displaced, and the broken head remaining in its socket; but when the trochanter remains in its place, we should conclude that the joint is but little injured, or that it is only a bruise of those glands or mucous follicles, which are lodged within the socket, for lubricating the joint.

Tibia.

Form.

The TIBIA is named from its resemblance to a pipe; the upper part of the tibia, representing the expanded or trumpet-like end, the lower part representing the flute end of the pipe. The tibia, on its upper end, is flat and broad, making a most singular articulation with the thigh-bone; for it is not a ball and socket like the shoulder or hip, nor a hinge joint guarded on either side with projecting points, like the ancle. There is no security for the knee-joint, by the form of its bones, for they have plain flat heads; they are broad indeed, but they are merely laid upon each other. It is only by its ligaments that this joint is strong; and by the number of its ligaments it is a complex and delicate joint, peculiarly liable to disease.

The UPPER HEAD of the tibia is thick and spongy, and we find there two broad and superficial hollows, as if impressed, while soft, with the marks of the condyles of the thigh-bone; and these slight hollows are all the cavity that it has for receiving the thigh-bone. A pretty high ridge rises betwixt these two hollows, so as to be received into the interstice betwixt the condyles, on the back part, which is the highest point of the ridge. There is a pit on the fore and on the back part for the attachment of the crucial ligaments. The spongy head has also a rough margin, to which the capsular ligament is tied. On the fore part of this bone, just below the knee, there is a bump for receiving the great ligament of the patella, or, in other words, the great tendon of all the extensor muscles of the leg: and lastly, there is upon the outer side of this spongy head, just under the margin of the joint, a smooth articulating surface, (like a dimple impressed with the finger,) for receiving the head of the fibula. It is under the margin of the joint, for the fibula does not enter at all into the knee-joint; it is only laid upon the side of the tibia, fixed to it by ligaments, but not received into any thing like a cavity.

Upper head. Two articulating surfaces. Ridge. Pits. Margin. Tubercle. Articulating surface for the fibula.

The BODY or shaft of the bone is of a prismatic or triangular form, and its three edges or acute angles are very high lines running along its whole length. The whole bone is a little twisted to give a proper position to the foot. One line, the anterior angle, a little waved, and turned directly forwards, is what is called the shin. At the top of this ridge is that bump into which the ligament of the rotula or patella is implanted; and the whole length of this acute line is so easily traced through the skin, that we can never be mistaken about fractures of this bone. Another line, less acute than this, is turned directly backwards; and the third acute line, which completes the triangular form, is turned toward the fibula, to receive a broad ligament, or interosseous membrane, which ties the two bones together.

Body triangular. Shin. Posterior angle. Lateral angle.

The middle of the posterior surface of the bone is hollowed for the lodgment of the muscles, which extend the foot and bend the toes; and the anterior and outer surface is hollowed by the lodgment of that muscle, which is called tibialis anticus, and the long extensors of the toes.

On the back part of the bone, near its head, there is a flat surface made by the insertion of the popliteus muscle, which is bounded on the lower part by a ridge giving origin to one of the flexors.

The lower head of the tibia composes the chief part of the ancle-joint. The lower head is smaller than the upper, in the

Lower head.

Malleolus internus. same proportion that the ancle is smaller than the knee. The pointed part of this head of the tibia represents the mouth-piece, or flat part of the pipe, and constitutes the bump of the INNER ANCLE. The lower end of the fibula lies so upon the lower end of the tibia, as to form the outer ancle; and there is Impression of the fibula. on the one side of the tibia a deep hollow, like an impression made with the point of the thumb, which receives the lower end of the fibula. The acute point of the tibia, named the process of the inner ancle, passes beyond the bone of the foot, and by lying upon the side of the joint, guards the ancle, so that it cannot be luxated outward, without this pointed process of the Scaphoid cavity. malleolus internus, or inner ancle, being broken. The lower extremity of the tibia has that sort of excavation to correspond with the astragalus, to which anatomists give the name of scaphoid cavity.

Groove for the tibialis posticus. On the back of the lower head of the bone there is a groove which transmits the tendon of the tibialis posticus muscle, and at its apex a pit giving origin to the deltoid ligament.

On the back part of the tibia, and a little below its head, we have to observe the hole for the transmission of the nutritious artery to the centre of the bone. In amputation of the leg, this artery is sometimes cut across just where it has entered the bone, and the bleeding proves troublesome.

The tibia is a bone of great size, and needs to be so, for it supports the whole weight of the body. It is not at all assisted by the fibula in bearing the weight, the fibula, or slender bone, being merely laid upon theside of the tibia, for uses which shall be explained presently. The tibia is thick, with much cancelli or spongy substance within; has pretty firm plates without; is much strengthened by its ridges, and by its triangular form: its ridges are regular with regard to each other, but the whole bone is twisted as if it had been turned betwixt the hands when soft: this distortion makes the process of the inner ancle lie not regularly upon the side of that joint, but a little obliquely forward, which determined the obliquity of the foot, and this must be of much consequence, since there are many provisions for securing this turning of the foot, viz. the oblique position of the trochanters, the oblique insertion of all the muscles, and this obliquity of the ancles; the inner ancle advancing a little before the joint, and the outer ancle receding in the same degree behind it.

Fibula. The FIBULA, which is named so from its resemblance to the Roman clasp, is a long slender bone, which is useful partly in strengthening the leg, but chiefly in forming the ancle-joint and in affording attachment to muscles. The tibia only is connected with the knee, while the fibula, which has no place in the knee-joint, goes down below the lower end of the tibia, forming the long process of the outer ancle.

The fibula is a long and slender bone, the longest and slenderest in the body. It lies by the side of the tibia like a splint, so that when at any time the tibia is broken without the fibula, or when the tibia, having spoiled, becomes carious, and a piece of it is lost, the fibula maintains the form of the limb till the last piece be replaced, or till the fracture be firmly re-united. It is, like the tibia, triangular in the middle part, but square towards the lower end, and has two heads, which are knots, very large, and disproportioned to so slender a bone. The sharpest line of the fibula is turned to the sharp line of the tibia, and the interosseous membrane passes betwixt them. The other lines or spines are in the interstices of the attachment of muscle, of which no fewer than six take their origin here, making the bone irregular with spines and grooves. There arise from the fibula, 1. The soleus from the back part of the head; 2. The tibialis posticus from the back and lower part of the bone; 3. The flexor longus pollicis all down the back part of the bone; 4. The peroneus longus from nearly the whole length of the bone; 5. The peroneus brevis from the middle and lower part; 6. The peroneus tertius from the fore part of the bone. The bone lies in a line with the tibia, on the outer side of it, and a little behind it. The upper head of the fibula is rough on the outer surface, for the insertion of the lateral ligament, and of the *biceps cruris;* smooth, and with cartilage within; and is laid upon a plain smooth surface, on the side of the tibia, a little below the knee: and though the fibula is not received deep into the tibia, this want is compensated for by the strong ligaments by which this little joint is tied; by the knee being completely wrapped round with the expanded tendons of those great muscles which make up the thigh; by the knee being still farther embraced closely by the fascia, or tendinous expansion of the thigh; but above all, by the tendons of the outer hamstrings being fixed into this knot of the fibula, and expanding from that over the fore part of the tibia.

Spines. **Upperhead.** **Firmly united to the tibia.**

The lower head of the fibula is broad and flat, and is let pretty deep into a hollow on the side of the tibia; together they form the socket of the ancle-joint for receiving the bones of the foot. The extreme point of the thin extremity gives attachment to the perpendicular ligament of the joint, and is called the malleolus externus. On the back part of this lower head there is a furrow which lodges the tendons of the peronei muscles. The ancle-joint is one of the purest hinge-joints, and is very secure; for there is the tibia, at the process of the inner ancle, guarding the joint within, there is the fibula passing the joint still further, and making the outer ancle still a stronger guard without. These two points, projecting so as to enclose the bones of the foot, making a pure hinge, prevent all lateral motion; make the joint firm and strong, and will not allow of luxations, till one or both ancles be broken. We know that there is little motion betwixt the tibia and fibula; none that is sensible outwardly, and no more in truth than just to give a sort of elasticity, yielding to slighter strains.

Lower head. **Malleolus externus.** **Ancle-joint.**

But we are well assured that this motion, though slight and imperceptible, is very constant; for these joinings of the fibula with the tibia are always found smooth and lubricated; and there are no two bones in the body so closely connected as the tibia and fibula are, and which are so seldom anchylosed, *i. e.* joined into one by disease.

General description of the fibula.

The fibula may be thus defined: it is a long slender bone, which answers to the double bone of the fore-arm, completes the form, and adds somewhat to the strength of the leg; it gives a broader origin for its strong muscles, lies by the side of the tibia like a splint; and being a little arched towards the tibia, supports it against those accidents which would break it across, and maintains the form of the leg when the tibia is carious or broken; the fibula, though it has little connection with the knee, passes beyond the ancle-joint, and is its chief guard and strength in that direction in which the joint should be most apt to yield; and in this office of guarding the ancle, it is so true, that the ancle cannot yield till this guard of the fibula be broken. This fracture of the lower part of the fibula, attended with more or less injury of the inner ligament of the ancle-joint, is by far the most frequent accident received into a London hospital.

Patella. Basis. Apex. Ridge.

PATELLA, ROTULA, or KNEE-PAN, is a small thick bone, of an oval, or rather triangular form. The basis of this rounded triangle is turned upwards to receive the four great muscles which extend the leg; the pointed part of this triangle is turned downwards, and is tied by a very strong ligament to the bump or tubercle of the tibia, just under the knee. The convex surface is rough, the concave smooth, and divided by a ridge into two unequal parts: round the margin of the bone there is a slight depression for the attachment of the capsular ligament. This ligament is called the ligament of the patella, or of the tibia, connecting the patella so closely, that some anatomists of the first name choose to speak of the patella as a mere process of the tibia, (as the olecranon is a process of the ulna,) only flexible and loose; an arrangement which I think so far right and useful, as the fractures of the olecranon and of the patella are so much alike, especially in the method of cure, that they may be spoken of as one case; for these two are exceptions to the common rules and methods of setting broken bones.

The patella is manifestly useful, chiefly as a lever; for it is a pully, which is a species of lever, gliding upon the fore part of the thigh-bone, upon the smooth surface which is betwixt the condyles. The projection of this bone upon the knee removes the acting force from the centre of motion, so as to increase the power; and it is beautifully contrived, that while the knee is bent, and the muscles at rest, as in sitting, the patella sinks down, concealed into a hollow of the knee. When the muscles begin to act, the patella begins to rise from this hollow; in proportion as they contract, they lose of their strength, but the patella, gradually rising, increases the power; and when the contraction is nearly perfect, the patella has risen to the summit of the knee, so that the rising of the patella raises the mechanical power of the joint in exact proportion as the contraction expends the living contractile power of the muscles. What is curious beyond almost any other fact concerning the fractures of bones, the patella is seldom broken by a fall or blow; in nine of ten cases, it is rather torn, if we may use the expression, by the force of its own muscles, while it stands upon the top of the knee, so as to rest upon one single point; for while the knee is half-bended, and the patella in this dangerous situation, the leg fixed, and the muscles contracting strongly to support the weight of the body, or to raise it as in mounting the steps of a stair, the force of the muscles is equivalent at least to the weight of the man's body; and often, by a sudden violent exertion, their power is so much increased, that they snap the patella across, as we would break a stick across the knee.

The TARSUS, or INSTEP, is composed of seven large bones, which form a firm and elastic arch for supporting the body; which arch has its strength from the strong ligaments with which these bones are joined, and its elasticity from the small movements of these bones with each other; for each bone and each joint has its cartilage, its capsule or bag, its lubricating fluid, and all the apparatus of a regular joint; each moves, since the cartilages are always lubricated, and the bones are never joined by anchylosis with each other; but the effect is rather a diffused elasticity than a marked and perceptible motion in any one joint. **Of the tarsus.**

The seven bones of which the tarsus is composed are, 1. The ASTRAGALUS, which, united with the tibia and fibula, forms the ancle-joint. 2. The os CALCIS, or heel-bone, which forms the end or back point of that arch upon which the body stands. 3. The os NAVICULARE, or boat-like bone, which joins three smaller bones of the fore part of the tarsus to the astragalus. 4. The os CUBOIDES, which joins the fore part of the os calcis to the external cuneiform bone. The 5th, 6th, and 7th, are the smaller bones making the fore part of the tarsus; they lie immediately under the place of the shoe-buckle, and are named the three CUNEIFORM BONES, from their wedge-like shape; and it is upon these and the anterior surface of the cuboides that the metatarsal bones, forming the next division of the foot, are implanted.

These bones of the tarsus form, along with the metatarsal bones, a double arch: first, from the lowest point of the heel to the ball of the great toe, is one arch, the arch of the sole of the foot which supports the body; then there is a transverse arch formed by the cuboides and the cuneiform bones; and again, there is another arch within this, formed among the tarsal bones themselves, one within another, and laid horizontally, *i. e.* betwixt the astragalus, os calcis, cuboides, cuneiform bones, and naviculare. It is these arches which give so perfect an elasticity to the foot, and must prevent the bad effects of leaping, falls, and other shocks, which would have broken a part less curiously adapted to its office.

Astragalus. (1.) The ASTRAGALUS is the greatest and most remarkable bone of the tarsus, and which the surgeon is most concerned in knowing. The semicircular head of this bone forms a curious and perfect pully. The circle of this pully is lârge; its cartilage is smooth and lubricated; it is received deep betwixt the tibia and fibula, and rolls under the smooth articular surface of the latter, which, being suited to this pully of the astragalus, with something of a boat-like shape, is often named the scaphoid cavity of the tibia. 1. We remark in the astragalus its articulating surface, which is arched, high, smooth, covered with cartilage, lubricated, and in all respects a complete joint. Its form is that of a pully, which, of course, admits of but one direct motion, viz. forwards and backwards. 2. We observe its sides, which are plain, smooth, and flat, covered with the same cartilage, forming a part of the joint, and closely locked in by the inner and outer ancles, so as to prevent luxations, or awkward motions to either side. 3. We observe two large irregular articulating surfaces, backwards and downwards, by which it is joined to the os calcis. 4. There is on the fore part, or rather the fore end, of the astragalus, a large round head, as regular as the head of the shoulder-bone, by which it is articulated with the scaphoid bone.

(General description.)

Points of demonstration. Trochlea. Internal articulating surface. External surface. Inferior posterior. Inferior anterior. Ball. Smooth surface. Fossa.

1. Superior surface corresponding with the scaphoid cavity of the tibia. 2. Internal articulating surface for the malleolus internus. 3. External articulating surface for the extremity of the fibula. 4. Inferior and posterior articulating surface joining with the body of the os calcis. 5. Inferior and anterior surface articulating also with a corresponding surface of the os calcis. 6. The ball or anterior articulating surface which enters into the socket of the naviculare. 7. A smooth part, which is like a continuation of this last, but which rests upon a cord of ligament, which is stretched betwixt the os calcis and naviculare. 8. Deep fossa, dividing these two inferior articulating surfaces, for the lodgment of a ligament which unites this bone to the os calcis. 9. Furrow for attachment of the capsular ligament. On the inside of the bone we see a hollow and a rough protuberance for the attachment of the deltoid ligament, which comes down from the tibia; a point of the anatomy of the first consequence to the surgeon.

(Attachment of the deltoid ligament.)

Os calcis. (2.) The OS CALCIS is the large irregular bone of the heel; it is the tip or end of the arch formed by the tarsal and metatarsal bones. There is an irregular surface on the highest part of the projection backwards, to which the tendo Achillis is inserted. The lower and back part of the bone is rough, but peculiar in its texture, for the attachment of the cartilaginous and cellular substance on which it rests. We next notice an irregular articular surface, or rather two surfaces co-

(Great process. First. Second.)

vered with cartilage, by which this bone is joined with the astragalus. Another articulating surface by which it is joined with the os cuboides. A sort of arch or excavation, on the inside, under which the vessels and nerves, and the tendons also, pass on safely into the sole of the foot. On the outer surface of this bone we may observe a groove, which transmits the tendon of the peroneus longus. Third articulating surface. Arch. Groove.

On the upper surface of the bone, and betwixt the surfaces which articulate with the astragalus, there is an irregular rough fossa, which is opposite to a corresponding depression in the astragalus, and which gives attachment to powerful ligaments which unite the bones; and, on the lower and inner part, is the sinuosity. Fossa.

We further notice the tubercle which stands internally, and gives attachment to the ligamentum inter os calcis et naviculare, which forms an elastic support to the lower part of the ball of the astragalus. Tubercle.

(3.) The next bone is named OS NAVICULARE, or OS SCAPHOIDES, from a fanciful resemblance to a boat. But this is a name to which anatomists have been very partial, and which they have used with very little discretion or reserve: the student will hardly find any such resemblance. That concave side which looks backwards is pretty deep, and receives the head of the astragalus: that flat side which looks forward has not so deep a socket, but receives the three cuneiform bones upon a surface rather plain and irregular. From the inner and lower part of this bone a tubercle stands out for the attachment of a powerful gristly ligament, already described, running betwixt this and the os calcis. Naviculare: Concave surface. Convex surface. Tubercle.

(4, 5, 6.) The CUNEIFORM BONES are so named, because they resemble wedges, being laid close to each other like the stones of an arch. The most simple and proper arrangement is 1, 2, and 3; counting from the side of the great toe towards the middle of the foot; but they are commonly named thus: the first cuneiform bone, on which the great toe stands, has its cutting edge turned upwards; it is much larger than the others, and so is called OS CUNEIFORME MAGNUM. The second cuneiform bone, or that which stands in the middle of the three cuneiform bones, is much smaller, and is therefore named OS CUNEIFORME MINIMUM. The third in order, of the cuneiform bones, is named OS CUNEIFORME MEDIUM.* These cuneiform bones receive the great toe and the two next to it. The fourth and fifth toes are implanted upon the os cuboides. Cuneiform bones. Os cuneiforme magnum. Minimum. Medium.

(7.) Os CUBOIDES.—The os cuboides is named from its cubical figure, and is next to the astragalus in size, and greater Cuboides.

* The confusion in these names arises from sometimes counting them by their place, and sometimes reckoning according to their size. It is only in relation to its size that we call one of these bones os cuneiforme medium; for the os cuneiforme medium is not in the middle of the three; it is the middle bone with respect to size: it is the smallest of the cuneiform bones that stands in the middle betwixt the other two.

Surface for the third cuneiform bone. than the os naviculare. The three cuneiform bones are laid regularly by the side of each other; and this os cuboides is again laid on the outer side of the third cuneiform bone, and **Articulated with os calcis.** joins it to the os calcis. Its anterior point is divided into two surfaces, for two metatarsal bones: in the lower surface of **Groove.** the bone is a groove for transmitting the tendon of the long peroneus muscle. The place and effect of the cuboid bone is very curious; for as it is jammed in betwixt the third cunei- **Place and use.** form bone and the os calcis, it forms a complete arch within an arch, which gives at once a degree of elasticity and of strength which no human contrivance could have equalled.

Metatarsus.—The metatarsus, so named from its being placed upon the tarsus, consists of five bones; they extend betwixt the tarsus and the proper bones of the toes.

Distinctions. The metatarsal bone of the great toe is the shortest, and is otherwise distinguished by its strength and the great size of its extremities. The metatarsal of the second toe is the longest, its nearer head being wedged betwixt the cuneiforme magnum and minimum, while it has a surface of contact with the medium and the head of the extremity of the metatarsal bone of the third toe. The metatarsal bone of the little toe is also peculiar in the size of its nearer head, and the manner in which that head projects upon the outside of the foot to receive the tendons of the peroneus secundus and tertius. The **General form.** metatarsal bones generally have these peculiarities. They are rather flattened, especially on their lower sides, where the tendons of the toes lie; they have a ridge on their upper or arched surface; they are very large at their ends next the tarsus, where they have broad square heads, that they may be implanted with great security; they grow smaller forwards, where again they terminate, in neat small round heads, which receive the first bones of the toes, and permit of a very free and easy motion in them, and a greater degree of rotation than our dress allows us to avail ourselves of, the toes being cramped together, in a degree that fixes them all in their places, huddles one above another, and is quite the reverse of that free and strong-like spreading of the toes, which the painter always represents.

Ball. The further extremities of these bones terminate in round balls, which correspond with the sockets in the first bones of **Groove.** the toes, and a distinct groove runs round the upper part of the extremity of the bone for the attachment of the capsule. **Condyles.** Processes stand out laterally from the anterior extremities, which give attachment to the lateral ligaments of the joint. These bones, by the connection of their nearer extremities, form an arch corresponding with the lateral arch of the tarsus: owing to this the metatarsal of the great toe is placed on a lower level, so that its great extremity projects into the sole of the foot, and into it are inserted part of the tendon of the tibialis posticus, and the peroneus longus, whilst the tibialis anticus is inserted into its upper surface.

The marks of the metatarsal bones are chiefly useful as directing us where to cut in amputating these bones ; and the surgeon will save the patient much pain, and himself the shame of a slow and confused operation, by marking the places of the joints, and the form of the extremities of the bones.

THE TOES.—The last division of the foot consists of three distinct bones ; and as these bones are disposed in rows, they are named the first, second, and third phalanges or ranks of the toes.

The great toe has but two phalanges ; the other toes have three ranks of bones : these bones are a little flattened on their lower side, or rather, they have a flattened groove which lodges the tendons of the last joint of the toes. The articulating surfaces of the nearer extremities of the first bones are deep sockets for the extremities of the metatarsal bones, and the motions are free. But the articulations of the second and third joints are proper hinge joints, the further extremities of the first and second bones being a flattened trochlea. It is particularly to be noticed, that the heads of these bones are large, and that they send out a lateral projection for the attachment of the lateral ligament. The consideration of the size and form of the extremities of these bones, and the nature and attachment of their ligaments, is of the first importance, as explaining the peculiarity in the dislocation of these bones, and the manner of reduction. **Their extremities large.**

The SESAMOID BONES are more regularly found about the toes than any where else. They are small bones, like flattened peas, found in tendons, at the points where they suffer much friction ; or rather they are like the seeds of the sesamum, whence their name. They are found at the roots of the great toe, and of the thumb. We find two small sesamoid bones, one on each side of the ball of the great toe ; and grooves may be observed on the lower part of the articulating surface of that bone, for their lodgment and play : they are within the substance of the tendons ; perhaps, like the patella, they remove the acting force from the centre of motion, and so, by acting like pullies, they increase the power ; perhaps, also, by lying at the sides of the joint in the tendons of the shorter muscles of the toes, they make a safe gutter for the long tendons to pass in. They are not restricted to the balls of the great toe and thumb, but sometimes are also found under the other toes and fingers, and sometimes behind the condyles of the knee ; or in the peronei tendons, which run under the sole of the foot.

BONES OF THE SHOULDER, ARM, AND HAND.

OF THE SCAPULA, OR SHOULDER-BLADE.

THIS is the great peculiarity of the superior extremity, that it is connected not directly with the trunk, like the thigh-bone with the haunch, but is hung by a moveable intermediate bone, and not only is not immediately joined to the trunk by ligaments, nor any other form of connection, but is parted from it by several layers of muscular flesh, so that it lies flat, and glides upon the trunk.

Scapula. General description. The SCAPULA is a thin bone, which has originally, like the skull, two tables, and an intermediate diploe; but it grows gradually thinner, its tables are more and more condensed, till in old age it has become in some parts transparent, and is supported only by its processes, and by its thicker edges; for its SPINE is a ridge of firm and strong bone, which rises very high, and gives a broad origin and support for its muscles. The ACROMION, in which the spine terminates, is a broad and flat process, a sure guard for the joint of the shoulder. The CORACOID process is a strong but shorter process, which stands out from the neck of the bone; and the COSTA, or borders of the bone, are also rounded, firm, and strong, so that the processes and borders support the flat part of the bone, which is as thin as a sheet of paper.

There is no part nor process of the scapula which does not require to be very carefully marked; for no accidents are more frequent than luxations of the shoulder; and the various luxations are explained best by studying the skeleton, and being able to recognize on the living body all the processes and projecting points.

Surfaces. The FLAT SIDE of the scapula is smooth, somewhat concave, and suited to the convexity of the ribs: it is sometimes called VENTER. **Venter or lower surface.** The scapula is connected with no bone of the trunk, tied by no ligaments, is merely laid upon the chest, with a large mass of muscular flesh under it, upon which it glides, being limited only by the clavicle: there are below it two layers of muscles, by one of which the shoulder-bone is moved upon the scapula, while by the other, the scapula itself is moved upon the ribs. The subscapularis muscle, lying in the hollow of the scapula, marks it with many smooth hollows, and wave-like risings, which are merely the marks of the several divisions of this muscle, but which were mistaken even by the great Vesalius for the impressions of the ribs.

Exterior surface or dorsum. The upper or exterior flat surface is slightly convex; it is traversed by the SPINE, which is a very acute and high ridge of bone; it is called the DORSUM SCAPULÆ. Now the spine thus traversing the bone from behind forwards, divides its upper surface into two unequal parts, of which the part above the spine is smaller, and that below the spine is larger. Each of these spaces has its name, one supra spinatus, and the other infra spinatus; and each of them lodges a muscle, named, the one the musculus supra spinatus scapulæ, as being above the spine; the other musculus infra spinatus scapulæ, as being below the spine. A third muscle is named subscapularis, as lying under the shoulder-blade, upon that concave surface which is towards the ribs; so that the whole scapula is covered with broad flat muscles, whose offices are to move the humerus in various directions, and which impress the scapula with gentle risings and hollows on its upper as well as on its lower surface. Divided into fossa supra, and infra spinata.

The TRIANGULAR form of the scapula must be next observed. The upper line of the triangle is the shortest; it is named the SUPERIOR COSTA or border; here the omo-hyoideus has its origin. On this superior edge is seen the notch, through which a nerve and sometimes an artery passes. The lower edge, which is named the COSTA INFERIOR, or the lower border of the scapula, receives no muscles; because it must be quite free to move and glide as the scapula turns upon its axis, which is indeed its ordinary movement. But it gives rise to two smaller muscles, which, from being a little rounded, are named the musculi teretes; they leave their impressions on this lower costa. Scapula triangular. Superior costa. Notch. Inferior costa.

The long side of the scapula, which bounds its triangular form backwards, is named the BASIS of the SCAPULA, as it represents the base of the triangle. This line is also like the two borders, a little thicker or swelled out; and this edge receives powerful muscles, which lie flat upon the back, and coming to the scapula, in a variety of directions, can turn it upon its axis: sometimes raising, sometimes depressing the scapula; sometimes drawing it backwards; and sometimes fixing it in its place; according to the various sets of fibres which are put into action. These are the larger and lesser rhomboid muscles, and the great serrated muscle of the fore part of the chest, which runs under the scapula to be inserted into the inner edge of the base of the bone. Basis.

The angles of the scapula are two, the superior more obtuse, and the inferior more acute. From the inferior angle the the teres major takes its origin, and the outer surface of the bone is made smooth by the passage of the latissimus dorsi muscle. To the superior angle the levator scapulæ is inserted. Angles. Superior. Inferior.

The GLENOID or ARTICULATING CAVITY of the scapula is on the point or apex of this triangle. The scapula is more strictly triangular in a child, for it terminates almost in a point or apex; and this articulating surface is a separate ossification, and is joined to it in the adult. The scapula towards this point terminates in a flat surface, not more than an inch in diameter, very little hollowed, and scarcely receiving the Glenoid cavity.

head of the shoulder-bone, which is rather laid upon it than sunk into it: it is indeed deepened a little by a circular gristle, which tips the edges or lips of this articulating surface, but so little, that it is still very shallow and plain, and luxations of the shoulder are infinitely more frequent than of any other bone.

Neck. This head, or glenoid cavity of the scapula, is planted upon a narrower part, which tends towards a point, but is finished by this flat head; this narrower part is what is named the NECK of the SCAPULA, which no doubt sometimes gives way, and breaks.* A rough line bordering the glenoid cavity receives the capsular ligament, or rather the capsule arises from the bordering gristle, which I have said tips this circle.

Spine. The SPINE of the SCAPULA is that high ridge of bone which runs the whole length of its upper surface, and divides it into two spaces for the origin of the supra and infra spinatus muscles. It is high and very sharp, standing up at one place to the height of two inches. It is flattened upon the top, and with edges, which, turning a little towards either side, give rise to two strong fasciæ, *i. e.* tendinous membranes, which go from the spine, the one upwards to the upper border of the scapula, the other downwards to the lower border: so that by

Triangular space. these strong membranes the scapula is formed into two triangular cavities, and the supra and infra spinatus muscles rise not only from the back of the scapula, and from the sides of its spine, but also from the inner surface of this tense membrane. The spine traverses the whole dorsum, or back of the scapula; it receives the trapezius muscle, that beautiful triangular muscle which covers the neck like a tippet, into its upper edge; whilst from its lower edge a part of the deltoid muscle departs. This spine beginning low at the basis of the scapula, where a certain triangular space may be observed, gradually rises as it advances forwards, till it terminates in that high point or promontory which forms the tip of the shoulder, and overhangs and defends the joint.

Terminates in the acromion. This high point is named the ACROMION PROCESS. It is the continuation and ending of the spine, which at first rises perpendicularly from the bone, but, by a sort of turn or distortion, it lays its flat side towards the head of the shoulder-bone, and is articulated with the clavicle; here it is hollow, to transmit the supra and infra spinati muscles. At this place, it is thickened, flat, and strong, overhangs and defends the joint, and is not merely a defence, but also makes a part of the joint itself; for, without this process, the shoulder-bone could not remain a moment in its socket; every slight accident would displace it. The acromion prevents luxation upwards; and is so far a part of the joint, that when it is full under the

* I have met with the accident in practice, and have preparations of the fractured bone, so that there can be no doubt of this accident sometimes occurring, yet it is very rare.

acromion, the joint is safe; but when we feel a hollow, so that we can push the points of the fingers under the acromion process, the shoulder is luxated, and the socket empty. The point of the acromion forming the apex of the shoulder, a greater projection of this point, and a fulness of the deltoid muscle which arises from it, is a chief cause, and of course a chief mark of superior strength.

But there is still another security for the joint; for there arises from the neck of the scapula, almost from the border of the socket, and its inner side, a thick, short, and crooked process, which stands directly forwards, and is very conspicuous; and which, turning forwards with a crooked and sharp point, somewhat like the beak of a crow, is thence named the CORACOID PROCESS. This also guards and strengthens the joint; though it cannot prevent luxations, it makes them less frequent, and most probably when the arm is luxated inwards, it is by starting over the point of this defending process. This process has three surfaces for the attachment of muscles, and these muscles are, the pectoralis minor, the coraco-brachialis, and the short head of the biceps. **Coracoid process.** **Three surfaces on it.**

Now the glenoid surface, and these two processes, form the cavity for receiving the shoulder-bone. But still, as if nature could not form a joint at once strong and free, this joint, which performs quick, free, and easy motions, is too superficial to be strong. Yet there is this compensation, that the shoulder-joint, which could not resist, if fairly exposed to shocks and falls, belongs to the scapula, which, sliding easily upon the ribs, yields, and so eludes the force. Falls upon the shoulder do not dislocate the shoulder; that accident almost always happens to us in putting out the hand to save ourselves from falls: it is luxated by a twisting of the arm, not by the force of a direct blow. This bone is subject to be fractured; and then the muscles pull asunder the fractured portions. The acromion is very apt to be broken off by falls on the shoulder, and if the accident be not treated with due attention to the action of the deltoid muscle, permanent lameness is the consequence.

THE CLAVICLE.

The clavicle, or collar-bone, named clavicle from its resemblance to an old-fashioned key, is to the scapula a kind of hinge or axis on which it moves and rolls; so that the free motion of the shoulder is made still freer by the manner of its connection with the breast. **Clavicle.**

The clavicle is placed at the root of the neck, and at the upper part of the breast: it extends across from the tip of the shoulder to the upper part of the sternum; it is a round bone, a little flattened towards the end which joins the scapula; it is curved like an Italic *ſ*, having one curve turned out towards the breast; it is useful as an arch supporting the shoulders, **Curve.**

preventing them from falling forwards upon the breast, and making the hands strong antagonists to each other, which, without this steadying, they could not have been.

Pars acromialis, sternalis, and me ia. Sternal head round.

It is described by authors in three divisions or parts, viz. the scapular, sternal extremities, and middle portion. The end next the sternum is round and flat, or button-like; the articulating surface is triangular, and is received into a suitable hollow on the upper piece of the sternum. It is not only, like other joints, surrounded by a capsule or purse; it is further provided with a small moveable cartilage, which (like a friction-wheel in machinery) saves the parts, and facilitates the motion, and moves continually as the clavicle rolls. From this inner head there stands out an angle, which, when the clavicles are in their places, gives attachment to the interclavicular ligament; it ties them to the sternum and to each other.

Groove.

The lower surface has a groove in it for the subclavius muscle; the upper surface is marked by the attachment of the clavicular portion of the mastoid muscle, and the insertion of trapezius.

Scapular head flat.

But the outer end of the clavicle is flattened as it approaches the scapula, and the edge of that flatness is turned to the edge of the flattened acromion, so that they touch but in one single point; this outer end of the clavicle, and the corresponding point of the acromion, are flattened and covered with a crust of cartilage; and on the under surface of it, there is a groove corresponding to the groove under the acromion: there is also a small tubercle for a ligament; but the motion here is very slight and quite insensible: they are tied firmly by strong ligaments; and we may consider this as almost a fixed point, for there is little motion of the scapula upon the clavicle; but there is much motion of the clavicle upon the breast-bone, for the clavicle serves as a shaft or axis, firmly tied to the scapula, upon which the scapula moves and turns, being connected with the trunk only by this single point, viz. the articulation of the clavicle with the breast-bone.

The use of the clavicle being to keep the shoulders apart, it is very obvious that fracture of this bone must be the consequence of falling, as from horseback, so as to pitch upon the prominence of the shoulder. It is a very common accident, and requires considerable care and management in setting the bone.

HUMERUS.

Humerus.

The os HUMERI is one of the truest of the cylindrical bones: it is round in the middle; but it appears twisted and flattened towards the lower end; and this flatness makes the elbow-joint a mere hinge, moving only in one direction. It is again regular and round towards the upper end, dilating into a large round head, where the roundness forms a very free and moveable joint, turning easily in all directions.

The HEAD of this bone is very large: it is a neat and regular circle; but it is a very small portion of a large circle, so that it is flat; and this flatness of the head, with the shallowness of the glenoid cavity of the scapula, makes it a very weak joint, easily displaced, and nothing equal to the hip-joint for security and strength. Head.

The NECK of this bone cannot fairly be reckoned such; for, as I have explained in speaking of the neck of the thigh-bone, this neck of the humerus, and the necks of most bones (the thigh-bone still excepted,) are merely a rough line close upon the head of the bone, without any straitening or intermediate narrowness, which we can properly call a neck. The roughness round the head of the shoulder-bone is the line into which the capsular ligament is implanted. Neck. Line for the capsule.

The TUBEROSITIES of the os humeri are two small bumps of unequal size, (the one called the greater, the other the smaller, tuberosity of the os humeri,) which stand up at the upper end of the bone, just behind the head: they are not very remarkable. Though infinitely smaller than the trochanter of the thigh-bones, they serve similar uses, viz. receiving the great muscles which move the limb. The GREATER TUBEROSITY is higher towards the outer side of the arm, and receives the supra-spinatus muscle; while the infra-spinatus and teres minor muscles, which come from the lower part of the scapula, are implanted into the same protuberance, but a little lower. The LESSER TUBEROSITY has a single muscle fixed into it, the subscapularis muscle. Greater tuberosity. Lesser tuberosity.

The two tuberosities form betwixt them a groove, which is pretty deep; and in it the long tendon of the biceps muscle of the arm runs: and as it runs continually, like a rope in the groove of a pully, this groove is covered in the fresh bones with a thin cartilage, smooth, and like the cartilages of joints. On the outside of this groove there is a long ridge for the insertion of the pectoralis, on the inside one for the latissimus dorsi. On the body of the bone, about one third part of its length from the head, there is an irregularity for the attachment of the deltoid muscle; and on the inside of the bone near its middle, is the hole for the nutritious artery. Groove. Ridges. Insertion of the deltoid. Foramen.

The os humeri at its lower part changes its form, is flattened and compressed below, and is spread out into a great breadth of two inches or more; where there is formed on each side a sharp projecting point, (named condyle,) for the origin of great muscles; and in the middle, betwixt the two condyles, there is a grooved articulating surface, which forms the hinge of the elbow. At the lower extremity, the bone is somewhat twisted.

At the lower end of the bone there are two ridges, one leading to either condyle, which it is of some consequence to observe; for the articulation of the humerus and ulna is a mere hinge, the most strictly so of any joint in the body: it has, of course, but two motions, viz. flexion and extension: and there are two Ridges internal and external.

muscles, chiefly one for extending, the other for bending the arm: the flexor muscle lies on the fore part, and the extensor on the back part of the arm; and so the whole thickness of the arm is composed at this place of these two muscles and of the bone: but that the fore and back parts of the arm might be thoroughly divided, the bone is flattened betwixt them; and that the division might extend beyond the mere edges of the bone, there are two fasciæ or tendinous webs, which go off from either edge of the humerus, and which continue to divide the fore from the back muscles, giving these muscles a broader origin; they are named, from their office, intermuscular membranes; and this is the meaning of the two ridges which lead to the two condyles.

Condyles.

The two projections in which these edges end, are named CONDYLES. The condyles of the thigh-bone are the broad articulating surfaces by which that bone is joined with the tibia; while the condyles of the shoulder-bone are merely two sharp projecting points for the origin of muscles, which stand out from either side of the joint, but which have no connection with the joint. The chief use of the condyles of the shoulder-bone is to give a favourable origin and longer fulcrum for the muscles of the fore-arm, which arise from these points. The outer tubercle being the smaller one, gives origin to the extensor muscles, where less strength is required. But the inner tubercle is much longer, to give origin to the flexor muscles with which we grasp, which require a bolder and more prominent process to arise from; for greater power is needed to perform such strong actions as grasping, bending, pulling, while the muscles which extend the fingers need no more power than just to antagonise or oppose the flexors; their only business being to unfold or open the hand, when we are to renew the grasp.

The inner longest, and why.

It is further curious to observe, that the inner tubercle is also lower than the other, so that the articulating surface for the elbow-joint is oblique, which makes the hand fall naturally towards the face and breast, so that by being folded merely without any turning of the os humeri, the hands are laid across.

Trochlea.

The articulating surface which stands betwixt these condyles, forms a more strict and limited hinge than can be easily conceived, before we explain the other parts of the joint. The joint consists of two surfaces; first, a smooth surface, upon which the ulna moves as on a hinge; and secondly, of a small knob upon the outside of the trochlea, which has a neat round surface, upon which the face or socket belonging to the button-like end of the radius rolls. These two surfaces are called, the one the small head, and the other the cartilaginous pully, or trochlea, of the humerus.

Knob for the head of the radius.

Belonging to the joint, and within its capsular ligament, there are two deep hollows, which receive certain processes of the bones of the fore-arm. One deep hollow on the fore part of the humerus, and just above its articulating pully, receives

Fossa for the coronoid process.

the horn-like or coronoid process of the ulna, viz. fossa coronoidea; the other receives the olecranon, or that process of the ulna which forms the point of the elbow, viz. fossa olecranalis. **Fossa for the olecranon.**

RADIUS AND ULNA.

The radius and ulna are the two bones of the fore-arm. The radius, named from its resemblance to the ray or spoke of a wheel; the ulna, from its being often used as a measure. The radius belongs more peculiarly to the wrist, being the bone which is chiefly connected with the hand, and which turns along with it in all its rotatory motions: the ulna, again, belongs more strictly to the elbow-joint, for by it we perform all the actions of bending or extending the arm.

Ulna. The ULNA is in general of a triangular or prismatic form, like the tibia, and the elbow is formed by the ulna alone; for there is a very deep notch or hinge-like surface, which seems as if it had been moulded upón the lower end of the humerus, embraces it very closely, and takes so sure a hold upon the humerus, that it allows not the smallest degree of lateral motion, and almost keeps its place in the dry skeleton, without the help of ligaments or muscles; it presents, in profile, somewhat of the shape of the letter ς of the Greek, and therefore is named the SIGMOID CAVITY of the ulna. **Sigmoid cavity.** But this sigmoid cavity were a very imperfect hinge without the two processes by which it is guarded before and behind; the chief of these is the OLECRANON, **Olecranon.** or large bump, which forms the extreme point upon which we rest the elbow. It is a big and strong process, which, fitting into a deep hollow on the back of the humerus, serves two curious purposes; it serves as a long lever for the muscles which extend or make straight the fore-arm; and when by the arm being extended, it checks into its place, it takes so firm a hold upon the hinge or joint of the os humeri, as to secure the joint in pulling, and such other actions as might cause a luxation forwards. The other process which guards the elbow-joint is named the CORONOID PROCESS, **Coronoid process.** from its horn or pointed form: it stands up perpendicularly from the upper or fore part of the bone; it forms the fore part of the sigmoid cavity, and completes the hinge. **Tubercle.** On the root of the coronoid process there is a rough tubercle for the attachment of the brachialis internus. The coronoid process is useful, like the olecranon, in giving a fair hold and larger lever to the muscles, and to secure the joint; for the arm being extended, as in pulling, the olecranon checks into its place, and prevents luxation forwards: and the arm again being bent, as in striking, pushing, or saving ourselves from falls, the coronoid process prevents luxation backwards; so the joint consists of the olecranon and the coronoid process as the two guards, and of the sigmoid cavity or hollow of articulation betwixt them. But the smaller or upper head of the radius also enters into the joint, and lying upon the inner side of the coronoid process, it makes a small hollow there in which it rolls; and this second hollow, touching the edge of the sigmoid cavity, forms a double sigmoid cavity, of which the first, or GREATER SIGMOID CAVITY, is for receiving the lower end of the humerus; and the second or LESSER SIGMOID CAVITY, for receiving the upper head of the radius. Betwixt these there is a pit for receiving the glandular apparatus of the joint. The form of the bone being prismatic, or triangular, it has, like the tibia, three ridges, one of which is turned towards a corresponding ridge in the radius, and betwixt them the interosseous ligament is stretched; and this interosseous ligament fills all the arch or open space betwixt the radius and ulna, and saves the necessity of much bone; gives as firm an origin to the muscles as bone could have done, and binds the bones of the fore-arm together so strongly, that though the ulna belongs entirely to the elbow-joint, and the radius as entirely to the wrist, they have seldom been known to depart from each other. On the outside of the greater extremity of the ulna, there is a triangular surface for the attachment of the anconeus muscle. The ulna, bigger at the elbow, grows gradually smaller downwards, till it terminates almost in a point. It ends below in a small round head, which is named the LOWER HEAD of the ulna, which scarcely enters into the joint of the wrist; but being received into a hollow on the side of the radius, the radius turns upon the lower head of the ulna, like an axis or spoke.

Greater sigmoid. Lesser sigmoid cavities. Pit. Form prismatic. Ligament. Triangular surface. Lower head.

Styloid process.

Below this little head, the bone ends towards the side of the little finger in a small rounded point, which is named the STYLOID PROCESS of the ulna; it is chiefly useful in giving a strong adhesion to the ligament which secures the wrist there. And as the styloid process and the olecranon, the two extremities of the ulna, are easily and distinctly felt, the length of this bone has been used as a measure; and so it was named cubitus by the ancients, and is named ulna by us.

RADIUS.

Radius. Position.

The radius is the second bone of the fore-arm, and has its position exactly reversed with that of the ulna: for the ulna, belonging to the elbow, has its greater end upwards; the radius, belonging to the wrist, has its greater end downwards; and while the ulna only bends the arm, the radius carries the wrist with a rotatory motion, and so entirely belongs to the wrist, that it is called the manubrium manus, as if the handle of the hand.

Form of the body.

The BODY of the radius is larger than that of the ulna. The transverse strength of the arm depends more upon the radius, which has more body and thickness, is more squared, and is arched in some degree so as to stand off from the ulna, without approaching it, or compressing the other parts. The radius lies along the outer edge of the fore-arm, next to the thumb; and being, like the ulna, of a prismatic or triangular form, it has one of its angles or edges turned towards the ulna to receive the interosseous ligament.

Upper head smaller. The UPPER HEAD of the radius is smaller, of a round, flattish, and button-like shape, and lies so upon the lower end of the humerus, and upon the coronoid process of the ulna, that it is articulated with both bones; for, 1st, The hollow of its head is directly opposed to the outer condyle of the os humeri; and, 2dly, The flat side of its button-like head rubs and turns upon the side of the coronoid process, making a socket there, which is called the lesser sigmoid cavity of the ulna. Hollow.

Neck. Immediately below the round flat head is a narrowness or straitening, called the NECK of the radius; round this neck there is a collar or circular ligament, (named the coronary ligament of the radius,) which keeps the bone securely in its place, turning in this ligamentous band like a spindle in its bush or socket; for the radius has two motions, first, accompanying the ulna in its movements of flexion and extension; and, secondly, its own peculiar rotation, in which it is not accompanied in return by the ulna; but the ulna continuing steady, the radius moves and turns the wrist.

Tubercle. Immediately under this neck, and just below the collar of the bone, there is a prominent bump, like a flat button, soldered upon the side of the bone, which is the point into which the biceps flexor cubiti, the most powerful flexor muscle of the fore-arm, is inserted. On the outside of the bone, and near the middle, there is a roughness for the insertion of the pronator teres. Where the face of the radius is towards the ulna, there is a long sharp spine for the attachment of the interosseous ligament. Roughness. Spine.

Lower head. The upper head is exceedingly small and round; while the LOWER HEAD swells out, broad and flat, to receive the bones of the wrist. There are two greater bones in the wrist, the scaphoides and lunare, which form a large ball, and this ball is received into the lower end of the radius: the impression which these two bones make there is pretty deep, and somewhat of a boat-like shape; whence it is called (like the articulating surface of the tibia) the scaphoid cavity of the radius: it is sometimes partially divided by a ridge; and on the edge of the radius, next to the thumb, the bone ends in a sort of peak or sharper point, which is named, (though with very little meaning,) the STYLOID PROCESS of the radius. Scaphoid cavity. Styloid process.

So the scaphoid cavity of the radius forms the joint with the wrist; but there is another small cavity, on the side of the radius, near to the little-head of the ulna, into which the lesser head of the ulna is received, and this is enclosed in a proper and distinct capsule. The little head of the ulna does not descend so low as to have any share in forming the wrist. There are properly two distinct joints: the great joint of the wrist, moving upon the radius; the other a little joint within this, of the radius rolling upon the ulna, and carrying the wrist along with it. On the outside of the extremity of the radius, we find a ridge, in the grooves on the sides of this ridge the extensor tendons run. The extensors of the thumb also make impressions. On the inside of the head of the bone, there is a flattened surface for the lodgment of the pronator quadratus muscle; and a sharp line for its insertion.

Ridge and grooves.

OF THE HAND AND FINGERS.

The wrist is the most complex part of all the bony system, and is best explained in a general way, by marking the three divisions of the hand, into—the carpus, or wrist bones; the metacarpus, or bones that stand upon the wrist; and the fingers, consisting each of three joints. 1. The carpus, or wrist, is a congeries of eight small bones, grouped together into a very narrow space, very firmly tied together by cross ligaments, making a sort of ball or nucleus, a solid foundation, or centre, for the rest of the hand. 2. The metacarpus is formed of five long bones, founded upon the carpal bones, and which, departing from that centre in somewhat of a radiated form, give, by their size and strength, a firm support to each individual finger, and by their radiated or spoke-like form, allow the fingers free play. 3. The fingers, consisting each of three very moveable joints, are set free upon the metacarpus, so as to show a curious gradation of motion in all these parts; for the carpal bones are grouped together into a small nucleus, firm, almost immoveable, and like the nave of a wheel; then the metacarpal bones founded upon this are placed like the spokes of the wheel, and having a freer motion; and, lastly, the fingers, by the advantage of this radiated form in the bones upon which they are placed, move very nimbly, and have a rotatory as well as a hinge-like motion: so that the motion is graduated and proportioned in each division of the hand; and even where there is no motion, as in the carpus, there is an elasticity, which, by gentle bendings, accommodates itself to the more moveable parts.

Carpus. Metacarpus. Fingers.

Carpus. The CARPUS, or wrist.—Looking upon the external surface of the carpus, we count eight small bones disposed in two rows, with one bone only a little removed from its rank; and we observe that the whole is arched outwards, to resist injuries, and to give strength; and that the bones lie like a pavement, or like the stones of an arch, with their broader ends turned outwards. On the internal surface, again, we find the number of bones not so easily counted; for their smaller ends are turned towards the palm of the hand, which being a concave surface, the narrow ends of the wedges are seen huddled together in a less regular form, crowded, and lapped over each other; but in this hollow, the four corner bones are more remarkable, projecting towards the palm of the hand, so as to

Form.

be named processes; and they do indeed perform the office of processes; for there arises from the four corner points a strong cross ligament, which binds the tendons down, and makes under it a smooth floor or gutter for them to run in.

The individual bones of the carpus are small, cornered, and very irregular bones, so that their names do but very poorly represent their form. To describe them without some help of drawing, or demonstration, is so very absurd, that a description of each of them seems more like a riddle, than like a serious lesson: it cannot be understood, and indeed it need hardly be remembered; for all that is useful, is but to remember the connection and place, and the particular uses of each bone: in reading of which, the student should continually return to the plates, or he must have the bones always in his hand.

1. ROW FORMING THE WRIST: VIZ.

OS SCAPHOIDES, LUNARE, CUNEIFORME, PISIFORME.

Os scaphoides.

Os SCAPHOIDES.—The boat-like bone. This name of boat-like bone, or boat-like cavity, has been always a favourite name, though a very unmeaning one. The scaphoid bone is worthy of notice, not merely from its being the largest bone, but also as it forms a chief part of the joint of the wrist; for it is this bone which is received into the scaphoid cavity of the radius: it is a very irregular bone, in which we need remember only these points,—the large round surface covered with cartilage, smooth, and answering to the cavity in the head of the radius; the hook-like or projecting process, which forms one of the corner points of the carpus, and gives a hold to one corner of the ligament which binds down the tendons of the wrist. There is also a furrow for the capsular ligament, the concavity from which this bone takes its name, and by which it is articulated with the trapezium and trapezoides; and on its inner surface an oval cavity for the os magnum.

Received into the scaphoid cavity of the radius.

The process.

Concavity.

Os lunare.

The os LUNARE is named from one of its sides being somewhat of the shape of a half moon; it is next in size to the scaphoid bone, and is equal to it in importance; for they are joined together, to be articulated with the radius. This bone takes an equal share in the joint with the scaphoid bone; and, together, they form a great ball, fitting the socket of the radius, and of a long form: so that the wrist is a proper hinge. The chief marks of this bone are, its greater size, its lunated edge, and its round head forming the ball of the wrist-joint. These are its surfaces:

Surfaces.

1. The surface of a semilunar shape, and, on the radial side, attached to the last bone. 2. The convex surface for articulation with the radius. 3. The ulnar surface for articulation with the os cuneiforme. 4. The hollow surface for articulation with the os magnum, the central bone of the second row.

Os cuneiforme. The os CUNEIFORME, or wedge-like bone, is named rather perhaps from its situation, locked in among the other bones, than strictly from its form. Its side forming the convex of the hand is broader; its point towards the palm of the hand is narrower: and so far, we may say, it is a wedge-like bone; but it is chiefly so from its situation, closely wedged in betwixt the lunare and pisiform bones.

Surfaces. 1. We may readily distinguish the surface articulated with the os lunare. 2. Opposite to this the surface of attachment of the os pisiforme. 3. The further surface, that is, the side most remote from the fore-arm, is articulated with the unciforme; a loose cartilage is interposed betwixt this bone and the end of the ulna.

Os pisiforme. The os PISIFORME is a small, neat, and round bone, named sometimes ORBICULAR, or round bone, but oftener pisiform, from its resemblance to a pea. It is placed upon the cuneiform bone, and it stands off from the rest into the palm of the hand, so as to be the most prominent of all the corner bones; of course, it forms one of the corner points or pillars of that arch under which the tendons pass. The pisiform bone is a little out of its rank, is very moveable, and projects so into the palm as to be felt outwardly, just at the end of the styloid process of the ulna; it can be easily moved and rolled about, and is the point into which the ligament of the wrist is implanted; the flexor carpi ulnaris, one of the strong muscles for bending the wrist, is inserted into it.

One surface of articulation.

2. ROW SUPPORTING THE METACARPAL BONES: VIZ.

OS TRAPEZIUM, TRAPEZOIDES, MAGNUM, ET UNCIFORME.

Trapezium. The second row begins with the TRAPEZIUM, a pretty large bone, which, from its name, we should expect to find of a regular squared form; while it has, in fact, the most irregular form of all, especially when detached from the other bones. The chief parts to be remarked in the bone, are the great socket, or rather the trochlea for the thumb; and as the thumb stands off from one side of the hand, this socket is rather on one side. There is also a little process which makes one of the corner points, and stands opposite to the hook of the unciforme.

Irregular.

Surfaces of articulation.

Opposite to the surface of articulation with the thumb, and towards the first row, there is a semilunar surface which touches the convexity of the scaphoides, and another which articulates with the trapezoides. The fourth articulating surface of this bone is opposed to the head of the metacarpal bone of the finger.

Trapezoides. The TRAPEZOIDES is next to the trapezium, is somewhat like the trapezium, from which it has its name. It also resembles the cuneiform bone of the first row in its shape and size, and in its being jammed in betwixt the two adjoining bones.

It is articulated by its nearer surface to the scaphoides; on its further surface, by two planes, to the metacarpal bone of the fore finger; on the radial surface, to the trapezium; and on the ulnar surface, to the os magnum; having thus five planes or surfaces. **Five planes or articulating surfaces.**

The os MAGNUM is named from its great size; not that it is the largest of all, nor even the largest bone of the second row, for the unciform bone is as big; but there is no other circumstance by which it is well distinguished. It is placed in the centre of the upper row; has a long round head, which is jointed with the socket formed of the os lunare and scaphoides: on the radial surface the magnum is articulated with the trapezoides; on the ulnar surface with the unciform; on the further surface it has three planes, and receives the whole head of the metacarpal of the middle finger, and part of the metacarpal of the fore finger and of the ring finger. **Os magnum.**

The os UNCIFORME, or hook-like bone, is named from a flat hook-like process, which projects towards the palm of the hand. This is one of the corner bones; and standing in the end of the row, it is wedged betwixt the os magnum of its own row, and the os lunare and cuneiforme of the first row. It is large and squared; but the thing chiefly remarkable is that process from which it takes its name; a long and flat process of firm bone, unciform, or hook-like, and projecting far into the palm of the hand, which being the last and highest of the corner points, gives a very firm origin to the great ligament by which the tendons of the wrist are bound down. On its further surface, it has two articulating surfaces corresponding with the metacarpal bones of the ring and middle fingers. **Os unciforme.** **Its situation and its process.**

All these bones of the carpus, where they are joined to each other, are covered with a smooth articulating cartilage, are bound to each other by all forms of cross ligaments, and are consolidated, as it were, into one great joint. They are in general so firm as to be scarcely liable to luxation; and although one only is called cuneiform, they are all somewhat of the wedge-like form, with their broader ends outwards, and their smaller ends turned towards the palm of the hand; they are like stones in an arch, so that no weight nor force can beat them in; if any force do prevail, it can beat others in only by forcing one out. A bone starting outwards, and projecting upon the back of the hand, is the only form of luxation among these bones, and is extremely rare.* **Their connections.**

* Late years have presented to me a subluxation of the centre bones of the first row, which generally ends in considerable obliquity of the hand, or distortion of the wrist. The boy that played the dragon in the pantomime at Covent-Garden, fell upon his hands, owing to the breaking of the wire that suspended him in his flight, and he suffered this accident in both his wrists. These bones, and their ligaments, are subject to scrofulous inflammation.

Four metacarpal bones.

METACARPUS.—The metacarpus is composed of four bones, upon which the fingers are founded. They are big, strong bones, brought close together at the root, but wider above; for the lower heads are small and flat, and grouped very closely together, to meet the carpal bones. But they swell out at their upper ends into big round heads, which keep the bones much apart from each other. Nothing of importance can be said concerning the individual bones. To speak of them individually is a mere waste of time. We may observe of the metacarpal bones in general: 1. That their nearer heads, being flat and squared, gives them a firm implantation upon their centre or nucleus, the carpus; and they have scarcely any freer motion upon the carpal bones, than the carpal bones have upon each other. 2. Their further heads are broader, whereby the articulating parts of the bone are kept apart, which gives freedom to the lateral motions of the bones of the fingers. 3. Each metacarpal bone is slightly bent; 4. and being smaller in the middle, there is a space left betwixt the bones for the lodgment of the interossei muscles, and they have ridges which mark the place of attachment of the interossei muscles. 5. These bones taken collectively still preserve the arched form of the carpal bones, being, with the carpal bones, convex outwardly, and concave inwardly, to form the hollow of the hand; and though they have little motion of flexion or extension, they bend towards a centre, so as to approach each other, increasing the hollowness of the hand, to form what is called Diogenes's cup. 6. The articulating heads of the further extremities of these bones are flattened, or somewhat grooved, for the play of the tendons of the interossei muscles; and small processes stand out laterally for the attachment of ligaments, like little condyles. It is farther necessary to observe, into how small a space the carpal bones are compressed, how great a share of the hand the metacarpal bones form, and how far down they go into the hollow of the hand; for I have seen a surgeon, who, not having the smallest suspicion that their lower ends were so near the wrist as they really are, has, in place of cutting the bone neatly in its articulation with the carpus, broken it, or tried to cut it across in the middle.

Their nearer head square.

Their further head round and free.

They diverge somewhat.

Ridges.

They are arched.

Condyles.

FINGERS.—We commonly say, that there are five metacarpal bones; in which reckoning we count the thumb with the rest: but what is called the metacarpal of the thumb is properly the first phalanx, or the first proper bone of the thumb, so that the thumb, regularly described, has, like the other fingers, three joints, and no metacarpal bone.

THUMB.—The first bone of the thumb resembles the metacarpal bones in size and strength, but it differs widely in being set upon the carpus, with a large and round head; it being set off from the line of the other fingers, standing out on one side, and directly opposed to them; it rolls widely and freely: it is opposed to the other fingers in grasping, and, from its very superior strength, the thumb is named pollex, from pollere; and the peculiar shape of the articulating extremities, and the lateral processes or condyles are, as it were, better characterized than in the bones of the fingers.

The FINGERS have each of them three bones:—These bones are gently arched, uniform, and convex upon their outer surface, grooved within for the lodgment of the stronger flexor tendons. 1. The first bone is articulated with the metacarpal bones by a ball and socket; the socket, or hollow on the lower part of the first finger-bone, being set down upon the large round head of the metacarpal bone. 2. The second and third joints of the fingers are gradually smaller, and though their forms do a good deal resemble the first joint, they are more limited in their motions; and are strictly hinge joints. 3. Here, as in other hinge joints, there are strong lateral ligaments, and lateral processes or condyles, for their attachment. When these lateral ligaments are burst or cut, the finger turns in any direction; so that the motions of the fingers are limited rather by their lateral ligaments, than by any thing peculiar in the forms of the bones. 4. The face of each finger-bone is grooved, so that the tendons, passing in the palm of the hand, run upwards along this groove or flatness of the fingers; and from either edge of this flatness there rises a ligament of a bridge-like form, which covers the tendons like a sheath, and converts the groove into a complete canal. 5. The last joint or phalanx of each finger is flattened, rough, and drawn smaller gradually towards the point of the finger; and it is to this roughness that the skin and nail adhere at the point.

OF THE SKULL IN GENERAL.

THE BONES OF WHICH IT IS COMPOSED—THEIR TABLES—DIPLOE—SUTURES—THEIR ORIGINAL CONDITION, AND THEIR PERFECT FORM REPRESENTED AND EXPLAINED.

WHILE the bones in general serve as a basis of the soft parts, for supporting and directing the motions of the body, certain bones have a higher use in containing those organs whose offices are the most essential to life. The skull defends the brain; the ribs and sternum defend the heart and lungs; the spine contains that prolongation of the brain which gives out nerves to all the body: and the injuries of each of these are important in proportion to the value of those parts which they contain.

How much the student is interested in obtaining a correct and perfect knowledge of the skull he must learn by slow degrees. For the anatomy of the skull is not important in itself only; it provides for a more accurate knowledge of the brain; explains, in some degree, the organs of sense; instructs us in all those accidents of the head which are so often fatal, and so often require the boldest of all our operations. The marks which we take of the skull, record the entrance of arteries; the exit of veins and nerves; the places and uses of those muscles which move the jaws, the throat, the spine. Indeed, in all the human body, there is not found so complicated and difficult a study as this anatomy of the head; and if this fatiguing study can be at all relieved, it must be by first establishing a very regular and orderly demonstration of the skull.

For this end, we distinguish the face, where the irregular surface is composed of many small bones, from the cranium or proper skull, where a few broad and flat-shaped bones form the covering of the brain. It is these chiefly which enclose and defend the brain, which are exposed to injuries, and are the subject of operation. It is these also that transmit the nerves: so that the cranium is equally the object of attention with the physiologist and with the surgeon.

All the bones of the cranium are of a flattened form, consisting of two tables, and an intermediate diploe, which corresponds to the cancelli of other bones. The tables of the skull are two flat and even plates of bone: the external is thought to be thicker, more spongy, less easily broken; the inner table, again, is dense, thin, and brittle, very easily broken, and is sometimes fractured, while the external table remains entire: thence it is named tabula vitrea, or the glassy table. These tables are a little parted from each other;* and this space is filled up with the diploe, or cancelli. The cancelli, or lattice-work, have membranes, covered with vessels, partly for secreting marrow, and partly for nourishing the bone; and by the dura mater adhering to the internal surface, and sending in arteries, which enter into the cancelli by passing through the substance of the bone, and by the pericranium covering the external plate, and giving vessels from without, which also enter into the bone, the whole is connected into one system of vessels. The pericranium, dura mater, and skull depend so entirely one upon the other, and are so fairly parts of the same system of vessels, that an injury of the pericranium spoils the bone, separates the dura mater, and causes an effusion upon the brain: a separation of the dura mater is, in like manner, followed by separation of the pericranium, which had been sound and unhurt; and every disease of the cancelli, or substance of the bone, is communicated

* In anatomy, there is occasion, in almost every description, for a scale of smaller parts. The French divided their inch into twelve parts, each of which is a line. The French line, or twelfth of an inch, is a measure which I shall often have occasion to use.

both ways; inward to the brain, so as to occasion very imminent danger; outwards towards the integuments, so as to warn us that there is disease. The general thickness of the skull, and the natural order of two tables, and an intermediate diploe, is very regular, in all the upper parts of the head. In perforating with the trepan, we first cut, with more labour, through the external table; when we arrive at the cancelli, there is less resistance, the instrument moves with ease, there is a change of sound, and blood comes from the tearing of these vessels, which run in the cancelli, betwixt the tables of the skull. Surgeons thought themselves so well assured of these marks, that it became a rule to cut freely and quickly through the outer table, to expect the change of sound, and the flow of blood, as marks of having reached the cancelli, and then to cut more deliberately and slowly through the inner table of the skull. But this shows an indiscreet hurry, and unpardonable rashness in operation. The patient, during this sawing of the skull, is suffering neither danger nor pain, unless when the bone is inflamed; and many additional reasons lead us to refuse altogether this rule of practice: for the skull of a child consists properly of one table only; or the tables are not yet distinguished, nor the cancelli formed: in youth, the skull has its proper arrangement of cancelli and tables; but still, with such irregularities and exceptions, as make a hurried operation unsafe: in old age, the skull declines towards its original condition, the cancelli are obliterated, the tables approach each other, or are closed and condensed into one; the skull becomes irregularly thick at some points, and at others thin, or almost transparent; so that there can hardly be named any period of life in which this operation can be performed quickly and safely at once. But, besides this gradual progress of a bone increasing in thickness and regularity as life advances, and growing irregular and thinner in the decline of life, we find dangerous irregularities in skulls of all ages. The author had specimens in his possession where the thickness of the skull-cap varied from nearly an inch to the thinness of common paper. There are often at uncertain distances, upon the internal surface of the skull, hollows and defects of the internal table, deep pits, or foveæ, as they are called. These foveæ increase in size and in number as we decline in life: they are more frequent on the inner surfaces of the parietal and frontal bones; so that in those places where the skull should be most regular, we are never sure, and must, even in places considered to be the safest, perforate gradually and slowly. Let the reader pursue this subject under the title of THE FORMATION AND GROWTH OF BONES.

The BONES of the skull are divided into those of the cranium; the bones of the face; and common or intermediate bones.*

* The head is divided into the cranium and face. For the *cranium* we

The following is the usual division of the bones of the head:—

In the adult head there are thirty bones and thirty-two teeth.

Of the Cranium, Six Bones.	Intermediate or Common Bones, Two.	Bones of the Face, Fourteen.
1 Os Frontis	1 Os Sphenoides	2 Ossa Maxillaria Supr^a
2 Ossa Parietalia or Bregmatis	1 Os Æthmoides	2 Ossa Malarum
2 Ossa Temporalia		2 Ossa Nasi
1 Os Occipitis		2 Ossa Palati
		2 Ossa Unguis vel Lachrymalia
		2 Ossa Turbinata Infr^a
		1 Vomer
		1 Maxilla Inferior

Bones of the Ear, Four on each Side, viz.	Teeth.
	In the child twenty.
	In the adult thirty-two, viz.
Malleus	8 Incisores
Incus	4 Cuspidati
Os Orbiculare	8 Bicuspides
Stapes	12 Molares.

We see, therefore, that the bones of which the cranium, or skull, is formed, by which the brain is surrounded and protected, are in all eight in number. 1. The FRONTAL BONE, or bone of the forehead, forms the upper and fore part of the head,—extends a little towards the temples, and forms also the upper part of the socket for the eye. 2, 3. The PARIETAL BONES are the two large and flat bones which form all the sides and upper part of the head; and are named parietalia, as they are the walls or sides of the cranium. 4. The OS OCCIPITIS is named from its forming all the occiput or back of the head, though much of this bone lies in the neck, and is hidden in the basis of the skull. 5, 6. The OSSA TEMPORALIA form the lower parts of the sides of the cranium: they are called temporal, from the hair that covers them being the first to turn grey, marking the time of life. 7. The OS ÆTHMOIDES, and 8. the OS SPHENOIDES, are quite hidden in the basis of the skull: they are very irregular, and very difficultly described or explained. The OS ÆTHMOIDES is a small square bone, hollow, and with many cells in it: it hangs over the nose, and constitutes a great and important part of that organ, and at

find in old authors the words *calva* or *calvaria*, from calvus, bald, or sometimes *cerebri galea*, as being like a helmet to protect the brain.

We find some terms distinguishing certain parts of the cranium, as *glabella*, the smooth part in the centre and lower part of the forehead; *occiput*, the utmost convexity of the head backward; *vertex*, the crown of the head where the hairs turn; *bregma*, or *fontanelle*, which are terms derived from very false notions, but which mean the interstices left in a child's skull betwixt the cranial bones.

The student ought to know these terms, but good taste rejects them even from medical language, when the description can be given in plain English.

the same time supports the brain. The olfactory nerves, by passing through it at many points, perforate it like a sieve; and it takes its name from this perforated or æthmoid plate. The os SPHENOIDES is larger and more irregular still; placed further back; locked in betwixt the occipital and æthmoidal bones; lies over the top of the throat, so that its processes form the back of the nostrils, and roof of the mouth; and it is so placed, as to support the very centre of the brain, and transmit almost all its nerves.*

OF THE SUTURES OF THE SKULL.

The joinings of the bones being indented and irregular, and like seams, they are called sutures.

4. The CORONAL SUTURE is that which joins the frontal to the parietal bones; extends almost directly across the head, from ear to ear; descends behind the eye, into the deep part of the temple; and there, losing its serrated appearance, becomes like the squamous or scaly suture, which joins the temporal bones. It is named coronal, because the ancients wore their garlands on this part of the head. But the suture had been better entitled to this name, had it surrounded the head, than as it crosses it.

2. The LAMBDOIDAL SUTURE is that one which joins the parietal bones to the occipital bone. It begins behind one ear, ascends and arches over the occiput, descends behind the other ear. It thus strides over the occiput, in a form somewhat resembling the letter lambda (Λ) of the Greeks, whence its name.

4. The SAGITTAL SUTURE joins the parietal bones to each other; runs on the very top of the head; extends forwards from the lambdoid suture till it touches, or sometimes passes, the coronal suture; and from lying betwixt these two sutures, like an arrow betwixt the string and the bow, it has been named sagittal.

4. The TEMPORAL or SQUAMOUS SUTURES join the temporal bones to the parietal, occipital, and frontal bones; the sphenoid bone also enters into the temporal suture, just behind the eye. The temporal suture makes an arch corresponding almost with the arch of the external ear; it meets the coronal suture an inch before the ear, and the lambdoidal an inch behind it. This back part belongs as much to the occipital as to the temporal bone; and so has been named, sometimes additamentum suturæ lambdoidalis, sometimes additamentum suturæ squamosæ: for this temporal suture is, on account of the edge of the temporal and occipital bones being thin, and like scales of armour laid over each other, often named the squamous or scaly suture.

5. The SPHENOIDAL and ÆTHMOIDAL SUTURES are those

* Some foreign authors, as if it were to make a complex piece of anatomy still more complicated, describe the sphenoid and occipital bone as one, calling it *os spheno-occipitale*, or *os basilare*.

which surround the many irregular processes of these two bones, and join them to each other, and to the rest.

6. The TRANSVERSE SUTURE is one which, running across the face, and sinking down into the orbits, joins the bones of the skull to the bones of the face; but with so many irregularities and interruptions, that the student will hardly recognise this as a suture.

7. The ZYGOMATIC SUTURE is one which joins a branch of the temporal bone to a process of the cheek bone; forming an arch, zygoma, or yoke: but this suture has not extent; it has a serrated appearance at one single point only.

To mark and know these sutures, and to be able to trace them in imagination upon the naked head, to foresee where a suture will present, and how far it runs, may be a matter of great importance to the surgeon. Hippocrates, who has had more to praise his honesty than to follow his example, acknowledges his having mistaken a suture for a fracture of the skull; and since this warning, various contrivances and marks have been thought of, for preventing the like mistake. It may be useful to remember, that the suture has its serræ or indentations, is firmly covered by the pericranium, is close, and does not bleed: but that a fissure, or fracture of the skull, runs in one direct line, is larger and broader at the place of the injury, and grows smaller, as you recede from that, till it vanishes by its smallness; and that it always bleeds. Indeed the older surgeons, observing this, poured ink upon the suspected part, which, if the skull was hurt, sunk into the fissure, and made it black and visible; but left the suture untouched.* The old surgeons, or rather the ancient doctors, directed to make the patient take a wire betwixt his teeth, which being struck like the spring of an instrument, he would feel the twang produce a painful and particular sensation in the fractured part of the head. But after all these observations, in place of any true and certain marks, we find a number of accidents which may lead us into a mistake.

Sutures cannot be distinguished by their serræ or teeth; for the temporal sutures want this common character, and rather resemble capillary fractures of the skull†; nor even by their places, for we know that there are often insulated bones (ossa Wormiana) surrounded with peculiar joinings, which so derange the course of the common sutures, that the joinings may be mistaken for fractures of the skull, and the ossa Wormiana for broken parts. Sometimes the squamous suture is double, with a large arch of bone intercepted betwixt the true and the false suture; or the sagittal suture, descending beyond its usual extent, and quite to the nose, has been mistaken for a

* In matter of fact, the blood serves this purpose by its sinking into the fissure, and giving it a dark appearance. There is a roughness on the edge of the fissure, which, being felt by means of the probe, will distinguish the fissure from the suture.

† Viz. Fractures as small as a hair, thence named capillary.

fracture, and trepanned; and oftener in older skulls, the sutures are entirely obliterated all over the head. If the surgeon should pour ink upon the skull, he would have reason to be ashamed of an experiment so awkward and unsuccessful; and for the old contrivance of a wire or cord held in the mouth, it cannot be done, since the patient is commonly insensible; and even, though less hurt, his feelings, after such an accident, must be very confused; he must be too liable to be deceived: and we cannot, on such slender evidence as this, perform so cruel an operation as cutting up the scalp, or so dangerous a one as the trepan.

For various reasons, we are careful to trace the bones from their original soft and gristly or membraneous state, to their perfect condition of hard bone: and most of all, we are concerned to do so in the head, where, in childhood, the appearances are not singular and curious only, but have always been supposed to indicate some wise and useful purpose. It is in this original condition of the soft and growing bones, that anatomists have sought to find a theory of the sutures, how they are formed, and for what uses. It has been remarked, that the number of pieces in the skull is infinitely greater in the child than in the man. These bones, ossifying from their centre towards their circumference, it happens, of course, that the fibres are close at the centre of ossification, and are more scattered at the extremities of the bone; when these scattered fibres of opposite bones meet, the growing fibres of one bone shoot into the interstices of that which is opposed: the fibres still push onwards, till they are stopped at last, and the perfect suture, or serrated line of union is formed.

In dilating this proposition, we should observe, that in the child the bones in the head are membraneous and imperfect. The membraneous interstices begin to be obliterated; the sutures are beginning to close; the distinction of two tables is not yet established; the cancelli are not yet interposed between the plates; the sinuses or caverns of the bones, as in the forehead, the nose, and the jaw, are not formed; and each bone is not only incomplete towards its edges and sutures, but consists often of many parts. The os FRONTIS is formed of two pieces, which meet by a membraneous union in the middle of the bone. The OSSA PARIETALIA, have one great and prominent point of ossification in the very centre of each, from which diverging rays of ossification extend towards the edges of the bone. The os OCCIPITIS is formed in four distinct pieces; and the TEMPORAL BONES are so fairly divided into two, that their parts retain in the adult the distinct names of petrous and squamous bones. Although these are all the regular points of ossification, yet sometimes there occur small and distinct points, which form irregular bones, uncertain in number or size, found chiefly in the lambdoid suture, sometimes numerous and small, more commonly they are few in number, and sometimes of the full size of a crown, always distorting more or less the course of the suture, and being thus a subject of caution to the surgeon: these are named OSSA TRIQUETRA or TRIANGULARIA, from their angular shape, or WORMIANA, from Olaus Wormius, who remarked them first. Now the os frontis being formed into two larger pieces, their edges meet early in life, and they form a suture; but the bones continuing to grow, their opposite points force deeper and deeper into each other, till at last the suture is entirely obliterated, and the bones unite; and so this suture is found always in the child, seldom in the adult, almost never in old age. The occipital bones have four parts, they are close upon each other, they meet early, are soon united; and, although very distinct in the child, no middle suture has ever been found in the adult, but always the four pieces are united into one firm and perfect bone. The parietal bones have their rays most of all scattered; the rays of ossification run out to a great distance, and diverge from one single point, so that at their edges they are extremely loose, and they never fail to form sutures by admitting into their interstices the points and edges of the adjoining bones. The surest and most constant sutures are those formed by the edges of the parietal bones; the sagittal in the middle, the coronal over the forehead, the lambdoidal behind, and the squamous suture, formed by their lower edges.

But another phenomenon is supposed to result at the same time, from this meeting and opposition of the fibres and interstices of the growing bones: that when the opposite fibres meet too early, they are not fairly admitted into the open spaces of the opposite bone; but the fibres of each bone being directly opposed point to point, they both turn inwards, and form a ridge or spine, such as is seen on the inner surfaces of the frontal and occipital bones. Such is the common theory, which I suspect is imperfect, and which should be received with some reserve, for all the phenomena are not yet explained; we find each suture always in its appointed place; we find nothing like a suture formed betwixt the head and body of a long bone, though they are formed in distinct points, and are not united till after the years of manhood; we find no sutures when bones are broken and reunited, when they have been spoiled, and are replaced, when a piece of spoiled bone has been cut away, nor when a new shaft of a bone is formed by the secreting vessels, and is united to the heads of the old bone. These are accidents which hold us at least in doubt. It is, indeed, an idle mode of proceeding on such a subject, to suppose that the spinous processes and sutures of the skull are accidentally produced, when design, and the most curious adaptation of parts to their office, are very apparent. To suppose these things produced by chance, is at once to end all enquiry, and to leave a blank in our minds. On this subject I must refer the reader to the dissertation in the following chapter.

It has been supposed, and, with much appearance of truth, that the sutures limit the extent of fractures, leave a free communication of the internal with the external parts; that they must serve as drains from the brain; that they are even capable of opening at times, so as to give relief and ease in the most dreadful diseases of the head: but these uses of them are far from being proved.

The sutures were not intended by nature for limiting the extent of fractures: for fractures traverse the skull in all directions; cross the sutures with ease; and very often, passing all the sutures, they descend quite to the basis of the skull, where we dare not follow them with the knife, nor apply the trepan. Indeed we do not even know that limiting the extent of fractures could be a gracious provision of nature, since it would rather appear by the common accidents, that the more easily the bone yields, the less is the injury to the brain. If a certain violence and shock be committed, and the bone does not yield, and is not fractured, yet the vibration is propagated through it; and concussion is even more dangerous than fracture, because it is a general injury to the brain.

Neither were they intended as drains; for surely it is a bold position to assume, that nature has carefully provided for our making issues upon the sutures. When the original openness of the head and the membraneous condition of the sutures were first observed, it was thought to be an observation of no small importance. The ancients believed that the membranes of the brain came out by the sutures, to form the pericranium, and going from that over the several joints, formed the periosteum for all the bones. They saw a close connection betwixt the external and internal membranes of the skull, and they thought that nature had intended there a freer communication, and an occasional drain. They found the sutures particularly wide and membraneous in a child, which they attributed to the watery state of its brain, requiring a freer outlet than in the adult; and accordingly they named the opening of the child's head the bregma, fons, fontanelle, the fountain, by which they believed there was a continual exudation of moisture from the brain.

We might have expected these notions to have vanished with the doctrines of humours and revulsion which gave rise to them; but both the doctrines, and the practice, have been revived of late years; and a surgeon of some eminence has been at pains to examine various skulls, trying to find which of all the sutures remains longest open, and which should form the readiest and surest drain; and after a curious examination of each, he decidedly condemns the fontanelle; finds the additamentum of the squamous suture always open, and expects this superior advantage from placing his issues there, that he will command at once a drain both from the cerebellum and from the brain. But these notions of derivation and revulsion, of serous humours falling upon the brain, of drains of pituita by the nose, and through the sutures, though much cherished by the ancients, have been long forgotten, and have not been effectually revived by this attempt.

It cannot be denied, that, in some instances, the sutures have continued quite open in those grown in years, or have opened after a most wonderful manner, in some diseases of the head.

The fontanelle, or opening at the meeting of the coronal and sagittal sutures, was once thought to be a sure mark for the accoucheur to judge by, both of the life of the child, and of the direction in which its head presents. It is large and soft in a child, and the good women lay a piece of firm cloth upon it, and defend it with particular care. It begins to contract from the time of birth; and in the second and third year it is entirely closed. Its closing is delayed by weakness, scrophulous complaints, and indeed by any lingering disease; it closes very late in rickets, and in hydrocephalic children the bones never close, but continue soft, yield to the watery swelling of the brain, and separate in a wonderful degree, so as to hold ten or twelve pounds. As the sutures continue open in a hydrocephalic child, they are said to open again in the few instances where adults are seized with the same disease.

We cannot pass unnoticed their looseness and flexibility in the new-born child; how wonderfully the head of the child is increased in length, and reduced in breadth in the time of delivery, and how much this conduces to an easy and happy labour.

Were I to assign a reason for the flexible bones, and wide sutures, and the yielding condition of the head of the child, I should say that it were meant by nature to stand in the place of that separation of the bones of the pelvis which has been supposed, but which cannot exist; for the child's head is moulded with little injury, is evolved again without help; and it seems a provision of nature, since the child scarcely feels the change: but no woman has been known to have the joinings of the pelvis relaxed or dissolved without pain and danger, confinement for many months, a temporary lameness, and sometimes being rendered unable to walk for life.

DESCRIPTION OF THE INDIVIDUAL BONES OF THE SKULL.

OS FRONTIS.—This bone is compared with a clam-shell. It is of a semicircular shape, hollowed like a shell. It is divided into the frontal, nasal, and orbitary portions, and it has within it the cavities which are named the sinuses of the frontal bone. The frontal bone is connected by sutures with the parietal bones, &c.

Its connections. Its relations. The frontal bone stands connected with the parietal bones by the coronal suture; it is connected to the great ala of the sphenoid bone by the sutura spheno-frontalis; while its orbitary plates are united to the lesser alæ by the linea sphenofrontalis. The nasal bones are attached to it by part of the transverse suture of the face. The cribriform plate of the æthmoid bone is united to the orbitary plates by the linea æthmoidea frontalis, and looking into the orbits the same orbitary plates are seen to be contiguous to the ossa plana of the æthmoid bone and ossa unguis; and, lastly, the ossa malarum are attached to the frontal bone by the extremities of the transverse suture of the face. Its orbitary plates are two thin and diaphanous lamellæ that depart from the part of the bone which forms the forehead in a horizontal direction, so as to form a part of the socket of the eye, and a floor for supporting the anterior lobes of the cerebrum. These two orbitary plates leave an open space, called FISSURA ÆTHMOIDEA, into which part of the æthmoid bone is received.

Points of demonstration. 1. Orbitary plates. 2. Fissura æthmoidea.

The first point to be remarked is the SUPERCILIARY RIDGE, on which the eye-brows are placed: it is a prominent arched line, corresponding in size and length with the eye-brow, which it supports: over this line the integuments are loose: here many arteries perforate the bone, which are properly the nutritious arteries of this part of the bone; and we find all over the superciliary ridge many small holes through which these arteries had passed. Among these, there is one hole which is larger, and which is distinguished from the rest; for its use is not like the others, to transmit arteries to the bone, but to give passage to the frontal nerve and a small artery which come out from the orbit, to mount over the forehead. Sometimes the nerve turns freely over the border of the orbit, and makes no mark, or but a slight one; often lying closer upon the bone, it forms a notch; but most commonly, in place of turning fairly over the edge of the orbit, it passes obliquely through the superciliary ridge, and, by perforating the bone, makes a hole. It is accompanied by the superciliary branch of the ophthalmic artery. This hole is named the SUPERCILIARY HOLE.

3. Superciliary ridge. 4. Pores, or minute foramina. 5. Superciliary hole.

The second foramen is the FORAMEN ORBITALE INTERNUM. It is within the orbit, near the junction of the orbital plate with the æthmoid. It transmits a branch of the ophthalmic division of the fifth nerve from the orbit into the cranium, from which the same nerve immediately passes through the æthmoid into the nose. Sometimes there are two, when they are distinguished by the terms anterior and posterior orbitary foramina; but occasionally there is only a groove, or one side of the foramen, the other being formed by the æthmoid.

6. Foramen orbitale.

The orbitary, or superciliary ridge, ends by two processes, which, forming the angles of the eye, are named the ANGULAR PROCESSES. The frontal bone has, therefore, four angular processes: 1. The two internal angular processes, forming the internal angles of the eyes; and 2. The two external angular processes, which form the external angles of each eye.

7. Angular processes.

Betwixt the two internal angular processes there is the NASAL POINT OR PROCESS. This nasal process is a small sharp projecting point, occupying that space which is exactly in

8. Nasal process.

the middle of the bone, and is betwixt the two internal angular processes. It is very irregular and rough all round its root, for supporting the two small nasal bones; and this gives them a firm seat, and such a hold upon the root of the forehead, that they oftener are broken than displaced.

9. Temporal ridge. From the external angular process there extends backwards and upwards the temporal ridge or spine.

Eminentiæ superciliares. At the inner end of the superciliary ridge, is that bump which marks the place of the frontal sinus, which also indicates their size; for where this rising is not found, the sinuses are wanting, or are very small; but this is no sure nor absolute mark of the presence of these sinuses, which often, in the flattest foreheads, are not entirely wanting.

10. Sinuses. The sinuses* of the os frontis are two in number, one on either side above the root of the nose: they are formed by a receding of the two tables of the skull from each other: they are formed at first with the common cancelli, and at first they resemble the common cancelli, as if they were only larger cells: gradually they enlarge into two distinct cavities, often of very considerable size, going backwards into the orbitary plate, or sideways into the orbitary ridge, or upwards through one half of the frontal bone; and Ruysch had, in a giantess (puella gigantica), seen them pass the coronal suture, and extend some way into the parietal bones.

11. Partitions of the sinuses. The two sinuses of either side are divided by a partition; but still they communicate by a small hole: sometimes the partition is almost wanting, and there are only crossings of the common lamellated substance; and though the communication with one another is not always found, they never fail to communicate with the nose: this indeed seems to be their chief use; for the frontal sinuses are the beginning of a great train of cells, which, commencing thus in the frontal bone, extend through the æthmoidal, sphenoidal, and maxillary bones, so as to form cavities of great extent and use belonging to the nose. These cavities extend and give form to the face, enlarge the cavities which receive effluvia, and allow them to circulate and pass over the proper organ of smelling; and they give perfection and strength to the voice. The membrane which lines these cavities is thin, exquisitely sensible, and is a continuation of the common membrane of the throat and nose. A thin humour is poured out upon its surface to moisten it and keep it right. This the ancients did not consider as a mere lubricating fluid, but as a purgation of the brain, drawn from the pituitary gland, which could not be di-

* The word sinus is used in two senses: we call the cavities or cells, within the substance of a bone, the sinuses of that bone; as the sinuses of the forehead, of the sphenoid, æthmoid, or maxillary bones; we call also certain great veins by the same name of sinuses; thus the great veins being enlarged where they approach the heart, and the veins being particularly large in the brain and the womb, we call them the sinuses of the heart, of the brain, and of the womb.

minished without danger, and which it was often of consequence to promote.

These cells, or thin membranes, are subject to inflammation and abscess. They are also subject to the accidental nestling of insects, which nestle there, and produce inconceivable distress; and it is particular, that they more frequently lodge in the frontal sinuses, than in the cavities of any of the other bones. In sheep and dogs such insects are very frequent, as in seeking their food, they carry their nose upon the ground; and it has been proved, or almost proved, that in man they arise from a like cause. Indeed, what can we suppose, but that they get there by chance; thus, a man having slept in barns, was afflicted with dreadful disorders in the forehead, which were relieved upon discharging from the nose a worm of that kind which is peculiar to spoiling corn; while others have had the complaint by sleeping upon the grass. The patient might be relieved on easier terms than by the operation of the trepan, which has been proposed, by the injection of aloes, assafœtida, myrrh, the use of snuff or smoking, and pressing the fumes upwards into the nose. Much should be tried, before undertaking a dangerous operation on slender proofs.

It may be right in cases of fractures, to decline applying the trepan above the sinuses, unless a fracture cannot be raised in any easier way; and we must be especially careful to distinguish a fracture of the outer table only from entire fractures of this bone. For Palfin says, that the outer table being broken, and the natural mucus of the sinus being corrupted and flowing out, has been mistaken for the substance of the brain itself. And Parèe, who first gives this caution, affirms, "that "he had seen surgeons guilty of this mistake, applying the "trepan, and so killing their unhappy patients."*

The SPINE or RIDGE which runs upon the internal surface **12. Internal spine.**
of the frontal bone, is to be observed, as it gives a firm hold to the falx, or that perpendicular membrane, which, running in the middle of the skull, divides and supports the brain. This is more or less prominent in different skulls, and according to the age. The spine is more prominent at its root; but as it advances up the forehead, it decreases, and often ends in a groove. The spine gives firm hold for the falx, and the groove **13. Groove.**
lodges the great longitudinal sinus, or, in other words, the great vein of the brain, which runs along the head, in the course of the perpendicular partition or falx. At the root of **14. Foramen cæcum.**
this spine, there is a small blind hole; it is named blind, because it does not pass quite through the bone, and the beginning of the falx, dipping down into this hole, gets a firmer hold. The ancients, thinking that the hole descended through both tables into the nose, ignorantly believed, that the dangerous and

* For a more perfect account of the pathology of the sinuses, see Mr. John Bell's Principles of Surgery.

ungovernable bleedings at the nose must be through this hole, and from the fore-end, or beginning of the longitudinal sinus.

15. Pit of the trochlea.

Upon the orbitary plate, and just under the superciliary ridge, there are two depressions in the socket of each eye: the one is very small, and deeper at the inner corner of the eye, under the superciliary hole, which is the mark of the small cartilaginous pully, in which the tendon of one of the muscles of the eye plays; the other, a more gentle and diffused hollow, lies under the external angular process, is not deep, but is wide enough to receive the point of a finger, and is the place where the lachrymal gland lies, that gland which secretes the tears, and keeps the eye moist.*

16. Pit for the lachrymal gland.

On the whole, this bone affords a very important subject of study to the surgeon, and he is especially called to attend to the sinuses, the internal spine, and to the orbitary processes of this bone. These orbitary processes are the most remarkable points of this bone. They are often fractured by a blow on the forehead, and being extremely brittle, the splinters are beat up, and enter the brain. They are no defence to the brain when a weapon enters the orbit. We have known a young man killed by the push of a foil which had lost its guard, and which passed through this plate into the brain.

PARIETAL BONE.—The parietal bones form much the greater share of the cranium: they are more exposed than any others, are the most frequently broken, and the most easily trepanned: for the parietal bones are more uniform in their thickness, and more regular in their two tables and diploe, than any others. But the accidental varieties of pits and depression are very frequent in them, and the sinus or great vein, and the artery which belongs to the membranes of the brain, both make their chief impressions upon this bone. It enters into the formation of the *coronal*, the *sagittal*, the *lambdoidal*, and the *squamous* sutures.

Points of demonstration.

1. The four angles.

The square form of the bone produces four angles; and in surgery, we speak of the frontal, the occipital, the mastoidean, and temporal angles of the parietal bone. It has deeply serrated edges which unite the two bones with each other, and with the occipital and frontal bones. All the corners of this bone are obtuse, except that one which lies in the temple, and which, running out to a greater length than the other corners, is sometimes named the SPINOUS OR TEMPORAL PROCESS of the parietal bone, though there can be no true process in a bone so regular and flat. The lower edge of the bone is a neat semicircle, which joins the parietal to the temporal bone; and the edge of each is so slanted off, that the edge of the temporal overlaps the edge of the parietal, with a thin scale forming the squamous suture. About an inch above the squamous suture,

2. Spinous process or sphenoidal angle.

3. Squamous edge.

* In addition, as points of demonstration, we may add the *eminentiæ frontales*. See the general review of the skeleton.

there is a semi-circular ridge, where the bone is particularly white and hard; and rays extend downwards from this, converging towards the jugum. The white semi-circular line represents the origin of the temporal muscle; and the converging lines express the manner in which the fibres of the muscle are gathered into a smaller compass, to pass under the jugum, or arch of the temple. The sagittal suture, or meeting of the two parietal bones, is marked with a groove as big as the finger, which holds the longitudinal sinus, or great vein of the brain; but the groove is not so distinctly seen, unless the two bones are put together; for one half of this flat groove belongs to each bone.

4. Temporal ridge.

5. Groove for the sinus.

The great artery of the dura mater touches the bone at that angle of it which lies in the temple. It traverses the bone from corner to corner, spreading from the first point, like the branches of a tree: it beats deep into the bone where it first touches it; but where it expands into branches, its impressions are very slight; commonly it makes a groove only, but sometimes it is entirely buried in the bone; so that at the lower corner of the parietal, we cannot escape cutting this vessel, if we are forced to operate with the trepan.

6. Groove of the meningeal artery.

There is but one hole in the parietal bone: it is small and round, is within one inch of the meeting of the lambdoidal and sagittal sutures, and gives passage to a small external vein, which goes inwards to the sinus, and to a small artery, which goes also inwards to the dura mater, or rather to the falx.

7. Foramen parietale.

On the inner surface of the bone, and commonly near the sagittal edge, we very often see pits or foveæ, which receive those bodies which are called glands, of the dura mater.

8. Fovea.

The lateral sinus makes a depression on the inside of the mastoidean angle.

9. Fossa of the sinus.

The meeting of the frontal and parietal bones, being imperfect in the child, leaves that membraneous interstice which, by some, is named folium or folliolum, from its resembling a trefoil leaf, and was named by the ancients, hypothetically, bregma, fons*, or fountain; they thinking it a drain for the moisture from the brain: and so the parietal bones are named ossa bregmatis. The parts of these bones which form the upper portion of the skull are equable in their thickness, and there the surgeon would apply his trephine, if he had it in his power to choose; but towards the temporal angle he would apply it unwillingly, because of the meningeal artery, which is apt to be opened, and to be at least troublesome. Formerly, surgeons were forbid to trepan over the longitudinal sinus: now the fashion is altered, and some surgeons would persuade us to prefer it! We do it when necessary, but always with due consideration of the great vein or sinus.

For an account of the veins contained within this bone, see

* The word pulsatilis, or fons pulsatilis, or beating fountain, was added, because we feel the beating of the arteries of the brain there.

the concluding observations on the bones of the cranium, and under the head of *Emmissariæ*.

OS OCCIPITIS has also the names of os memoriæ and os nervosum. It is the thickest of the cranial bones, but is the least regular in its thickness, being transparent in some places, and in others swelling into ridges of very firm bone. It gives origin or insertion to many of the great muscles which move the head and neck; it supports the back part of the brain, contains the cerebellum or lesser brain, transmits the spinal marrow, and is marked with the conflux of the chief sinuses, or great veins of the brain.

This bone is united to the parietal bones by the lambdoidal suture, to the mastoidean portions of the temporal bone by the additamentum suturæ lambdoidalis, laterally and forward it is attached to the petrous portion of the temporal bone, and at its lower and most anterior part, it is attached to the sphenoid bone, by that peculiar bond of union called synostosis.

Points of demonstration.

In beginning the demonstration, we point out its divisions: 1. Pars occipitalis. 2. Pars lateralis or condyloidea. 3. Pars basilaris or cuneiformis; which, at birth, are distinct bones divided by cartilage. It is also necessary to name its angles, viz. the superior or parietal angle, and the mastoidean angles.

1. Perpendicular external spine.
2. Superior transverse spine.
3. Inferior.
4. Tuberosity.

The EXTERNAL SURFACE is exceedingly irregular, by the impressions of the great muscles of the neck: betwixt the insertions of the muscles, projecting lines are on the bone. In the middle of the bone, and betwixt the muscles of opposite sides, there runs a ridge from above downward; at the upper margin of the insertion of the trapezius, there is formed a superior transverse spine or ridge, and in the same way, directly above the insertion of the recti, which make two irregular depressions, there is an inferior transverse spine. In a strong man, advanced in years, where the ridges and hollows are strongly marked, at the point where the superior transverse crosses the perpendicular one, it is so very prominent, as to be named the POSTERIOR TUBEROSITY of the occipital bone.

5. Internal crucial ridges.

The INTERNAL SURFACE.—Opposite to these ridges there are similar crucial ridges within; but larger, more regular, smooth, and equal, and making only one transverse line, and one perpendicular line. The *tentorium cerebello super-extensum* is a diaphragm or transverse partition, which crosses the skull at its back part; cuts off from the rest of the cranium the hollow of the occipital bone, appropriates that cavity for the cerebellum, and defends the cerebellum from the weight and pressure of the brain. This tentorium, or transverse membrane, is attached to the GREAT INTERNAL RIDGE of the occipital bone. In the angle where this membrane is fixed to the ridge, lies the great sinus or vein, which is called the longitudinal sinus, while it is running along the head; but the same sinus, dividing, in the back of the head, into two great branches, changes its name with its direction; and the forkings of the vessel are named the right and left lateral sinuses, which go down through the basis of the skull; and being continued down the neck, are there named the great or internal jugular veins. This forking of the longitudinal into the lateral sinuses, makes a TRIANGULAR OR TRIPODLIKE GROOVE, which follows the internal ridges of the occipital bone: and above and below the transverse ridge there are formed four plain and smooth hollows. The two upper ones are above the tentorium, and contain the posterior lobes of the brain; the two lower ones are under the tentorium, and hold the lobes of the cerebellum or little brain.

6. Grooves for the sinuses.

7. Fossa cerebelli, and fossa cerebri.

PROCESSES.—The processes or projections of the occipital bone are few and simple. 1. There is a part of the bone which runs forward from the place of the foramen magnum, lies in the very centre of the base of the skull, joins the occipital to the sphenoidal bone, and which, both on account of its place, (wedged in the basis of the skull,) and of its shape, which is rather small, and somewhat of the form of a wedge, is named the CUNEIFORM, OR WEDGE-LIKE PROCESS of the occipital bone. On the inside of this part of the bone is a slight hollow, to which the name of fossa basilaris is given, and lateral to this the groove of the lower petrous sinus may be observed. And there are two small oval processes, or button-like projections, which stand off from the side, or rather from the fore-part of the foramen magnum, or great hole, and which, being lodged in sockets belonging to the upper bone of the neck, form the hinge on which the head moves. These two processes are named the CONDYLES of the occipital bone. They are not very prominent, but rather flattened; are of an oval form, and have their fore-ends turned a little towards each other; so that by this joint the head moves directly backwards or forwards, but cannot turn or roll. The turning motions are performed chiefly by the first bones of the neck. Round the root of each condyle, there is a roughness, which shows where the ligament ties this small joint to the corresponding bone of the neck.

8. Cuneiform process.

9. Fossa basilaris.

Lateral groove.

10. Condyles.

On the lower part of the cuneiform process, there are two tubercles for the attachment of the recti capitis anteriores. Near the condyle, and immediately behind the foramen lacerum, there is a tubercle for the rectus capitis lateralis.

11. Tubercles of the cuneiform process.

12. Small lateral tubercles.

HOLES.—These condyles stand just on the edge of the FORAMEN MAGNUM, or great hole of the skull, which transmits the spinal marrow, or continuation of the brain; and the edges of this hole (which is almost a regular circle) are turned and smoothed; a little thicker at the lip, and having a roughness behind that, giving a firm hold to a ligament, which, departing from this hole, goes down through the whole cavity of the spine, forming in part a sheath for the spinal marrow, and a ligament for each individual bone. There pass down through this great hole the spinal marrow, and the vertebral vein; there come up through it the vertebral arteries, which are of

13. Foramen magnum.

great importance and size; and a nerve, which, from its coming backwards from the spine to assist certain nerves of the brain, is named the spinal accessory nerve.

14. Foramen condyloideum anterius. The second hole is placed a little behind the ring of the foramen magnum, and, just at the root of either condyle, is round and large, easily found, and sometimes it is double; it transmits the ninth pair, or great lingual nerve.

15. Posterius. There is another hole smaller, and less regular than this last. It is exactly behind the condyle, while the lingual hole is before it. It is for permitting a small vein of the neck to enter and drop its blood into the great lateral sinus; sometimes it is a hole common to the temporal and occipital bones, but often it is not found, and this trifling vein gets in by the great occipital hole.

16. Part of the foramen lacerum. We shall describe with the temporal bone that wide hole which is common to the temporal and occipital bones, and which transmits the great lateral sinus, and the nerves of the eighth pair.

The surgeon would do well to study, with great care, the place of the posterior tubercle, and to teach himself to calculate the place of the sutures from their protuberance, and as it were from the same land-mark, to estimate the place of the internal spines, and the fossa cerebrales; for these inequalities in the thickness of this bone become of the first consequence in applying the trephine to the back of the head.

TEMPORAL BONE.—The temporal bone is, in the child, two bones; which retain their original names of pars petrosa and pars squamosa. The whole bone is very irregular in its thickness, and hollows and processes. Pars squamosa. The PARS SQUAMOSA is a thin or scaly part; rises like a shell over the lower part of the parietal bone, and is smoothed and flattened as it were by the rubbing of the temporal muscle. Pars petrosa. The PARS PETROSA, often named os LAPIDOSUM, or stony bone, is hard, irregular, rocky; juts inwards towards the basis of the skull; contains the organ of hearing, and, of course, receives and transmits all the nerves which are connected with the ear.* There is a third portion of this bone, viz. the mastoidean angle, which is thick and hard, is divided into cells, and forms those caverns which are supposed to be chiefly useful in reverberating the sound. Mastoidean angle.

The squamous part is grooved, to make the squamous suture; is scolloped or fringed: and exceedingly thin on its edge; it is radiated, in consequence of its original ossification shooting out in rays. The petrous part again is triangular, unequal by the cavities of the ear; it has a very hard, shining, polished-like surface; exceeded in hardness by nothing but the enamel of the teeth. Where it projects into the base, it

* The anterior and posterior semi-circular canals are protuberant upon its surfaces.

has several open points, which are filled up with cartilaginous or ligamentous substance; and its occipital angle is connected with the other bones by the additamentum suturæ squamosæ.

The temporal bone closes the cranium, upon the lower and lateral part; backwards it is connected by the additamentum suturæ lambdoidalis to the occipital bone; by the squamous suture and the additamentum suturæ squamosæ, it is joined to the parietal bone; whilst anteriorly it is united to the sphenoid bone by the spheno-temporal suture, the spinous process of the sphenoid bone being deeply wedged betwixt the petrous and squamous portions of the temporal bone.

PROCESSES.—The ZYGOMATIC PROCESS rises broad and flat before the ear; grows gradually smaller as it stretches forward to reach the cheek-bone: it forms with it a zygoma, yoke, or arch of the temple, under which the temporal muscle plays. The temporal muscle is strengthened by a firm covering of tendon, which stretches from the upper edge of this zygoma to the white line on the parietal bone; and several muscles of the face arise from the lower edge of the zygoma, particularly one named masseter, which moves the jaw; and one named zygomaticus, or distortor oris, because it draws the angle of the mouth. The zygomatic process is united by a short suture to the cheek-bone. **1. Zygomatic process.**

The STYLOID PROCESS is so named from a slight resemblance to the stylus, or point with which the ancients engraved their writings on tables of wax. It is cartilaginous long after birth; even in the adult, it is not completely formed; it is exceedingly delicate and small; and when its cartilaginous point is fairly ossified, as in old men, it is sometimes two inches long. It stands obliquely out from the basis of the head, and is behind the jaws; so that it gives convenient origin to a ligament which goes downwards to support the os hyoides, or bone of the tongue; and it is the origin of many curious muscles, chiefly of the throat and jaws. One slender muscle going downwards from the styloid process, and expanding over the pharynx, is called stylo-pharyngeus; one going to the os hyoides, is the stylo-hyoideus; one going to the tongue, is the stylo-glossus: and since the process is above and behind these parts, the muscles must all pull backwards and upwards, raising according to their insertions, one the pharynx, another the os hyoides, another the tongue. **2. Styloid process.**

PROCESSUS VAGINALIS will not be easily found, nor acknowledged as a process; for it is only a small rising of a ridge of the bone, with a rough and broken-like edge, on the middle of which the styloid process stands: it is, in short, the root of the styloid process which anatomists have chosen to observe, though it gives origin to no particular part; and which they have named vaginalis, as if it resembled a sheath for the styloid process. **3. Vaginal process.**

PROCESSUS MASTOIDEUS, or MAMMILLARIS, is a conical nipple-like bump, like the point of the thumb; it projects from **4. Mastoid process.**

under the ear, and is easily felt with the finger without; it is hollow, with many cells which enlarge the tympanum, or middle cavity of the ear, and are thought to reverberate and strengthen the sound. Under its root there is a deep and rough rut which gives a firm hold to the first belly of the digastric muscle: and the point or nipple of this process is the point into which the mastoid muscle is inserted from before; and the complexus, obliquus and trachelomastoideus muscles from behind.

Grove for the digastricus.

5. Auditory process.

The AUDITORY PROCESS is just the outer margin of the hole of the ear. It is in a child a distinct ring, which is laid upon the rest of the bone.* The membrane of the ear is extended upon this ring, like the head of a tambour upon its hoop, whence this is named the circle of the tambour by the French, and by us the drum of the ear. In the adult, this ring is fairly united to the bone, and is named the processus auditorius; and may be defined a circle, or ring of bone, with a rough irregular edge; the drum or membrane of the ear is extended upon it, and the cartilaginous tube of the ear is fixed to it; and this ring occupies the space from the root of the mammillary to the root of the zygomatic process.

Betwixt this and the mastoid process there is a kind of fissure, the *rima mastoidea.*

6. Articular fossa.
7. Articular tubercle.
8. Fissure.

The lower jaw is articulated with this bone by a shallow fossa, which is anterior to the auditory process, and at the root of the zygomatic process. A tubercle immediately before this articulating surface deepens it. A fissure may be observed in nearly the middle of the cavity, which is for the attachment of the ligament which unites the intermediate cartilage of this articulation. This fissure divides the proper articular or glenoid cavity from that fossa which gives lodgment to a deep portion of the parotid gland.

HOLES.—The temporal bone is perforated with many holes; some for permitting nerves to enter; others to let them out; others for the free passage of air to the internal ear.

9. Meatus auditorius externus.

The MEATUS AUDITORIUS EXTERNUS (the circle of which has been described) is that deep tube which in the dry bones leads to the interior cavity, the tympanum, but which is closed at the bottom by the membrane of the tympanum in the living body.

10. Internus.

The MEATUS AUDITORIUS INTERNUS is that hole by which the auditory nerves have access to the ear. It is a very large hole seated upon the back of the pars petrosa. The hole is at first large, smooth, almost a regular circle, with a sort of round lip. Within this are seen many small holes, the meaning of which is this: the nerve of the 7th pair is double from its very origin in the brain: it consists, in fact, of two distinct nerves, the portio dura, and the portio mollis. The portio mollis is a large soft and delicate nerve, which constitutes the true organ

* In brutes it is, indeed, a process standing out.

of hearing; and when it is admitted into the ear, it is expanded into a thin web which spreads into all the cavities of the ear, as the cochlea, semi-circular canals, &c. The portio dura, the smaller part of the nerve, passes indeed through the ear, but it is quite a foreign nerve; it is not distributed within the ear; it keeps the form of a distinct cord, and, passing through the temporal bone, it comes out upon the cheek, where it is expanded; so that the portio dura is a nerve of the face, passing through the ear, but forming no part of that organ. Thus the two nerves, the portio dura and mollis, enter together; they fill the greater hole, and then they part: the portio dura, entering by one distinct hole, takes its course along a distinct canal, the aqueduct of Fallopius, from which it comes out upon the cheek; while the portio mollis, entering by many smaller holes into the cochlea, semi-circular canals, and cavity of the vestibule, is expanded in these cavities to form the proper organ of hearing.

11. Videan foramen. There is a small hole which will admit the point of a pin upon the fore-part of the petrous bone. This hole receives a small twig reflected from the fifth pair of nerves: the nerve is as small as a sewing thread; it can be traced along the petrous bone by a small groove, which conducts it to the hole; and when it enters the ear it goes into the same canal with the portio dura, and joins itself to it.

12. Stylomastoid foramen. The hole by which the portio dura passes out upon the cheek, is found just before the mastoid, and behind the styloid process; and being betwixt the two, it is named the STYLO-MASTOID hole.

13. Eustachian tube. The hole for the Eustachian tube is very irregular. No air can pass through the membrane of the drum; and as air is necessary within the ear, it is conveyed upwards from the palate by the ITER A PALATO AD AUREM, or, as it is commonly called, the EUSTCAHIAN TUBE. This tube is long, and of a trumpet form; its mouth, by which it opens behind the nostril, is wide enough to receive the point of the finger, it grows gradually smaller as it advances towards the ear: it is cartilaginous in almost its whole length; very little of it consists of firm bone; so that the student, in examining the skull, will hardly find the Eustachian tube; for the cartilage being rotted away, nothing is left but that end of the canal that is next the ear, and which opens both above and below, ragged, irregular, and broken.

14. Canal of the corda tympani. Above and to the outside of the Eustachian tube there is a narrow canal which conveys the nerve called corda tympani. This nerve, traversing the tympanum, enters into the aqueduct of Fallopius, and unites with the facial nerve.

15. Canal of the long muscle of the malleus. On the inside of the Eustachian tube we may observe a canal which, leading backwards, opens into the cavity of the tympanum with a mouth like a spoon; it gives lodgment to the long muscle of the malleus.

The other holes do not relate to the ear, and are chiefly for transmitting the great blood-vessels of the brain.

16. Carotid foramen, for the passage of the great artery, The CAROTID ARTERY, the chief artery of the brain, enters into the skull near the point of the petrous bone, and just before the root of the styloid process. The artery goes first directly upwards, then obliquely forwards through the bone, and then again upwards, to emerge upon the inside of the skull; so that the carotid makes the form of an italic *S*, when it is passing through the substance of the bone; and, in place of a mere hole, we find a sort of short canal, wide, a little crooked, and very smooth within. It is at this particular point that we are sensible in our own body of the beating of these two great arteries; and Haller informs us, that, during a fever, and for the sympathetic nerve. he felt this beating in a very distressing degree. The sympathetic nerve accompanying the carotid artery is also transmitted through this canal.

17. Foramen lacerum posterius. transmits the internal jugular, The GREAT LATERAL SINUS comes out in part through the temporal bone, to form the internal jugular vein. The course of the sinus may be easily traced by the groove of the occipital bone downwards, behind the pars petrosa: there also it makes a deep groove, and ends with a large intestine-like turn, which makes a large cavity in the temporal bone, big enough to receive the point of the finger. The sinus passes out, not by any particular hole in the temporal bone, but by what is called a COMMON HOLE, viz. formed one half by the temporal and one half by the occipital bone. This hole is very large; is lacerated or ragged-like. It is sometimes divided into two openings, by a small point, or spine of bone. The larger and the nerves of the eighth pair. opening on one side of that point transmits the great sinus, where it begins to form the jugular vein; and the smaller opening transmits the eighth nerve of the brain.

18. Mastoidean foramen. There is a small hole on the outside of this bone, in the occipital angle; or rather the hole is oftener found in the line of the suture (the additamentum suturæ squamosæ). Sometimes it is in the occipital bone; or sometimes it is wanting: it transmits a trifling vein from without, into the great sinus, or a small artery going to the dura mater.

19. Ducts of Cotunnius. There are two very small canals, which carry blood-vessels and lymphatics from the inner cavities of the ear; they have been called aqueductus vestibuli, and aqueductus cochleæ; they open on the posterior surface of the petrous bone, near the internal auditory foramen.

Among the irregular depressions on the different faces of this bone are sometimes enumerated these: the groove already mentioned on the mastoid process for the lodgment of the head of the digastricus; certain cerebral fossæ, which are the impressions of the convolutions of the brain upon the inside of the squamous portion; the jugular fossa, or thimble-like depression, made by the first turn of the great jugular vein; the temporal sinuosity for the lodgment of the temporal muscle; and, lastly, we observe in a well-marked bone, the sulci for the artery of the dura mater, and the groove for the petrous sinus on the ridge which divides the surfaces of the petrous bone.

The temporal bone is important as a bone of the cranium, and lying in contact with the membranes of the brain. It is subject to scrofulous disease, from containing the complicated organ of hearing. Its diseases not only affect the brain, but in a particular manner influence the muscles of the face, from the nerves transmitted being those of expression.

In concluding the description of the bones of the cranium, I should not omit to state, that all these bones are hollowed out into canals for veins—a late discovery of M. Breschet, of the Hotel Dieu. These veins run in the diploe, and are of a size that makes the surprise the greater they should have been so long neglected. These channels are numerous in the frontal and occipital bone; but they are very conspicuous and regular in the parietal bone. They converge towards the temple considerably behind the course of the meningeal artery. They are to be demonstrated by filing off the external table of the bone. Do these internal and concealed channels determine the course of fractures of the skull? Are these internal veins ever the seat of tumor?*

The ÆTHMOID BONE is perhaps one of the most curious bones of the human body. It appears almost a cube, not of solid bone, but exceedingly light, spongy, and consisting of many convoluted plates which form a net-work like honeycomb. It is curiously enclosed in the os frontis, betwixt the orbitary processes of that bone. One horizontal plate receives the olfactory nerves, which perforate that plate with such a number of small holes, that it resembles a sieve, whence the bone is named cribriform, or æthmoid bone. Other plates, dropping perpendicularly from this one, receive the divided nerves, and give them an opportunity of expanding into the organ of smelling; and these bones, upon which the olfactory nerves are spread out, are so much convoluted, as to extend the surface of this sense very greatly, and are named spongy bones. Another flat plate lies in the orbit of the eye, which being very smooth, for the rolling of the eye, is named the os planum, or smooth bone; so that the æthmoid bone supports the fore part of the brain, receives the olfactory nerves, forms the organ of smelling, and makes a chief part of the orbit of the eye; and the spongy bones, and the os planum, are neither of them distinct bones, but parts of this æthmoid bone. Thus the æthmoid is united to the frontal bone, by the linea æthmoidea frontalis, and to the sphenoid bone by a similar line of contact, visible on the inside of the base of the cranium. Looking into the orbit, we again see a union with the frontal, and with the sphenoidal and palate bones. Its perpendicular

Connections.

* See *Recherches Anatomiques sur les Canaux veinaux des Os* Par M. Breschet.

plate stands connected to the back part of the nasal process of the frontal bone; the vomer is attached to the back part of this plate. The ossa unguis close the cells of this bone anteriorly. *In the fœtus* the æthmoid bone is divided into two by a cartilaginous partition, which becomes afterwards the perpendicular plate and crista galli.

Processes.

1. Cribriform plate. The CRIBRIFORM PLATE is exceedingly delicate and thin, lies horizontally over the root of the nose, and fills up neatly the space betwixt the two orbitary plates of the frontal bone. The olfactory nerves, like two small flat lobes, lie out upon this plate, and, adhering to it, shoot down like many roots through this bone, so as to perforate it with numerous small holes, as if it had been dotted with the point of a pin, or like a nutmeg-grater.

This plate is horizontal; but its processes are perpendicular, one above, and three below.

2. Crista galli. The first perpendicular process is what is called CRISTA GALLI, a small perpendicular projection somewhat like a cock's comb, but exceedingly small, standing directly upwards from the middle of the cribriform plate, and dividing that plate into two; so that one olfactory nerve lies upon each side of the crista galli; and the root of the falx, or septum, betwixt the two hemispheres of the brain, begins from this process. The foramen cæcum, or blind hole of the frontal bone, is formed partly by the root of the crista galli, which is very smooth, and sometimes, it is said, hollow or cellular.

3. Nasal plate. Exactly opposite to this, and in the same direction with it, *i. e.* perpendicularly to the æthmoid plate, stands out the NASAL PLATE of the æthmoid bone. It is sometimes called the azygos, or single process of the æthmoid, and forms the beginning of that septum or partition which divides the two nostrils. This process is thin, but firm, and composed of solid bone; it is commonly inclined a little to one or other side, so as to make the nostrils of unequal size. The azygos process is united with the vomer, which forms the chief part of the partition; so that the septum, or partition of the nose, consists of this azygos process of the æthmoid bone above, of the vomer below, and of the cartilage in the fore or projecting part of the nose; but the cartilage rots away, so that whatever is seen of this septum in the skull must be either of the æthmoid bone or the vomer.

4. The labyrinth. The lateral parts of the æthmoid bone consist of a series of cells communicating with each other, and which are called the labyrinths. The cells of the labyrinth are closed by the external plate called os planum. These cells belong to the organ of smelling, and are useful by detaining the effluvia of odorous bodies, and by reverberating the voice.

5. Processes called superior spongy bones. From each of these labyrinths there hangs down a SPONGY BONE, one hanging in each nostril. They are each rolled up like a scroll of parchment; they are very spongy; are covered with a delicate and sensible membrane, and when the olfactory nerves depart from the cribriform plate of the æthmoid bone, they attach themselves to the septum, and to these upper spongy bones, and expand upon them so, that the convolutions of these bones are of material use in expanding the organ of smelling, and detaining the odorous effluvia till the impression be perfect. Their convolutions are more numerous in the lower animals, in proportion as they need a more acute sense. They are named spongy, or turbinated bones, from their convolutions resembling the many folds of a turban.

6. Os planum. The orbitary plate of the æthmoid bone is a large surface, consisting of a very firm plate of bone, of a regular quadrangular form, exceedingly smooth and polished: it forms a great part of the socket for the eye, lying on its inner side. When we see it in the detached bone, we know it to be just the flat side of the æthmoid bone; but while it is incased in the socket of the eye, we should believe it to be a small square bone; and from this, and from its smoothness, it has got the distinct name of os planum.

The os unguis. The OS UNGUIS should also, perhaps, be counted as a part of the bone; for though when observed in the orbit, it seems to be a small detached bone, thin, like a scale, and of the size of the finger nail (whence it has its name,) yet in the adult the os unguis is firmly attached to the æthmoid bone, comes along with it when we separate the pieces of the skull, and when the os unguis is pared off from the æthmoid bone, it exposes the cells. This os unguis is a small scaly-like plate, in the inner corner of the orbit just over the nose, which closes the cells of the æthmoid bone; however, it will be described below as a distinct bone.

The cells of the æthmoid bone, which form so important a share of the organ of smelling, are arranged in great numbers, along the spongy bone. They are small neat cells, much like a honey-comb, and regularly arranged in two rows, parted from each other by a thin partition; so that the os planum seems to have one set of cells attached to it, while another regular set of cells belongs in like manner to the spongy bones. The cells are thus twelve in number,* opening into each other, and into the nose.

These cells are frequently the seat of venereal ulcers, and the spongy bones are the surface where polypi often sprout up. And from the general connections and forms of the bone, we can easily understand how the venereal ulcer, when deep in the nose, having got to these cells, cannot be cured, but undermines all the face; how the venereal disease, having affected the nose, soon spreads to the eye, and how even the brain itself is not safe. We see the danger of a blow upon the nose, which by a force upon the septum, or middle partition, might depress the delicate cribriform plate, so as to oppress the brain with all the effects of a fractured skull, and where

* The number is commonly twelve, but not regularly so.

no operation could give relief. And we also see much danger in pulling away polypi, which are firmly attached to the upper spongy bone.*

SPHENOIDAL BONE.—The sphenoidal bone completes the cranium, and closes it below. It is named SPHENOID, CUNEIFORM, or WEDGE-LIKE bone, from its being incased in the very basis of the skull; or it is named OS MULTIFORME, from its irregular shape. It is united to fourteen distinct bones. It is much of the shape of a bat, whence it is often named the PTERYGOID BONE: its temporal processes being like extended wings; its proper pterygoid processes like feet; its middle like the body and head of a bat. Its wing-like processes are in the hollow of the temple, forming a part of the squamous suture, and also composing a part of the orbit of the eye: its pterygoid processes hang over the roof of the mouth, forming the back of the nostrils: the body is in the very centre of the skull, and transmits five of the nerves from the brain, besides a reflected nerve; but still the body bears so small a proportion to the bone, that we have not a regular centre to which

* In the year 1814, WISTAR read a paper before the American Philosophical Society, in which he showed that the triangular plates of bone which were described by Bertin as forming the *sphenoidal cornets*, were continued from the cribriform plate of the æthmoid bone, in the form of two hollow triangular pyramids, which, when in their proper position, receive between them the azygous process of the sphenoid bone. "The internal side of each of these pyramids applies to the aforesaid azygous process; the lower side of each forms part of the upper surface of the posterior nares; the external side at its basis is in contact with the orbitar process of the os palati. The base of each pyramid forms also a part of the surface of the posterior nares, and contains a foramen which is ultimately the opening into the sphenoidal sinus of that side.

"In the sphenoidal bones, which belong to such æthmoids as are above described, there are no cells or sinuses; for the pyramids of the æthmoid bones occupy their places. The azygous process, which is to become the future septum between the sinuses, is remarkably thick, but there are no cavities or sinuses in it.

"The sides of the pyramids which are in contact with this process are extremely thin, and sometimes have irregular foramina in them, as if their osseous substance had been partially absorbed. That part of the external side of the pyramid, which is in contact with the orbitar process of the os palati, is also thin, and sometimes has an irregular foramen, which communicates with the cells of the aforesaid orbitar process.

"Upon comparing these perfect specimens of the æthmoid and sphenoidal bones of the subject about two years of age, with the os sphenoides of a young subject, which was more advanced in years, it appears probable, that the azygous process and the sides of the pyramids applied to it, are so changed in the progress of life, that they simply constitute the septum between the sinuses; that the external side of the pyramid is also done away, and that the front side and basis of the pyramid only remain, constituting the 'cornets sphenoidaux of M. Bertin.'" Wistar. Anat. vol. i. p. 35.

Notwithstanding the ease with which the accuracy of Wistar's observations on this structure may be demonstrated, European anatomists still continue to describe the *sphenoidal cornets*, without reference to the true condition of this arrangement; a circumstance, which, whether originating in prejudice or ignorance, is far from creditable to those who desire to be considered lovers of scientific improvement.—J. D. G.

all the processes can be referred; so that we are always, in describing this bone, moving forwards from point to point, from one process or hole to the next.

Points of demonstration.

1. Great alæ.

PROCESSES.—The ALÆ, or WINGS, often named temporal processes, rise up in the temple, to form a part of the hollow of the temple; and the wings of the sphenoid bone meeting the frontal, parietal, and temporal bones, by a thin scaly edge, they make part of the squamous suture, and give a smooth surface for the temporal muscle to play upon.

Its surfaces.

2. Orbital plate.

The other side of this same process looks towards the socket of the eye, and has a very regular and smooth surface; it is opposite to the os planum. As the æthmoid bone forms part of the inside of the orbit, the wing of the sphenoid bone forms part of the outside of the orbit; and so the surface turned towards the eye is named the ORBITARY PROCESS of the sphenoid bone, or ORBITARY PLATE of the great alæ.

3. Cerebral. 4. and Temporal fossæ.

The surface of the great wing which looks backward receives the middle lobe of the cerebrum, and is called the CEREBRAL FOSSA; and that which is external and receiving the temporal muscle, is called the TEMPORAL FOSSA.

5. Spinous process.

The lower, or back part of this bone runs out into a narrow point, which sinks in under the petrous portion of the temporal bone, and being sharp pointed, it is named the SPINOUS PROCESS. It is very remarkable for a small hole which permits the great artery of the dura mater to enter.

6. Styloid process.

The point of this spinous process projects in the form of a very small peak, which will hardly be found by the student. It projects from the basis of the skull, just within the condyle of the lower jaw, and being a small point, like the point of the stylus, or iron pen, it also is named STYLOID PROCESS.

7. Wing of Ingrasias.

The LESSER WING OF INGRASIAS next attracts the eye. It is that part of the bone which unites (by harmonia) with the orbitary plate of the frontal bone, and with the æthmoid bone.

8. Transverse spinous process.

This lesser wing projects laterally into the TRANSVERSE SPINOUS PROCESS.

Pterygoid processes.

The PTERYGOID PROCESSES* are four in number, two on each side. They are those processes upon which (with the spinous process) the bone naturally stands, and which, when we compare it with a bat, represent the legs; one of each side, is named external pterygoid, the other is named the internal pterygoid process.

9. External. 10. Internal.

Each EXTERNAL PTERYGOID PROCESS is thin and broad, and extends farther backwards. Each INTERNAL PTERYGOID PROCESS is taller and more slender, and not so broad. It has its end rising higher than the other, and tipped with a small neat hook, named the hook of the pterygoid process (viz. the HAMULAR PROCESS). The inner pterygoid processes form the back of the nostrils. The hook of the pterygoid process is

11. Hamular process.

* There is some confusion in this name, since pterygoid signifies alform or wing-like processes.

called the hook of the palate, of which it forms the backmost point. The musculus circumflexus vel tensor palati, rising from the mouth of the Eustachian tube, turns with a small tendon round this hook, like a rope over its pulley; and the great muscles of the lower jaw, the only ones for moving it sideways, or for its grinding motions, arise from the pterygoid processes. Betwixt the two processes there is a hollow which is called the fossa pterygoidea, and at the root of the internal pterygoid process there is a groove which leads to the mouth of the Eustachian tube.

12. Fossa pterygoidea.

13. Azygos process.

The AZYGOS PROCESS* is so named, from its being single, because it is seated in the centre of the bone, so that it can have no fellow. It stands perpendicularly downwards and forwards, over the centre of the nose, and its chief use is to give a firm seat or insertion for the vomer or bone, which forms the septum. The vomer, or proper bone of the partition, stands with a split edge, astride over this process, so as to have a very firm seat. A kind of union which has been called *gomphosis*.

14. Anterior clynoid processes.

The CLYNOID PROCESSES have, like many parts of the human body, a very whimsical name, very ill-suited to express their form; for it is not easy, in this instance, to acknowledge the likeness of four little knobs to bed-posts; yet the clynoid processes are very remarkable. The two ANTERIOR CLYNOID PROCESSES are small bumps, rather sharp, projecting backwards, and terminating in two flat projecting points. The POSTERIOR CLYNOID PROCESSES rise about an inch farther backwards, and are, as it were, opposed to the others. They rise in one broad and flat process, which divides above into two points, small and round, or knobby at their points; and they look forwards towards the anterior clynoid processes.

15. Posterior.

16. Tuberculum.

The TUBERCULUM OLIVARE is an eminence betwixt the anterior clynoid process and before the *sella turcica*.

17. Sella turcica.

The SELLA TURCICA, EPHIPPIUM, or Turkish saddle, is the space enclosed by these four processes, and is well named. The sella turcica, supports the pituitary gland, an appendage of the brain, the use of which is unknown. The carotid arteries rise up by the sides of the sella turcica, and mark its sides with a broad groove. The optic nerves lie upon a groove at the fore-part of the sella turcica, betwixt the two anterior clynoid processes; and sometimes the two anterior processes stretch backwards, till they meet the posterior ones, and form an arch, under which the carotid artery lies. Often the posterior clynoid knobs cannot be fairly distinguished; since, in many skulls, they form but one broad process.

* Azygos is a term which is applied to such parts as have no fellow; because almost always the parts on one side of the body are balanced by similar and corresponding parts on the other side. When they stand in the centre of the body, or are otherwise single, we call them azygos, and so the azygos process of the æthmoid and sphenoid, and other bones; or the azygos vein, which runs in the centre of the thorax, and is single.

On the side of the posterior clynoid process, the carotid artery as it rises impresses its form upon the bone. 18. Depression for the carotid.

The cone, or triangular process, is singularly placed in obscurity, when the bones are in union, and in separating the sphenoid bone it is very apt to be broken off. This process closes the cell, and projects laterally towards the deepest part of the orbit, but so as to be concealed by the palate bone. 19. Triangular process.

This bone has also its cells, for all that part which we call the body of the bone, all the sella turcica, that space which is betwixt the clynoid processes within and the azygos process without, is hollowed into one large cell, divided with a middle partition. It is, indeed, less regular than the other cells; it is sometimes very large, sometimes it is not to be found; it has other trifling varieties which it were idle to describe. As it communicates with the æthmoid cells, it probably performs one office with them, is almost a continuation of them, so that when any one is less or wanting, the others are proportionably larger. 20. Sphenoid cell.

In the fœtus there is no sphenoid cell; and the great alæ can be separated by maceration.

HOLES.—The sphenoid bone is so placed in the very centre of the skull, that its holes transmit the principal nerves of the skull, and it bears the marks of the chief arteries.

The OPTIC HOLES are large round holes, just under each anterior clynoid process. We trace the optic nerves by a large groove into each optic hole; and an artery goes along with them, named the ophthalmic artery, nearly the size of a crow-quill, twisting round the optic nerve, and giving arteries to the eye-lids, muscles, and lachrymal gland, but most especially to the ball and humours of the eye itself. This ocular or ophthalmic artery comes off from the great carotid, while it lies by the side of the sella turcica: and it is a branch again of this ophthalmic artery, which goes out upon the forehead, through the superciliary notch, or hole. 21. Optic foramen.

The FORAMEN LACERUM ANTERIUS is next in order, and is so named because it is a wide slit. It is also called superior orbitary fissure. The foramen lacerum is wide near the sella turcica, grows gradually narrower, as it goes out towards the temple, till it terminates almost in a slit. The upper line of the foramen lacerum is formed by the transverse spinous process, extending outwards, sharp and flat. 22. Foramen lacerum.

The nerves of the skull are counted from before backwards. There are nine nerves, proper to the skull; the first, or olfactory nerve, perforates the cribriform bone; the second, or optic nerve, passes through the optic hole; the third, fourth, part of the fifth, and sixth pairs of the nerves, pass through this foramen lacerum, or wide hole, to go also into the orbit. The optic nerve forms the proper organ of vision. The smaller nerves of the third, fourth, fifth, and sixth pairs, go to animate its muscles or bestow sensibility, and, passing through the orbit, to mount upon the forehead, or go downwards into the nose.

23. Foramen rotundum. The FORAMEN ROTUNDUM is named from its round shape. The foramen opticum is indeed round, but it has already got an appropriated name. Now to give the young anatomist a regular notion of this, and of the next hole, we must enumerate the branches of the fifth pair. The fifth nerve of the brain is as broad as the little finger, and lies by the side of the sella turcica, where it divides into three lesser nerves, which are called branches of the fifth pair. The first branch of the fifth pair is destined for the eye; the second branch of the fifth pair for the upper jaw; the third branch of this fifth pair for the lower jaw: so the first branch of the fifth pair passes through the foramen lacerum to the eye; the second branch of the fifth pair passes through the foramen rotundum to the upper jaw; the third branch of this great nerve passes through the foramen ovale to the lower jaw.

The foramen rotundum, then, is a hole exactly round, pretty large, opening immediately under the inner end of the foramen lacerum, and transmitting the second branch of the fifth pair of nerves to the upper jaw.

24. Foramen ovale. The FORAMEN OVALE is an oval hole, larger than the foramen rotundum; about half an inch behind it: and transmitting the third branch of the fifth pair to the lower jaw.

25. Foramen spinale. The FORAMEN SPINALE, or SPINOUS HOLE, is a very small round hole, as if made with a large pin; is in the very point of the spinous process; is one third of an inch behind the oval hole, and transmits the small artery, less than a crow-quill, which constitutes the chief artery of the dura mater, viz. that artery which makes its impression upon the parietal bone.

26. Foramen pterygoideum. There is still another hole, which transmits a nerve curious in this respect, that it is not going out from the skull, but returning into it: for the second branch of the fifth pair, or the superior maxillary nerve, sends a small branch backwards, which, having come within the skull, enters the temporal bone, and goes to join itself to the portio dura of the seventh pair, and in its way gives a small branch, to help out the slender beginning of the great sympathetic nerve. This retrograde branch of the superior maxillary nerve gets back again into the skull, by a hole which is found just under the root of each pterygoid process, whence it is named PTERYGOID HOLE: or, by many, is named after its discoverer, the VIDIAN HOLE.* This hole is almost hidden under the point of the petrous bone; is not to be seen unless in the separated bones, and is nearly of the size of the spinous hole.

27. Irregular foramina. If there are found some minute holes about the sella turcica, they are the marks of some blood-vessels entering the bone to nourish it.

* This retrograde twig is the little nerve which perforates the os petrosum on its fore part. Vidus Vidius was a professor of Paris, and physician to Francis the First.

When the bones of the cranium are united, there is apparent an irregular hole, which corresponds well with the name foramen lacerum medium. It is the continuation of the carotid foramen, but belongs equally to the sphenoid, temporal, and occipital bones. The petrous portion of the temporal bone points to it.* Common foramina. 28. Foramen lacerum medium.

There is a second common hole formed betwixt the sphenoid, the maxillary, and cheek-bone. It is called the spheno-maxillary fissure. 29. Spheno-maxillary fissure.

There is a third common hole betwixt the cell of the palate-bone (in the separate bone a groove may be noticed on the back part of this cell) and the root of the pterygoid process. This hole transmits an artery, and a twig of the fifth pair of nerves, into the membrane of the nose. 30. Spheno-palatine fissure.

OF THE BONES OF THE FACE AND JAWS.

The face is composed of a great number of small bones, which are grouped together under the common name of upper and lower jaw. There are bones on either side of the face, and a central or azygos bone: but as their names could convey no distinct notion of the uses, forms, or places of these bones, to enumerate them were but waste of time: they have indeed sutures, and their sutures have been very regularly enumerated; but these bones meet each other by such thin edges, that no indentation nor proper suture is formed. None of these sutures run for any length, or are of any note, therefore I have only this to say, concerning the sutures of the face, that they are acknowledged to be purely a consequence of the ossification having begun in many points: no particular design of nature has been supposed. The sutures, if they require names, are to be named after the bones which they unite together.

OSSA NASI.—The ossa nasi are small bones, rather thin, having no cancelli, being merely firm and condensed plates. They are convex outwardly, so that the two together form nearly an arch. They are opposed to each other by a pretty broad surface, so that their thin arch is firm. They have a flat rough surface, by which they are laid upon the rough surface of the frontal bone; so that there also their connection is strong. They are enclosed by a branch of the upper jaw-bone, which, stretching upwards, is named its nasal process: and they lie with their edges under it in one part, and above it

* It is called medium because there is a foramen lacerum betwixt the temporal and occipital bones which make three of that name.

in another, in such a way that they cannot easily be forced in. Lastly, their lower edge is rough, for the firm attachment of the cartilages of the nose; and their lowest point, or that where the bones of the nose and the gristles of the nose are joined, is the most prominent point (or, as it is vulgarly called, the bridge) of the nose; from which connection, notwithstanding its firmness, the cartilages are sometimes luxated.

The only point like a process in these bones is, that rough ridge formed by their union which projects towards the cavity, to give attachment to the nasal plate of the æthmoid bone.

Os UNGUIS, so named from its being of the size and shape of the nail of the finger; or sometimes named the os LACHRYMALE, from its holding the duct which conveys the tears, is that thin scale of bone which I have described as belonging to the os æthmoides. It is commonly described as a distinct bone; it is a thin flat bone, a single scale, without any cancelli, having only one sharp ridge upon it; it forms a groove for lodging the lachrymal sac, and is of course found in the inner angle of the eye at its fore part, and just touching the top of the nose. One half of this bone is behind the groove, and there the eye rolls upon it. One half of it is occupied by the groove for the nasal duct; and the other side of the groove is formed by the rising branch or nasal process, as it is called, of the upper jaw-bone. The os unguis is delicate, and easily broken, being as thin as a sheet of paper. It is this bone which is pierced in the operation for the fistula lachrymalis, which is easily done, almost with a blunt steel or probe; and the chief caution is to perforate in the place of the groove, as that will lead into the nose, and not behind it, which would carry the perforating instrument into the æthmoidal sinuses, and perhaps wound the spongy bone; nor more forward, as that would be ineffectual from the strength of the nasal process of the maxillary bone.

1. Ridge.
2. Groove.

This bone seems peculiarly liable to caries, which is perhaps the nature of all these thin bones; for as they have no marrow, they must depend entirely on their periosteum for their blood-vessels, which they are no sooner robbed of than they die.

OSSA MAXILLARIA SUPERIORA.—The upper jaw-bones are particularly worthy of notice; for here we find all that is curious in the face, even to its size and shape. The upper jaw-bones are of a very great size, forming, as it were, the foundation or basis of the face. They send a large branch upwards, which forms the sides of the nose; a broad plate goes backwards, which forms the roof of the palate. There is a circular projection below, which forms the alveoli, or sockets of the teeth. The upper jaw-bones are quite hollow within, forming a very large cavity, which is capable of containing an ounce of fluid, or more: and the size of this cavity seems to determine the height of the cheek-bone and the form of the face; and the diseased enlargement of this cavity raises the cheek-bone, protrudes the eye, and deforms the face in a very extraordinary degree.

These processes, and this cavity of the bone, are what deserve most particular notice.

The surfaces or plates of the bone are these: external or *malar*; the superior or *orbital*; the internal or *nasal*; the inferior or *palatine*. **Surfaces.**

From this description we shall understand the connections of the bone. It is attached forward and upward to the nasal and frontal bones; laterally to the cheek-bone, and in the orbit it is connected with the lachrymal and æthmoid bones; towards the nasal cavities it has the vomer, palate-bone and lower spongy bones attached to it; and at the back part it touches the sphenoid bone. **Connections.**

The first process is the NASAL PROCESS, which extends upwards to form the side of the nose. It is arched outwards, to give the nostrils shape. Its sides support the nasal bones; and the cartilages of the alæ nasi, or wings of the nose, are fixed to the edges of this process. On the inside and root of the nasal process there is a rough horizontal ridge, which gives attachment to the fore part of the inferior spongy bone. **1. Nasal process.** **2. Internal ridge.**

A plate of this bone is called the orbitary process. This thin plate is the roof of the great cavity, which occupies this bone entirely. It is at once as a roof to the antrum maxillare, and as a floor for the eye to roll upon. There is a wide groove along the upper surface of this plate, in which the chief branch of the upper maxillary nerve lies: and this nerve, named infra-orbitary nerve, from its lying thus under the eye, comes out by a hole of the jaw-bone under the eye, which is named infra-orbitary hole. And thus the nerve appearing upon the cheek, becomes a nerve of the face. **3. Orbitary plate.** **Infra-orbitary canal.**

This great bone is the basis upon which the cheek-bone stands; and that it may have a firm place, there is a rough and (as anatomists call it) scabrous surface, of a triangular shape, which makes a very firm suture with the cheek-bone; and as this surface rises a little, it is named the MALAR PROCESS. **4. Malar process.**

From the lower circle of the upper bone there projects a semicircle of bone, which is for lodging the teeth of the upper jaw. This circle of bone is as deep as the fangs of the teeth are long. And it may be very truly named a process (PROCESSUS ALVEOLARIS,) since it does not exist in the fœtus, nor till the teeth begin to be formed; since it grows along with the teeth, and is absorbed and carried clean away when in old age the teeth fall out. The sides of the sockets in which the teeth are lodged are extremely thin, and surround them closely. The teeth are so closely embraced by their sockets, and we are so far from being possessed of any instrument by which they can be pulled perpendicularly out, that the sockets can seldom escape; they are broken or splintered in perhaps one **5. Alveolar process.**

of four extractions, even by the most dexterous artists in that line.

6. Palate process. The PALATE PROCESS is a plate of bone which divides the nose from the mouth, constituting the roof of the palate, and the floor or bottom of the nostrils. This plate is thinner in its middle, and thicker at either edge: thus, it is thick where it first comes off from the alveolar process; it is thin in its middle; and it is again thick where it meets its fellow of the opposite side. For at the place where the two upper jaw-bones meet, the palate-plate is turned upwards, so that the two bones are opposed to each other in the middle of the palate by a broad flat surface, which cannot be seen but by separating the bones. This surface is so very rough, that the middle palate-suture almost resembles the sutures of the skull; and the maxillary bones are neither easily separated, nor easily joined again. This meeting of the palate-plates by a broad surface makes a rising spine, or sharp ridge, towards the nostrils, so that the broadness of the surface by which these bones meet serves a double purpose; it joins the bones securely, and it forms a small ridge upon which the split edge of the vomer, or partition of the nose, is planted. Thus we find the palate-plate of the maxillary bones conjoined, forming almost the whole of the palate, while what are properly called the palate-bones form a very small share of the back part of the roof of the mouth. As these thinner bones of the face have no marrow, they are nourished by their periosteum only; they are of course perforated with many small holes. A great many minute holes are found along the palate-plate, about the place of the sockets, and indeed all over the maxillary bones; and this is particular in the palate, that the hard membrane, or covering of it, is fixed to the bony plate by many rough tubercles, and even by small hooks, which are easily found in the dried bone.

Its suture.

7. Nasal spine.

8. Internal nasal plate. Since we are describing the plates of the bone as processes, we ought to enumerate the *facies interna nasalis* as an INTERNAL NASAL PLATE. This is the side of the bone which is towards the cavity of the nose, on which the lower spongy bone hangs, and which is perforated to allow a communication betwixt the great cell and the nose.

9. Antrum maxillare. The ANTRUM MAXILLARE, or cavity of the jaw-bone, is commonly named ANTRUM HIGHMORIANUM, after its discoverer, Highmore. We have gone round the antrum on all its sides, in describing these processes of the bone: the palate-plate makes the floor of the antrum; the orbitary process makes its roof; the cheek, quite up from the sockets of the teeth to the lower part of the eye, forms its walls or sides: so that when the antrum enlarges, it is the cheek that becomes deformed; and when we design to open the antrum, we either perforate its anterior surface within the cheek, or pull one of the teeth. The antrum is round towards the cheek, but it has a flat side towards the nose; it is divided from the cavity of

the nostril by a flat and very thin plate of bone; it seems in the naked skull to have a very wide opening; but in the skull, covered with its soft parts, we find the antrum almost closed by a membrane which stretches over the opening, and leaves but one or two very small holes, of the size of the smallest pea, by which, perhaps, the reverberation of sound in the antrum is more effectual in raising the voice, and by which small hole the mucus, which is secreted in the antrum, drops out into the nose. The cavity of the antrum, like the inner surfaces of the nostrils, is covered with a membrane, and is bedewed with mucus; and the mucus drops more or less freely in various positions of the head. Sometimes by cold or other accidents, inflammations and swellings of the membrane come on; the holes are closed; the drain of matter is suppressed and confined within, and the cheek swells. Perhaps there may be some particular disease of the membrane with which the cavity is lined, or of the bone itself: in one way or other, diseases of this cavity, and collections of matter, dreadful pain and caries of the bone, are very frequent: then the cheek rises: the face is irrecoverably deformed. Sometimes the matter makes its way by the sides of the teeth, or at last it bursts through the bones, makes an ulcer in the cheek; and then there is a natural cure, but slow and uncertain. There is no very sure mark of this disease; it may be known by an attentive retrospect of all the circumstances. The disease is not to be easily nor certainly discovered; but a very long continued tooth-ache, an uncommon degree of pain or greater affection of the eye, with a swelling and redness and gradual rising of the cheek, are very suspicious signs. The pulling of the second or third of the grinding teeth, often bring a splinter away with it, which opens a road for the matter to flow; or though there be no breach of the socket, often the confined matter follows the tooth, because not unfrequently the longer fangs of the grinders naturally penetrate quite into this cavity of the jaw: if the matter should not flow, the floor of the antrum is easily perforated, by introducing a sharp stilet by the socket of the tooth that is pulled. The flow of the matter gives relief, and injections complete the cure. But as this opening is sometimes a cure, it is sometimes also a disease; for the breaking of a socket, sometimes opening a way into this antrum, there follows inflammation of its internal surface, a running of matter, and sometimes caries of the bone.

Its membrane.

Root of the second molaris projects into it.

Foramina.

10. Infra-orbitary hole.

HOLES.—There is only one perfect hole in this bone; but, by its union with other bones, it forms four more: the INFRA-ORBITARY hole, for transmitting the infra-orbitary nerve from the bottom of the eye, is the opening of the canal which comes along under the eye. It is just under the margin of the orbit, or sometimes the nerve which it transmits, divides, and makes two smaller holes in its passage upon the cheek. A hole in the palate-plate, which belongs equally to each of the maxillary bones, may be counted the second foramen; for it is betwixt the two bones in the fore part or beginning of the palate-suture behind the two first cutting teeth. This hole is named FORAMEN INCISIVUM, as opening just behind the incisive or cutting teeth; or it is named ANTERIOR PALATINE HOLE, to distinguish it from one in the back of the palate. This hole is large enough to receive the point of a quill; it is single towards the mouth; but towards the nose it has two large openings, one opening distinctly into each nostril.

11. Foramen incisivum.

But it will be well to explain here a third hole, which is common to the maxillary with the proper palate-bone. It is formed on the back part of the palate (one on either side), in the suture which joins the palate-bones to the jaw-bones: it is named POSTERIOR PALATINE HOLE: it is as large as the anterior palatine hole, but it serves a much more important purpose; for the upper maxillary nerve sends a large branch to the palate, which branch comes down behind the back of the nostril, perforates the back of the palate by the posterior palatine hole, and then goes forward in two great branches along the palate. Thus the chief nerves of the palate come down to it through these posterior palatine holes. The use of the anterior palatine hole has long been a problem. It looks almost as if it were merely designed for giving the soft palate a surer hold upon the bone; but Hunter and Scarpa describe a nerve from the fifth pair, taking its course in this way to the soft palate.

12. Posterior palatine hole.

13. Lachrymal groove.

The fourth foramen is formed by the union of the lower spongy bone to the internal nasal plate of the bone; and is for the transmission of the lachrymal duct: the groove will be observed just behind the upright nasal process.

14. Lateral orbitary fissure.

The LATERAL ORBITARY FISSURE, called oftener SPHENO-MAXILLARY FISSURE, has been already noticed: it is a slit formed by this bone and the sphenoid bone; it is a communication betwixt the orbit and temple; the deepest part is named spheno-palatine fissure.

The whole surface of the bone which forms the antrum is perforated with frequent small holes, especially towards its back part, transmitting small arteries and nerves to the teeth; and the back part of the antrum forms with the orbitary part of the sphenoid bone a second foramen lacerum for the orbit, which is an irregular opening towards the bottom of the socket, and is for the accumulation of fat, rather than for the transmission of nerves; and it is from the wasting of this fat, taken back into the system, that the eye sinks so remarkably in fevers, consumptions, and such other diseases as waste the body. At the termination of the alveolar circle, backwards, there are two or three holes, into which the branches of the internal maxillary artery enter, which go to supply the teeth of the upper jaw. There is a trifling hole for the transmission of an artery on the nasal plate of this bone.

15. Alveolar foramina.

The OSSA PALATI, or PALATE-BONES, are very small, but have such a number of parts, and such curious connections, as are not easily explained. They seem to eke out the superior maxillary bones, so as to lengthen the palate, and complete the nostrils behind: they even extend upwards into the socket, so as to form a part of its circle; although, in looking for them upon the entire skull, all these parts are so hidden, that we should suppose the palate-bones to be of no greater use nor extent than to lengthen the palate a little backwards.

The parts of the palate-bone are these:

The PALATINE PLATE, or process of the palate-bone, whence it has its name, lies horizontal in the same level with the palatine process of the jaw-bone, which it resembles in its rough and spinous surface, in its thinness, in its being thinner in the middle, and thicker at each end; in its being opposed to its fellow by a broad surface, which completes the MIDDLE PALATINE SUTURE; and it is connected with the palate process of the jaw by a suture resembling that by which the opposite bones are joined; but this suture, going across the back part of the palate, is named the TRANSVERSE PALATINE SUTURE. Where the two palate-bones are joined, they run backwards, into an acute point; on either side of that middle point, they make a semi-circular line, and again run out into two points behind the grinding teeth of each side. By this figure of the bones, the back line of the palate has a scolloped or waved form. The velum palati, or curtain of the palate, is a little arched, following the general line of the bones; the uvula, or pap, hangs exactly from the middle of the velum, taking its origin from the middle projecting point of the two bones; and a small muscle, the azygos uvulæ, runs down in the middle of the velum, taking its origin from this middle part of the bones. **1. Palatine plate.**

The small projecting point of the palate-bone, just behind the last grinding tooth, touches the pterygoid process of the sphenoid bone; it is, therefore, named the PTERYGOID PROCESS of the palate-bone; but it is so joined with the pterygoid process of the sphenoidal bone, that they are not to be distinguished in the entire skull. The posterior pterygoid hole, or third hole of the palate, is just before this point. **2. Pterygoid process.**

The NASAL PLATE, or PROCESS, is a thin and single plate; rises perpendicularly upwards from the palate; lies upon the side and back part of the nostrils, so as to form their opening backwards into the throat; it is so joined to the upper jaw-bone, that it lies there like a sounding-board upon the side of the antrum Highmorianum, and completes that cavity forming the thin partition betwixt it and the nose. On the inside of the nasal plate there is a rough projection which runs horizontally, and is the continuation of a spine of the maxillary bone, for the attachment of the lower spongy bone. On the outside of the nasal process is the groove for the palatine nerve. **3. Nasal plate. 4. Ridge. 5. Groove.**

This nasal process extends thus up from the back arch of **6. Orbitary plate and cell.**

the palate to the back part of the orbit; and, though the nasal plate is very thin and delicate in its whole length, yet, where it enters into the orbit, it is enlarged into an irregular kind of knob of a triangular form. This knob is named its ORBITARY PROCESS; or, as the knob has two faces looking two ways in the orbit, it is divided sometimes (as by Monro the father) into two orbitary processes, the anterior and posterior; the anterior one is the chief. The orbitary process, or point of the palate-bone, being triangular, very small, and very deep in the socket, is not easily discovered in the entire skull.

7. Its cell. This orbitary process is most commonly hollow or cellular, and its cells are so joined to those of the sphenoid bone, that it is the palate-bone that shuts the sphenoid cells, and the sphenoid and PALATINE CELLS of each side constitute but one general cavity.

The OSSA SPONGIOSA, or TURBINATA INFERIORA, are so named, to distinguish them from the upper spongy bones, which belong to the os æthmoides; but these lower spongy bones are quite distinct, formed apart, and connected in a very slight way with the upper jaw-bones.

The OSSA SPONGIOSA INFERIORA are two bones, much rolled or convoluted, very spongy, much resembling puff-paste, having exactly such holes, cavities, and net-work, as we see in raised paste, so that they are exceedingly light. They lie rolled up, in the lower part of the nose; are particularly large in sheep; are easily seen either in the entire subject or in the naked skull. Their point forms that projection which we touch with the finger in picking the nose; and from that indecent practice, very often serious consequences arise; for in many instances, polypi of the lower spongy bones, which can be fairly traced to hurts of this kind, grow so as to extend down the throat, causing suffocation and death.

One membrane constitutes the universal lining of the cavities of the nose, and the coverings of all the spongy bones. This continuity of the membrane prevents our seeing in the subject how slightly the spongy bones are hung; but in the bare and dissected skull we find a neat small HOOK upon the spongy bone, by which it is hung upon the edge of the antrum maxillare; for this lower spongy bone is laid upon the side of the antrum, so as to help the palate-bone in closing or covering that cavity from within. One END of the spongy bone, rather more acute, is turned towards the opening of the nostril, and covers the end of the lachrymal duct: the other END of the same bone points backwards towards the throat. The curling plate hangs down into the cavity of the nostril, with its arched side towards the nose. This spongy bone differs from the spongy process of the æthmoid bone, in being less turbinated or complex, in having no cells connected with it, and perhaps it is less directly related to the organ of smell. If polypi arise from the upper spongy bone, we can use less freedom, and dare hardly pull them away, for fear of injuring the cribriform plate of the æthmoid bone. We are indeed not absolutely prohibited from pulling the polypi from the upper spongy bone; but we are more at ease in pulling them from the lower one, since it is quite an insulated bone. When peas, or any such foreign bodies, are detained in the nose, it must be from swelling, and being detained among the spongy bones.

The spongy bones are not absolutely limited in their number: there is sometimes found betwixt these two a third set of small turbinated bones, commonly belonging to the æthmoid bone.

VOMER.—The nose is completed by the vomer, which is named from its resemblance to a plough-share, and which divides the two nostrils from each other: it is a thin and slender bone, consisting evidently of two plates, much compressed together, very dense and strong, but still so thin as to be transparent. The two plates of which the vomer is composed split or part from each other at every edge of it, so as to form a groove on every side. 1. On its upper part, or, as we may call it, its base, by which it is fixed to the skull, the vomer has a WIDE GROOVE, receiving the perpendicular plate of the æthmoid and sphenoid bones: thus it stands very firm and secure, and capable of resisting very violent blows. 2. Upon its lower part its groove is narrower, and receives the rising line in the middle of the palate plate, where the bones meet to form the palate-suture. At its fore part it is united by a ragged surface, and by something like a groove, to the middle cartilage of the nose; and, as the vomer receives the other bones into its grooves, it is in a manner locked in on all sides: it receives support and strength from each; and if the vomer and its cartilage should seem too slender a support for the fabric of the nose, let it be remembered, that they are all firmly connected, and covered by one continuous membrane, which is thick and strong, and that this is as a periosteum, or rather like a continued ligament, which increases greatly the thickness and the strength of every one of these thin plates. The vomer, in almost every subject, bends much towards one or other nostril, so as sometimes to occasion no small apprehension, when it happens to be first observed.

Plates.

United with the æthmoid.

The sphenoid.

The palate-bone.

OS MALÆ, or the bone of the cheek, is easily known. It is that large square bone which forms the cheek: it has four distinct points, which anatomists have chosen to demonstrate with a very superfluous accuracy. The UPPER ORBITARY PROCESS stands highest, running upwards to form part of the socket, the outer corner of the eye, and the sharp edge of the temple. The INFERIOR ORBITARY PROCESS, which is just opposite to this, forming the lower part of the orbit, and the edge of the cheek. The MAXILLARY PROCESS is that broad and rough surface, by which it is joined to the upper jaw-bone.

1. Upper orbitary process.

2. Inferior orbitary process.

3. Maxillary process.

The one the best entitled to the name of process, because it stands out quite insulated, and goes outwards and backwards to unite with the temporal bone, forming the zygoma or temporal arch, is named the ZYGOMATIC PROCESS. That plate, which goes backwards to form a part of the orbit, is named the INTERNAL ORBITARY PROCESS. A small hole is observed on the outer surface of the bone, which transmits an artery, and sometimes a very small nerve, from the orbit.

4. Zygomatic process. **5. Internal orbitary process.** **6. Foramen.**

OS MAXILLÆ INFERIORIS.—The lower jaw-bone is likened to a horse-shoe, or to a crescent, or to the letter U, though we need be under no anxiety about resemblances for a form so generally known. There is such an infinite complication of parts surrounding the jaw, of glands, muscles, blood-vessels, and nerves, that it were endless to give even the slightest account of these. They shall be reserved each for its proper place, while I explain the form of the lower jaw, in the most simple and easy way. The lower jaw is divided into the chin, viz. the space betwixt the two mental foramina ; the base, properly the sides, extending backward to the angle ; and the upright portion of the bone.

Chin. The fore part, or chin, is in a handsome and manly face very square ; and this portion is marked out by this squareness, and by two small holes, one on either side, by which the nerves of the lower jaw come out upon the face.

Base. The base of the jaw is a straight and even line, terminating the outline of the face. It is distinctly traced all along, from the first point of the chin, backwards to the angle of the jaw. Fractures of this bone are always more or less transverse, and are easily known by the falling down of one part of this even line, and by feeling the crashing bones when the fallen part is raised. Such fractures happen from blows or falls ; but not by pulling teeth, for the sockets of the teeth bear but a small proportion to the rest of the jaw ; even in children, this cannot happen ; for in them the teeth have shorter roots, and have no hold nor dangerous power over the jaw : though (as I have said) the sockets often suffer, the jaw itself never yields.

Angle. The angle of the jaw is that corner where the base of the jaw ends, where the bone rises upwards, at right angles, to be articulated with the head. On the upright branch, as it is termed, we see the impressions of the masseter muscle. This part, also, is easily felt, and by it we judge well of the situation of veins, arteries, and glands, which might be in danger of being cut, in wounds or in operations. There are two processes of the jaw of particular importance, the coronoid or horn-like process, for the insertion of its strong muscles, especially of the temporal muscle, and the condyloid or hinge-process, by which it is jointed with the temporal bone.

1. Coronoid process. The CORONOID PROCESS, named from its resemblance to a horn, is, like the rest of the jaw-bone, flat on its sides, and turned up with an acute angle, very sharp at its point, and, when the bone is in its place, lying exactly under the zygoma or temporal arch. The temporal muscle runs under this arch, and lays hold on the coronary process, not touching it on one point only, but grasping it on every side, and all round. And the process is set so far before the articulation of the jaw, that it gives the muscle great power. This process is so defended by the temporal arch, and so covered by muscles, that it cannot be felt from without.

The CONDYLOID PROCESS, or the articulating process of the jaw, is behind this. This also is of the same flat form with the rest of the jaw. The condyle, or joint of the jaw-bone, is placed upon the top of the rising branch, and has a lengthened neck. The condyle, or articulating head, is not round, but flat, of a long form, and set across the branch of the jaw. This articulating process is received into a long hollow of the temporal bone, just under the root of the zygomatic process; so that by the long form of the condyles, and of the cavity into which it is received, this joint is a mere hinge, not admitting of lateral or rotatory motions, at least of no wider lateral motions than those which are necessary in grinding the food; but the hinge of the jaw is a complex and very curious one, which shall be explained in its proper place. The line of continuation between these two last processes forms what is called the semi-lunar notch. 2. Condyloid process. Cervix. Semi-lunar notch.

The ALVEOLAR PROCESS, or the long range of sockets for the teeth, resembles that of the upper jaw. The jaw, as the body grows, is slowly increasing in length, and the teeth are added in proportion to the growth of the jaws. When the jaws have acquired their full size, the sockets are completely filled; the lips are extended, and the mouth is truly formed. In the decline of life the teeth fall out, and the sockets are re-absorbed, and carried clean away, as if they had never been; so that the chin projects, the cheeks become hollow, and the lips fall in, the surest marks of old age. 3. Alveolar process.

The SPINA INTERNA, or internal tubercle of the lower jaw, is just behind the symphysis, or on the inside of the circle of the chin. It gives origin to muscles which move the tongue and larynx. On the inside of the lateral portion of the jaw, we observe an oblique ridge for the attachment of the mylo-hyoideus. On the inside of the angle, the bone is rough for the attachment of the pterygoid muscle. 4. Spina interna. 5. Linea interna. 6. Roughness for the attachment of the pterygoid muscles.

The successive changes of the form of the jaw are worthy of being mentioned once more. First, That in the child the jaw consists of two bones, which are joined slightly together in the chin. This joining, or symphysis, as it is called, is easily hurt, so that in preternatural labours it is, according to the common method of pulling by the chin, always in danger, and often broken. During childhood the processes are blunt and short, do not turn upwards with a bold and acute angle, but go off obliquely from the body of the bone. The teeth are Symphysis.

not rooted, but sticking superficially in the alveolar process; and another set lies under them, ready to push them from the jaws.

Secondly, That in youth the alveolar process is extending, the teeth are increasing in number. The coronoid and articulating processes are growing acute and large, and are set off at right angles from the bone. The teeth are now firmly rooted; for the second set has come up from the body of the jaw.

Thirdly, In manhood the alveolar process is still more elongated. The dentes sapientiæ are added to the number of the teeth; but often, by this, the jaw is too full, and this last tooth coming up from the backmost point of the alveolar process in either jaw, it sometimes happens that the jaw cannot easily close; the new tooth gives pain; it either corrupts, or it needs to be drawn.

Fourthly, In old age the jaw once more falls flat; it shrinks, according to the judgment of the eye, to half its size; the sockets are absorbed, and conveyed away; and in old age the coronoid process rises at a more acute angle from the jaw-bone, and by the falling down of the alveolar process, the coronoid process seems increased in length.

HOLES.—The holes of the jaw are chiefly two:

7. Internal maxillary hole.

A LARGE HOLE on the inner side, and above the angle of the jaw, just at the point where these two branches, the condyloid and the coronoid processes, part. A wide groove, from above downwards, leads to the hole; and the hole is, as it were, defended by a small point, or pike of bone, rising up from its margin. This is the GREAT HOLE for admitting the LOWER MAXILLARY NERVE into the hollow of the jaw, where it goes round within the circle of the jaw, distributing its nerves to all the teeth. But at the point where this chief branch of the nerve goes down into the jaw, another branch of the nerve goes forward to the tongue. And as nerves make an impression as deep as that of arteries in a bone, we find here two grooves, first, one marking the great nerve, as it advances towards its hole; and secondly, a smaller groove, marking the course of the lesser branch, as it leaves the trunk, and passes this hole to go forward to the tongue.

8. Impression of nerves.

Along with this nerve the lower maxillary artery, a large branch, enters also by the hole; and both the nerve and the artery, after having gone round the canal of the jaw, emerge again upon the chin.

9. Mental hole.

The second hole of the lower jaw is that on the side of the chin, which permits the remains of the great nerve and artery (almost expended upon the teeth) to come out upon the chin: it is named the MENTAL HOLE.

REVIEW OF THE SKELETON.

Although we are obliged to study the parts of the human body separately, in what we choose to call systems, as the bones, the muscles, the blood-vessels, yet these in nature form one system, and have the most intimate correspondence. The bones correspond with the muscular parts; and as the strength of the muscular frame distinguishes the male, so the male skeleton is marked by stronger and heavier bones, where all the processes and tubercles are more distinctly marked. It is for the same reason that the skeleton of an athletic man is valuable, because, corresponding with the fulness and symmetry of the muscular frame, that activity which has perfected the moving parts, has added distinctness to all the points of demonstration of the bones. It is a correspondence of the same kind which accounts for the bones of a man suddenly cut off in the vigour of health and exercise, being hard as ivory, compared with the bones of one who has lived an indolent life, or has long lain in sickness.

The skeleton of woman is further distinguished from that of man: 1. By the depth of the vertebræ; 2. The narrowness of the lower part of the thorax; 3. The sternum shorter, and more projecting; 4. The diameters of the pelvis greater; the sacrum more hollow, as well as broader; the os coccygis slender and more flexible at its articulation; 5. The acetabula more distant; 6. The thigh bones more oblique in their position under the body; 7. The feet small, and the toes more pointed outward; 8. The bones of the face smaller, and the cavities less developed. To these some add a peculiarity in the sagittal sutures, since the lateral divisions of the os frontis are joined later than in man.

As to the height of the human skeleton, we have, in the collections in London, skeletons of the natural form, varying from eight feet two inches to thirty-five inches in height. However we may account for the giant height, that of the dwarf is undoubtedly from disease, a diseased limitation of the growth of the whole body, which we sometimes see in individual parts of the body.

In reviewing the general form of the skeleton, we are naturally called to observe the SPINE.

When we contemplate the mechanism of the skull, we shall find that for protecting the brain its form is perfect, secure on all sides, and strengthened where the exposure to injury is the greatest. The spinal column, which sustains the skull, has equal provisions for the security of the brain; and, what is most admirable, there is an entirely different principle introduced here; for whereas in the head, the whole aim is firmness in the joinings of the bones, in the spine which supports the head, the object to be attained is mobility or pliancy. In the head, each bone is firmly secured to another; in the spine the bones are not permitted to touch: there is interposed a soft and elastic material, which takes off the jar that would result from the contact of the bones. We shall consider this subject a little more in detail.

The spinal column, as it is called, serves three purposes: it is the great bond of union betwixt all the parts of the skeleton; it forms a tube for the lodgment of the spinal marrow, a part of the nervous system as important to life as the brain itself; and lastly, it is a column to sustain the head.

We now see the importance of the spine, and we shall explain how the various offices are provided for.

If the protection of the spinal marrow had been the only object of this structure, it is natural to infer that it would have been a strong and unyielding tube of bone; but, as it must yield to the inflexions of the body, it cannot be constituted in so strict an analogy with the skull. It must, therefore, bend; but it must have no abrupt or considerable bending at one part; for the spinal marrow within would in this way suffer.

By this consideration we perceive why there are twenty-four bones in the spine, each bending a little; each articulated or making a joint with its fellow; all yielding in a slight degree, and, consequently, permitting in the whole spine that flexibility necessary to the motions of the body. It is next to be observed that, whilst the spine by this provision moves in every direction, it gains a property which belongs more to our present purpose to understand. At each interstice between the vertebræ there is a peculiar elastic gristly substance, which is squeezed out from betwixt the bones, and permits them to approach and play a little in the motions of the body. This gristly substance is enclosed in an elastic binding, or membrane of great strength, which passes from the edge or border of one vertebra to the border of the one next it. When a weight is upon the body, the soft gristle is pressed out, and the membrane yields: the moment the weight is removed, the membranes recoil by their elasticity, the gristle is pressed into its place, and the bones resume their position.

We can readily understand how great the influence of these twenty-four joinings must be in giving elasticity to the whole column; and how much this must tend to the protection of the brain. Were it not for this interposition of elastic material, every motion of the body would produce a jar to the delicate texture of the brain, and we should suffer almost as much in alighting on our feet as in falling on our head. It is, on the same principle, necessary for the builder to interpose thin plates of lead or slate between the different pieces of a column to prevent the edges (technically called arrises) of the cylinders from coming in contact, as they would, in that case, chip or split off.

But there is another very curious provision for the protection of the brain: we mean the curved form of the spine. If a steel spring, perfectly straight, be pressed betwixt the hands from its extremities, it will resist, notwithstanding its elasticity, and when it does give way, it will be with a jerk. Such would be the effect on the spine if it stood upright, one bone perpendicular to another; for then the weight would bear equally; the spine would yield neither to one side nor to the other; and, consequently, there would be a resistance from the pressure on all sides being balanced. We, therefore, see the great advantage resulting from the human spine being in the form of an italic *ſ*. It is prepared to yield in the direction of its curves; the pressure is of necessity more upon one side of the column than on the other; and its elasticity is immediately in operation without a jerk. It yields, recoils, and so forms the most perfect spring; admirably calculated to carry the head without jar, or injury of any kind. The most unhappy illustration of all this is the condition of old age. The tables of the skull are then consolidated, and the spine is rigid: if an old man should fall with his head upon the carpet, the blow, which would be of no consequence to the elastic frame of a child, may to him prove fatal; and the rigidity of the spine makes every step which he takes vibrate to the interior of the head, and jar on the brain.

We may observe, that the spine of an infant is not so pyramidal as in the adult. It is some time before the vertebræ of the loins assume their just form. The spine of the infant is straight, compared to the column of the adult: by which we see that there is a growth, and gradual change in the conformation of the chain of bones, fitting them for the erect posture.

In the adult the direction of the lumbar vertebræ, forward from the sacrum, protects the spine in the motion of the body; for if the spine stood perpendicularly, its base would be jarred in advancing forwards. We may take the comparison betwixt the attachment of the spine to the pelvis, and the insertion of the mast of a ship into the hull. The mast goes directly through the decks without touching them, and the heel of the mast goes into the step, which is formed of large solid pieces of oak timber laid across the keelson. The keelson is an inner keel, resting upon the floor-timbers of the ship, and directly over the proper keel. These are contrivances for enlarging the base, on which the mast rests as a column: for, in proportion to the height and weight of a column, its base must be enlarged, or it would sink into the earth; and so, if the mast were to bear upon a point, it would break through the bottom of the ship.

The mast is supported upright by the shrouds and stays. The shrouds secure it against the lateral or rolling motion, and the stays and backstays against the pitching of the ship.

These form what is termed the standing rigging. The mast does not bear upon the deck, or on the beams of the ship; indeed there is a space covered with canvas, betwixt the deck and the mast.

We often hear of a new ship going to sea to stretch her rigging; that is, to permit the shrouds and stays to be stretched by the motion of the ship, after which they are again braced tight: for if she were overtaken by a storm before this operation, and when the stays and shrouds were relaxed, the mast would lean against the upper deck, by which it would be sprung or carried away. Indeed, the greater proportion of masts that are lost, are lost in this manner. There are no boats which keep the sea in storms like those which navigate the gulf of Finland; their masts are not attached at all to the hull of the ship, but simply rest upon the step.

Although the spine has not a strict resemblance to the mast, the contrivances of the ship-builder, however different from the provisions of nature, show what is the object to be attained; and when we are thus made aware of what is necessary to the security of a column on a moveable base, we are prepared to appreciate the superior provisions of nature for giving security to the human spine.

The human spine rests on the *pelvis*, or basin; a circle of bones, of which the haunches are the extreme lateral parts; and the sacrum (which is as the keystone of the arch) is the central part. To this central bone of the arch of the pelvis the spine is connected; and, taking the similitude of the mast, the sacrum is as the *step* on which the base of the pillar, like the heel of the mast, is socketed or mortised. The spine is tied to the lateral parts of the pelvis by powerful ligaments, which may be compared to the shrouds. They secure the lower part of the spine against the shock of lateral motion or rolling; but, instead of the stays to limit the play of the spine forwards and backwards in pitching, or to adjust the rake of the mast, there is a very beautiful contrivance in the lower part of the column.

The spine forms here a semicircle, which has this effect; that, whether by the exertion of the lower extremities the spine is to be carried forward upon the pelvis, or whether the body stops suddenly in running, the jar which would necessarily take place at the lower part of the spine, C.* if it stood upright like a mast, is distributed over several of the bones of the spine; and, therefore, the chance of injury at any particular part is diminished.

For example, the sacrum, or centre bone of the pelvis, being carried forward, as when one is about to run, the force is communicated to the lowest bone of the spine. But, then, the surfaces of these bones stand with a very slight degree of obliquity to the line of motion; the shock communicated from

* See the woodcut, p. 144.

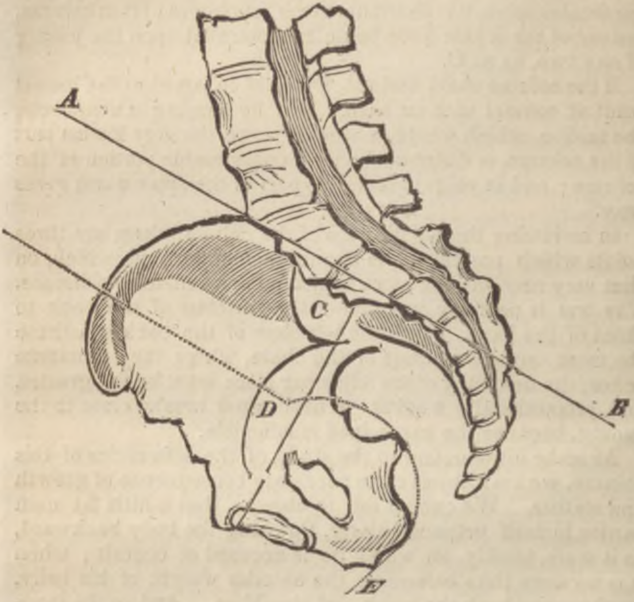
the lower to the second bone of the vertebræ is still in a direction very nearly perpendicular to its surface of contact. The same takes place in the communication of force from the second to the third, and from the third to the fourth; so that before the shock of the horizontal motion acts upon the perpendicular spine, it is distributed over four bones of that column, instead of the whole force being concentrated upon the joining of any two, as at C.

If the column stood upright, it would be jarred at the lowest point of contact with its base. But by forming a semicircle, the motion, which would produce a jar on the very lowest part of the column, is distributed over a considerable portion of the column; and in point of fact, this part of the spine never gives way.

In reviewing the building up of the column, there are three points which possess more extensive motion, and which, on that very account, are more subject to accident and to disease. The first is near the junction of the vertebræ of the back to those of the loins; for as the vertebræ of the back constitute the most unyielding part of the chain, where they terminate below, the flexibility of the adjoining piece must be the greater, and proportionally weaker—a fishing-rod breaks close to the joining, because the part joined is inflexible.

As some introduction to the study of the deformities of this column, we may observe the necessary consequence of growth and stature. We cannot fail to observe, that a little fat man carries himself perpendicularly, throwing the body backward, as it were, briskly, for which he is accused of conceit; when it is no more than balancing the anterior weight of his belly, by throwing back the trunk and shoulders. And so the *incessus* of a pregnant woman is stately, and she is accused of carrying her burden proudly, when, it may be, there is more shame than pride; yet she must throw her body back, to poise the increased weight of her condition. It is upon the same principle, that parents have so much trouble with a tall and thin young person, who naturally stoops, since the spine and head are always brought to bear perpendicularly over the sacrum; and the want of filling up, and consequent comparative deficiency of weight in front, makes the head and shoulders project forward. The spine, being a flexible column, produces that consent through the whole body, to which the eye is familiar, without our seeking to account for it. The stiff knee, and the erect position of the head, correspond, just as the relaxed knees, and the pelvis projecting backwards in old age, is accompanied with the curve in the back and the stoop of the neck and shoulders. These natural consequences should be well considered by those who append weights to young people to correct their carriage, when they should be attending to the conformation and the natural exercise of the trunk and limbs.

It has been explained how the PELVIS stands, as an arch betwixt the spine and the lower extremities. From the term pelvis, and from the manner in which the student has these collected bones demonstrated to him, he is apt to forget how they stand in relation to the body. If a line were drawn per-



pendicularly from the centre of the brim of the pelvis, that line would come through the umbilicus. If that line were carried through the cavity of the pelvis, equi-distant from the sacrum and pubis in all its course, it would form a curve D E; and this curved line, passing through the pelvis, is properly the axis of the pelvis. It is the line in which the child's head descends; it is the line in which instruments are used: the forceps in midwifery, the gorget in lithotomy; the trocar in puncturing the bladder must also be used with due regard to this line.

And now that the bones are contemplated in their natural relation, we see into what form the pelvis will be distorted, by the combined influence of rickets, pressure, and the progress of growth in the bones. The arch receives the pressure in three points; on the acetabula, where they rest on the thigh-bones, and on the sacrum, which, like the key-stone of an arch, closes the bones of the pelvis, and supports the column of the spine and the incumbent weight of the body. The consequence of this is, that the distorted pelvis assumes, most frequently, a triangular form. Sometimes, however, the ossa pubis are pressed in so uniformly as to give the pelvis a flattened form; and the accoucheur would do well to consider the form of the distorted pelvis, before he gives out his absolute rule, regarding what is to be done in certain degrees of diminished diameter in the brim and outlet of the pelvis.

OF THE CHEST.

In extending the parallel between the structure of the body and the works of human art, it signifies very little to what part we turn; for the happy adaptation of means to the end will every where call for our admiration, in exact proportion to our success in comprehending the provisions which Supreme Wisdom has made. We turn now to a short view of the bones of the chest.

The thorax, or chest, is composed of bones and cartilages, so disposed as to sustain and protect the most vital parts, the heart and lungs, and to turn and twist with perfect facility in every motion of the body: and to be in incessant motion in the act of respiration, without a moment's interval during a whole life. In anatomical description, the thorax is formed of the vertebral column or spine, on the back part, the ribs on either side, and the breast-bone or sternum, on the fore part. But the thing most to be admired is the manner in which these bones are united, and especially the manner in which the ribs are joined to the breast-bone, by the interposition of cartilages, or gristle,—of a substance softer than bone, and more elastic and yielding. By this quality, they are fitted for protecting the chest against the effects of violence, and even for sustaining life after the muscular power of respiration has become too feeble to continue without this support.

If the ribs were complete circles, formed of bone, and extending from the spine to the breast-bone, life would be endangered by any accidental blow; even the rubs and jolts to which the human frame is continually exposed, would be too much for their delicate and brittle texture. But these evils are avoided by the interposition of the elastic cartilage. On their fore part the ribs are eked out, and joined to the breast-bone by means of cartilages, of a form corresponding to that of the ribs, being, as it were, a completion of the arch of the rib, by a substance more adapted to yield in every shock or motion of the body. The elasticity of this portion subdues those shocks which would occasion the breaking of the ribs. We lean forward, or to one side, and the ribs accommodate themselves, not by a change of form in the bones, but by the bending or elasticity of the cartilages. A severe blow upon the ribs does not break them, because their extremities recoil and yield to the violence. It is only in youth, however, when the human frame is in perfection, that this pliancy and elasticity have full effect. When old age approaches, the cartilages of the ribs become bony. They attach themselves firmly to the breast-bone, and the extremities of the ribs are fixed, as if the whole arch were formed of bone unyielding and inelastic. Then every violent blow upon the side is attended with fracture of the rib, an accident seldom occurring in childhood, or in youth.

But there is a purpose still more important to be accomplished by means of the elastic structure of the ribs. This is in the action of breathing, especially in the more highly-raised respiration which is necessary in great exertions of bodily strength, and in violent exercise. There are two acts of breathing—*expiration*, or the sending forth of the breath; and *inspiration*, or the drawing in of the breath. When the chest is at rest, it is neither in the state of expiration nor in that of inspiration; it is in an intermediate condition between these two acts. And the muscular effort by which either inspiration or expiration is produced, is an act in opposition to the elastic property of the ribs. It is the property of the ribs to preserve the breast in that intermediate state between expiration and inspiration. The muscles of respiration are excited alternately, to dilate or to contract the cavity of the chest, and, in doing so to raise or to depress the ribs. Hence it is, that both in inspiration and in expiration the elasticity of the ribs is called into play; and, were it now within our province, it would be easy to show, that this property of the cartilages of the ribs preserves life, by respiration being continued after the vital muscular power, without such assistance, was too weak to carry it on.

It will at once be understood, from what has now been explained, how, in age, violent exertion is under restraint, in so far as it depends on respiration. The elasticity of the cartilages is gone, the circle of the ribs is now unyielding, and will not allow that high breathing, that sudden and great dilatation and contraction of the cavity of the chest, which is required for circulating the blood through the lungs, and relieving the heart amidst the more tumultuous flowing of the blood which exercise produces.

The thorax of the human skeleton is remarkable for its transverse diameter, its elevation and shortness*, and, consequently, for the large space betwixt the pelvis and margin of the chest, which gives a remarkable facility and extent to the motion of the human body. Quadrupeds have the thorax compressed laterally, with a projecting and lengthened sternum, so that the scapulæ rest on the sides of the thorax, and the fore legs stand perpendicularly under the chest.

OF THE EXTREMITIES.

There are a class of philosophers who conjoin, as necessary parts of the same plan, man's reason and the perfection of the hand, the one for council, the other for action. The peculiarity of the upper extremity, as distinguishing it from the lower

* The horse has thirty-six ribs; there are thirty-two in the hyena; forty in the elephant.

extremity, is the smallness of the bones, the freedom of their articulations, and the great variety of motions attainable through the combination of the whole. As distinguished from the anterior extremity of brutes, we find its peculiarity principally in the perfect clavicle, in the great mobility of the scapula, and the lateral projection of the glenoid cavity; in the provision of the joint of the elbow for the co-operation of the hands, and in the perfect articulation of the twenty-nine bones of the carpus, metacarpus, and fingers; in the position of the bones, and in the strength of the muscles of the thumb. There is a sort of resemblance in the arrangement of the bones of the lower and upper extremities: but the solid junction of the bones of the leg, the firm building of the bones of the tarsus, and the strength and size and firmly wedged position of the metatarsal of the great toe, are in remarkable contrast with the free rotatory motions of the radius, and the mobility of the thumb, and the freedom and extent of motion of the fingers.

The size and strength of the lower extremities at once declare the provision of the human skeleton for the upright position, and that there is no true biped but man. The admirable adaptation of all creatures to their condition, and the provision of monkeys and apes to climb and spring among the branches of trees, has given rise to long and useless speculations, not very creditable to philosophy. These creatures are of the class quadrumanus; their hind feet are as perfect instruments of prehension as their paws, which shows the limited object of their structure. A silly observation is copied through many books, that we owe the position of the toe to the dancing-master; but every thing in the shape of the bones of the lower extremity, and the insertion of the muscles, conform to this object; and it is that which gives elasticity, freedom, and, consequently, elegance to the motion of the body. How awkward is that man's gait who walks directly over his toes; and if a woman have one foot placed straight forward and the other pointed, you perceive the effect in the awkward motion of the whole of one side of the body compared with the other.

There are, in all, thirty-six bones in the foot; and the first question that naturally arises, is, Why should there be so many bones? The answer is, In order that there may be so many joints; for the structure of a joint not only permits motion, but bestows elasticity.

A joint consists of the union of two bones, of such a form as to permit the necessary motion; but they are not themselves in contact: each articulating surface is covered with cartilage, to prevent the jar which would result from the contact of the bones. This cartilage is elastic, and the celebrated Dr. Hunter discovered that the elasticity was in consequence of the numberless filaments being closely compacted, and extending from the surface of the bone, in such a manner that every filament was perpendicular to the pressure made upon it. The surface of the articulating cartilage is perfectly smooth, and is lubricated by the fluid called *synovia*, a viscous or oily liquor. A delicate membrane extends from bone to bone, confining this lubricating fluid, and forming the boundary of what is termed the cavity of the joint, although, in fact, there is no unoccupied space. External to this capsule of the joint, there are strong ligaments going from point to point of the bones, and so ordered as to bind them together without preventing their proper motions. From this description of a single joint, we can easily conceive what a spring or elasticity is given to the foot, where thirty-six bones are jointed together.

The most obvious proof of contrivance is the junction of the foot to the bones of the leg at the ankle joint. The two bones of the leg, the *tibia* and the *fibula*, receive the great articulating bone of the foot (*astragalus*) betwixt them. And the extremities of these bones of the leg project so as to form the outer and inner ankle. Now, when we step forward, and whilst the foot is raised, it rolls easily upon the ends of these bones, so that the toe may be directed according to the inequalities of the ground we are to tread upon ; but when the foot is planted, and the body is carried forward perpendicularly over the foot, the joint of the leg and foot becomes fixed, and we have a steady base to rest upon. Notwithstanding this mobility of the foot in some positions, when the weight of the body bears directly over it, it becomes so immoveable that the bones of the leg must be fractured before it yields.

We next observe, that, in walking, the heel first touches the ground. If the bones of the leg were perpendicular over the part which first touches the ground, we should come down with a sudden jolt, instead of which we descend in a semicircle, the centre of which is the point of the heel. And when the toes have come to the ground we are far from losing the advantages of the structure of the foot, since we stand upon an elastic arch, the hinder extremity of which is the heel, and the anterior the balls of the toes. A finely formed foot should be high in the instep. The walk of opera dancers is neither natural nor beautiful ; but the surprising exercises which they perform give to the joints of the foot a freedom of motion almost like that of the hand. We have seen the dancers, in their morning exercises, stand for twenty minutes on the extremities of their toes ; after which the effort is made to bend the inner ankle down to the floor, in preparation for the Bolero step. By such unnatural postures and exercises the foot is made unfit for walking, as may be observed in any of the retired dancers and old *figurantes*. By standing so much upon the toes, the human foot is converted to something more resembling that of a quadruped, where the heel never reaches the ground, and where the paw is nothing more than the phalanges of the toes.

This arch of the foot, from the heel to the toe, has the astragalus resembling the keystone of an arch; but, instead of being fixed, as in masonry, it plays freely betwixt two bones, and from these two bones, the os calcis and os naviculare, a strong elastic ligament is extended, on which it rests, sinking or rising as the weight of the body bears upon it, or is taken off, and this it is enabled to do by the action of the ligament which runs under it.

This is the same elastic ligament which runs extensively along the back of the horse's hind leg and foot, and gives the fine spring to it, but which is sometimes ruptured by the exertion of the animal in a leap, producing irrecoverable lameness.

Having understood that the arch of the foot is perfect from the heel to the toe, we have next to observe, that there is an arch from side to side; for when a transverse section is made of the bones of the foot, the exposed surface presents a perfect arch of wedges, regularly formed like the stones of an arch in masonry. If we look down upon the bones of the foot, we shall see that they form a complete circle horizontally, leaving a space in their centre. These bones thus form three different arches—forward; across; and horizontally: they are wedged together, and bound by ligaments. And this is what we alluded to when we said that the foundations of the Eddystone lighthouse were not laid on a better principle; but our admiration is more excited in observing, that the bones of the foot are not only wedged together, like the courses of stone, for resistance, but that solidity is combined with elasticity and lightness.

How much system there is in every thing belonging to an animal body, and what relation there is established through the whole skeleton, we may learn from the following considerations.

What we have now to state has been the result of the studies of many naturalists; of men who have laboured in the department of comparative anatomy, but have failed to seize upon it with the privilege of genius, and to handle it in the masterly manner of Cuvier.

Suppose a man ignorant of anatomy picks up a bone in an unexplored country, he learns nothing, except that some animal has lived and died there; but the anatomist can, by that single bone, estimate, not merely the size of the animal, as well as if he saw the print of its foot, but the form and joints of the skeleton, the structure of its jaws and teeth, the nature of its food, and its internal economy. This, to one ignorant of the subject, must appear wonderful, but it is after this manner that the anatomist proceeds: let us suppose that he has taken up that portion of bone in the limb of the quadruped which corresponds to the human wrist; and that he finds that the form of the bone does not admit of free motion in various directions, like the paw of the carnivorous creature. It is obvious, by the structure of the part, that the limb must have been merely for supporting the animal, and for progression, and not for seizing prey. This leads him to the fact that there were no bones resembling those of the hand and fingers, or those of the claws of the tiger; for the motions which that conformation of bones permits in the paw would be useless without the rotation of the wrist—he concludes that these bones were formed in one mass, like the cannon-bone, pastern-bone, and coffin-bones of the horse's foot.*

The motion limited to flexion and extension of the foot of a hoofed animal implies a restrained motion in the shoulder-joint; and thus the naturalist, from the specimen in his hand, obtains a very perfect notion of all the bones of the anterior extremity! The motions of the extremities imply a condition of the spine which unites them. Each bone of the spine will have that form which permits the bounding of the stag, or the galloping of the horse, but it will not have that form of joining which admits the turning or writhing of the spine, as in the leopard or the tiger.

And now he comes to the head:—the teeth of a carnivorous animal, he says, would be useless to rend prey, unless there were claws to hold it, and a mobility of the extremities like the hand, to grasp it. He considers, therefore, that the teeth must have been for bruising herbs, and the back teeth for grinding. The socketing of these teeth in the jaw gives a peculiar form to these bones, and the muscles which move them are also peculiar; in short, he forms a conception of the shape of the skull. From this point he may set out anew, for by the form of the teeth, he ascertains the nature of the stomach, the length of the intestines, and all the peculiarities which mark a vegetable feeder.

Thus the whole parts of the animal system are so connected with one another, that from one single bone or fragment of bone, be it of the jaw, or of the spine, or of the extremity, a really accurate conception of the shape, motions, and habits of the animal, may be formed.

It will readily be understood that the same process of reasoning will ascertain, from a small portion of a skeleton, the existence of a carnivorous animal, or of a fowl, or of a bat, or of a lizard, or of a fish; and what a conviction is here brought home to us, of the extent of that plan which adapts the members of every creature to its proper office, and yet exhibits a system extending through the whole range of animated beings, whose motions are conducted by the operation of muscles and bones!

After all, this is but a part of the wonders disclosed through the knowledge of a thing so despised as a fragment of bone.

* For these are solid bones, where it is difficult to recognise any resemblance to the carpus, metacarpus and bones of the fingers; and yet comparative anatomy proves that these moveable bones are of the same class with those in the solid hoof of the *belluæ* of Linnæus.

It carries us into another science; since the knowledge of the skeleton not only teaches us the classification of creatures, now alive, but affords proofs of the former existence of animated beings which are not now to be found on the surface of the earth. We are thus led to an unexpected conclusion from such premises; not merely the existence of an individual animal, or race of animals, but even the changes which the globe itself has undergone in times before all existing records, and before the creation of human beings to inhabit the earth, are opened to our contemplation.

REVIEW OF THE BONES OF THE CRANIUM, &c.

It requires no disquisition to prove that the brain is the most essential organ of the animal system, and being so, we may presume that it must be especially protected. We are now to inquire how this main object is attained?

We must first understand that the brain may be hurt, not only by sharp bodies touching and entering it, but by a blow upon the head which shall vibrate through it, without the instrument piercing the skull. Indeed, a blow upon a man's head, by a body which shall cause a vibration through the substance of the brain, may more effectually deprive him of sense and motion than if an axe or a sword penetrated into the substance of the brain itself.

Supposing that a man's ingenuity were to be exercised in contriving a protection to the brain, he must perceive that if the case were soft, it would be too easily pierced; that if it were of a glassy nature, it would be chipped and cracked; that if it were of a substance like metal, it would ring and vibrate, and communicate the concussion to the brain.

Further thoughts might suggest, that whilst the case should be made firm to resist a sharp point, the vibrations of that circular case might be prevented by lining it with a softer material; just as no bell can vibrate having such an incumbrance; its sound is stopped like the ringing of a glass by the touch of a finger.

If a soldier's head be covered with a steel cap, the blow of a sword which does not penetrate will yet bring him to the ground by the percussion which extends to the brain; therefore, the helmet is lined with leather, and covered with hair; for, although the hair is made an ornament, it is an essential part of the protection: we may see it in the head-piece of the Roman soldier, where all useless ornament, being despised as frivolous, was avoided as cumbrous.

We now perceive why the skull consists of two plates of bone, one external, which is fibrous and tough, and one internal, dense to such a degree that the anatomist calls it *tabula vitrea* (the glassy table.)

Nobody can suppose this to be accidental. It has just been stated, that the brain may be injured in two ways: a stone or a hammer may break the skull, and the depressed part of the bone injure the brain; whilst, on the other hand, a mallet struck upon the head will, without penetrating, effectually deprive the brain of its functions, by causing a vibration which runs round the skull and extends to every portion of its contents.

Were the skull, in its perfect or mature state, softer than it is, it would be like the skull of a child; were it harder than we find it is, it would be like that of an old man. In other words, as in the former it would be too easily pierced, so, in the latter, it would vibrate too sharply and produce concussion. The skull of an infant is a single layer of elastic bone; on the approach to manhood it separates into two tables; and in old age it again becomes consolidated. During the active years of man's life the skull is perfect: it then consists of two layers, united by a softer substance; the inner layer is brittle as glass, and calculated to resist any thing penetrating; the outer table is tough, to give consistence, and to stifle the vibration which would take place if the whole texture were uniform and like the inner table.

The distinction in the tables of the skull is of the utmost consequence to the surgeon: it explains what takes place in fracture of the skull, and affords him the principles upon which he performs the operation of trepan. Where a portion of the skull is driven in, owing to the greater brittleness of the inner table, the internal part is broken off to a greater extent than the outer. Thus it happens that the diameter of the inner table of the broken portion is greater than the diameter of the outer table: and the inner margin of the detached portion of bone shelves under the margin of the hole in the skull. It is necessary, therefore, that the hole in the skull should be enlarged, to bring out the detached portion of bone. From the same peculiarity of the two layers in the skull, the inner table of bone will be fractured when there is hardly any injury apparent on the outer table.

The alteration in the substance of the bones, and more particularly in the skull, is marvellously ordered to follow the changes in the mind of the creature, from the heedlessness of childhood to the caution of age, and even the helplessness of superannuation. The skull is soft and yielding at birth; during childhood it is elastic, and little liable to injury from concussion; and during youth, and up to the period of maturity, the parts which come in contact with the ground are thicker, whilst the shock is dispersed towards the sutures which are still loose. But when, with advancing years, something tells us to give up feats of activity, and falls are less frequent, the bones lose that nature which would render concussion harmless, and at length the timidity of age teaches man that his structure is no longer adapted to active life.

We must understand the necessity of the double layer of the skull, in order to comprehend another very curious contrivance. The sutures are the lines of union of the several bones which form the cranium, and surround and protect the brain. These lines of union are called sutures (from the Latin word for sewing), because they resemble seams. If a workman were to inspect the joining of two of the bones of the cranium, he would admire the minute dove-tailing by which one portion of the bone is inserted into, and surrounded by, the other, whilst that other pushes its processes or juttings out between those of the first in the same manner, and the fibres of the two bones are thus interlaced, as you might interlace your fingers. But when you look to the internal surface, you see nothing of this kind; the bones are here laid simply in contact, and this line is called *harmonia*, or harmony: architects use the same term to imply the joining by masonry. Whilst the anatomists are thus curious in names, it is provoking to find them negligent of things more interesting. Having overlooked the reason of the difference in the tables of bone, they are consequently blind to the purpose of this difference of the outward and inward part of a suture.

Suppose a carpenter employed upon his own material, he would join a box with minute and regular indentations by dovetailing, because he knows that the material on which he works, from its softness and toughness, admits of such adjustment of its edges. The processes of the bone shoot into the opposite cavity with an exact resemblance to the foxtail wedge of the carpenter—a kind of tenon and mortice when the pieces are small.

But if a workman in glass or marble were to inclose some precious thing, he would smooth the surfaces and unite them by cement, because, even if he could succeed in indenting the line of union, he knows that his material would chip off on the slightest vibration. The edges of the marble cylinders which form a column are, for the same reason, not permitted to come in contact; thin plates of lead are interposed to prevent the edges, technically termed *arrises*, from chipping off or splitting.

Now apply this principle to the skull. The outer softer tough table, which is like wood, is indented and dovetailed; the inner glassy table has its edges simply laid in contact. It is mortifying to see a course of bad reasoning obscure this beautiful subject. Thêy say that the bone growing from its centre, and diverging, shoots its fibres betwixt those which come in an opposite direction; thus making one of the most curious provisions of nature a thing of accident. Is it not enough to ask such reasoners, why there is not a suture on the inside as well as on the out?

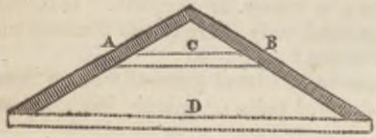
The junction of the bones of the head generally being thus exact, and like the most finished piece of cabinet work, let us next enquire, whether there be design or contrivance shown in the manner in which each bone is placed upon another.

A. The *parietal* bone.
B. The *frontal* bone.
C. The *occipital* bone.
D. The *temporal* bone.
E. The *sphenoid* bone.

When we look upon the side of the skull thus, the temporal suture betwixt the bones A and D is formed in a peculiar manner; the lower or temporal bone laps over the superior or parietal bone. This, too, has been misunderstood: that is to say, the plan of the building of the bones of the head has not been considered; and this joining, called the squamous suture, which is a species of scarfing, has been supposed a mere consequence of the pressure of the muscle which moves the jaw. Dr. Monro says, "the manner how I imagine this sort of suture is formed at these places, is, that by the action of the strong temporal muscles on one side, and by the pressure of the brain on the other, the bones are made so thin that they have not large enough surfaces opposed to each other to stop the extension of their fibres in length, and thus to cause the common serrated appearance of sutures; but the narrow edge of the one bone slides over the other."

The very name of the bones might suggest a better explanation. The ossa parietalia, the two large bones of a regular square shape, serve as walls to the interior or room of the head, where the brain is lodged. Did the reader ever notice how the walls of a house are assisted when thin and overburdened with a roof?

The *wall plate* is a portion of timber built into the wall, to which a transverse or tie-beam is attached by carpentry. This *cogging*, as it is termed, keeps the wall in the perpendicular, and prevents any lateral pressure of the roof. We sometimes see a more clumsy contrivance, a clasp, or a round plate of iron, upon the side of a wall; this has a screw going into the ends of a cross-beam, and by embracing a large portion of the brick-work, it holds the wall from shifting at this point. Or take the instance of a roof supported on inclined rafters, A B:—



Were they thus, without further security, placed upon the walls, the weight would tend to spur or press out the walls, which must be strong and heavy to support the roof; therefore, the skeleton of the roof is made into a *truss*, (for so the whole joined carpentry is called.) The upper cross-beam marked by the dotted lines C, is a collar-beam, connecting the rafters of the roof, and stiffening them, and making the weight bear perpendicularly upon the walls. When the transverse beam joins the extremities of the rafters, as indicated by the lower outline D, it is called a *tie-beam*, and is more powerful still in preventing the rafters from pushing out the walls.

Now when a man bears a burden upon his head, the pressure, or horizontal push, comes upon the lower part of the *parietal bones*, and if they had not a tie-beam, they would, in fact, be spurred out, and the bones of the head be crushed down. But the temporal bone D, and still more, the sphenoid bone E, by running across the base of the skull, and having their edges lapping over the lower part of the great walls, or the parietal bones, lock them in as if they had iron plates, and answer the purpose of the tie-beam in the roof, or the iron plate in the walls. But the connexion is at the same time so secure, that these bones act equally as a straining piece, that is, as a piece of timber, preventing the tendency of the sides of the skull to each other.

It may be said, that the skull is not so much like the wall of a house as like the arch of a bridge: let us then consider it in this light.

We have here the two parietal bones, separated and resting against each other, so as to form an arch. In the centering, which is the wooden frame for supporting a stone arch while building, there are some principles that are applicable to the head.

We see that the arch formed by the two parietal bones is not a perfect semi-circle; there is a projection at the centre of each bone, the bone is more convex, and thicker at this part. The cause assigned for this is, that it is the point from which ossification begins, and where it is, therefore, most perfect. But this is to admit a dangerous principle, that the forms of the bones are matter of chance: and thence we are left without a motive for study, and make no endeavour to comprehend the uses of parts. We find that all the parts which are most exposed to injury are thus strengthened;—the centre of the forehead, the projecting point of the skull behind, and the lateral centres of the parietal and frontal bones. The parts of the head which would strike upon the ground when the man falls, are the strongest, and the projecting arch of the parietal bone is a protection to the weaker temporal bone.

If we compare the skull to the *centering*, where a bridge is to be built over a navigable river, and consequently where the space must be free in the middle, we find that the scientific workmen are careful, by a transverse beam, to protect the points where the principal thrust will be made in carrying up the masonry: this beam does not act as a tie-beam, but as a straining-piece, preventing the arch from being crushed in at this point.

The necessity of strengthening certain points is well exhibited in the carpentry of roofs. In this figure it is clear, that the points A A will receive the pressure of the roof, and if the joining of the puncheons* and rafters be not secure, it will sink down in the form of the dotted line. The workmen would apply braces at these angles to strengthen them.

In the arch, and at the corresponding points of the parietal bones, the object is attained by strengthening these points by increase of their convexity and thickness; and where the workman would support the angles by braces, there are ridges of bone, in the calvaria†, or roof of the skull. If a stone arch fall, it must give way in two places at the same time; the centre cannot sink unless that part of the arch which springs from the pier yields: and in all arches, from the imperfect Roman arch to that built upon modern principles, the aim of the architect is to give security to this point.

In the Roman bridges still entire, the arch rises high, with little inclination at the lower part; and in bridges of a more modern date, we see a mass of masonry erected on the pier, sometimes assuming the form of ornament, sometimes of a tower or gateway, but obviously intended at the same time, by the perpendicular load, to resist the horizontal pressure of the arch. If this be omitted in more modern buildings, it is supplied by a finer art, which gives security to the masonry of the pier (to use the terms of anatomy), by its internal structure. In what is termed Gothic architecture, we see a flying buttress, springing from the outer wall, carried over the roof of the aisle, and abutting against the wall of the upper part, or *clerestory*. From the upright part of this masonry, a pinnacle is raised, which at first appears to be a mere ornament, but which is necessary, by its perpendicular weight, to counteract the horizontal thrust of the arch.

By all this, we see that if the skull is to be considered as an

* The puncheons are the upright lateral pieces; the rafters are the timbers which lie oblique, and join the puncheons at A A.

† From the Latin *calva* or *calvaria, a helmet.*

arch, and the parietal bones as forming that arch, they must be secured at the temporal and sphenoid* bones, the points from which they spring. And, in point of fact, where is it that the skull yields when a man falls, so as to strike the top of his head upon the ground?—in the temples. And yet the joinings are so secure, that the extremity of the bone does not start from its connexions. It must be fractured before it is spurred out, and in that case only does the upper part of the arch yield.

But the best illustration of the form of the head is the dome. A dome is a vault rising from a circular or elliptical base; and the human skull is, in fact, an elliptical surmounted dome, which latter term means that the dome is higher than the radius of its base. Taking this matter historically, we should presume that the dome was the most difficult piece of architecture, since the first dome erected appears to have been at Rome, in the reign of Augustus—the Pantheon, which is still entire. The dome of St. Sophia, in Constantinople, built in the time of the Emperor Justinian, fell three times during its erection: and the dome of the Cathedral of Florence stood unfinished 120 years for want of an architect. Yet we may, in one sense, say that every builder who tried it, as well as every labourer employed, had the most perfect model in his own head. It is obvious enough, that the weight of the upper part of the dome must disengage the stones from each other which form the lower circle, and tend to break up their joinings, and consequently to press or thrust outwards the circular wall on which it rests. No walls can support the weight, or rather the lateral thrust, unless each stone of the dome be soldered to another, or the whole hooped together and girded. The dome of St. Paul's has a very strong double iron chain, linked together, at the bottom of the cone; and several other lesser chains between that and the cupola, which may be seen in the section of St. Paul's engraved by Hooker.

The bones of the head are securely bound together, so that the anatomist finds, when every thing is gone, save the bone itself, and there is neither muscle, ligament, nor membrane of any kind, to connect the bones, they are still securely joined, and it requires his art to burst them asunder; and for this purpose he must employ a force which shall produce a uniform pressure from the centre outwards; and all the sutures must receive the pressure at one time and equally, or they will not give way. And now is the time to observe another circumstance, which calls for our admiration. So little of accident is there in the joining of the bones, that the edge of a bone at the suture lies over the adjoining bone at one part and under it at another, which, with the dovetailing of the suture, as be-

* In the Greek, *sphenoid*—in the Latin, *cuneiform*—like a wedge, because it is wedged among the other bones of the head; but these processes, called wedges, are more like dovetails, which enter into the irregularities of the bones, and hold them locked.

fore described, holds each bone in its place firmly attached; and it is this which gives security to the dome of the cranium.

If we look at the skull in front, we may consider the orbits of the eye as crypts under the greater building. And these under-arches are groined, that is to say, there are strong arched spines of bone, which give strength sufficient to permit the interstices of the groinings, if I may so term them, to be very thin. Betwixt the eye and the brain, the bone is as thin as parchment; but if the anterior part of the skull had to rest on this, the foundation would be insufficient. This is the purpose of the strong ridge of bone which runs up like a buttress from the temple to the lateral part of the frontal bone, whilst the arch forming the upper part of the orbit is very strong: and these ridges of bone, when the skull is formed with what we call a due regard to security, give an extension to the forehead.*

In concluding this survey of the architecture of the head, let us suppose it so expanded that we could look upon it from within. In looking up to the vault, we should at once perceive the application of the *groin* in masonry; for the groin is that projection in the vault which results from the intersection of two arches running in different directions. One rib or groin extends from the centre of the frontal bone to the most projecting part of the occipital foramen, or opening on the back of the head; the other rib crosses it from side to side of the occipital bone. The point of intersection between these two groins is the thickest and strongest part of the skull, and it is most exposed, since it is the part of the head which would strike upon the ground when a man falls backwards.

What is termed the base of the skull is strengthened, if we may so express it, on the same principle: it is like a cylinder groin, where the rib of an arch does not terminate upon a buttress or pilaster, but is continued round in the completion of the circle. The base of the skull is irregular, and in many places thin and weak, but these arched spines or ribs give it strength to bear those shocks to which it is of course liable at the joining of the skull with the spine.

CRANIOLOGY.

We possess a very remarkable power of discriminating minute differences in the human countenance, and slight variations of expression, although we are so familiar with the exercise of this faculty, that it ceases to be surprising. There are varieties in the proportions of the head too, but we should be sadly puzzled to discover our best friends by the most careful inspection of their crania. While the design of producing a

* Although they are solid arches connected with the building of the cranium, and bear no relation to the surfaces of the brain, the early craniologists would have persuaded us that their forms correspond with the surfaces of the brain, and indicate particular capacities or talents.

variety in the faces of men, and a power of expression, is obvious, it would be a useless provision if we did not also possess a corresponding capacity of minute observation of the human face. One source of this capacity is, that our sympathies are alive to every change of countenance ; we are naturally or instinctively led to peruse those features, where every sentiment of the heart has a corresponding character displayed, which differ from the character of a language only in being transient. But if nature had intended that we should estimate the capacities or affections of our friends by a measurement of the skull, it is probable that she would not have covered the head with hair, nor have left our hearts so little susceptible of impression from a bald one.

Whilst there is a never failing source of interest in the human countenance, it is probably conducive to our happiness that our opinions of men, drawn from this source, are not infallible. Yet disappointment, and unrequited affection or friendship, cannot erase that which is so deeply impressed on our natures : we nevertheless do not cease to scan the human features. Certain expressions go to our hearts, and we love not merely the expression of qualities, but the appropriate fitness of the countenance to express those qualities of mind which we love.

Whilst there is so much instinctive feeling, and such a mingling of accidental associations, in the formation of our opinions on the beauty and fitness of the human countenance, we must be liable to continual delusion ; and this is the source of the popularity of works, in which the authors, like Lavater, have sought to connect the intellectual endowments with the features ; or, like Gall, sought to discover the propensities of our natures in the lesser irregularities of our skulls. We have a natural propensity to examine the human countenance, and we do, in fact, possess a certain natural power of discrimination : we comprehend a part without the aid of teaching, and we yield ourselves to the delusion, that by the lights of physiology the sphere of our knowledge may be extended. But I apprehend that this faculty is of the nature of those instinctive powers that are matured early, and do not admit of unlimited improvement.

I may be permitted to touch upon a subject which has too much interested my countrymen ; I mean the opinion of Dr. Gall, that the propensities of our nature may be ascertained by the protuberance of certain parts of the skull. I shall confine myself to the examination of the skull.

How far are the lesser convexities and irregularities of the human skull to be attributed to the peculiar form of the brain ?

In my lectures it is necessary to give a severe or minute demonstration of the bones of the head ; and for this purpose, I first exhibit the membrane, or little vesicle that surrounds the brain in the fœtus, before any bone is formed. I then demonstrate, that the several bones of the cranium are formed betwixt the layers of that membrane; and that they are necessarily adapted to the form of the brain previously existing; but when on that subject I take occasion to remark that a pregnant error has grown out of this demonstration, and one which, though blown out to the extent of a splendid folio, is only a more monstrous misconception. Some have contemplated this matter, as if the brain and skull were pieced together after the manner of a cunning artificer, and not formed as a perfect whole. Has not the skull those forms which best resist violence from without? Are not all the exposed parts strengthened, and is not the substance and the internal texture of the skull calculated to stop the vibrations that would be conveyed through a helmet differently constructed? This much I shall prove. I may then ask, is the brain, while it is yet exposed, and has no bony covering, formed with a relation to the case which is destined to cover it, or not? Look to the whole skeleton, and we shall find the answer; observe how the bones are formed in their just proportions to bear the weight, and to move in certain directions, long before they can be exposed to pressure, or put to use. How they are strengthened with spines wherever the force is destined to be applied; how curiously fashioned at their extremities to permit motion in the direction proper to the joint, and consistent with the movement of the whole limb. These provisions are made while the bones of the extremities are soft and transparent cartilages, and have not yet been put to their proper offices; and shall the skull, which is intended to protect the noblest organ, be merely an accidental cast of the brain: and can it be supposed that its forms bear no relation to its proper office? This cannot be admitted; it must be granted, that the skull bears relation to external circumstances; and if this be so, must not the brain be formed with relation to the skull, and to such forms of the skull as are capable of protecting it? It follows, therefore, that although the skull be in close contact with the surface of the brain, and formed over it; yet if the external shape be obviously that which is best calculated to resist injury from without, we must conclude that the brain conforms to what is necessary in the shape of the skull; and although first formed, that it is bound up in that manner which shall best secure its protection by bone.*

But I shall prove further, that the lesser prominences of the skull, which are adding strength to it, result from circumstances quite independent of the brain, and ought not, therefore, to be brought forward as indications of propensities of the mind.

In contemplating the forms of the skull, the eye fixes naturally on the frontal bone, and on the slighest, as on the most

* All the viscera conform to a system of packing.

careful inspection, it appears that the form of the bone on its lower part has relation to the orbits of the eyes, and the organ of smelling. It is evident, that but for the eyes there would be no orbits, no lateral ridge of the frontal bone, and no relative flatness of the temples; and but for the developement of the cavities of the nose, there would be nothing of that manly form which is so necessary to the perfection of the countenance; no support for the eyebrows, and no space for the muscles which move them; the flat insipidity of the child's forehead would be continued in after age.

Higher on the frontal bone, and on the upper division of the forehead, are two eminences, the *eminentiæ frontales*. When natural, they give a fine variety of surface to the full and polished forehead; when not visible, there is a defect; when too prominent, there is a deformity. What are these? Are they indications of a corresponding prominence of the brain? by no means: they are obviously intended to give strength to these parts of the skull, which are much exposed; the bone is more raised and arched at these two parts; and that this is to afford protection, is demonstrated on making a section of the bone, for the frontal bone is thicker at these parts, and there is no concavity on the inside, to correspond with the external convexities. Let my reader here distinguish betwixt that opinion so long and generally acknowledged to have a foundation in nature;—that a full and high forehead indicates the perfection of the organ of the intellect; and these new opinions, that the lesser irregularities are produced by the greater developement of distinct organs in the brain. To the former opinion, I shall by experiments afford some support; the latter has no foundation.

Let us now direct our attention to the prominence of the parietal bone. If a man were to fall on the side of the head, the injury would be inflicted on the point of the utmost convexity, the lateral projection: and here, where the bone assumes the arched form of strength, we find that it is also increased in thickness. In this instance, as in the forehead, the outward convexity, or the elevation of the surface of the bone into a higher arch, bears no relation to the surface of the brain beneath.

Suppose, again, that we were to place a weight, accurately balanced, upon the top of the head; when the head was adjusted, so as to bear the weight with most ease, we should find that it was placed on the utmost convexity near the meeting of the coronal and sagittal sutures, where the bone rises into a fuller arch, I may say, the better to sustain the weight. We shall also find, on sawing the bone across here, that it is thicker, we must presume for the same purpose that its convexity is increased, to give strength. I can have no doubt that this is a provision for bearing burdens on the head; and certainly the outer convexity has no relation to the form of the brain.

When we come round, in this examination, to the back of the head, we cannot fail to observe, that the occiput is least of all protected by the hands, and therefore we may presume that it is best protected by its form and thickness. The occipital bone is crossed with spines, which centre in a remarkable protuberance, which projects so as to meet the ground when we fall backwards. Besides, within, the occipital bone is in a manner groined, with crossing arches of bone, which add much to the strength of the skull at this part.

In short, after a general and unprejudiced inspection of the shape of the skull, we must believe that it is formed with reference to the pressure it has to sustain from without, or of resistance to external violence. If it be so, and the brain and skull are close in contact, the former must be constituted with reference to the latter. That the size and general dimensions of the cranium do correspond with the volume of the brain, there can be no doubt; but the lesser convexities have no such relation to the internal organ.

It is a strange delusion that would lead some men to believe, that, in the outward configuration of the skull, by which I mean the forms which have relation to the organs of sight, smell, and voice, and those spines and prominences which have respect to the strength of the skull, or to the attachment of muscles, they see the indications of particular properties of the mind, or the organs of certain propensities.

That the size of the brain-case, or the prevailing form of the whole head, may not have some relation to the perfection of the intellect, it would be bold to affirm. Most anatomists have believed that they have; but we must distinguish this question from the speculations of Drs. Gall and Spurzheim, opinions which they have attempted to engraft upon the acknowledgment of men every way worthy of credit.*

* The tyranny of inveterate prejudice is very distinctly manifested in the foregoing remarks of the author, relative to the views of Gall and Spurzheim, which we are sorry to find as little understood by him as the generality of those who consider themselves bound to oppose what they are pleased to denounce as "delusions" and speculations. The canons of inductive philosophy demand an accurate examination of the facts upon which judgments are to be formed, or from which principles are to be deduced. Instead of setting forth, as our author and others do, to overturn the observations of Gall and Spurzheim by force of argument and play of words, these opponents should examine the previous question, of the degree to which the doctrine is supported by fact, or nature, and the extent of evidence to be adduced in its favour, independent of all theory or system. If it be true that certain protuberances of the skull are found in numerous individuals, and each of these individuals are remarkable for the possession of given qualities or dispositions of mind—and if it be true that a number of persons are found wanting in the same qualities of mind, and, at the same time, destitute of the first-mentioned protuberances of the skull—it is perfectly justifiable, after a sufficiently extensive examination has been made to decide upon the general rule, to declare that the protuberance is a correct indication of the mental quality; or that the manifestation of the mental qualities indicates the presence of certain protuberances upon the skull. This is the foundation upon which the doctrines of Gall and Spurz-

Varieties in the forms of the Head indicative of national peculiarities.

It is impossible to conceal from ourselves, that much theory, and a great deal of misplaced enthusiasm, has had an influence on the opinions of physiologists, regarding the varieties

heim rest—purely upon observation; and this is the reason why these doctrines have so triumphantly outlived all the misrepresentation and violence of opposition.

In this view of the case, it is altogether unessential whether the protuberance be caused by the brain within, or the membranes or bone without. The fact of the relation between the natural protuberance and the intellectual character, is not in the slightest degree altered by our being unable to account for it. It is because we commence with a determination to see and believe, in a certain way, that our improvement is so much impeded, and our advances are so slow. We appear afraid to discover a truth, lest we be obliged to relinquish some cherished notion, and we find as much fault with those who attempt to arrive at a better knowledge, as if they were doing so with a view to our injury. If we remain unwilling to submit to the evidence of our own senses, we certainly are under no necessity of denouncing those who do: yet such is the perverseness of our nature, that nothing is more common than this preposterous conduct.

Let it be granted for a moment, that the facts observed by Gall and Spurzheim are supported by general observation, and then let it be fully admitted that the developement of the *brain* is *not* always indicated by protuberance; we are driven to the necessity—not of denying the facts, nor of showing their incompatibility with commonly received opinions, but of allowing that we are not able to explain the connection between the outward and visible sign of the inward and intelligent principle. This supposed case is the actual one: Gall and Spurzheim's observations, as a general rule, *are* supported and confirmed by the observations of all competent investigators. The natural protuberances of the skull *are* correct indications of the existence of certain mental qualities—the developement of the brain *does not* uniformly correspond to the protuberances—and this fact is *not* of the slightest importance in the decision, although it may be entirely contrary to our preconceived views. We may explain the case according to the best of our abilities, but none of our explanations can possibly affect the state of the fact, which must rest upon unbiassed observation alone.

As a general rule, it is perfectly safe to infer that the opponents of Gall and Spurzheim do not understand the exact nature of the case against which they dispute. At least, no man who has ever set himself honestly to work to examine the subject fairly, has remained in opposition. A great degree of ingenuity has been wasted in discussion on both sides. The opposition, taking it for granted that the whole doctrine is one supported merely by plausible arguments, and therefore to be overthrown by argumentation—and the defenders of Gall and Spurzheim unavailingly endeavouring to induce those to reason from facts, who have determined previously to be solely influenced by prejudice. The rational student has only to examine candidly for himself, without reference to any predetermination, and the result will be perfectly satisfactory.

But a few years have elapsed since the writer of this note was filled with zeal against the views of Gall and Spurzheim, and even deemed it his duty to join the hue and cry against them; so much was his mind imbued with the prejudices derived from the fulminations of a public teacher, whose "zeal," unequivocally, on this subject at least, was not "according to knowledge." An investigation of the evidences on which Gall and Spurzheim's views rely for support, fully dissipated the clouds in which the subject had been involved by misguided ignorance, and taught with force the valuable lesson, that no judgment should be formed in matters of science without a careful examination of the facts connected therewith.—J. D. G.

of mankind. It is, however, allowable to take as a principle, that there will be a relation betwixt vigour of intellect and perfection of form; and that, therefore, history will direct us to the original and chief family of mankind. We therefore ask, which are the nations that have excelled and figured in history, not only as conquerors, but as forwarding, by their improvements in arts and sciences, the progress of human knowledge?

It is not to be denied, that there are national peculiarities in the form of the skull, as there are of features, of colour, and of general form. These, in their extremes, are very distinct; but they are joined, as it were, by intermediate degrees of difference; and there are distinctions to be observed in the individuals of any one people, as great at least as those which mark national peculiarity. There are as great varieties among individuals of the tribes of America or of Africa, as among the nations of Asia or of Europe.

Among the ancient nations, one great character seems to have prevailed: the Assyrians, Chaldeans, Medes, Persians, Jews, the Greeks, and Romans, appear to have had their origin and centre in the Western part of Asia, perhaps betwixt the mountains of Caucasus and the Caspian Sea. To this day there is in the people seated there, Circassians and Georgians, a degree of beauty and perfection of form, that at least agrees with this hypothesis; and from this, as the centre of the old Continent and of ancient nations, departure from a a common form of the head and features is to be observed in all directions over the face of the globe. It is noticed as we depart eastward through Tartary, and to the extreme north-eastern parts of Asia even to America. Again, departing from the centre, we may descend south-east to the Peninsula of India, and the Asiatic Islands, and to those of the great Pacific Ocean. Or, on the other hand, we may trace a change towards Egypt and the African varieties; or lastly, towards the western extremities of Europe; where in the extreme islands of the west, there is a perfection of manly form and feminine beauty, happily combined with qualities still more to be esteemed, and which are now spread to the New Continent, and destined to characterize the larger portion of the inhabitants of our globe.

These varieties are distinguishable into five grand families: I. In the people seated betwixt Mount Caucasus and the Caspian, there is observed a due balance betwixt the cranium and bones of the face, that is a full developement of the cranium or brain-case, and, as we may suppose, a perfection in the organ of intellect; a due proportion betwixt the bones of the face, both in comparison with the cranium and amongst each other; so that the face is small, the outline smooth, the contour of the features regular, and there is no harshness from their undue prominence. With this there is combined beauty of the frame generally: long hair and fair skin, and blooming complexion, varying with emotion, and an index of the mind not to be neglected in estimating the perfection of the human body. This is the white variety of mankind, which spreads over Western Asia and Europe. The form of the skull is considered as the medium and more perfect form, betwixt the Mongolian races, in which the face is compressed, so as to be extended laterally, and the Ethiopian, which exhibits the jaws lengthened, and the face projecting from a receding forehead.

II. The Mongolian variety extends to the Calmucks, the Tungooses of China, and round by Siberia to the transition forms of the Esquimaux and the Greenlander. The cranium is globular, the bones of the face broad and flattened, the os frontis broad and flat, the malar bones projecting laterally, the orbits large and open, the superciliary ridges elevated, corresponding with the Calmuc countenance; the face is broad, the eyes are apart, and the space betwixt them flat, the aperture of the eyelids is narrow, and the nose round.

III. The third variety is the Ethiopian, and comprehends the well-known African skull. The head is the reverse of the globular form. The great peculiarity is not, as has been supposed, in the comparative size of the bones of the face, over the cranium, but merely in the size of the teeth and jaws, and the forms of the bones connected with the teeth in office, as giving origin to the muscles which move the jaws; and here I may observe, that whatever peculiarity of form may distinguish the teeth and jaws of any nation, there is always a correspondence in the soft parts placed over them, and hence the thick and fleshy lips, and the heavy cheeks of the African, are combined with their protuberant jaws and teeth.*

IV. The fourth variety includes the native Americans; and a race arriving from the eastern extremity of Asia may be traced down the North American continent, until it meets the natives of the South, the Caribbees or Caribs, who have the bones of the face broad, but not flat, prominent cheek bones, a short forehead, the eyes deep, and the bones of the nose developed, but the nose flattened.

V. The fifth is the Malay variety, which is intermediate betwixt the Asiatic and the Negro. It would appear as if mankind had spread more easily by the influence of the winds and the currents of the ocean, than by the regular progress of wandering tribes. The peculiarities under this head may be traced from the Red Sea, along the coasts of Hindoostan, through the Straits of Malacca, to the islands of Sumatra, Java, and the Celebes, to New Guinea, to New Holland, and Van Diemen's Land. The skull of a Buggess, from the island of Celebes, has the low forehead and the prominent

* Some years ago I made a comparison betwixt the extreme forms of the European and Negro skull. This I did by suspending them on a rod introduced through the foramen magnum. I then compared their position and the inclination of the facial line. See the Philosophy of Expression, Second edition.

jaws of the Negro, with the lateral projection of the face of the Mongolian variety, a combination which we might expect on looking to the map of Eastern Asia. Captain Cook has informed us, that among the Friendly Islanders, he met with hundreds of European faces, and "genuine Roman noses." In the islands of the Pacific Ocean, there is scope for the re-union of the families of mankind; arrivals from the North of the American Continent: men sprung from the natives of the Southern Continent of America: the Ethiopian extreme, floating through the Eastern Archipelago, and meeting the descending current of the maritime people of China, Corea, and Japan, form varieties and transitions. In the Marquesan, Society, Friendly, and Sandwich islands, the Caucasian variety prevails, and it meets in the New Hebrides and New Zealand with the tribes of New Guinea and New Holland.

OF THE FORMATION AND GROWTH OF BONES.*

It is not easy to explain, in their natural order, the various parts of which the human body is composed;† for they have that mutual dependence upon each other, that continual circle of action and re-action in their various functions, and that intricacy of connection, and close dependence, in respect of the individual parts, that, as in a circle there is no point of preference from which we should begin to trace its course, so in the human body there is no function so insulated from the other functions, no part so independent of other parts, as to determine our choice. We cannot begin without hesitation, nor hope to proceed in any perfect course; yet, from whatever point we begin, we may so return to that point, as to represent truly this consent of functions, and connection of parts, by which it is composed into one perfect whole.

* I have arranged the preparations illustrative of the growth and structure of bone, so as to correspond with this dissertation. This referred to the collection which is now in the possession of the College of Surgeons of Edinburgh; but the series is complete in the Anatomical Museum in the London University.

† This figure represents the skeleton of the arm of the fœtus; it is dried, and while the cartilages have shrunk and become of a dark colour, the portions of the bones which have begun to form are visible in the scapula, clavicle, humerus, radius, and ulna, the metacarpal bones, and some of the phalanges of the fingers.

As dead parts, the bones are the most permanent, unchangeable parts of all the body; while as living parts, and partaking in the laws of the living system, their substance changes continually. We see them exposed to the seasons, without suffering the smallest change; remaining for ages the memorials of the dead; the evidence of a former race of men, or of animals which have ceased to exist since the last great revolution of our globe; the proofs of such changes on our globe as we cannot trace but by these uncertain marks. It is from such circumstances that we are apt to conceive that, even in the living body, bones are hardly organized, scarcely partaking of life, not liable, like the soft parts, to disease and death. But minute anatomy, the most pleasing part of our science, unfolds and explains to us the internal structure of the bones; shows their myriads of vessels; and proves them to be as full of blood as the most succulent and fleshy parts, and as subject to change; having, like them, their periods of growth and decay; that they are more liable to accidents, and as subject to internal disease.

According to the chemists bone consists of albumen, a little jelly, and the earth of bone, the proper hardening material which gives the property of resistance.* This earth of bone consists of 82 parts in the hundred of phosphate of lime, the remainder containing fluate and carbonate of lime, with the phosphates of magnesia and soda.

I have a notion that some of these may be products arising out of the processes employed.

The phenomena of fractured bones first suggested some indistinct notions of the way in which bone might be formed. It was observed, that in very aged men, a hard crust was often formed upon the surface of the bones; that the fluid exuding into the joints of gouty people, sometimes coagulated into a chalky mass. Le Dran had thought that he had seen, in a case of scrophulous bone, an exudation which flowed out like wax, and hardened into perfect bone. Daventer, that he had seen the juice exuding from a split in a bone, coagulate into a bony crust; and they thought it particularly well ascertained, that callus was but a coagulable juice, which might be seen exuding directly from the broken ends, and which gradually coagulated into hard bone. The best physiologists did not scruple to believe, that bones, and the callus of broken bones, were formed of a bony juice, which was deposited by the vessels of the part, and which, passing through all the successive conditions of a thin uncoagulated juice, of a transparent cartilage, and of soft and flexible bone, became at last, by a slow coagulation, a firm, hard, and perfect bone, depending but little upon vessels or membranes, either for its genera-

* M. Herissant has some merit in the investigation of this subject. See Memoires Acad. pour 1758, p. 322. Malpighi is considered to be the first who announced that the basis of bone was an animal matter, like cellular membrane.

tion or growth, or for nourishment in its perfect state. This opinion, erroneous as we now know it to be, once prevailed; and if other theories were at that time proposed, they did not vary in any very essential point from this first notion. De Heide, a surgeon of Amsterdam, believed that bone or callus was not formed from a coagulable juice, but from the blood itself. He broke the bones of animals, and examining them at various points of time, he never failed (like other speculators) to find exactly what he desired to find. "In every experiment" he found a great effusion of blood among the muscles, and round the broken bone; and he has easily traced this blood through all the stages of its progress. In the first day red and fluid; by and by coagulated; then gradually becoming white, then cartilaginous, and at last (by the exhalation of its thinner parts) hardening into perfect bone.

It is very singular that those who abjure theory, and appeal to experiments, who profess only to deliver facts, are least of all to be trusted; for it is theory which brings them to try experiments, and then the form and order, and even the result of such experiments, must bend to meet the theories which they were designed to prove: it is by this deception that the authors of two rival doctrines arrive at opposite conclusions, by facts directly opposed to each other. Du Hamel believed, that as the bark formed the wood of a tree, adding, by a sort of secretion, successive layers to its growth, the periosteum* formed the bone at the first, renewed it when spoiled or cut away, and when broken, assumed the nature of bone, and repaired the breach. He broke the bones of pigeons, and, allowing them to heal, he found the periosteum to be the chief organ for re-producing bone. He found that the callus had no adhesion to the broken bone, was easily separated from the broken ends, which remained rough and bare; and, in pursuing these dissections, he found the periosteum fairly glued to the external surface of the new bone; or he found rather the callus or regenerated bone to be but a mere thickening of the periosteum, its layers being separated, and its substance swelled.

* The PERIOSTEUM is a strong fibrous membrane, covering the whole surface of the bones except where their articular extremities are tipped with cartilage, and having inserted into it the tendons, ligaments, and aponeurotic expansions. It is in infancy soft, thick, and readily separable; in adult life, it is more compact, and thinner in texture, adhering firmly to the bones, in consequence of having secreted osseous matter from its internal surface. Its fibres, except in the flat bones, are commonly arranged according to the length of the bones, the outer layer being longer and the inner shorter; fibres appear to pass thence into the bone accompanying the blood-vessels which enter them from this membrane, making its adhesion much stronger. The periosteum receives blood-vessels from the adjacent arteries, which divide minutely in its substance, sending the branches just mentioned. The lymphatic vessels are few in number, and the nerves must be exceedingly small, as no sensibility is evinced by the periosteum, except when injured while in a state of inflammation. The uses of this membrane, as may be readily gathered from what has been said, is to convey the blood-vessels to and from the bone, regulate the growth of the bone, &c.—J. D. G.

On the first days he found the periosteum thickened, inflamed, and easily divided into many lamellæ or plates; but while the periosteum was suffering these changes, the bone was in no degree changed. On the following days, he found the tumour of the periosteum increased at the place of the fracture, and extending further along the bone; its internal surface already cartilaginous, and always tinged with a little blood, which came to it through the vessels of the marrow. He found the tumour of the periosteum spongy, and divisible into regular layers, while still the ends of the bone were unchanged, or only a little roughened by the first layer of the periosteum being already converted into earth, and deposited upon the surface of the bone: and in the next stage of its progress, he found the periosteum firmly attached to the surface of the callous mass. By wounding, not breaking the bones, he had a more flattering appearance still of a proof; for having pierced them with holes, he found the holes filled up with a substance, proceeding from the periosteum, which was thickened all round them. In an early stage, this plug could, by drawing the periosteum, be pulled out from its hole: in a more advanced stage, it was inseparably united to the bone so as to supply the loss.

Haller, doubting whether the periosteum, a thin and delicate membrane, could form so large a mass of bone or callus, repeated the proofs, and he again found quite the reverse of all this: that the callus, or the original bone, was in no degree dependent on the periosteum, but was generated from the internal vessels of the bone itself; that the periosteum did indeed appear as early as the cartilage which is to produce the bone, seeming to bound the cartilage, and give it form; but that the periosteum was at first but a loose tissue of cellular substance, without the appearance of vessels, or any mark of blood, adhering chiefly to the heads or processes, while it hardly touched the body of the bone. He also found that the bone grew, became vascular, had a free circulation of red blood, and that then only the vessels of the periosteum began to carry red blood, or to adhere to the bone. We know that the bones begin to form in small nuclei, in the very centre of their cartilage, or in the very centre of the yet flexible callus, far from the surface, where they might be assisted by the periosteum; and here it is justice to add, that while these questions were agitated on the continent, Dr. William Hunter had proved that the callus of broken bones was organized, and that the secretion of bone into it proceeded from the arteries taking on them a new action, and secreting the earthy matter into the first formed substance.

Thus has the formation of bone been falsely attributed to a gelatinous effusion, gradually hardened; or to that blood which must be poured out from the ruptured vessels round the fractured bone; or to the induration and change of the periosteum, depositing layer after layer, till it completed the form of the bone.

But when, neglecting theory, we set ourselves to examine, with an unbiassed judgment, the process of nature in forming the bones, as in the chick, or in restoring them, as in broken limbs, a succession of phenomena present themselves, the most orderly, beautiful, and simple of any that are recorded in the philosophy of the animal body: for if bones were but condensed gluten, coagulated blood, or a mere deposition from the periosteum, they were then inorganized, and out of the system, not subject to change, nor open to disease; liable, indeed, to be broken, but without any means of being healed again; while they are, in truth, as fully organized, as permeable to the blood, as easily hurt, and as easily healed, as sensible to pain,* and as regularly changed as the softer parts are. We are not to refer the generation and growth of bone to any one part. It is not formed by that jelly in which the bone is laid, nor by the blood which is circulating in it, nor by the periosteum which covers it, nor by the medullary membrane with which it is lined; but the whole system of the bone, of which these are parts only, is designed and planned, is laid out in the very elements of the body, and goes on to ripeness, by the concurring action of all its parts. The arteries, veins, and lymphatics exist, in the cartilage or the membranes, before bone is formed. At a certain regular period, the arteries, by a determined action, deposit the bone; which is formed commonly in a bed of cartilage, as the bones of the leg or arm are; sometimes betwixt two layers of membrane, like the bones of the skull, where true cartilage is never seen.

My readers understand that cartilage is a substitute for bone in the early months of the fœtus; that at a regulated period in each bone, at a given point, and in a perfectly regular manner, portions of the cartilage are absorbed, and bone deposited.

This cartilage never is hardened into bone; but, from the first, it is in itself an organized mass. It has its vessels, which are at first transparent, but which soon dilate; and whenever the red colour of the blood begins to appear in them, ossification very quickly follows.† The first mark of ossification is an artery, which is seen running into the centre of the cartilage, in which the bone is to be formed. Other arteries soon appear, overtake the first, mix with it, and form a network of vessels; then a centre of ossification begins, stretching its

* The obscurity on this subject is from the neglect of defined terms. We shall presently see that the sensibility possessed by the bones, and the kind of pain to which they are subject, differs from the sensibility and pain of the skin and soft parts.

† This figure (see next page) represents the tibia of a fœtus cut through. The central part (*diaphysis*) is already bony; but the extremities are yet cartilage. The red blood is, however, entering the arteries and veins in the cartilaginous extremities; and the black spots in the midst of the cartilage mark the beginning of ossification, and formation of the *epiphysis*.

rays according to the length of the bone, and then the cartilage begins to grow opaque, yellow, brittle; it will no longer bend, and the small nucleus of ossification is felt in the centre of the bone, and, when touched with a sharp point, is easily known by its gritty feel. Other points of ossification are successively formed; always the ossification is foretold by the spreading of the artery, and by the arrival of red blood. Every point of ossification has its little arteries, and each ossifying nucleus has so little dependence on the cartilage in which it is formed, that it is held to it by vessels only; and when the ossifying cartilage is cut into thin slices, and steeped in water till its arteries rot, the nucleus of ossification drops spontaneously from the cartilage, leaving the cartilage like a ring, with a smooth and regular hole where the bone lay. This is because the cartilage was a substitute for the bone, and, because preparatory to the formation of the nucleus of bone, the cartulage is absorbed, and a bed prepared for the new formation.

The colour of each part of a bone is proportioned exactly to the degree in which its ossification is advanced. When ossification begins in the centre of the bone, redness also appears, indicating the presence of those vessels by which the bony matter is to be poured out. When the bony matter begins to accumulate, the red colour of those arteries is obscured, the centre of the bone becomes yellow or white, and the colour removes towards the ends of the bone. In the centre, the first colouring of the bone is a cloudy, diffused, and general red, because the vessels are profuse. Beyond that, at the edges of the first circle, the vessels are more scattered and asunder, distinct trunks are easily seen, forming a circle of radiated arteries, which point towards the heads of the bone. Beyond that, again, the cartilage is transparent and pure, as yet untouched with blood; the arteries have not reached it, and its ossification is not begun. Thus, a long bone, while forming, seems to be divided into seven various coloured zones. The central point of most perfect ossification is yellow and opaque. On either side of that, there is a zone of red: on either side of that, again, the vessels being more sparingly distributed, form a vascular zone, and the zone at either end is transparent cartilage.* The ossification follows the vessels, and buries and

* It is curious to observe how completely vascular the bones of a chicken are before the ossifications have fairly begun; how the ossifications, being begun, overtake the arteries, and hide them, changing the transparent and vascular part of the bone into an opaque white; how, by peeling off the

hides those vessels by which it is formed: the yellow and opaque part expands and spreads along the bone: the vessels advance towards the heads of the bones: the whole body of the bone becomes opaque, and there is left only a small vascular circle at each end; the heads are separated from the body of the bone by a thin cartilage, and the vessels of the centre, extending still towards the extremities of the bone, perforate that cartilage, pass into the head of the bone, and then its ossification also begins, and a small nucleus of ossification is formed in its centre. Thus the heads and the body are, at the first, distinct bones formed apart, joined by a cartilage, and not united till the age of fifteen or twenty years.

Now we know the difference of apophysis and epiphysis, for anatomists make a sort of juggle betwixt these names, as if they were engaged in important matters. The *apophysis* is a process, or projection of bone. The epiphysis is the distinct portion of the bone, which is formed in a distinct nucleus of bone, and becomes afterwards joined and incorporated with the main body of the bone, and may then be described as an apophysis.

It is more important a great deal to observe, that as the extremities of the long bones forming the articulations are joined to the bodies or shafts by cartilage in childhood and adolescence, they are subject to be torn off, and to present a very puzzling case, that is, a fracture without crepitus; for as the crepitus of the fractured bone arises from the irregularity of the broken ends, and as in this sort of fracture [or diastasis] the surfaces are smooth, the surgeon is liable to be deceived, and the patient to permanent lameness and distortion. I have some specimens in my museum of this accident.

The vessels may be seen entering in one large trunk (the nutritious artery) into the middle of the bone.* From that centre they extend towards both ends, and the fibres of the bone extend in the same direction; there are furrows betwixt the rays, and the arteries run along in the furrows of the bone, as if the arteries were forming these ridges, secreting and pouring out the bony matter, every artery piling it up on each side to form its ridge; yet the arteries of a bone branch with freedom, and with the same seeming irregularity as in other parts

periosteum, bloody dots are seen, which show a living connection and commerce of vessels betwixt the periosteum and the bone; how, by tearing up the outer layers of the tender bone, the vascularity of the inner layers is again exposed, and the most beautiful proof of all is that of our common preparations, where, by filling with injection the arteries of an adult bone, by its nutritious vessels, and then corroding the bone with mineral acids, we dissolve the earth, leaving nothing but the transparent jelly, which restores it to its original cartilaginous state: and then the vessels appear in such profusion, that the bone may be compared in vascularity with the soft parts, and it is seen that its arteries were not annihilated, but its high vascularity only concealed by the deposition of the bony parts.

* This is an important point of demonstration, because the artery, though small, acquires importance from its place. See Demonstration of the Femur and of the Tibia.

of the body. The arteries do not exude their secretion from their sides, so as to pile up the ridge of bone in their course. The secretion is performed in their very extremities. The body of the bone is supplied by its own vessels; the heads of the bone are in part supplied by the extremities of the same trunks which perforate the dividing cartilage like a sieve: the periosteum adhering more firmly to the heads of the bone, brings assistant arteries from without, which meet the internal trunks, and assist the ossification; which, with every help, is not accomplished in many years.

It is by the action of the vessels that all the parts of the human body are formed, fluids and solids, each for its respective use: the blood is formed by the action of the vessels, and all the fluids are in their turn formed from the blood. We see in the chick, where there is no external source from which its red blood can be derived, that red blood is formed within its own system. Every animal system, as it grows, assimilates its food, and converts it to the animal nature, and so increases the quantity of its red blood: and as the red blood is thus prepared by the actions of the greater system, the actions of particular vessels prepare various parts: some to be added to the mass of solids, for the natural growth; others to supply the continual waste, or to allow new matter to be received; others to be discharged from the body as effete and hurtful, as the secretions into the intestines, and from the kidney and from the skin; others again to perform certain offices within the body, as saliva, bile, or pancreatic fluid. Thus the body is furnished with various apparatus for performing various offices, and for repairing the waste. These are the secretions, and the formation of bone is one of these. The plan of the whole body lies in the embryo, in perfect order, with all its forms and parts. Cartilage is laid in the place of bone, and preserves its form for the future bone, with all its apparatus of surrounding membranes, its heads, its processes, and its connection with the soft parts. The colourless arteries of this pellucid but organized mass of cartilage keep it in growth, extend, and yet preserve its form, and gradually enlarging in their own diameter, at last receive the entire blood.* Then the deposition of earthy matter begins. The bone is deposited in specks, which spread and meet and form themselves into perfect bone. While the bone is laid by arteries, the cartilage is conveyed away by the absorbing vessels; and while they convey away the super-

* Previous to the formation of bone, (or the preparation for it,) in the cartilage, there is no proof of there being vessels in it. But we presume, that the cartilage must have vessels, because it grows with the growth of the animal, previous to the formation of bone in it.

However, the change, previous to the deposition of bone, has not been very accurately noticed: the firm cartilage suffers a change: there is a tract from the circumference to the centre of it, in which the firm cartilage is dissolved, and in the spot where the first particle of bone is to be deposited, there is a little soft well of matter, different from the firm substance of the cartilage.

fluous cartilage, they model the bone into its due form, shape out its cavities, cancelli, and holes, remove the thinner parts of the cartilage, and harden it into due consistence.

If the organization of arteries and veins, arteries to deposit bone, and absorbents to take up the cartilage, and make room for the osseous matter, be necessary in the formation and growth, it is no less necessary for the life and health of the full formed bone. Its natural condition depends on the regular deposition and re-absorption, moulding and forming the parts; and by various degrees of action, bone is liable to inflame, ulcerate, and spoil, to become brittle by too much secreted earth, or to become soft by a deficient secretion, or by a greedy diseased absorption of its earthy parts. The cartilage is in itself a secretion, to which the full secretion of bone succeeds.

In the re-union of a fractured bone, we have to observe nearly the same phenomena which accompany its first formation.

The first effect is the tearing of the periosteum and surrounding cellular textures, and perhaps some part of the muscular substance. The consequence of which is, that the broken extremities are surrounded with coagulum of blood. The extravasated blood being absorbed, an effusion is poured out by the vessels of the broken bone. This matter is a regular secretion: it appears to the eye like a uniform jelly; but so does the embryo itself. It is bone in embryo, the membranes and vessels, arteries, veins, and absorbents, are in it; the arteries of the surrounding parts do not shoot into it, but veins, as well as arteries and absorbents, inosculate with the vessels of this new formed matter; and whatever vessels may, by accidental contact, inosculate with this substance, whether coming from bone, muscles, or membrane, still bone is formed, because it is the destined constitution of the new formed mass, or rather of the vessels which are already in it to form bone.

If the broken limb be too much moved during the cure, then are the secreting arteries interrupted in their office, perfect bone is never formed, it remains a cartilage, and an unnatural joint is at length produced; but by injuring the bone the vessels are opened again, the process is renewed, and the bones unite; or even by rubbing, by stimulating, by merely cutting the surrounding parts, the vessels are made active, and their secretion is renewed.* During all the process of ossification, the absorbents proportion their action; they remove the cartilage as the bone is laid; they continue removing the bony particles also, which the arteries continually renew.

Nothing can be more curious than this continual renovation and change of parts, even in the hardest bones. We are accustomed to say of the whole body, that it is daily changed; that the older particles are removed, and new ones supply

* Those principles become of the utmost importance in the practice of surgery.

their place; that the body is not now the same individual body that it was; but it could not be easily believed that we speak only by guess concerning the softer parts, what we know for certain of the bones. It was discovered by chance, that animals fed upon the refuse of the dyer's vats received so much of the colouring matter into the system, that the bones were tinged by the madder to a deep red, while the softer parts were unchanged; no tint remaining in the ligaments nor cartilages, membranes, vessels, nor nerves, not even in the delicate vessels of the eye. It was easy to distinguish by the microscope, that such colour was mixed with the bony matter, resided in the interstices only, but did not remain in the vessels of the bone, which, like those of all the body, had no tinge of red; while our injections again fill the vessels of the bone, make all their branches red, but do not affect the colours of the bony part. When madder is given to animals, withheld for some time, and then given again, the colour appears in their bones, is removed, and appears again with such a sudden change as proves a rapidity of deposition and absorption, exceeding all likelihood or belief. All the bones are tinged in twenty-four hours; in two or three days their colour is very deep; and if the madder be left off but for a few days, the red colour is entirely removed.

This tinging of the bones with madder, was the great instrument in the hands of Du Hamel, for proving by demonstration, that it was by layers from the periosteum that the bone was formed; and how very far the mind is vitiated by this vanity of establishing a doctrine on facts, is too easily seen here. Du Hamel, believing that the periosteum deposited successive layers, which were added to the bone, it was his business to prove that the successive layers would be deposited alternately red, white, and red again, by giving a young animal madder, withholding it for a little while, and then beginning again to give it. Now, it is easy to foresee that this tinging of the lamellæ should correspond with the successive times in which the periosteum is able to deposit the layers of its substance, but Du Hamel very thoughtlessly makes his layers correspond only with the weeks or months in which his madder was given or withheld. It is easy to foresee also, that if madder be removed from the bones in a few days, (which he himself has often told us,) then his first layer, viz. of red bone, could not have waited for his layer of white to be laid above it, nor for a layer of red above that again, so that he should have been able to show successive layers: And if madder can so penetrate as to tinge all the bones that are already formed, then, though there might be first a tinged bone, then a white and colourless layer, whenever he proceeded to give madder for tinging a third layer, it would pervade all the bone, tinge the layer below, and reduce the whole into one tint. If a bone should increase by layers, thick enough to be visible, and of a distinct tint, and such layers be continually accumulated upon each other every week, what kind of a bone should this grow to? Yet such is the fascinating nature of a theory, that Du Hamel, unmindful of any interruptions like those, describes boldly his successive layers, carrying us through regular details, experiment after experiment, till at last he brings up his report to the amount of five successive layers, viz. two red layers, and three white ones. And in one experiment he makes the tinge of the madder continue in the bones for six months, forming successive layers of red and white, although in an earlier experiment (which he must have forgotten in his hurry) he tells us, that by looking through the transparent part of a cock's wing, he had seen the tinge of the madder gradually leave the bones in not many days.

I have before me preparations in which we see three distinct layers; and of the general fact there can be no doubt. If I doubt the exhibition of six layers, yet we may draw the same important conclusion from three as from six. Mr. John Hunter said, that in the growth of bone, the inner part was absorbed, while the outer surface had addition; and that the whole bone did not extend, but that the extension of the shaft resulted from an addition to the extremity. But be it at the same time understood, that while the additional increment is on the surfaces and the extremities of the bone, the whole substance of the bone is submitting to change.

By these experiments with madder, one most important fact is proved to us; that the arteries and absorbents, acting in concert, alternately deposit and re-absorb the earthy particles, as fast as can be conceived of the soft parts, or even of the most moveable and fluctuating humours of the body. The absorption of the hardest bones is proved by daily observation; when a carious bone disappears before the integuments are opened; when a tumour, pressing upon a bone, destroys it; when an aneurism of the temporal artery destroys the skull; when aneurism of the heart beats open the thorax, destroying the sternum and ribs; when aneurism of the ham destroys the thigh-bone, tibia, and joint of the knee; when a tumour coming from within the head, forces its way through the bones of the skull;—in all these cases, since the bone cannot be annihilated, what can happen, but that it must be absorbed and conveyed away? If we should need any stronger proofs than these, we have mollities ossium, a disease by which, in a few months, the bony system is entirely broken up, and conveyed away by a high action of the absorbents, with continual and deep-seated pain; a discharge of the earthy matter by the urine; a gradual softening of the bones, so that they bend under the weight of the body; the heels are turned up behind the head; the spine is crooked; the pelvis distorted; the breast crushed and bent in: and the functions, beginning to fall low, the patient, after a slow hectic fever, long and much suffering of pain and misery, expires, with all the bones distorted in a shocking degree, gelatinous, or nearly so, robbed of all their earthy parts, and so thoroughly softened as to be cut with the knife.*

Thus every bone has, like the soft parts, its arteries, veins, and absorbent vessels; and every bone has its nerves too. We see them entering into its substance in small threads, as on the surfaces of the frontal and parietal bones: we see them entering for particular purposes, by a large and peculiar hole, as the nerves which go into the jaws to reach the teeth: we find delicate nerves going into each bone along with its nutritious vessels; and yet we dare hardly believe the demonstration, since bones seem quite insensible and dead. We have no pain when the periosteum is rasped and scraped from a bone: we have no feeling when bones are cut in amputation; or when, in a broken limb, we cut off with pincers the protruding end of a bone: we feel no pain when a bone is trepanned, or when caustics are applied to it; and it has been always known, that the heated irons, which the old surgeons used so much, made no other impression than to excite a particular titillation and heat, rather pleasant than painful, running along the course of the bone. But there is a deception in all this. A bone may be exquisitely sensible, and yet give no pain; a paradox which is very easily explained. A bone may feel acutely, and yet not send its sensations to the brain. It is not fit that parts should feel in this sense, which are so continually exposed to shocks and blows, and all the accidents of life; which have to suffer all the motions which the other parts require. In this sense, the bones, the cartilages, ligaments, bursæ, and all the parts that relate to joints, are quite insensible and dead. A bone does not feel, or its feelings are not conveyed to the brain; but except in the absence of pain, it shows every mark of life. Scrape a bone, and its vessels bleed; cut or bore a bone, and its granulations sprout up; break a bone, and it will heal; or cut a piece of it away, and more bone will readily be produced; hurt it in any way, and it inflames; burn it, and it dies. This is a deep subject, but a very curious one. The meaning attached to common terms of speech are not applicable here; and hence the obscurity. We would require to define sensation, sensibility, and pain; the liability of the part to be injured and excited to inflame, and the perception of that injury. I come to this conclusion:—The sensation of pain is bestowed as a safeguard to the frame, forcing us to avoid whatever is hurtful. To this effect, sensibility varies in different parts, and in general, the sensibility of the more superficial parts being sufficient protection to the parts beneath, the deep parts are but little sensible. The sensibility possessed by the skin would not be sufficient protection to the eye; and it differs in kind as well as in degree. Experiments have been

* See the examples of distortion in my former Collection, and in particular the skeleton of the woman who died in consequence of the Cæsarean operation.

made by cutting and burning the bones and tendons, and the conclusion has been, that they were insensible. But when a man sprains his ankle-joint, he is in extreme pain, though he can easily satisfy himself that the pain he feels is not in the skin, but must be in the joint and tendons. It appears, then, that such parts, usually thought insensible, feel pain, and can propagate that pain to the sensorium; and further, that the peculiar sensibilities are so suited as to allow of the free and natural motion, and of the necessary degree of attrition, but are bestowed for the purpose of making us avoid that degree of violence, which would endanger the texture or healthy function of the part.

We have further to understand, that if there be any doubt of the sensibility of a bone, it is only when it is in health; for when inflamed, it becomes exquisitely sensible. When the texture of a bone is loosened by inflammation, its feeling is roused; and the hidden sensibility of the bone rises up like a new property of its nature: and as the eye, the skin, and all feeling parts have their sensibility increased by disease, the bones, ligaments, bursæ, and all the parts whose feeling, during health, is obscure and hardly known, are roused to a degree of sensibility far surpassing the soft parts. The wound of a joint is indeed less painful at first, but when the inflammation comes, its sensibility is raised to a dreadful degree: the patient cries out with anguish. No pains are equal to those which belong to the bones and joints.

Ossification is a process which, at first, appears so rapid, that we should expect it to be soon complete; but it becomes in the end a slow and difficult process. It is rapid at first; it advances slowly after birth; it is not completed till the twentieth year; it is forwarded by health and strength, retarded by weakness and disease. In scrophula it is imperfect, because there is an imperfect assimilation of food, and the earth of bone is not furnished or not secreted into the bone; and so children become ricketty, the bones soften and swell at their heads, and bend under the weight of the body. And why should we be surprised, that carelessness of food or clothing, bad air, or languid health, should cause that dreadful disease, when more or less heat, during the incubation of a chick, prevents the growth of its bones; when the sickness of a creature, during our experiments, protracts the growth of callus; when, in the accidents of pregnancy, of profuse suppuration, or of languid health, the knitting of broken bones is delayed, or prevented quite?

This process, so difficult and slow, is assisted by every provision of nature. The progress of the whole is slow, that so long as the body increases in stature, the bones also may grow; but it is assisted in the individual parts, where some are slow, some rapid in their growth, some delayed, as the heads of joints, that their bones may be allowed to extend, and others hastened, as the pelvis, that it may acquire its perfect size early in life. Ossification is assisted by the softness of the cartilaginous bed in which the bone is formed; by those large and permeable vessels which carry easily the grosser parts of the blood; by a quick and powerful absorption, which all along is modelling the bone; and, most of all, by being formed in detached points, multiplied and crowded together, wherever much bone is required.

We have understood that the bones of the head have membranes as their substitutes, as the long bones have cartilage.

The ossification, for example, of the frontal or parietal bone begins in a point (as here represented;) a few delicate meshes of bony matter are formed in the interstices of the membrane. The membrane is by this means split into two other membranes, we afterwards recognize under the names of pericranium and dura mater. In this figure we have the commencement of the one half of the frontal bone. On the extreme margin we see through the meshes or net-work of new bone; but other

layers of bone similar to this are superadded, and the interstices of the first layer being opposed to the wire-work of the second, a solid appearance and opacity is produced. In a further state of advancement the bone assumes this appearance, and the filaments diverge regularly from the centre, which was the original spot where the ossification commenced.

It is thus that in the bones* of the skull ossification goes from one or more central points, and the radiated fibres meet the radii of other ossifying points, or meet the edges of the next

* The brain of the fœtus while of the size of a hazel-nut is invested with a membrane, in which there is as yet no speck of bone. In the third month the ossification of the cranial bones commence, and the first process exhibits a very beautiful net of ossific wire-work. In a circle, the diameter of which is half an inch, we see a perfect net-work, resembling a fine lace, or the meshes of a spider's web. Upon this first layer another is deposited, and this superimposed net-work of bone is finer than the first: the meshes being smaller and the bony matter more abundant. The holes of the second net are not opposite to those of the first, so that the eye no longer penetrates the bone, although the structure be quite light and porous. While the second and third layer of bone is deposited on the outside of the first, the inner layer is extending in threads diverging from the centre, betwixt which delicate processes of bone intervening ribs are formed irregularly, still resembling the texture of the spider's web; and the diverging line of bone, being the stronger, it appears as if the cranial bones formed in diverging radii, while the edge of the bone extends in fine net-work, like to the first formed speck of ossification.

It is further worthy of remark, that this is the texture of true bone, and that what are called morbid ossifications, as of the coats of arteries and other membranes, are merely the deposit of earthy matter without organic structure.

bone. The thick round bones which form the wrist and foot have one ossification in their centre, which is bounded by cartilage all round. The processes are often distinct ossifications joined to the bones, like their heads, and slowly consolidated with them into firm bones.

In the original cartilage of the long bones there is no hollow nor cavity; it is all one solid mass. When the ossification first appears, the cavity of the bone also begins, and extends with the ossification: at first the cavity is confined chiefly to the middle of the bone, and extends very slowly towards the ends. This cavity in the centre of the bone is at first smooth, covered with an internal membrane, containing the trunks and branchings of the nutritious vessels, which enter by a great hole in the middle of the bone; and the cavity is traversed with divisions of its lining membrane, which, like a net-work of partitions, conduct its branches to all parts of the internal surface of the bone; and its nets, or meshes, are filled with a reddish and serous fluid in the young bone, but secrete and contain a perfect marrow in the adult bone.

In the middle of the bone the cavity is small, the walls thick, and having all their bony plates; the cells of net-work few, and large; but towards the ends the bone swells out, the cavity also is large; but it is not like that in the middle, a large tubular cavity: it is so crossed with lattice-work, with small interstices and cells, that it seems all one spongy mass of bone: and so many of the inner layers are separated, to form this profusion of cells, that the whole substance of the bone has degenerated into this lattice-work, leaving only a thin outward shell. This reticular form is what anatomists call the cancelli, lattice-work, net-work, or alveolar part of the bone: it is all lined with one delicate membrane, and inward partitions of the same lining membrane cover each division of the lattice-work, forming each cell into a distinct cavity. In these cavities, or cells, the marrow is secreted. The secretion is thin and bloody in children; it thickens as we advance in years; it is a dense oil or marrow in the adult. The marrow is firmer, and more perfect in the middle of the bone, and more thin and serous towards the spongy ends. The whole mass, when shaken out of the bone, is like a bunch of grapes, each hanging by its stalk. The globules, when seen with the microscope, are neat, round, and white, resembling small pearls; and each stalk is seen to be a small artery, which comes along the membrane of the cancelli, spreads its branches beautifully on the surface of the bag, and serves to secrete the marrow, each small twig of artery filling its peculiar cell. To this, an old anatomist added, that they had their contractile power, like the urinary bladder, for expelling their contents; that they squeezed their marrow, by channels of communication, through and among the bony layers; and that their oil exuded into the joint, by nearly the same mechanism by which it got into the substance of the bone; which is now known to be pure fancy, and to have no foundation.

While the constitution of a bone was not at all understood, anatomists noted with particular care every trifling peculiarity in the forms or connections of its parts; and these lamellæ attracted particular notice. Malphigi had first observed the lamellated structure of bones, likening them to the leaves of a book. Gagliardi, who, like Hippocrates, went among the burial places of the city, to observe the bones there, found in a tomb, where the bones had been long exposed, a skull, the os frontis of which he could dissect into many layers, with the point of a pin.* He afterwards found various bones, from all parts of the body, thus decomposed; and he added to the doctrine of plates, that they were held together by minute processes, which, going from plate to plate, performed the offices of nails: these appeared to his imagination to be of four kinds, straight and inclined nails, crooked or hook-like, and some with small round heads, of the forms of bolts or pins.†

Another notable discovery was the use of the holes, which are very easily seen through the substance of bones, and among their plates. They are, indeed, no more than the ways by which the vessels pass into the bones; but the older anatomists imagined them to be still more important, allowing the matter to transude through all the substance of the bone, and keep it soft. Now this notion of lubricating the earthy parts of a bone, like the common talk of fomentations to the internal parts of the body, is very mechanical, and very ignorant; for the internal parts of the body are both hot and moist of themselves, and neither heat nor moisture can reach them from without: the bone is already fully watered with arteries; it is moist in itself, and cannot be further moistened nor lubricated, unless by a fuller and quicker circulation of its blood. It must be preserved by that moisture only which exists in its substance, and must depend for its consistence upon its own constitution; upon the due mixing up of its membrane, cartilage, and earth. Every part is preserved in its due con-

* There is no proof of the bones being lamellated. As to the exfoliation of bone, the dead portion is generally irregular in its thickness, and rugged on its inner surface. This exfoliation of bone is a process of the living bone, and the inner living surface recedes from the outer one by absorption of its particles, because that outer surface is injured or dead. The nature of the injury, or the depth to which the bone has become dead, determines the extent and form of the portion cast off. When a scale only is thrown off, it is because the bone is only dead upon the surface. In regard to the breaking up of the surface of the cranial bones, when they lie exposed, the scales are similar to those from stones or metals exposed to the influence of the air, and moisture, and varying temperature: the thickness and succession of exfoliations depend on the operation of the weather, not on the original formation of the bone. I have never seen heat produce a lamellated decomposition of bone.

† These nails Gagliardi imagined were no more than the little irregularities, risings, and hollows of the adjoining plates, by which they are connected.

sistence by the vessels which supply it; and I should no more suppose fat necessary for preserving the moistness of a bone, than for preventing brittleness in the eye. This marrow is, perhaps, more an accidental deposition than we, at first sight, believe. We, indeed, find it in such a regularity of structure, as seems to indicate some very particular use; but we find the same structure exactly in the common fat of the body. When, as we advance in years, more fat is deposited in the omentum, or round the heart, we cannot entertain the absurd notion, of fat being needed in our old age, to lubricate the bowels or the heart; no more is the marrow (which is not found in the child,) accumulated in old age, for preventing brittleness of the bones.*

The internal periosteum is that membrane which surrounds the marrow, and in the bags of which the marrow is formed and contained. It is more connected with the fat than with the bone; and in animals, can be drawn out entire from the cavity of the bone; but its chief use is to conduct the vessels which are to enter into the substance of the bone.

The periosteum, the outer membrane of bone, which was once referred to the dura mater,† is merely condensed cellular substance; of which kind of matter we now trace many varied forms and uses, for so close is the connection of the periosteum, tendons, ligaments, fasciæ, and bursæ, and so much are these parts alike in their nature and properties, that we reckon them but as varied forms of one common substance, serving for various uses in different parts. The periosteum consists of many layers, accumulated and condensed one above another: it adheres to the body of the bone by small points or processes, which dive into the substance of the outer layer, giving a firm adhesion to it, so as to bear the pulling of the great tendons, which are fixed rather into the periosteum than into the bone. It is also connected with the bone by innumerable vessels. The layers of the periosteum nearest to the bone are condensed and strong, and take a strong adhesion to the bone, that the vessels may be transmitted safe, and the fibres of this inner layer follow the longitudinal directions of the bony fibres. The periosteum is looser in its texture outwardly, where it is recticulated and lax, changing imperceptibly into the common cellular substance. There the fibres of the peri-

* If we look to the difference there is in the adipose membrane, we shall find it more apparent than real. The fat on the soles of the feet and palms of the hands is particularly firm, but this firmness results from the strong intertexture of filaments of a tendinous strength. The fat in the exposed parts of the limbs is less firm, in the orbits of the eyes more delicate, but in the bones it lies in transparent membranes, and is quite soft and compressible. The difference, however, is only in the manner in which the bags containing the fat are bound up and protected; where the substance is exposed to pressure, it is firm; where it lies concealed, it is less so; but where it is altogether within the protection of the bones, the membranes are very delicate, and the fat takes the appearance of marrow.

† See what is said under the head of membranes.

osteum assume the directions of the muscles, tendons, or other parts which run over it. Any accident which spoils the bone of its periosteum, endangers the life of the bone itself. The surface of the bone becomes first affected, and then it exfoliates; the accidental wounds of the periosteum, deep ulcers of the soft parts, as on the shin, the beating of aneurisms, the growth of tumours, the pressure even of any external body, will, by hurting the periosteum, cause exfoliation.

The cartilages are also a part of the living system of the bone; and we see too well, in the question of the bones themselves, how unphilosophical it must be, to deny organization and feeling to any part of the living body, however dead or insulated it may appear; for every part has its degree of life: the eye, the skin, the flesh, the tendons, and the bones, have successive degrees of feeling and circulation. We see, that where even the lowest of these, the bone, is deprived of its small portion of life, it becomes a foreign body, and is thrown off from the healthy parts, as a gangrened limb is separated from the sound body; and we speak as familiarly of the death of a bone, as of the gangrene of soft parts. How, then, should we deny organization and life to the cartilages? Though surely, in respect of feeling, they must stand in the very last degree.

We now understand the constitution of a bone, and can compare it fairly with the soft parts in vascularity, and in feeling; in quickness of absorption; in the regular supply of blood necessary to the life of the bony system; in the certain death of a bone, when deprived of blood by any injury of its marrow, or of its periosteum, as a limb dies of gangrene, when its arteries are cut or tied; in the continual action of its absorbents, forming its cavity, shaping its processes and heads, keeping it sound and in good health, and regulating the degree of bony matter, that the composition may neither be too brittle nor too soft. From this constitution of a bone, we could easily foresee how the callus for uniting broken bones must be formed; not by a mere coagulation of extravasated juice, but by a new organization resembling the original bone.

The primordium of all the parts of the body is a thin coagulated mass, in which the forms of the parts are laid; and the preparation for healing wounds, and for every new part that needs to be formed, is a secretion of a fluid which coagulates, which is soon animated by vessels coming into it from every point. In every external wound, in every internal inflammation, wherever external parts are to be healed, or internal viscera are about to adhere, matter of this kind is secreted, which serves as a bed or nidus, in which the vessels spread from point to point, till the part is fully organized, and it is in this manner that the heart, the intestines, the testicle, and other parts, adhere by inflammation to the coats which surround them, and which are naturally loose. It is by a process not dissimilar that the broken ends of bones unite.

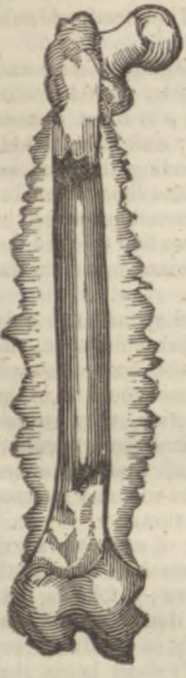
When we find the substance of the oldest bone thus full of vessels, why should we doubt its being able, from its own peculiar vessels, to heal a breach, or to repair any loss? How little the constitution of a bone has been understood, we may know from the strange debates which have subsisted so long about the proper organ for generating callus. Some have pronounced it to be the periosteum; others the medullary vessel, and internal membrane; others the substance of the bone itself. In the heat of this dispute, one of the most eminent anatomists produced a diseased bone, where a new bone was formed surrounding a carious one, and the spoiled bone rattled within the cavity of the sound one: here we should have been ready to pronounce, that bone could be formed by the periosteum only. But presently another anatomist produced the very reverse, viz. a sound young bone, forming in the hollow cylinder of a bone which had been long dead; where, of course, the callous matter must have been poured into the empty cavity of the spoiled bone, from the ends which still remained sound, or must have been secreted by the medullary vessels. But the truth is, that callus may be thus produced from any part of the system of a bone.* If we pierce the bone of any animal, and destroy the marrow, the old bone dies, and a new one is formed around the old: if we kill the creature early, we find the new bone to be a mere secretion from the old bone; and if we wait the completion of the process, we find the new bone beautiful, white, easily injected, and thick, loose in its texture, and vascular and bloody, but still firm enough for the animal to walk upon; and in the heart of it we find the old bone, and that it has become dead and black.† If we reverse this operation, and destroy the periosteum only, leaving the nutritious vessels entire, then the new bone is formed fresh and vascular by the medullary vessels, and the old one, quite black and dead, surrounds it.‡

* In the experiments and observations which I have made, neither the periosteum or marrow seemed to have formed the bone; and I conclude, that nothing but bone can form bone, by the continuation of natural actions; and that in the case of *necrosis*, the old bone inflames and begins the new formation, before the continued irritation in the centre kills it. C. B.

† The figure represents the necrosed bone, the new bone, soft and irregular around the old.

‡ When I injured the marrow of the bone, necrosis was the consequence. When I deprived the bone of its periosteum and surrounded it with a bit of bladder, I found the whole surface exfoliated, and the cavity of the bone

The effect of injury to a living bone is very curious. But the manner in which the bone resumes its pristine form is still more worthy of observation. At first, the outward exfoliation is attended with a proportionate filling up of the cavity of the bone: and the injury to the centre and body of the bone produces a new bone around the old one, and the old one at last dies, and is absorbed or discharged. But after years these changes are again reversed, and the new bone contracts its diameter, and the cavity becomes of its natural dimensions, so that the evidence of the changes which the bone has undergone are quite removed. This is a very beautiful example of the influence of that principle which controuls the growth of all the parts of the body, which may have its operation deranged by violent injury or by disease; but which will at last, by slow degrees, restore the part to its natural form and action.*



The diseases of the bones are the most frequent in surgery; and it is impossible to express how much the surgeon is concerned in obtaining true ideas of the structure, constitution, and diseases of bones; how tedious, how painful, and how loathsome they are; how often the patient may lose his limb, or endanger his life; how very useful art is; but, above all, what wonders nature daily performs in recovering bones from their diseased state.

filled up; but this was not a consequence of the destruction of the vessels of the periosteum, but of the contact of foreign matter with the surface of the bone. An effect precisely similar is the consequence of the sloughing of the soft parts over a bone, for the dead slough lying on the surface of the bone, causes an exfoliation. C. B.

* This figure is a plan of necrosis. The shaft of the old bone is dark; the new bone is in outline; and now we perceive how the new bone encloses the old, and how it forms the medium of union betwixt the two extremities, after the old bone is loose or altogether cast out.

OF THE TEETH.

The structure, and growth, and decay of the teeth are subjects of considerable interest.

Considering the teeth generally, as belonging to man and brutes, they are for masticating the food; they are for retaining the prey; they are weapons of defence; in some classes they are for digging and searching for food; and in some animals we can see no other use than for defending the eyes, as in the sus æthiopicus. Nor are we to consider them as exclusively belonging to the jaws, for they are sometimes seated in the back part of the mouth; and in fishes we find them in the beginning of the œsophagus, or at its termination, as in the crab and lobster.

The teeth differ from common bone: they are not only harder, but they are covered with a peculiar substance, the enamel, which is not found elsewhere in the body: though they stand exposed, they do not suffer as bone would do in the same circumstances; though worn by friction, they are not excited to diseased action; their mode of formation is peculiar, and so is the manner of their decay: and all these instances of their being different from common bone are so many reasons for instituting a distinct enquiry into their structure.

These peculiarities impose the necessity of a double set of teeth, since they cannot accommodate themselves by growth to the increasing size and strength of the jaws; it follows, that they must yield in succession, and that a double set be provided. The first set is called the milk teeth, or deciduous set of teeth; the second, the adult teeth. We shall begin this description with the perfect adult teeth.

DESCRIPTION OF THE HUMAN ADULT TEETH.

There are thirty-two teeth in the adult skull. These are divided into classes, according to their form and use. There are eight *incisores;* four *cuspidati*, or canine teeth; eight *bicuspides;* and twelve *molares*, or grinding teeth.

Every tooth has three parts; the crown, neck, and fang or root.

Incisores.—The crown of the incisor tooth is a wedge, having its anterior and posterior surface inclined and meeting in a sharp edge. On the fore-part the surface is convex; on the inside the surface is concave; and viewing the tooth laterally, it is broader and flat near the neck, and rising pyramidal towards the cutting edge. The cortex or enamel covers the crown of the tooth; it descends on the back and anterior surface further than on the side. The fangs of the incisores are long and straight, and of a pyramidal form, so that they are deeply socketed in the jaw.

From their position in the jaw, the upper incisor teeth project more than the lower, and in chewing their edges do not meet. They pass each other so as to cut, and yet do not meet, and this prevents the rapid wasting of the edge which would otherwise take place, as we see in the horse.*

The incisor teeth of the horse, being subject to attrition, have a provision against this, in the cavity lined with enamel, which is observed in their centre; nevertheless, we see them worn down even below the bottom of that cavity; thus the surface of the tooth becomes smooth, and the horse loses the mark.

In some animals, as in the rodentia, the front teeth are still better formed for cutting; but as they suffer attrition, in order to preserve the outer edge sharp, they have a peculiar structure. They are so deeply socketed, that they reach the whole length of the jaw, and they are provided with a continual growth from behind, which pushes the tooth out in proportion as it is worn away on the fore part. The enamel in these animals is more accumulated on the anterior edge of the tooth, so that the edge stands up fine and sharp.

The CUSPIDATI, or CANINE TEETH, are next in order, counting backwards. They are two in number in each jaw. They have a general resemblance to the incisor teeth, for when their points are worn off, they are hardly distinguishable. Their fangs are longer, and being the corner teeth of the jaw, and deeply socketed, they form the strength of the front teeth. Their principal distinction is in the form of the upper part of the crown, which is like a spear, having a point with two lateral shoulders.

In the larger carnivorous mammalia, this order of teeth is of terrific length, whilst the front teeth are small and carved. The spiral tusk of the narwhal and the tusks of the walrus belong to this division of the teeth: so do the tusks of the babyroussa, which turn up in a spiral direction. The use of these teeth Blumenbach cannot comprehend, but Sir Everard Home conceives, that they are provided to defend the eyes of the animal as it rushes through the underwood. There is a small imperfect tooth, called the tush, in a horse, which belongs to this order of teeth, as it is placed betwixt the incisors and the grinding teeth.

The BICUSPIDES are four in each jaw: they stand betwixt the canine teeth and the grinding teeth, and in form are intermediate between these two orders. They are sometimes called the lesser molares, being in truth grinding teeth. The crown of the bicuspis rises in two sharp points, so that they are like two cuspidati incorporated, and their fangs prove this to be the case; for whilst they are always flatter and shorter

* And as, indeed, we sometimes see in the human teeth.

than those of the cuspidati, they have often a division, and sometimes there are distinctly two fangs: their roots are oftener curved than those of the other teeth. The second bicuspis is sometimes wanted.

MOLARES, or GRINDING TEETH, are six in each jaw. The form of the crown is an oblong square. They have four or more projections on their upper surface, and they are covered with enamel to a uniform level, and form indeed an approximation to the graminivorous tooth, since these regular projections being covered with enamel, a portion of the enamel remains in the depressions when the projections have been worn down; and this is sufficient in a certain degree to save the remaining part of the tooth from wasting rapidly under attrition. The lower grinders have two separate fangs, and those of the upper jaw three.

The molares are best considered as cuspidati united, in which idea four cuspidati are incorporated to form one grinder. The projections on the grinding surface correspond with the points of the cuspidati, and the fangs correspond with the projections of the crown; for although there are only two or three roots to each grinding tooth, yet we may discover that there would be always four fangs if they were disjoined.

The term grinder is not good in comparative anatomy, for in brutes of prey they are compressed, and terminate in three sharp processes, and these in the closing of the jaw intersect each other like the blades of scissars.

These four orders make the full number of thirty-two teeth in the adult jaws.

On the whole the teeth of man are peculiar, in being on a level, and being more nearly of one length than any instance which we observe in brutes. In all other animals the teeth differ remarkably in the length and size of their different classes; and they are separated by wider intervals: another peculiarity is the upright position of the incisors, and the regular inclination of the whole lateral phalanx, in proportion as they are distant from the centre of motion in the condyle of the jaw. It is indeed quite obvious that the front teeth have a use in speech, and therefore are different in man from those of animals. But there is a peculiarity in the molares also, in their obtuse tubercles, which exhibits a correspondence betwixt the teeth, taken collectively, and the variety of food and the mixed diet which is natural to man.

OF THE FIRST SET OF THE TEETH, THE MILK OR DECIDUOUS TEETH.

The first set of teeth are twenty in number: these are divided into three classes; the INCISORES, four in each jaw; the CUSPIDATI, two in each jaw; and the MOLARES, four in each jaw.

The teeth of a child generally appear in this order: first the central incisores of the lower jaw pierce the gum. In a month after, perhaps, their counterparts appear in the upper jaw. These in a few weeks are succeeded by the lateral incisores of the lower jaw; then the lateral incisores of the upper jaw, though sometimes the lateral incisores of the upper jaw appear before those of the lower jaw. The growth of the teeth is not after this in a regular progression backwards; for now, instead of the cuspidati, which are immediately lateral to the incisores, the anterior molares of the lower jaw show their white surface above the gum about the fourteenth or fifteenth month. Then the cuspidati pierce the gum; and, lastly, the larger molares make their appearance, the teeth of the lower jaw preceding those above. The last tooth does not rise till the beginning of the third year.*

The teeth do not always cut the gums in this order; but it is the more regular and common order. When the teeth appear in irregular succession, more irritation and pain, and more of those symptoms which are usually attributed to teething, are said to accompany them.

The deciduous set of teeth are perfected with the rising of the second molaris; for the third molaris being formed about the eighth year, when the jaw is advanced towards its perfect form, is not shed, but is truly the first permanent tooth. The molares of the adult are properly the permanent teeth, (IMMUTABILES), for they alone arise in this part of the jaw, and remain in their original places; yet we must recollect that, in opposition to Albinus, in this arrangement, it is more common to speak of the whole set of the adult teeth as the *immutabiles*.

In the sixth and seventh years the jaws have so much enlarged, that the first set of teeth seems too small, spaces are left betwixt them, and they begin to fall out, giving place to the adult teeth. But the shedding of the teeth is by no means regular in regard to time; the child is already no longer in a state of nature, and a thousand circumstances have secretly affected the health and growth. The teeth even fall out three years earlier in one child than in another: nay, so frequently

* The figure exhibits a section of the lower jaw, at that period when the milk teeth have all risen, and when the permanent teeth are preparing in the jaw.

are some of them retained altogether, that it would appear necessary to be assured of the forward state of the adult tooth before the tooth of the first set should be thoughtlessly drawn.

The jaw-bones are still so small, that the second set of teeth must rise slowly and in succession, else they would be crowded into too small a circle, and of course turned from their proper direction.

The incisores of the under jaw are loose commonly when the anterior of the permanent molares are thrusting up the gum. The permanent central incisores soon after appear, and in two or three months more those of the upper jaw appear. In three or four months the lateral incisores of the lower jaw are loose, and the permanent teeth appear at the same time with the anterior molares. The lateral incisores of the upper jaw follow next; and in from six to twelve months more, the temporary molares loosen, the long fangs of the cuspidati retaining their hold some time longer.

The anterior molares and the cuspidati falling, are succeeded about the ninth year by the second of the bicuspides and the cuspidati. The posterior of the bicuspides take place of the anterior of the molares about the tenth or eleventh year; the second permanent molaris does not appear for five or six years from the commencement of the appearance of the permanent teeth. The jaw acquires its full proportion about the age of eighteen or twenty, when the third molaris, or the *dens sapientiæ*, makes its appearance. This tooth is shorter and smaller, and is inclined more inward than the others. Its fangs are less regular and distinct, being often squeezed together. From the cuspidati to the last grinder, the fangs are becoming much shorter, and from the first incisor to the last grinder, the teeth stands less out from the sockets and gums.

OF THE STRUCTURE OF THE TEETH.

A tooth consists of these parts:—The ENAMEL (A), a peculiarly hard layer of matter composing the surface of the body of the tooth. The internal part, or bone of the tooth (B), is less stony and hard than the enamel, but of a firmer structure and more compact than common bone. In regard to the form of the tooth, we may observe, that it is divided into the crown, the neck, and the fangs, or roots of the tooth, which go deep into the jaw. There is a cavity in the body of the tooth (C), and the tube of the fangs communicates with it. This cavity receives vessels for supplying the remains of that substance upon which the tooth was originally formed. The roots of the teeth are received into the jaw by that kind of articulation which was called gomphosis. They are not firmly wedged into the bone, for in consequence of maceration, and the des-

truction of the soft parts, the teeth drop from the skull. There is betwixt the tooth and its socket in the jaw a common periosteum.

Of the enamel.—The surface of a tooth, that which appears above the gum, is covered with a very dense hard layer of matter, which has been called the enamel.* In this term there is some degree of impropriety, as assimilating an animal production with a vitreous substance, although the enamel very widely differs from the glassy fracture when broken. This matter bestows the most essential quality of hardness on the teeth; and when the enamel is broken off, and the body of the tooth exposed, the bony part quickly decays.

The enamel is the hardest production of the animal body; it strikes fire with steel. In church-yard skulls it is observed to remain undecayed when the centre of the tooth has fallen into dust. It has been found that the component parts of the enamel are nearly the same with those of bone. In bone, the phosphate of lime is deposited on the membranes, or cartilage, but this hardening matter of bones is a secretion from the vessels of the part, and is accumulated around the vessels themselves: it is still within the control of their action, and is suffering that succession of changes peculiar to a living part. In the enamel, the phosphate of lime has been deposited in union with a portion of animal gluten, and has no vascularity, nor does it suffer any change from the influence of the living system. Although the hardening matter be principally phosphate of lime, a small proportion of the carbonate of lime enters into the composition both of bone and of enamel. But in enamel, according to Morichini and Gay Lussac, there is fluat of lime, to which ingredient these chemists attribute the hardness of this crust.†

* This section of the tooth is a plan; for in our preparations we make the bone black by burning, to exhibit the enamel contrasted with it. In this figure the bone is white, and the enamel black.

In brutes there is a considerable variety in the relative form of the enamel and bone of the tooth; but it is always laid with reference to the friction against the tooth, and so as to protect it from the effects of attrition.

† By Mr. Hatchett's Experiments, (Philos. Transact. 1799,) we learn that bone consists of phosphate of lime, with a small proportion of carbonate of lime. The shell of the crab and lobster consist of phosphate of lime and carbonate of lime, the latter being in the greatest quantity. The testaceous shells consist entirely of carbonate of lime. The matter of bone and teeth consists of phosphate of lime and a small portion of carbonate deposited in the interstice of an animal substance, which is of the nature of cartilage, and proves to be gelatine. The bones of fish differ from those of man and brutes, in the larger proportion of animal substance. These chemical facts are, however, of little import to the anatomist: he is desirous of knowing what property of life these parts are endowed with; whether they are formed by a final deposition, or are still under the influence of the circulating vessels, whether they possess a principle of self-preservation independent of vascularity, or are like common dead matter altogether out of the system.

The formation of bone has been very fully described. The formation of shell is more like that of teeth. The testaceous shell consists of layers;

Although we call the earthy deposit the hardening matter, yet it is the union of the glutinous matter which bestows the extreme hardness; for, when the tooth is as yet within the jaw, and in an early stage of its formation, the deposition is soft, and its surface rough; but, by a change of action in the secreting surface, which throws out this fluid, the first deposition is penetrated with a secretion, which either by this penetration simply, or by causing a new apposition of its parts, (its structure, indeed, looks like crystallization,) bestows the density and extreme hardness on the crust or enamel.

When an animal is fed with madder, the colouring matter coming, in the course of the circulation, in contact with the earth of bone, is attracted by it, and is deposited upon it in a beautiful red colour. This colouring matter penetrates more than injection can be made to do in the dead body; and, as by this process of feeding, the enamel is not tinged, we have a convincing proof that the vascular system has no operation on the enamel after it is formed.

In the marmot, beaver, and squirrel, the enamel is of a nut-brown colour, on the anterior surface of the incisor teeth. The molares of some of the cloven-hoofed animals are covered with a black vitreous matter, and sometimes they have a crust of a shinning substance like bronze. In the grinding teeth of the graminivorous animals, the arrangement of the enamel is quite peculiar.

From the composition of the enamel, we must be aware of the bad effect of acidulated washes and powders to the teeth: they dissolve the surface, and give a deceitful whiteness to the teeth; they erode the surface, which it is not in the constitution of the part to restore.

OF THE CENTRAL BONY PART OF THE TOOTH.

The chemical composition, and the manner of combination of the matter forming the central part of the tooth, and of the fangs, is similar to other bones of the body; but when we examine the hardness and the density of the tooth, and see that it is not even porous, or apparently capable of giving passage to vessels, we conclude that it is not vascular, and are apt to suppose that it holds its connection with the living jaw-bone by some other tenor than that of vessels, or the circulation of the blood through it. The body and fangs of a tooth are covered with a periosteum like other bones. The vascularity of the periosteum, which surrounds the tooth, and the vessels which enter by the fangs to the cavity of the tooth,

the layers are formed successively by secretion from the animal body, and each successive layer is broader than the preceding, answering to the increased circumference of the animal. Reaumur broke the shell of a snail, and he found that when he covered the surface of the creature and prevented the exudation, no shell was formed.

seem to be a provision for supplying them plentifully with blood; but on further examination, it will prove to be a means only of fixing the tooth in the socket, and of preserving the sensibility of the nerve in the cavity of the tooth. As the bony part of the tooth has often been coloured by feeding young animals with madder, it might deceive some to suppose that there is blood circulating through the body of the tooth, and that the tooth undergoes the same changes by absorption which the other bones are proved to do. But these experiments may have been made while the teeth were forming by a secretion from the pulp, and of course they might be coloured, without the experiment affording a fair proof that the circulation continues in the tooth after it is formed.

OF THE VASCULARITY AND CONSTITUTION OF THE BONY PART OF THE TOOTH.

The teeth undergo changes of colour in the living body, to which it would appear they could not be liable as dead matter. They become yellow, transparent, and brittle with old age; and when a tooth has been knocked from its socket, and replaced, dentists have observed that it loses its whiteness, and assumes a darker hue.

The absorption of the roots in consequence of the caries of the body of the tooth, and the absorption of the fangs of the deciduous teeth, are further alleged in proof of their vascularity; not only the pressure of the rising tooth on the fangs of the temporary teeth will cause an absorption of the latter, but the fangs of the temporary teeth will waste and be absorbed, so as to drop out without the mechanical pressure of the permanent teeth, and before they have advanced to be in contact with the former. Of what nature is this absorption of the fangs of the deciduous teeth? Is it an influence commencing in the tooth, or is it the agency of the vascular substance around the tooth?

The teeth seem acutely sensible; but a little consideration teaches us that the hard substance of the teeth is not endowed with sensibility, and that it must be the remains of the vascular pulp, presently to be described, occupying the centre of the tooth, which being supplied with nerves, gives the acute pain in tooth-ach. It is as a medium communicating or abstracting heat, that the condition of the tooth is attended with pain. When wrought upon by the dentist's file, no sensation is produced unless the tremor be communicated to the centre, or unless the abrading, or cutting instruments, be so plied as to heat the tooth; then an acute pain is produced from the heat communicated to the centre; and so ice or extremely cold liquids, taken into the mouth, produce pain, from the cold affecting the pulp through the body of the tooth.

As living parts, the teeth have adhesion to the periosteum, and are connected with their internal pulp; but when they spoil, and are eroded, the disease spreads inwardly, probably destroying the life of the bony part of the tooth, the progress of which disease is marked, by a change of colour penetrating beyond the caries towards the centre of the tooth. When this discolouration has reached the internal surface, the pain of tooth-ach is excited; the pulp, vascular and supplied with nerves, inflames, from a want of accordance with the altered state of the tooth, just as the dead surface of a bone will inflame the central periosteum and marrow. The extreme pain produced by this state of the tooth probably proceeds from the delicate and sensible pulp swelling in the confinement of the cavity of the tooth.

In caries of the teeth, the body of the tooth is discoloured deep in its substance long before the pulp of the central cavity is exposed by the progress of the caries. No exfoliation, or exostosis, takes place upon that part of the tooth which is above the gum, which, however, some say, may be owing to the mere compactness of the ossific depositions.

In the further consideration of this subject, there are circumstances which will make us conclude that there is no vascular action in the teeth, and incline us to believe that they possess a low degree of life, independent of vascular action. Supposing the bony part of the tooth to be vascular, and to possess the principle of life, is not the firm adhesion and contact of the enamel to the body of the tooth a curious instance of a part destitute of life adhering to the surface of a living part, without producing the common effects of excitement and exfoliation or inflammation in the latter.

In rickets, and mollities ossium, and other diseases of debility in which the body wastes, or the growth is retarded, the grown teeth are not altered in their form or properties. The effects which we perceive in the bony system, under these diseases, are produced by the activity of the absorbents prevailing over the action of the red vessels; while in the teeth no such effect can take place, if they are formed by a deposition of bony matter which is not re-absorbed, nor subject to the revolution of deposition and re-absorption, which takes place in other parts of the body. Accordingly we find in rickets, where the hardest bone yields, and where the jaw-bone itself is distorted or altered in its form by the actions of its muscles, that the teeth remain distinguished for their size and beauty. In mollities ossium I have found the teeth loose, but hard in their substance. In rickets the teeth are large, and perfectly formed, while the jaws are stinted and interrupted in their growth. The consequence of this is, that the teeth form a larger range than the jaw, and give a characteristic protuberance to the mouth.

I must here observe, however, that if a child is in bad health during the formation of the teeth, they are often deficient in form, or the crust of enamel which covers them is irregular, and which circumstances continue through life; instances of this my reader may see in my Collection.

When an adult tooth of one jaw is lost, there appears to be a growth of the tooth of the opposite jaw; but I believe the tooth only projects from its socket a little further, in consequence of the want of that pressure to which it is naturally accommodated. The teeth of the *rodentia* are wasted by attrition, and seem to grow. This is, indeed, a growth, but it is of the nature of the first formation of the tooth proceeding from the pulp*; for while the tooth wastes by attrition on its anterior edge, it continues to grow by addition from the pulp, and to be pushed forwards.

Much has been said of balls being found in elephants' teeth, as they are found in bones, the bony matter accumulated around the ball, and considered to be a proof of the inflammation of the tooth, and of course of its vascularity. The specimens in the collections of Haller, Blumenbach, and Monro, are quoted. I possess a great variety of these specimens, of both iron and leaden balls immersed in the ivory of the elephant's tusk, but they prove that the pulp continuing to secrete bony matter, has enveloped the ball after it has pierced the shell of the tooth.

The roots of the teeth are sometimes found enlarged, distorted, or with exostosis formed upon them. Again, the cavity of the tooth is found filled up with what appears to be new matter, or around the fangs we often find a small sac of pus, which is drawn out in extracting the tooth. Nevertheless, in these examples of disease, there are no unequivocal marks of vascular action in the tooth; the unusual form, or exostosis of the roots, is produced by an original defect in the formation. The filling up of the cavity of the tooth is caused in the same way, or by the resumed ossific action of the pulp, in consequence of the disease and destruction of the body of the tooth; and the abscesses which surround the fangs are caused by the death of the tooth, in consequence of which it has lost its sympathy with the surrounding living parts, and becomes a source of irritation like a foreign body.

The transplanting of teeth presents another very interesting phenomenon. A tooth recently drawn, and placed accurately into a socket from which one has been taken, will adhere there: nay, it will even adhere to any living part, as in the comb of a cock. This, however, proves only that the tooth possesses vitality; for after it is taken from the natural socket, if it be kept any time it will not adhere; it has become a dead part, and the living substance refuses to unite with it. Again, and in opposition to this, is it not very extraordinary that a tooth may be burnt by chemical agents, or the actual cautery, down to the centre, and yet retain its hold; or that the body of the tooth may be cut off, and a new tooth fixed into it by a

* See the ingenious Inaugural Dissertation of Dr. Blake.

pivot? Had the teeth any vascular action, this torturing would cause reaction and disease in them. No doubt sometimes very distressing effects are produced by these operations, as tetanus, abscess in the jaws, &c.; but this happens in consequence of the central nerve being bruised by the wedging of the pivot in the cavity of the tooth, or by the roots of the tooth becoming, as dead bodies, a source of irritation to the surrounding sockets.

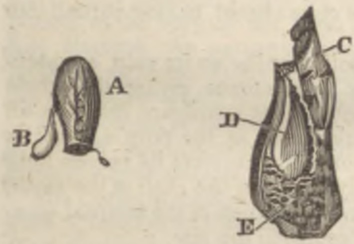
Of the gums.—The necks of the teeth are surrounded by the gums, a red, vascular, but firm substance, which covers the alveolar processes. To the bone and to the teeth the gums adhere very strongly, but the edge touching the tooth is loose. The gums have little sensibility in their healthy and sound state; and by mastication, when the teeth are lost, they gain a degree of hardness which proves almost a substitute for the teeth. The use of the gum is chiefly to give firmness to the teeth, and at the same time, to give them that kind of support which breaks the jar of bony contact. Like the alveolar process, the gums have a secret connection with the state of the teeth. Before the milk-teeth appear, there is a firm ridge which runs along the gums, but this is thrown off, or wastes with the rising of the teeth: and as the teeth rise, the proper gums grow, and embrace them firmly. The gum is firm, and in close adhesion, when the teeth are healthy; loose, spongy, or shrunk, when they are diseased. The only means of operating upon the general state of the teeth is through the gums; and by keeping them in a state of healthy action, by the brush and tinctures, the dentist fixes the teeth, and preserves them healthy; but when they are allowed to be loose and spongy, and subject to frequent bleeding, (which is improperly called a scorbutic state,) the teeth become loose, and the gums too sensible. If a healthy tooth be implanted in the jaw, the gum grows up around it, and adheres to it; but if it be dead or diseased, the gum ulcerates, loosens, and shrinks from it; and this shrinking of the gums is soon followed by the absorption of the socket.

We must conclude, that the whole of the phenomena displayed in the formation, adhesion, and diseases of the teeth, shows them to be possessed of life, and that they have a correspondence or sympathy with the surrounding parts. But are we prepared to acquiesce in the opinion of Mr. Hunter, that they possess vitality while yet they have no vascular action within them? We naturally say, how can such vitality exist independently of a circulation? In answer to this, there are not wanting examples of an obscure and low degree of life existing in animals, ova, or seeds, for seasons, without a circulation; and if for seasons, why not for a term of life? We never observe the animal economy providing superfluously; and since there is no instance to be observed in which the teeth have shown a power of renovation, why should they be possessed of vascularity and action to no useful purpose? All that seems necessary to them is, that they should firmly adhere without acting as a foreign and extraneous body to the surrounding parts; and this, vitality, without vascular action, seems calculated to provide.

OF THE FORMATION AND GROWTH OF THE TEETH.

In this figure we see the milk-teeth of one side of the lower jaw prepared to rise above the gum. They are in their distinct bony cells, and also surrounded with their membraneous sacs. The first of the permanent teeth is also seen in a state of advancement.

In the jaws of a child newly born, there are contained two sets of teeth as it were in embryo; the deciduous, temporary, or milk-teeth; and the permanent teeth. The necessity for this double set of teeth evidently is to be found in the incapacity of alteration of shape or size in the teeth, as in other parts of the body; the smaller teeth, which rise first, and are adapted to the curve and size of the jaw-bone of an infant, require to be succeeded by others, larger, stronger, and carrying their roots deeper in the jaw.



Each tooth is formed in a little sac, which lies betwixt the plates of bone that form the jaw-bone of the fœtus, or child, under the vascular gum, and connected with it. A is the sac containing the milk-tooth: B the sac of the permanent tooth attached to the sac of the milk-tooth.

When we open one of these sacs at an early period of the formation of the tooth, a very curious appearance presents itself: a little shell of bone is seen within the sac, but no enamel is yet formed. Upon raising the shell of bone, which is of the shape of the tooth, and is the outer layer of the bony substance of the tooth, a soft vascular stool, or pulp*, is found to have been the mould on which this outer layer of ossific matter has been formed; and a further observation will lead us to conclude, that this bony part of the tooth is in the pro-

* Le noyau, la coque, or le germe de la dent, by the French authors.

gress of being formed by successive layers of matter thrown out from the surface of this vascular pulp; though many have explained the formation of the tooth, by supposing that the layers of this pulp were successively ossified. A is the pulp on which the tooth is formed: B the sac opened, which surrounds the pulp and new tooth, and which secretes the enamel: C the shell of the new tooth taken off the pulp A, to which of course it corresponds accurately in shape.

If we now turn our attention to the state of those teeth which we know to be later of rising above the gum, we shall find the ossification still less advanced, and a mere point, or perhaps several points of the deposited matter, on the top of the pulp.

The pulp, or vascular papilla on which the tooth is formed, has not only this peculiar property of ossification, or rather secretion of ossific matter, but, as the period of revolution advances, where it forms the rudiments of the molares for example, its base splits so far as to form the mould of two, three, or four fangs, or roots; for around these divisions of the pulp the ossific matter is thrown out so as to form a tube, continued downwards from the body of the tooth. Gradually, and by successive layers of matter on the inside of this tube, it becomes a strong root, or fang, and the bony matter has so encroached on the cavity, that only a small canal remains, and the appearance of the pulp is quite altered, having shrunk into this narrow space.

We have said that the tooth forming on its pulp, or vascular bed, is surrounded with a membrane, giving the whole the appearance of a little sac. This membrane has also an important use. It is vascular also, as the pulp is, but it is more connected with the gums, and receives its vessels from the surface, while the pulp, lying under the shell of the tooth, receives its blood-vessels from that branch of the internal maxillary artery which takes its course in the jaw.

The enamel is formed after the body of the tooth has considerably advanced towards its perfect form. It is formed by a secretion from the capsule, or membrane, which invests the teeth*, and which is originally continuous with the lower part of the pulp. The enamel is thicker at the point, and on the body of the tooth, than at its neck. Mr. Hunter supposed that the capsule always secreting, and the upper part of the tooth being formed first, it would follow, of course, that the point and body of the tooth would be covered with a thicker deposition; but it rather appears that that part of the sac opposite to the upper part, and body of the tooth, has a greater power

* This outer sac has been called *chorion*, from the numerous vessels distributed upon it.

of secreting, being in truth more vascular and spongy; for the whole of the body of the bony part of the tooth is formed before the enamel invests the tooth.

We are indebted to M. Herissant for much of the explanation of the manner in which the enamel is formed. He describes the sac; its attachment to the pulp and to the neck of the teeth. As the tooth advances to its perfect form, the sac also changes. At first it is delicate and thin, but it thickens apace. And he asserts, that if after this progress is begun you examine the inner surface of it with a glass, you will perceive it to be composed of little vesicles in regular order, and which sometimes have a limpid fluid contained in them. This liquid exuded upon the surface of the teeth he supposes to form the enamel. He explains also how this sac, originally investing the body and neck of the tooth, being pierced by the edge of the tooth, and the tooth rising through it, is inverted, and by still keeping its connection with the circle of the crown of the tooth, rises up in connection with the gum, and in some degree forms the new gum which surrounds the tooth.

The sac which encloses the rudiments of the tooth consists of a double membrane. The outer membrane is of a looser texture, and vascular; the inner is vascular also, but delicate and soft. Mr. Hunter said, that while the tooth is within the gum, there is always a mucilaginous fluid, like the synovia in the joints, between this membrane and the pulp of the tooth. I do not imagine that the enamel is produced by the concretion of this humour, which we may find at any period of the growth of the body of the tooth; but that the secreting surface changes the nature of its action, when the bone of the tooth is perfected in its outer layer, and that it then throws out the matter which consolidates into enamel.

This subject of the formation of teeth would be incomplete if we left unexplained the peculiar structure of the teeth of graminivorous animals.

Mr. Corse, in a curious paper in the Philosophical Transactions of London for the year 1799, describes the grinding tooth of an *elephant* in the following terms:—In describing the structure of the grinders, it must be observed, that a grinder is composed of several distinct laminæ or teeth, each covered with its proper enamel; and that these teeth are merely joined to each other by an intermediate softer substance, acting like cement.

The structure of the grinders, even from the first glance, must appear very curious, being composed of a number of perpendicular laminæ, which may be considered as so many teeth, each covered with a strong enamel, and joined to one another by the common osseous matter. This being much softer than the enamel, wears away faster, by the mastication of the food; and, in a few months after some of these teeth cut the gum, the enamel remains considerably higher, so that the surface of each grinder soon acquires a ribbed appearance, as if originally formed with ridges.

The pulp of graminivorous animals is not shaped like that which forms the human tooth; it consists of several processes united at their base. The capsule has also processes which hang into the interstices of the pulp; the pulp forms a shell of bone which in time covers it. The processes of the capsule, which of course hang into the interstices of this layer of bone, (which has taken the exact form of the pulp,) form over the bone layers of enamel. The tooth now consists of conical processes of bone, united at their roots, and the surfaces of these processes have deposited on them the enamel. The membraneous productions of the capsule having completed the enamel, change the nature of their secretion somewhat, and throw out a bony matter, which Dr. Blake has called the *crusta petrosa.* By the formation of this last matter of the tooth, the processes which secrete are encroached upon so much, that they shrink altogether, and into the place left by them, after they have lost their power of secreting, foreign matter is sometimes introduced by mastication.*

The effect of this formation is to make the layers of the enamel pervade the whole substance of the tooth, the better to make it stand against the continued attrition necessary in the grinding and rumination of the herbivorous and graminivorous animals. The grinding teeth of the purely carnivorous animals, as of the lion and tiger, close like the blades of scissors: they are prevented by the long canine teeth from moving laterally; and as they are not subject to attrition, the enamel only covers their surfaces.

OF THE GROWTH OF THE SECOND SET OF TEETH, AND THE SHEDDING OF THE FIRST.

The teeth of the first or deciduous set are twenty in number. They are small, being adapted for the jaws of a child; they are destined to be shed, and to give place to the adult or permanent set of teeth. Accordingly, in observing the progress of the formation of this first set of teeth, the rudiments of the second may also be seen so early as in the fœtus of the seventh or eighth month; and in the fifth and sixth month after birth, the ossification begins in them. The rudiment of the permanent tooth may be observed even when the sac which contains it is very small, and appears like a filament stretching up to the neck of the sac of the deciduous tooth.† These sacs lie on the inner side of the jaw-bone, and when further advanced, the necks of the two sacs (both as yet under the gum) are united; but when the first teeth are fully formed,

* See a paper of Sir E. Home's in the Philosophical Transactions, and Dr. Blake's Inaugural Dissertation.

† See the two figures in page 197.

and have risen above the gum, the alveolar processes have been at the same time formed around them, and now the sacs of the permanent teeth have a connection with the gums through a small foramen in the jaw-bone, behind the space through which the first teeth have risen.

The opinion entertained, that the second set of teeth push out the first, is erroneous, for the change on the deciduous and the growing teeth seems to be influenced by laws of coincidence, indeed, but not of mechanical action. Sometimes we observe the falling tooth wasted at the root, or on the side of the fang, by the pressure of the rising tooth. Now here we should suppose that the newly formed tooth should be the most apt to be absorbed by the pressure of the root of the deciduous tooth, did we not recollect that the new tooth is invested with the hard enamel, while the pressure on the other is upon the bony root. But there is more than this necessary to the explanation of the shedding of the teeth, for often the fang is wasted, and the tooth adheres only by the gum, and the permanent tooth has made little progress in its elevation, and has not pressed upon it.

This decay and wasting of the fangs of the teeth looks more like a satisfactory proof of their vascularity, than any other change to which they are subject. Yet there seems to be no reason why we should not suppose, that as the rudiments of the teeth rise into action at a particular time, and form the bony centre of the tooth, the decomposition should be effected by similar laws; that at a particular period the tooth should decay, and that the decay of the tooth should begin with the destruction of the fangs. Has the bony part of the tooth a tendency to dissolution independently of a circulation of blood through it? and as the roots waste, do the surrounding vascular parts absorb its substance? or, does the surrounding vascular substance operate on the tooth dissolving, and absorbing it, as it is said a dead bone is absorbed, when placed upon an ulcer?

When the internal vascular substance of a tooth is destroyed, it does not waste: when teeth are pivoted, their roots remain twenty years without wasting or being absorbed; and when the vascular centre of the milk-teeth is destroyed, their roots waste no more, and they continue adhering to the gum. This seems to point to the internal membrane of the tooth as the means of its absorption.

It is no proof of the first set being pushed out by the second set of teeth, that if the permanent teeth do not rise, the first will remain, their roots unwasted and firm, even to old age; for still I contend, that there is an agreement and coincidence betwixt the two sets of teeth in their changes, and also in the alveoli by which they are surrounded; but this is not produced by the pressure of the rising teeth. When a dentist sees a tooth seated out of the proper line, and draws it, and finds that he has made the mistake of extracting the adult tooth, letting the milk-tooth remain, he must not expect that the milk-tooth will keep its place, for the contrary will happen; it will in general fall out.

The old and the new teeth are lodged in distinct compartments of the jaw-bone, and, what is more curious, their alveoli are distinct; for as the roots of the first teeth decay, their alveolar processes are absorbed, while again, as the new teeth rise from their deep seat in the jaw-bone, they are accompanied with new alveoli; and the chief art of the dentist in shifting the seat of the teeth, is gradually to push them along the jaw, notwithstanding the bony partitions or alveoli and processes, so as to bring them into equal and seemly lines. It is curious to observe, that the alveoli will, by the falling out of one tooth, or the operation of wedging betwixt the teeth, change their place in the jaw.

When a tooth is lost, it appears as if the space it occupied were partly filled up by an increased thickness of the adjacent teeth, and partly by the lengthening of that which is opposite: indeed, this appearance has been brought as a proof of the continual growth of teeth. But there is a fallacy in the observation; for when the space appears to have become narrow by the approximation of the two adjacent teeth, it is not owing to any increase of their breadth, but to their moving from that side where they are well supported to the other side where they are not. For this reason they get an inclined direction; and this inclination may be observed in several of the adjoining teeth.

No circumstance can better illustrate how perfect the dependence of the alveoli is upon the teeth, than that of their being thrown off with them in extensive exfoliations. I have a specimen of this in my Collection, where the whole circle of the alveolar processes and teeth is thrown off. This happened after the confluent small-pox. I think I recollect a similar case occurring to Dr. Blake. In those tumours which arise from the alveoli and gums, filling the mouth with a cancerous mass, and softening the upper part of the jaw, there is no eradicating the disease but by taking away the whole adventitious part of the jaw which belongs to the teeth, and leaving only the firmer base. But even this operation will be too often unsuccessful.

OF THE MUSCLES.

THEIR TEXTURE, AND THE VARIETIES IN THE ARRANGEMENT OF THEIR FIBRES.

The muscles are the appropriate organs of motion. They are distinguished by their peculiar texture, and by their singular vital property of contraction.*

The muscle is the only proper fibrous texture in the human frame. These fibres have the power of contracting, and are the active agents, in contradistinction to the bones and tendons, and ligaments, which are passive instruments under the influence of the muscles. The muscular fibres are formed into packets, or fasciculi: these fasciculi are variously ordered or arranged in the several muscles, and adapted to the action to be performed.

The proper muscular fibres are everywhere enveloped by the common cellular substance. Towards the extremities of the muscle, the proper fibres become fewer, and begin successively to terminate; by which the cellular membrane, being free from the interposition of the fibres, the divisions of it approach, and become more firmly combined, so as to form a tendon or rope. This tendon holds relation to each fibre of the proper muscle; and when these fibres contract, they concentrate and unite their power upon the tendon. The tendons, then, are not the continuations of the fibres of the proper muscle, but of the interstitial cellular membrane.

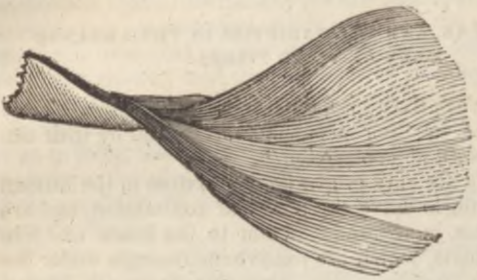
Every muscle is supplied with arteries, veins, lymphatics, and nerves. Without nerves they would be insulated parts, contracting perhaps spasmodically and irregularly; but through the nerves these contractions are regulated so as to be efficient in the economy of the system, or the motions of the body.

The muscles are divided into simple and compound; the simple muscles are those which have their fibres in a similar direction and disposition. The most common being the *ventriform*, so called because the middle is large, and they diminish gradually towards their tendons or extremities.

I have given here the example of the ventriform muscle in the biceps, which, as it has two heads or tendinous origins

* At the end of the history of the muscles, the subject of *muscular power* is treated of.

running into one belly, is so named. Another simple muscle is when the fibres are laid flat and *parallel:* these do not terminate in a round tendon, but in a broad web of the same material. The muscles are *radiated;* that is, their fibres are laid diverging, or like the radii of a circle. This is the pectoralis major, which is an example of the fibres converging to their tendinous insertion. Or they are *penniform;* that is, resembling the feathers of a quill, the fibres running parallel, but all of them oblique to their tendons.



There is a *double penniform* muscle, which, indeed, is the form most like a quill or feather; for a double range of parallel fibres are obliquely inserted or attached to the tendon, the tendon running up betwixt them. There are muscles which are called *complicated,* from their having two or more tendons, and a variety in the insertion of oblique fibres into these tendons. From the different disposition of the fibres results the absolute force of the muscles; but the mode of the attachment, or, as it is termed, the insertion of their tendons, determines their real effect.

The muscles accomplish very different purposes. Their first, or most important purpose, is to move the fluids through the intestines and hollow tubes, thus performing the motions necessary to the vital functions.* Besides these, they conform themselves, commonly, to the apparatus of the frame. 1. They envelope and compress, and sustain the viscera, as the abdominal muscles. 2. They lengthen, shorten, or compress some organ, as the tongue. 3. They widen or contract some aperture, as the sphincter muscles. 4. They relax, or draw up, or render rigid some valve, or septum, or curtain, as the velum of the palate. 5. They roll or move, and are thus subservient to the organs of the senses, as the eye and ear. 6. They are inserted or attached to the bones, and thus perform the voluntary motions. It is principally in this last office that we have now to study them. The human body is estimated to have 436 muscles, differing, however, in the sexes, and ac-

* They embrace and contract on the hollow viscera, as the bladder and uterus.

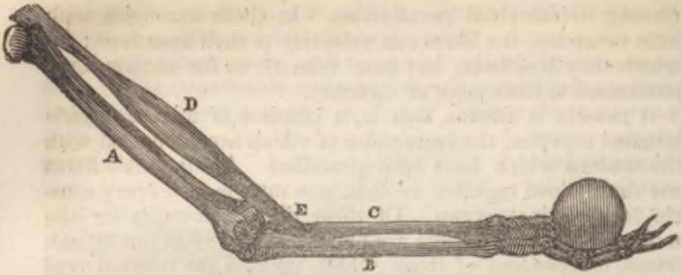
cording to individual peculiarities. In these examples, with little exception, the fibres run obliquely to their insertions; by which they lose force, but gain velocity, in the motion communicated to their point of insertion.

A muscle is fibrous, that is, it consists of minute threads bundled together, the extremities of which are connected with the tendons which have been described. Innumerable fibres are thus joined together to form one muscle, and every muscle is a distinct organ. Of these distinct muscles for the motions of the body there are not less than 436 in the human frame, independent of those which perform the internal vital motions. The contractile power, which is in the living muscular fibre, presents appearances which, though familiar, are really the most surprising of all the properties of life. Many attempts have been made to explain this property, sometimes by chemical experiment, sometimes on mechanical principles, but always in a manner repugnant to common sense. We must be satisfied with saying, that it is an endowment, the cause of which it would be as vain to investigate as to resume the search into the cause of gravitation.

The ignorance of the cause of muscular contraction does not prevent us from studying the laws which regulate it, and under this head are included subjects of the highest interest; which, however, we must leave, to pursue the mechanical arrangement of the muscles.

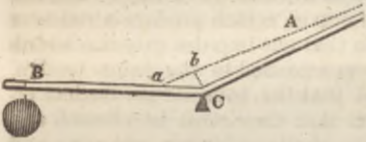
Since we have seen that there are so many muscles in the body, it is due to our readers to explain how they are associated to effect that combination which is necessary to the motion of the limbs and to our perfect enjoyment. In the first place, the million of fibres, which constitute a single muscle, are connected by a tissue of nerves, which produce a union or sympathy amongst them, so that one impulse causes a simultaneous effort of all the fibres attached to the same tendon. When we have understood that the muscles are distinct organs of motion, we perceive that they must be classed and associated, in order that many shall combine in one act; and that others, their opponents, shall be put in a state to relax, and offer no opposition to those which are active. These relations can only be established through *nerves*, which are the organs of communication with the brain, or sensorium. The nerves convey the will to the muscles, and at the same time they class and arrange them so as to make them consent to the motions of the body and limbs.

On looking to the manner in which the muscles are fixed into the bones, and the course of their tendons, we observe everywhere the appearance of a sacrifice of mechanical power, the tendon being inserted into the bone in such a manner as to lose the advantage of the lever. This appears to be an imperfection, until we learn that there is an accumulation of vital power in the muscle in order to attain velocity of movement in the member.



The muscle D, which bends the fore-arm, is inserted into the radius E, so near the fulcrum, or centre of motion in the elbow joint, and so obliquely, that it must raise the hand and fore-arm with disadvantage. But, correctly speaking, the power of the muscle is not sacrificed, since it gains more than an equivalent in the rapid and lively motions of the hand and fingers, and since these rapid motions are necessary to us in a thousand familiar actions; and to attain this, the Creator has given sufficient vital power to the muscles to admit of the sacrifice of the mechanical or lever power, and so to provide for every degree and variety of motion which may answer to the capacities of the mind.

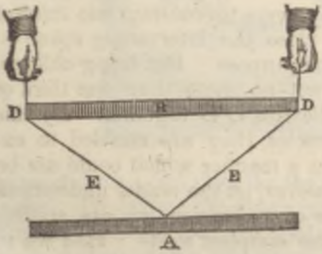
If we represent the bones and muscles of the fore-arm by this diagram, we shall see that power is lost by the inclination of the tendon to the lever, into which it is inserted. It represents the lever of the third kind, where the moving power operates on a point nearer the fulcrum than the weight to be moved.



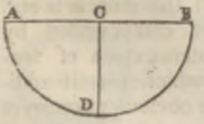
Here A represents the muscle, B the lever, and C the fulcrum. The power of the muscle is not represented by the distance of its insertion *a*, from the fulcrum C. The line which truly represents the lever must pass from the centre of motion, perpendicularly to the line of the tendon, *viz.*, C *b*. Here, again, by the direction of the tendon, as well as by its actual attachment to the bone, power is lost and velocity gained.

We may compare the muscular power to the weight which impels a machine. In studying machinery, it is manifest that weight and velocity are equivalent. The handle of the winch in a crane is a lever, and the space through which it moves, in comparison with the slow motion of the weight, is the measure of its power. If the weight, raised by the crane, be permitted to go down, the wheels revolve, and the handle moves with the velocity of a cannon-ball, and will be destructive if it hit the workman. The weight here is the power, but it operates with so much disadvantage, that the hand upon the handle of the winch can stop it: but give it way, let the accelerated motion take place, and the hand would be shattered which touched it. Just so the fly-wheel, moving at first slowly, and an impediment to the working of a machine, at length acquires momentum, so as to concentrate the power of the machine, and enable it to cut bars of iron with a stroke.

The principle holds in the animal machinery. The elbow is bent with a certain loss of mechanical power; but by that very means, when the loss is supplied by the living muscular power, the hand descends through a greater space, moves quicker, with a velocity which enables us to strike or to cut. Without this acquired velocity, we could not drive a nail: the mere muscular power would be insufficient for many actions quite necessary to our existence.

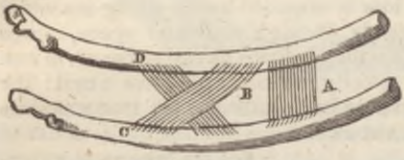


Let us take some examples to show what objects are attained through the oblique direction of the fibres or the muscle, and we shall see that here, as well as by the mode of atttachment of the entire muscle, velocity is attained by the sacrifice of power. Suppose these two pieces of wood are to be drawn together by means of a cord, but that the hands which pull, although possessing abundant strength, want room to recede more than what is equal to one third of the space betwixt the pieces of wood; it is quite clear, that if the hand were to draw directly on a cord between A and B, the point A would be brought towards B, through one third only of the intervening space, and the end would not be accomplished. But if the cord were put over the ends of the upper piece, as E D, and, consequently, directed obliquely to their attachment at A, on drawing the hand back a very little, but with more force, the lower piece of wood would be suddenly drawn up to the higher piece, and the object attained. Or we may put it in this form:—If a muscle contract in the direction of its tendon, the motion of the extremity of the tendon will be the same with that of the muscle itself: but if the attachment of the muscle to the tendon be oblique, it will draw the tendon through a greater space; and if the direction of the muscle deviate so far from the line of the tendon as to be perpendicular to it, it will then be in a condition to draw the tendon through the greatest space with the least contraction of its own length.



Thus, if A B be a tendon, and C D a muscle; by the contraction of C to D the extremities of the tendon A B will be brought together, through a space double the contraction of the muscle. It is the adjustment, on the same principle, which gives the arrow so quick an impulse from the spring of the bow, the extremities of the bow drawing obliquely on the string.

To free breathing, it is necessary that the ribs shall approach each other, and this is performed by certain *intercostal* muscles (or muscles playing between the ribs;) and now we can answer the question, why are the fibres of these muscles oblique?

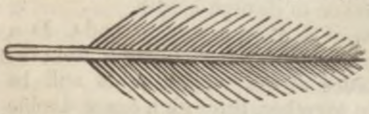


Let us suppose this figure to represent two ribs with thin intervening muscles. If the fibres of the muscle were in the direction A, across and perpendicular to the ribs; and if they were to contract one third of their length, they would not close the intervening space — they would not accomplish the purpose. But being oblique, as at B, although they contract no more than one third of their length, they will bring the ribs C D together. By this obliquity of the intercostal muscles, they are enabled to expand the chest in inspiration, in a manner which could not be otherwise accomplished. However, let the reader understand that, in respect to the motions of respiration, we are stating the action of these fibres in the simplest mode. Had we to explain here the expansion of the ribs in inspiration, it would be necessary to consider the attachments of the ribs as counteracting forces.

In the greater number of muscles the same principle directs the arrangement of the fibres; they exchange power for velocity of movement, by their obliquity. They do not go direct from origin to insertion, but obliquely, thus, from tendon to tendon:—

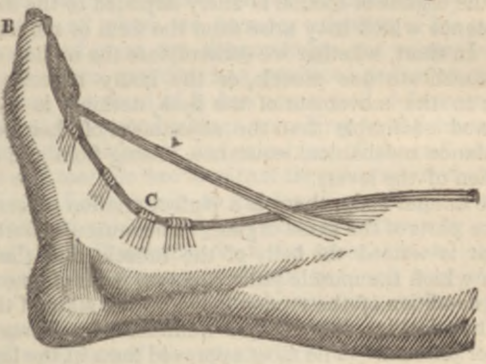
Supposing the point A to be the fixed point, these fibres draw the point B with less force, but through a larger space, or more quickly than if they took their course in direct lines; and by this arrangement of the fibres the freedom and extent of motion in our limbs are secured.

But the muscles must be strengthened by additional courses of fibres, because they are oblique; since by their obliquity they lose somewhat of their force of action: and therefore it is, we must presume, that we find them in a double row, making what is termed the *penniform* muscle, thus, —



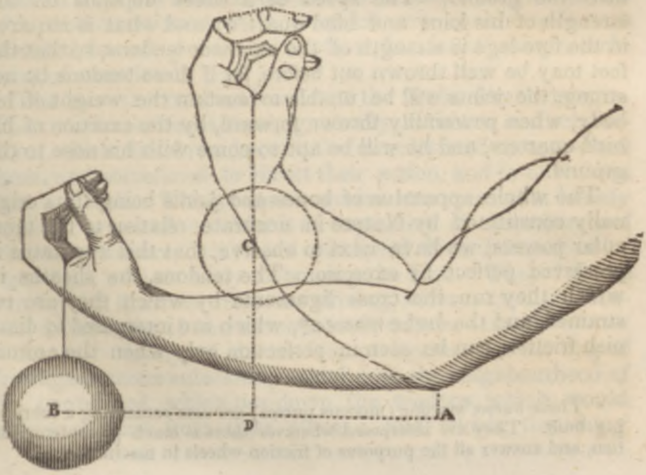
and sometimes the texture of the muscle is still further compounded by the intermixture of tendons, which permit additional series of fibres; and all this for the obvious purpose of accumulating power, which may be exchanged for velocity of movement.

We may perceive the same effect to result from the course of the tendons, and their confinement in sheaths, strengthened by cross-straps of ligament. If the tendon A took the shortest course to its termination at B, it would draw up the toe with



greater force; but then the toe would lose its velocity of movement. By taking the direction C close to the joints, the velocity of motion is secured, and by this arrangement the toes possess their spring, and the fingers their lively movements.

We may take this opportunity of noticing how the mechanical opposition is diminished as the living muscular power is exhausted. For example, in lifting a weight, the length of the lever of resistance will be from the centre of the elbow joint, A, to the centre of the weight, B. As the muscles of the arm contract, they lose something of their power; but in a greater proportion is the mechanical resistance diminished,



for when the weight is raised to C, then A D becomes the measure of the lever of resistance.

A more admirable thing is witnessed by the anatomist— we mean the manner in which the lever, rising or falling, is carried beyond the sphere of action of one class of muscles, and enters the sphere of activity of others. And this adaptation of the organs of motion is finely adjusted to the mechanical resistance which may arise from the form or motion of the bones. In short, whether we contemplate the million of fibres which constitute one muscle, or the many muscles which combine to the movement of the limb, nothing is more surprising and admirable than the adjustment of their power so as to balance mechanical resistance, arising from the change of position of the levers.

In the animal body, there is a perfect relation preserved betwixt the parts of the same organ. The muscular fibres forming what is termed the belly of the muscle, and the tendon through which the muscle pulls, are two parts of one organ; and the condition of the tendon indicates the state of the muscle. Thus jockies discover the qualities of a horse by its sinews or tendons. The most approved form in the leg of the hunter, or hackney, is that in which three convexities can be distinguished,—the bone; the prominence of the elastic ligament behind the bone; and behind that the flexor tendons, large, round, and strong. Strong tendons are provided for strong muscles, and the size of these indicate the muscular strength. Such muscles, being powerful flexors, cause high and round action, and such horses are safe to ride; their feet are generally preserved good, owing to the pressure they sustain from their high action. But this excellence in a horse will not make him a favourite at Newmarket. The circular motion cannot be the swiftest; a blood-horse carries his foot near the ground. The speed of a horse depends on the strength of his loins and hind quarter; and what is required in the fore-legs is strength of the extensor tendons, so that the feet may be well thrown out before, for if these tendons be not strong, the joints will be unable to sustain the weight of his body, when powerfully thrown forward, by the exertion of his hind-quarters, and he will be apt to come with his nose to the ground.

The whole apparatus of bones and joints being thus originally constituted by Nature in accurate relation to the muscular powers, we have next to observe, that this apparatus is preserved perfect by exercise. The tendons, the sheaths in which they run, the cross ligaments by which they are restrained, and the *bursæ mucosæ**, which are interposed to diminish friction, can be seen in perfection only when the animal

* These *bursæ mucosæ* (mucous purses) are sacs containing a lubricating fluid. They are interposed wherever there is much pressure or friction, and answer all the purposes of friction-wheels in machinery.

machinery has been kept in full activity. In inflammation, and pain, and necessary restraint, they become weak; and even confinement, and want of exercise, without disease, will produce imperfections. Exercise unfolds the muscular system, producing a full bold outline of the limbs, at the same time that the joints are knit, small, and clean. In the loins, thighs, and legs of a dancer we see the muscular system fully developed; and when we turn our attention to his puny and disproportioned arms, we acknowledge the cause — that, in the one instance, exercise has produced perfection, and that, in the other, the want of it has occasioned deformity. Look to the legs of a poor Irishman travelling to the harvest with bare feet: the thickness and roundness of the calf show that the foot and toes are free to permit the exercise of the muscles of the leg. Look, again, to the leg of our English peasant, whose foot and ankle are tightly laced in a shoe with a wooden sole, and you will perceive, from the manner in which he lifts his legs, that the play of the ankle, foot, and toes is lost, as much as if he went on stilts, and, therefore, are his legs small and shapeless.

For the purpose of dissection, it is as necessary to understand the varieties in the forms of the tendons as of the muscles. The tendons are textures of great strength and firmness, which are intermediate betwixt the irritable fibres, forming a muscle, and the points of attachment. The ligaments are of the same texture, but they want this part of the definition; they are stretched from one fixed point to another, not intermediate betwixt muscular fibres and bone.

Very often the TENDON of a muscle assumes a round form, and resembles a rope; but they are also of a flat form, or extended into a web, or they are radiated, and spreading in digitations. It is difficult actually to distinguish the expanded tendons from the FASCIÆ and APONEUROSES, which are sheets of a tendinous intertexture, to which very often muscles are attached, but which have other offices, besides affording attachment of muscles.

The FASCIÆ cover and embrace the limbs like bandages. Their under surfaces have, generally, divisions and subdivisions, which sink down betwixt the muscles, and serve to class them, and sometimes to direct their action, and to hold them as in a sheath. The APONEUROSIS is a term somewhat loosely applied: we shall consider it as expressive of those sheets of tendinous texture, which are continued from the tendons or ligaments, without fairly embracing the limb. They differ in density and firmness from the shining, silvery, expanded tendon, to the layer of the common, soft, cellular texture.

Another variety of the tendon, or ligament, is the ring of firm ligamentous substance, which is in the neighbourhood of the joints, and which ties down the tendons, which would otherwise start from their places: and which, furnishing sheaths to the tendons, directs their course, and, as it were, appropriates the action of the muscle.

See further of these subjects under the title of THE CELLULAR SUBSTANCE.

OF THE MUSCLES OF THE FACE, EYE, AND EAR.

MUSCLES OF THE FACE.

Occipito-Frontalis.

I. The OCCIPITO-FRONTALIS is a broad and thin muscular expansion, which covers all the upper part of the cranium. It consists of two bellies, with an intermediate sheet of flat tendon. The one belly covers the occiput, the other covers the forehead, and the tendinous expansion covers all the upper part of the head; by which it has happened that the most eminent anatomists, as Cowper, (p. 29.) have misnamed its tendon, pericranium; many have reckoned it two distinct muscles, viz. the OCCIPITAL and FRONTAL, while others (because of a sort of rapha, or line of division in the middle of each belly,) have described four muscles, viz. two frontal, and two occipital muscles. But it is truly a double-bellied muscle; and the broad thin tendon, which belongs equally to both bellies, lies above the true pericranium, and slides upon it. The muscle is therefore named, with strict propriety, occipito-frontalis, sometimes EPICRANIUS, sometimes BIVENTER, or DIGASTRICUS CAPITIS.

Or. sup. transverse ridge of the occipital bone, and from back part of the mastoid pro. of temporal bone. 1. *In.* orbicularis palpebræ, skin of the eye-brow. 2. Superciliary ridge; 3. by a distinct slip to the intern. ang. process.

ORIGIN.—The occipital portion is the fixed point of this muscle, arising from the superior transverse ridge of the occipital bone, and covering the back part of the head, from the mastoid process of one side, round to that on the opposite side of the head. And by the perpendicular ridge of the occiput, it is marked with a slight division in the middle.

INSERTION.—The fore belly of the muscle which covers the forehead is fixed more into the skin and eye-brows than into the bone: it is slightly attached to the bone, near the inner end of the orbitary ridge, and especially about the inner corner of the eye and the root of the nose, by a smaller and acute pointed process called the descending slip of the occipito-frontalis; but still its chief attachment is to the skin under the eye-brows.

The TENDON or thin MEMBRANEOUS expansion which joins the two bellies is exceedingly thin: it has on its inner side much loose cellular substance, by which, though attached to the true pericranium, it slides easily and smoothly upon it; but its outer surface is so firmly attached to the skin, and its fore belly adheres so firmly to the eye-brows, that it is very difficult to dissect it clean and fair.

I consider the occipital belly as the fixed point, having a firm origin from the ridge of the bone; its frontal belly has the loose end attached, not to the os frontis, but to the eye-brow and skin, and its office, that of raising the eye-brows, wrinkling the forehead, and corrugating the whole of the hairy scalp. It is a muscle expressive of passion, and it is sometimes so thin as hardly to be perceived.

Descending slip. There is a small, neat, and pointed slip of the occipito-frontalis, which goes down with a peak towards the nose, and is inserted into the small nasal bone. This process being much below the end of the eye-brow, must pull it downwards; so that while the great muscle raises the eye-brow and skin of the forehead, this small nasal slip pulls the eye-brow downwards again, restoring it to its place, and smoothing the skin.

Or. intern. angular process. In. skin of the eye-brow. II. The CORRUGATOR SUPERCILII is a small muscle which lies along the upper margin of the orbit, under the last. Its origin is from the internal angular process of the frontal bone. Thence it runs outward, and a little upward, to be inserted into the skin under the eye-brow. Its action is to knit and corrugate the eye-brows.

Orbicularis oculi. III. ORBICULARIS PALPEBRARUM is a neat and regular muscle, surrounding the eye, and covering the eye-lids in a circular form. It should be considered as two muscles, for there are a set of pale fibres running on the eye-lids, which move in the rapid and involuntary motion of the eye-lids. There are other stronger and redder fibres, which run round the orbit, and these are only used in passion, or in spasmodic closing of the eye-lids, as when something irritates the organ, and forces out the tears. **Or. orbitary pro. of the sup. maxillary bone.** It has one small tendon in the inner corner of the eye, which is both its origin and insertion; for it begins and ends in it. This small tendon is easily felt through the skin in the inner corner of the eye. It arises by a little white knot from the nasal process of the upper jaw-bone. Its fibres immediately become muscular, and spread out thin over the upper eye-lid. They pass over it to the outer corner of the eye, where they cross a little, and having covered just the edge of the temple with their thin expanded fibres, they return in a circular form round by the lower eye-lid to the point from whence they had set out. **In. the same.** It is rather a little broader over the lower eye-lid, extends itself a little upon the face beyond the brim of the socket, both at the temple and upon the cheek; and its fibres cross each other a little at the outer angle; so that some understanding this crossing as a meeting of fibres from the upper and from the lower muscle, have described it as two semicircular muscles. And those fibres which are next to the tarsus or cartilaginous circle of the eye-lids, were distinguished by Riolan, under the title of MUSCULUS CILIARIS. **Musculus ciliaris.** Our name expresses the common opinion, that it is a circular muscle, whose chief point or fulcrum is in the inner corner of the eye, and which serves as a sphincter for closing the eye. It squeezes with spasmodic violence, when the eye is injured, as by dust. And by its drawing down the eye-lids so firmly, it presses up the ball of the eye hard into the socket, and forces the lachrymal gland that is within the socket, so as to procure a flow of tears.

Levator palpebræ superioris. *Or.* upper part of margin of foramen opticum. *In.* whole length of superior ciliary cartilage.

IV. Levator palpebræ superioris.—This small muscle arises deep within the socket, from the margin of that hole which gives passage to the optic nerve. It begins by a small flat tendon in the bottom of the optic cavity, becomes gradually broader as it goes over the eye-ball; it ends in the eye-lid, by a broad expansion of muscular fibres, which finally terminate in a short flat tendon. It lies under the orbicularis palpebræ, is inserted into the whole length of the cartilage of the tarsus, and raises and opens the upper eye-lid.

Action of these muscles.

The occipito-frontalis, but especially its occipital belly, raises the eye-brows; the pointed slip of the same muscle pulls them downwards; the corrugator pulls them directly inwards, and knits the brows: the levator palpebræ opens the eye-lid, and the orbicularis oculi closes the eye. Whether certain fibres from the platysma-myoides (a thin flat muscle which mounts from the neck over the cheek) may not pull down the lower eye-lid, or whether some straggling fibres, arising from the zygoma, may not have the appearance of a depressor of the lower eye-lid, it is not necessary to determine, since there is no regularly-appointed muscle, and the lower eye-lid is not directly moved, at least in man.*

MUSCLES OF THE NOSE AND MOUTH.

Levator labii superioris alæque nasi.

Or. Nasal pro. of sup. max. bone.

In. Upper lip and ala nasi.

V. Levator labii superioris and alæ nasi.—Cowper describes the levator labii superioris as an irregular production of the frontalis, extending along the nostrils. But it is a neat and delicate muscle, which arises, by a small double tendon, from the nasal process of the upper jaw-bone, close by the tendon of the orbicularis oculi. It is one little fasciculus of muscular fibres above; but as it approaches the nose, it spreads out broader, dividing into two small fasciculi, one of which is implanted into the wing or cartilage of the nose, and the other, passing the angle of the nose, goes to the upper lip: thus it is pyramidal with its base downwards, and was named pyramidalis by Casserius, Winslow, and others. It is called by Cowper dilator alæ nasi; it raises the upper lip, and spreads the nostrils wide, as is observed in a paroxysm of rage, or in asthmatics.

Levator labii superioris proprius.

VI. The levator labii superioris proprius is distinguished by the name of levator proprius, because there are two others; one belonging to the angle of the mouth, and consequently to both lips; and one common to the lip and nostril.

Or. Orbit. pro. of sup. max. b.

The levator proprius is often named musculus incisivus, be-

* See of the motions of the eye, vol. ii.

cause it arises from the upper jaw, just above the incisores, or cutting teeth, and consequently just under the edge of the orbit; it is broad at its origin; it lies flat and runs downwards, and obliquely inwards, to the middle of the lip, till it meets its fellow just in the filtrum.* It pulls the upper lip and the septum of the nose directly upwards. It generally receives a slip from the orbicularis oculi.

below the infra orbit. foramen. *In.* Upper lip and orbicularis muscle.

VII. The LEVATOR ANGULI ORIS is called also LEVATOR COMMUNIS LABIORUM, because it operates equally on both lips. It is named CANINUS; for as the last-named muscle rises from the upper jaw-bone above the incisores or cutting teeth, this arises above the canini or dog-teeth, or above the first grinder, by a very short double tendon. The exact place of its origin is half way betwixt the first grinder and the infra orbitary hole: it is mixed with the orbicularis oris, at the corner of the mouth, so that it raises the angle of the mouth upwards.

Levator anguli oris. *Or.* super. maxillary b. between the first molaris and the inf. orb. for. *In.* angle of the mouth.

VIII. The ZYGOMATICUS MAJOR arises from the cheek-bone near the zygomatic suture; it runs downwards and inwards to the corner of the mouth; is a long and slender muscle, which ends by mixing its fibres with the orbicularis oris and the depressor of the lip.

Zygomaticus major. *Or.* os malæ near the zygomatic suture. *In.* angle of the mouth.

IX. The ZYGOMATICUS MINOR arises a little higher upon the cheek-bone, but nearer the nose; it is much slenderer than the last, and is often wanting. In negroes we frequently find three zygomatic muscles.

Zygomaticus minor. *Or.* os malæ higher and nearer the nose than the last. *In.* the lip between the lev. prop. & zygo major.

It is the zygomatic muscle that marks the face with that line which extends from the cheek-bone to the corner of the mouth, and which is so strong in many. The zygomatic muscles pull the angles of the mouth upwards as in laughter; or one of them distorts the mouth, whence the zygomatic muscle has got the name of distortor oris: the strong action of the muscle is particularly seen in laughter, rage, grinning.

X. BUCCINATOR.—The buccinator was long thought to be a muscle of the lower jaw, arising from the upper alveoli, and inserted into the lower alveoli to pull the jaw upwards; but its origin and insertion, and the direction of its fibres, are quite the reverse of this. For this large flat muscle, which forms, in a manner, the walls of the cheek, arises chiefly from the coronoid process of the lower jaw-bone, and partly also from the end of the alveoli or socket process of the upper-jaw, close by the pterygoid process of the sphenoid bone; it arises also from the upper jaw; it goes forwards with direct fibres to be implanted into the corner of the mouth, within the orbicularis. It is thin and flat, and forms the walls of the cheek; it is perforated in the middle of the cheek by the duct of the parotid gland. Albinus describes two irregular sets of fibres, besides mentioning those which are running directly to the angle of the mouth: 1. One narrow slip which runs in a semicircular

Buccinator. *Or.* 1. alveolar pro. of lower jaw. 2. the coronoid pro. 3. the space between the last molaris of upper jaw and pterygoid pro. of sphenoid bone. 4. the point of the ptery. pro. *In.* into the angle of the mouth.

* The filtrum is the superficial gutter along the upper lip from the partition of the nose to the tip of the lip.

direction, and joins the inner surface of the upper lip; 2. Another considerable slip which runs much in the direction of the orbicularis towards the middle of the lip; this he calls the appendix of the buccinator. These are its principal uses; that it flattens the cheek, and so assists in swallowing liquids: that it turns, or helps to turn, the morsel in the mouth while chewing, and prevents its getting without the line of the teeth: in blowing wind instruments, it both receives and expels the wind: it dilates like a bag, so as to receive the wind in the cheeks; and it contracts upon the wind so as to expel the wind, and to swell the note: In blowing the strong wind instruments, we cannot blow from the lungs, for it stresses the breathing, but reserve the air in the mouth, which we keep continually full; and from this it is named, from blowing the trumpet, the BUCCINATOR.

Use.

Depressor anguli oris.

XI. DEPRESSOR ANGULI ORIS.—The depressor anguli oris is a neat small triangular muscle, and is indeed very commonly named MUSCULUS TRIANGULARIS LABIORUM, from its shape. The base of the triangle is at the line of the lower jaw, where the muscle rises with a fat fleshy edge, more than an inch in breadth. It grows smaller gradually as it rises towards the corner of the mouth, where it is implanted, small almost in a point, and directly opposite to the zygomatic and levator muscles; and as the zygomatic muscle makes a line from the cheek down to the angle of the mouth, this makes a line from the chin up to the corner of the mouth. It is chiefly active in expressing the passions, and gives form to the chin and mouth. In cheerful motions, as laughter, smiling, &c. the zygomatics and levators pull the angles of the mouth upwards. In fear, hatred, revenge, contempt, and the angry passions, the triangulares pull the corners of the mouth downwards; and at the place where these meet, there is formed a sort of rising at the angle of the mouth: for a great many tendons are crowded into this one point; the zygomatic, levator, depressor, and orbicularis oris muscles meeting and crossing each other at this place.

Or. the base of the lower jaw near the chin.

In. the angle of the mouth.

Depressor labii inferioris.

XII. The DEPRESSOR LABII INFERIORIS is a small muscle, the discovery of which Cowper claims for himself. It is a small muscle, lying on each side of the chin, which, with its fellow, resembles very much the levators of the upper lip. The depressor labii inferioris arises on each side of the chin, from the lower jaw-bone, under the line of the triangular muscle. It grows obliquely upwards and inwards, till it meets its fellow in the middle of the lip; and where the muscles of the opposite side meet, there is a little filtrum or furrow on the lower lip, as on the upper one. It mixes its fibres with the orbicularis, and its use is to pull the lip downwards; each muscle is of a square form, and thence has been often named QUADRATUS GENÆ, the square muscle of the chin.

Or. base of lower jaw.

In. middle of lower lip.

Orbicularis oris.

XIII. The ORBICULARIS ORIS, or muscle round the mouth, is often named CONSTRICTOR ORIS, SPHINCTER, OR OSCULATOR.

It is very regular; it is an inch in breadth, and constitutes the thickness of the lips: it lies in the red part of the lips, and is of a circular form, surrounding the mouth after the same manner that the orbicularis oculi encircles the eye. We see a degree of crossing in the fibres at the angles of the mouth, whence it has been considered by many not as a circular muscle, but as one consisting of two semicircular muscles, the SEMI ORBICULARIS SUPERIOR, and SEMI ORBICULARIS INFERIOR. Its fixed points are the two angles of the mouth; at that swelling which is formed by the union of the zygomatic, triangular, and other muscles, part of it takes origin from the alveolar processes of the canine teeth. The chief use of this muscle is to contract the mouth, and antagonize the other muscles which I have just described. Often a small slip runs up from the middle of the upper lip to the tip of the nose; it is the NASALIS LABII SUPERIORIS of Albinus; it lies exactly in the furrow of the filtrum, and is occasionally a levator of the upper lip, or a depressor of the tip of the nose.

Attached to the alveolar process.

Nasalis labii superioris.

These muscles of the nose and lips are not useful merely in expressing the passions; their great office is to perform those continual movements, which breathing, speaking, chewing, swallowing, require. There are muscles for opening the mouth in various directions, which are all antagonized by this one, the orbicularis oris. The levator labii superioris, and the depressor labii inferioris, separate the lips and open the mouth. The levator anguli oris, along with the zygomatic muscles, raises the cheek, and dilates the corners of the mouth. The buccinator pulls the corner of the mouth directly backwards, opening the mouth. The angularis oris also dilates the mouth, pulls the angles of the mouth downwards and backwards, and forms it into a circle, if the others act at the same time; but the orbicularis oris is the largest and strongest, (formed, as it were, by the fibres of all these, taking a new direction, and turning round the lips,) shuts the mouth, and antagonizes them all, and from an opening as wide as the mouth can require, shuts the mouth at pleasure, so closely, as to retain the very breath against all the force of the lungs. It is the true antagonist of all the other muscles, and they and the orbicularis mutually react on each other, in alternately opening and closing the mouth. This phenomenon of the orbicularis muscle, dilating to such a wideness, and in an instant closing the mouth again, with such perfect accuracy, as to retain the breath, puts to nought all the vain calculations about the contraction of muscles, as that they can contract no more than one third of their length; for here is an infinite contraction, such as no process can measure. It is a paralysis of these muscles that so often occasions a hideous distortion of the face; for when one side of the body falls into palsy, the muscles of one cheek cease to act; the muscles of the other cheek continue to act with their usual degree of power. This contraction of the muscles of one cheek excites also the orbicu-

Their action.

laris oris to act, and so the mouth is pursed up, and the lips and angles of the mouth are drawn towards one side.

There are some smaller muscles, which, lying under these, could not be described without danger of confusion; as

Depressor alæ nasi.
Or. alveolar pro. of the incisores and canine teeth.
In. corner of the ala of the nose, and part of the upper lip.

XIV. The DEPRESSOR LABII SUPERIORIS and ALÆ NASI, which is very small, and lies concealed under the other muscles. It rises from the gum or socket of the fore teeth, and thence is named, by Winslow, incisivus medius. It goes into the root of the nostril, and pulls it, and, of course, the upper lip down, and is named, by Albinus, depressor alæ nasi.

Compressor naris.
Or. ant. point of os. nasi, and nasal pro. of sup. max. bone.
In. root of the ala nasi.

XV. The CONSTRICTOR NASI, or compressor of the nose, is a small scattered bundle of muscular fibres, which crosses the wings, and goes to the very point of the nose; for one arises from the wing of the nose on each side, and meets its fellow in the middle ridge, where both are fixed into the middle cartilage, or into the lower point of the NASAL bones meeting with the peak of the frontal muscle, or its scattered fibres. But this muscle is so difficultly found, that when Cowper saw it distinctly marked in Bidloo's 12th table, he considered it as a fiction, having sought for it very carefully, but in vain.

Levator labii inferioris.
Or. alveoli of the incisores and caninus.
In. chin.

And XVI. The LEVATOR MENTI, which arises from the lower jaw, at the root of the cutting tooth, has been named INCISIVUS INFERIOR. It is inserted into the skin, on the very centre of the chin: by its contraction it draws the centre of the chin into a dimple; and from its moving the under lip at the same time, it is named LEVATOR LABII INFERIORIS; sometimes the SUPERBUS.

MUSCLES OF THE EXTERNAL EAR.

Though perhaps not one of ten thousand has the power of moving the outward ear, yet there are many thin and scattered fibres of muscles about the root of the cartilage of the ear, to which we cannot refuse the name and distinction of muscles; and which serve, indeed, to indicate, that nature had intended a degree of motion, which, perhaps by the manner of covering the heads of children, we may have lost. But in a few, these fasciculi of fibres have not the form only, but the uses of muscles. The celebrated Mr. Mery was wont, when lecturing on this subject, to amuse his pupils, saying, pleasantly, "that in one thing, he surely belonged to the long ear'd tribe;" upon which, he moved his ears very rapidly backwards and forwards.*

Superior auris.
Or. tendon of occipito-frontalis.
In. back part of the antihelix.

XVII. SUPERIOR AURIS is named attollens because it lifts the ear upwards: it is a very thin, flat expansion, which can hardly be distinguished from the fascia of the temporal muscle, upon which it lies; it arises broad and circular, from the expanded tendon of the occipito-frontalis, and is inserted into the back part of the antihelix.

* Vide Palfin, who was his pupil. The celebrated Albinus could move his ears.

XVIII. ANTERIOR AURIS is a very delicate, thin, and narrow expansion, arising about the zygoma, or rather from the fascia, with which the zygoma is covered: it is inserted by a tendon into that eminence of the helix which divides the concha.

Anterior auris. *Or.* zygomatic pro. *In.* the point of the helix that divides the concha.

XIX. The POSTERIOR AURIS is also a small muscle, very delicate and thin; but the anterior rises in one small and narrow slip only, while this, the posterior, rises, commonly, in three narrow and distinct slips, from about the place of the mastoid process*; whence it is often named TRICEPS AURIS. These fibres are often described as two distinct muscles, retrahentes: it goes directly forwards to be inserted into the back part of the concha, opposite the septum that divides the concha, by two slips.

Posterior auris. *Or.* mastoid process. *In.* back part of the concha.

But there are still other muscles enumerated, which are not for moving the outward ear upon the head, but for moving, or rather giving tension to the cartilages of the outward ear. They, in all probability, prepare the cartilages of the ear for receiving and propagating the vibrations of sound inwards along the tube of the ear.

The ring and other bendings of the outward ear are called helix and antihelix, tragus and antitragus; and this determines the names of these ambiguous fibres, which are sometimes found lying upon these circles of the outward cartilage, just under the skin.

XX. The MUSCULUS HELICIS MAJOR lies upon the upper or sharp point of the helix or outward ring; rising from the upper and acute point of the helix, and inserted into the same cartilage a little above the tragus.

XXI. HELICIS MINOR rises lower than the former, upon the fore part of the helix, and runs across the notch which is in that part of the helix that projects into the concha, the muscle having its origin above the notch, and its insertion below it.

XXII. The TRAGICUS lying upon the concha, and stretching to the tragus, takes its origin from the middle of the concha to the root of the tragus, and is inserted into the tip of the tragus.

XXIII. The ANTITRAGICUS lies on the antitragus, running up from this cartilage to be inserted into the edge of the concha, at the notch on the termination of the helix.

XXIV. And, lastly, There is the TRANSVERSUS AURIS of Albinus, which runs in scattered fibres on the back part of the ear from the prominent part of the concha to the outer side of the antihelix.

MUSCLES OF THE EYE-BALL.

The eye-ball is entirely surrounded by muscles, which turn it in all directions. There is one muscle on either side, one

* Fibræ carneæ transversæ, a nobis descriptæ VALSALVA.

above and one below; these arise from the very bottom of the socket, spread out upon the ball of the eye, and are implanted into its fore part, where the expansions of their colourless tendons form what is called the white of the eye. Now these four muscles, coming in a straight course from the optic foramen to the anterior part of the eye-ball, are called the recti, or straight muscles: for their pulling is from the bottom of the socket. But there are two other muscles which are named the oblique muscles, because they pull from the edges of the socket, and turn the eye obliquely; for they go in a direction exactly opposite to the recti. The recti come directly forwards, from the bottom of the orbit; these go obliquely backwards, from the edge of the orbit; one rises from the lower edge of the socket, and goes backwards under the eye-ball; the other rises, indeed, along with the recti, in the bottom of the socket, but it has a cartilaginous pulley on the very edge of the socket, at its upper part; and its small round tendon first runs through this pulley, and then turns down upon the eye, and goes backwards; so that the straight muscles press down the eye-ball deep into the socket, while the oblique muscles bring the eye-ball forwards, pulling it outwards from the socket.

The truest description of the recti is as of one muscle, since their only variety is that difference of place, which is expressed by the name of each.

They all agree in these chief circumstances, that they arise by flat, but small tendons, round the margin of the optic hole, arising from the circle of that hole, or rather from the periosteum there; and there being one above, one below, and one on either side, they completely surround the optic nerve, and adhere to it. They are neat and delicate muscles, which gradually expand each into a fleshy belly, which surrounds and covers the middle of the ball of the eye. They still go on expanding, till they at last terminate, each in a broad, flat, and very wide tendon, which covers all the fore part of the eye, up to the circle of the lucid cornea or window; and their white and shining tendons form that enamelled-like part, which lies without the coloured circle, and which is named the white of the eye, or the TUNICA ALBUGINEA, as if it were absolutely a distinct coat.

Now the only difference in these straight muscles is in respect of length; for the optic nerve enters the eye, not regularly in the centre, but a little towards the inner side, so that the rectus internus, or muscle nearest the nose, is a little shorter. The rectus externus, or muscle nearest to the temple, is a little longer: but the rectus superior and the rectus inferior are of equal length. The uses of these muscles are exceedingly plain.

XXV. The RECTUS SUPERIOR, lifting the eye directly upwards, is named the MUSCULUS ATTOLLENS, the LEVATOR OCULI or SUPERBUS, as expressive of haughtiness and pride.

XXVI. And the RECTUS INFERIOR, which is directly opposite to it, is named DEPRIMENS OCULI or HUMILIS, as expressing modesty and submission.

XXVII. The RECTUS INTERNUS is called ADDUCENS, as carrying the eye towards the nose, or BIBITORIUS, because it directs the eye to the cup.

And (XXVIII.) the RECTUS EXTERNUS, the outer straight muscle, as it turns the eye away, is named ABDUCTOR OCULI, or INDIGNABUNDUS, expressing anger or scorn. Such is the effect of these muscles, that when they act in succession, they roll the eye; but if they act all at once, the power of each is balanced by the action of its opposite muscle, and the eye is immoveably fixed. So that sometimes in our operations, when the couching needle approaches the eye, fear comes upon the patient, and the eye is fixed by a convulsive action, more firmly than it could be by the instruments, or by the finger; so that the speculum oculi is after such an accident of no use. The eye continues fixed during all the operation, but it is fixed in a most dangerous way, by a power which we cannot controul, and which sometimes, when our operation is for extracting one of the humours only, squeezes out the whole.

XXIX. The OBLIQUUS SUPERIOR or TROCHLEARIS arises along with the recti in the bottom of the eye above, and towards the inner side, directing its long tendon towards the inner angle of the eye; and there it passes its tendon through that pulley, whose hollow I have marked in describing the os frontis, as under the superciliary ridge, and near to the inner corner of the eye. It arises by a small tendon like one of the recti; it goes over the upper part of the eye-ball, a long and slender muscle, whence it is often named LONGISSIMUS OCULI, the longest muscle of the eye. It forms a small smooth round tendon, which passes through the ring of the cartilaginous pulley, which is in the margin of the socket. The pulley is above the eye, and projects farther than the most prominent part of the eye-ball, so that the tendon returns at an acute angle, and bends downwards before it can touch the eye-ball. And it not only returns backwards in a direction opposite to the recti muscles, but it slips flat under the body of the rectus superior, and is spread out under it upon the middle or behind the middle of of the eye, viz. about half way betwixt the insertion of the rectus, and the entrance of the optic nerve.

Obliquus superior. *Or.* edge of the foram opticum.

In. the sclerotic, half way between the insertion of rect. sup. and entry of the optic nerve.

XXX. The OBLIQUUS INFERIOR is, with equal propriety, named the musculus brevissimus oculi. It is directly opposite to the obliquus superior in form, place, office, &c. for it arises from the orbitary process of the superior maxillary bone, near its union with the os unguis: it is short, flat, and broad, with a strong fleshy belly: it goes obliquely backwards and outwards, lying under the ball of the eye; and it is inserted broad and flat into the ball, exactly opposite to the insertion of the obliquus superior muscle.

Obliquus inferior. *Or.* outer edge of orb. pro. of sup. max. bone.

In. sclerotica opposite the obliquus superior.

These two muscles are said to roll the eye, whence they are named musculi circumagentes, or amatorii. It was Winslow's opinion that they had another office, viz. supporting the eye-ball, for the operation of its straight muscles: for when the obliqui act, they pull the eye forwards, the straight muscles resist, and the insertion of the oblique muscles at the middle of the eye-ball becomes, as it were, a fixed point, a centre or axis round which the eye-ball turns under the operation of the recti muscles. The conjoined effect of the oblique muscles is to bring the eye-ball forwards from the socket. The particular effect of the upper oblique muscle is not to bring the eye forward, but to roll the eye so as to turn the pupil downwards, and towards the nose. And the particular effect of the lower oblique muscle is to reverse this action, to turn the eye again upon its axis, and to direct the pupil upwards and outwards; but still there is some difficulty here, for if the question be put, —does not the eye-ball roll in all directions? we must answer that it does: which, if it were in any measure accomplished through the operation of the oblique, there should be four, and not two. *

MUSCLES OF THE LOWER JAW, THROAT, AND TONGUE.

MUSCLES OF THE LOWER JAW.

The lower jaw requires muscles of great power to grind the food; and accordingly it is pulled upwards by the strong temporal, masseter, and pterygoid muscles; but, in moving downwards, the jaw almost falls by its own weight, and having little resistance to overcome, any regular appointment of muscles for pulling down the jaw is so little needed, that it is pulled downwards by muscles of such ambiguous office, that they are equally employed in raising the throat, or pulling down the jaw, so that we hardly can determine to which they belong; for the chief muscles of the throat, coming from the lower jaw, must, when the jaw is fixed, pull up the throat, or when the throat is fixed, depress the jaw.

Temporalis. *Or.* 1. semicircular ridge of parietal bone.

XXXI. The TEMPORAL MUSCLE is the great muscle of the jaw.† It arises from all the flat side of the parietal bone, and

* The subject of the action of these muscles is taken up again, when discussing the physiology of the eye. See Vol. 2.

† *Temporal Fascia.*—Before dissecting these muscles of the jaw, the student must make himself acquainted with the strong *fascia* which covers the side of the head, and covers the temporal muscle. This strong tendinous web is continued from the periosteum of the temporal ridge of the os frontis, and from the jugum; it extends over the temporal muscle, and is attached to the ridge of the parietal bone, where it may be again traced into the pericranium. The surgeon has to take particular notice of this fascia, for, in wounds of the head, when matter gets under it, the fluid sinks deep, and perhaps appears at the angle of the jaw.

from the sphenoid, temporal, and frontal bones, in that hollow behind the eye, where they meet to form the squamous suture. It arises also from the inner surface of that strong tendinous membrane which is extended from the jugum to the semicircular ridge of the parietal bone. The fibres are bundled together and pressed into a small compass, so that they may pass under the jugum: there they take a new hold upon the inner surface of the jugum; the muscle is of course pyramidal, its rays converging towards the jugum; its muscular fibres are intermixed with strong tendinous ones; it is particularly tendinous where it passes under the jugum; and it has both strength and protection from that tendinous plate which covers it in the temple. Its insertion is into the coronoid process of the lower jaw-bone; not merely into the tip of the horn, but embracing it all around, and down the whole length of the process, so as to take the firmest hold.

2. Pars squamosa of temporal b. 3. ex. ang. pro. of frontal bone. 4. temporal plate of the sphenoid. 5. zygomatic process. 6. from a fascia covering the muscle. *In.* the coronoid pro. of inferior max. bone.

XXXII. The MASSETER is a short, thick, and fleshy muscle, which gives the rounding of the cheek at its back part. It arises from the upper jaw-bone, at the back of the antrum, and under the cheek-bone, and from the lower edge of the zygoma. It lies upon the outside of the coronoid process, covering the branch of the lower jaw quite down to its angle. It is particularly strong, has many massy bundles of flesh, interspersed with tendinous strings. Indeed, in dissection, this muscle may be divided into two portions, which cross each other obliquely; which reminds us that the action of the muscle is not simply to close the teeth, but also to produce the lateral or grinding motions of the jaw. The jaw is very firmly pulled up by these two, which are its most powerful muscles; and when we bite, we can feel the temporal muscle swelling on the flat part of the temple, and this, the masseter, upon the back part of the cheek. The parotid gland lies on its upper part, and the duct of the gland (as it crosses the cheek) lies over this muscle.

Masseter. *Or.* 1. sup. max. bone. 2. the os malæ, and 3. the zygoma in its whole length. *In.* outside of the angle and the base of the inf. maxilla.

XXXIII. XXXIV. The two PTERYGOID MUSCLES (of which there are four in all, two on each side,) are named from their origin in the pterygoid processes of the sphenoid bone. The PTERYGOIDEUS INTERNUS is that one which rises from the internal or flatter pterygoid process, and which goes downwards and outwards to the angle of the jaw on its inside; it fills up the fossa pterygoidea.

The PTERYGOIDEUS EXTERNUS arises from the outside of the external plate of the pterygoid process of the sphenoid bone, and from the adjoining part of the upper maxillary bone. It is inserted into the neck of the condyle of the lower jaw-bone, the upright part of the bone, and to the capsule of the joint.

The jaw is moved chiefly by these muscles; the temporalis acting upon the coronoid process like a lever, the masseter acting upon the angle, and before it, and the pterygoideus internus balancing it within, like an internal masseter fixed on the inside of the angle. All these pull strongly upwards for

Pterygoideus internus. *Or.* 1. Inner and upper part of internal pterygoid process. 2. the palatine bone. *In.* inside of the angle of the inf. max. bone.

Pterygoideus externus. *Or.* 1. external plate of pterygoid process. 2. the maxillary bone.

In. the neck and upright part of maxilla.

biting, holding, and tearing with the teeth; and the external or lesser pterygoid muscle, going from within outwards, pulls the jaw from side to side and performs the motion of grinding.

MUSCLES LYING ON THE FORE PART OF THE NECK, AND MOVING THE HEAD.

Although we might now, following the order of functions, be directly led to treat of the muscles of the tongue and throat, yet we shall, in the first place, dismiss those, which in dissection, must be first exposed upon the fore part of the neck.

Platysma myoides.

XXXV. PLATYSMA MYOIDES.—This is a very thin muscular expansion, which is spread over the other muscles of the neck and throat, and extends upwards, upon the lower part of the face. It arises by scattered fibres, which are attached to the cellular membrane, betwixt the pectoral and deltoid muscles and the skin of the chest. It extends upwards and forwards, over the clavicle and the mastoid muscle, going like a thin integument over the neck. It terminates on the face and jaw. Some of its fibres, mounting over the bone of the jaw, are inserted near the depressor anguli oris; and others, a little higher on the face, are called RISORIUS SANTORINI.

Or. superficially on the upper part of the chest.
In. the integuments covering the jaw and face.

Use.

This muscle supports the parts in the neck, as fasciæ do elsewhere; it compresses veins, and forces the blood down into the chest, when there is difficult respiration. It is, in truth, more a muscle of respiration and circulation, than for the motion of parts, or even for expression; yet it is very active in the expression of the stronger passions. In dissecting this muscle the surgical student will have a regard to a very important part of the surgical anatomy of the neck. Although there be no proper fascia investing the neck, for very obvious reasons, yet the fibres of this muscle interlacing with the common cellular membrane, form a pretty dense and firm covering. It will be noticed in dissection, that this compound web is very particularly connected to the transverse processes of the vertebræ, to the mastoid process, and to the angle of the jaw. It will be found, also, to be connected to the clavicle and first rib, and to make a sort of septum betwixt the region of the neck and the thorax.

The reason of the difference in the texture of this web in comparison with the fascia of the extremities, is to provide for the freedom of the trachea, and to permit its easy motion.

Mastoideus.

XXXVI. STERNO-CLEIDO MASTOIDEUS.—This is the most conspicuous and finest muscle of the body, giving the fleshy roundness of the neck, and when in action rising to produce the most beautiful contour of the neck, both in man and woman. Its origin and insertion are shortly described in its name, sterno-cleido mastoideus. It arises from the triangular portion of the sternum, by a strong round tendon, and from the sternal portion of the clavicle, by a broader and more fleshy origin. It ascends upon the neck, and in such a manner, that the dis-

Or. 1. sternum. 2. the clavicle.

sector can separate the two portions with the handle of his scalpel, to their termination. It is inserted into the mastoid process of the temporal bone, and extends its attachment backwards upon the mastoid angle of that bone. *In.* the mastoid process, and angle of the temporal bone.

When the muscles of both sides act together, they pull the head downwards, and bring the chin to the breast; but when one muscle acts, it pulls down the ear to the shoulder, and so twists the neck, as to throw the chin a little up, and to the other side. This effect of the single muscle it is important to notice, because this muscle is subject to a disease which produces wry neck; and it requires a knowledge of anatomy to distinguish the different causes of this distortion, whether arising from paralysis or disease of muscle, or affection of the spine, &c. Action.

MUSCLES OF THE THROAT AND TONGUE.

The MUSCLES of the THROAT and TONGUE cannot be understood without a previous acquaintance with certain cartilages and bones, which form the basis of the throat and tongue, and the centre of those motions which we have next to describe.

The OS HYOIDES is a small bone resembling in shape at least the lower jaw-bone. It has a middle thicker part, named its basis, which is easily felt outwardly; it corresponds in place with the chin, and during life it is distinguished about an inch below the chin, the uppermost of the hard points which are felt in the fore part of the throat. Next, it has two long horn-like processes, which go backwards along the sides of the throat, called the cornua, or horns of the os hyoides, and which are tied by a long ligament to the styloid process of the temporal bone. And, lastly, it has small cartilaginous pieces or joinings, by which the horns are united to the basis; and often in the adult this joining is converted into bone. At this point, where the two horns go backwards, like the legs of the letter U, there are commonly, at the gristly part of the os hyoides, two small perpendicular processes which stand up from the joining of the horns to the body, and these are named the appendices of the os hyoides, or the lesser cornua.

Now, this os hyoides forms by its basis the root of the tongue, thence it is often named the bone of the tongue. It forms at the same time a part of the larynx, which is the collection of cartilages forming the top of the trachea, or windpipe; and it carries upon it that cartilage named epiglottis, which, like a valve, prevents any thing getting down into the windpipe. Its horns extend along the sides of the throat, keeping the openings of the windpipe and gullet extended, as we would keep a bag extended by two fingers. The chief muscles of the tongue and of the windpipe arise from its body; the chief muscles of the gullet arise from its horns, and especially from their points; it receives the chief muscles which either raise or depress the throat; and it is the point d'appui, or fulcrum, for all the muscles of the throat and tongue, and the centre of all their motions. It is the centre of the motions of the tongue, for it is the origin of these muscles which compose chiefly the bulk of the tongue; of the motions of the trachea or windpipe, for it forms at once the top of the windpipe, and the root of the tongue, and joins them together; of the motions of the pharynx or gullet, for its horns surround the upper part of the gullet, and join it to the windpipe; and it forms the centre for all the motions of the throat in general: for muscles come down from the chin to the os hyoides, to move the whole throat upwards; others come up from the sternum, to move the throat downwards; others come obliquely from the coracoid process of the scapula, to move the throat backwards, while the os hyoides still continues the centre of all these motions.

The TRACHEA, or WINDPIPE, is that tube which conveys the air to the lungs; and the larynx is the head or figured part of that tube which is formed like a flute for the modulation of the voice, and consists of cartilages, that it may stand firm and uncompressed, either by the passage of the food, or by the weight of the outward air; and that it might resist the contraction of the surrounding parts, serving as a fulcrum for them in the motions of the jaw, tongue, and gullet. Its cartilages are, first, the SCUTIFORM, or THYROID cartilage, which is named from its resemblance to a shield, or rather it is like the flood-gates or folding doors of a canal, the meeting of the two sides being in the middle line of the throat. This prominent line of the thyroid cartilage is easily felt in the middle of the throat, is about an inch in length, and makes that tumour which is called the pomum Adami. The flat parts of the thyroid cartilage form the sides of the larynx. And there are two long horns at its two upper corners, which rise like hooks above the line of the cartilage, and are joined to the horns of the os hyoides, and two similar but shorter hooks below, by which it embraces the cricoid cartilage.

The CRICOID CARTILAGE is next to the thyroid, and below it; it is named from its resemblance to a ring.* It is indeed like a ring or hoop, but it is not a hoop equally deep in all its parts, it is shallow before, where it ekes out the length of the thyroid cartilage, and is deeper behind, where it forms the back of this flute-like top of the trachea; it is the top ring of the trachea, and the lower ring of the larynx or flute-part of the windpipe. And upon its back, or deeper part, are seated those two small cartilages, which, with their ligaments, form the opening for the breath.

The ARYTENOID CARTILAGES† are two small triangular bodies, seated within the protection of the thyroid cartilage.

* From κρικος, a ring.

† From αρυταινα, an ewer, and ειδος, like.

They are foolishly described with cornua, ridges and surfaces, when they are so small that nothing further can be observed of their forms, than that they are somewhat conical; that the base or broad part of each sits down upon the upper edge of the cricoid cartilage at its back; that the point of each stands directly upwards, and is a very little crooked, or hook-like; that standing, as they do, a little apart from each other, they form together an opening something like the spout of an ewer, whence their names. And these cartilages being covered with the common membrane of the throat, which is thick, and full of mucous glands, the opening gets a regular appearance with rounded lips. From the bases of these cartilages to the back part of the thyroid cartilages ligaments called the *cordæ vocales* are extended; over these ligaments the lining membrane of the larynx is laid, and betwixt them is formed the chink or rima glottidis; viz. the opening of the windpipe. The voice is, in a considerable degree, formed by the motion of these cartilages and their ligaments, and the action of the muscles of the arytenoid cartilages are so exquisitely minute, that for every changing of the note (and there are some thousand gradations in the compass of the voice) they move in a proportioned degree.

The EPIGLOTTIS is a fifth cartilage of the trachea, belonging to it both by connection and by office. It is a broad triangular cartilage, not so hard as the others, very elastic, and so exactly like an artichoke leaf, that no other figure can represent it so well. Its office is to defend the opening of the glottis. It is fixed at once to the os hyoides, to the thyroid cartilage, and to the root of the tongue, and it hangs obliquely backwards over the opening of the rima, or chink of the glottis; it is suspended by little peaks of the membrane, which we call ligaments of the glottis, and it is said to be raised or depressed by muscles, which yet are not very fairly described. But the rolling of the morsel which is swallowed, and the motion of the tongue, are sufficient to lay it flat over the rima, so that it is a perfect guard upon the windpipe.

Then this is the constitution of the larynx. It is of hard cartilages to resist compression, and of a flute form at its opening, to regulate the voice. The THYROID cartilage is the great one, the chief defence before, and which has edges slanting far backwards, to defend the opening of the larynx. The CRICOID cartilage, which forms the upper ring of the trachea, supports the arytenoid cartilages, and by its deepness behind raises them so, that the opening of the glottis is behind the middle of the great thyroid cartilage, and in the deepest part of it, well defended by its projecting wings. The ARYTENOID cartilages and ligaments form the rima glottidis, the chink by which we breathe; which, as it is narrower or wider, modulates and tunes the voice; the opening of which is so exquisitely moved by its muscles in singing, widening or contracting in most delicate degrees, and which is so spasmodically shut by the same muscles when it is touched by a drop of water, or by a crumb of bread; but the valve of the glottis, the EPIGLOTTIS, standing over it, flaps down like the key of a wind instrument, so that the rareness of such accidents is wonderful, when we consider that the least attempt to draw the breath, while we are swallowing, will produce the accident.

The muscles which move the tongue and throat must be far too complicated to be explained at all, without some previous knowledge of these parts; and still, I fear, not easily to be explained with every help of regularity and order.

MUSCLES OF THE THROAT.

By this arrangement, I mean to include under one class all those muscles which move the os hyoides or the larynx; and through these, as centrical points, move the jaws, gullet, and tongue; and which, though they are inserted into the larynx, have more relation to swallowing, or the motions of the gullet, than to breathing, or to the motions of the windpipe.

The muscles which pull the throat down are these:

Sterno-hyoideus. *Or.* 1. cartil. of first rib. 2. upper and inner part of sternum, 3. the clavicle near the sternum. *In.* base of the os hyoides.

XXXVII. The STERNO-HYOIDEUS, which passes from the sternum to the os hyoides, a flat, broad, ribbon-like muscle, arises from the upper piece of the sternum, rather within the breast, and partly also from the clavicle and cartilage of the first rib, goes flat and smooth along the fore part of the throat, mounts nearly of the same breadth to the os hyoides, and is implanted into its basis, or that part (which in comparing the os hyoides to the jaw) we should compare with the chin.

Sterno-thyroideus. *Or.* 1. the sternum, 2. the cartilage of first rib. *In.* lower edge of thyroid cartilage.

XXXVIII. The STERNO-THYROIDEUS, which passes in like manner from the sternum to the thyroid cartilage, is like the last, a flat, smooth, ribbon-like muscle, rather thicker and more fleshy, but very uniform in its thickness. As the thyroid cartilage is below the os hyoides, the sterno-thyroid muscle must lie under the sterno-hyoideus muscle. It arises under the sterno-hyoideus muscle from the sternum and cartilage of the rib, and is implanted into the rough line of the lower edge of the thyroid cartilage, and a little to one side, but not so much as is represented in Cowper's drawings. It immediately covers the thyroid gland.

Omo-hyoideus. *Or.* sup. costa near the notch of the scapula.

XXXIX. The OMO-HYOIDEUS, which was once named CORACO-HYOIDEUS, being thought to arise from the coracoid process, is a muscle of great length, and very slender; reaches from the shoulder to the os hyoides; it is, like these last mentioned, a long, flat, strap-like muscle, as flat and as fleshy, but not so broad as either of the former. It lies along the side of the neck; is pinched in a little in the middle, where it is divided by a tendinous cross line, which separates the fleshy belly into two heads, whence it has frequently the name of digastricus inferior. It arises from the upper edge of the scapula, which is called costa, near its notch, and from the ligament that crosses the notch, and is implanted into the side of the os hyoides, where the horn goes off from the body of the bone.

In. base of os hyoides opposite the lesser cornu.

These three muscles pull down the throat. The sterno-hyoideus and sterno-thyroideus pull it directly downwards: one of the omo-hyoidei acting, pulls it to one side; but if both act, they assist in pulling directly down, and bracing the trachea at the same time a little down to the back. These muscles are in almost constant action, and are perfectly relaxed only during the action of deglutition, when they yield to let the throat be drawn up, and the mouth thrust back.

The muscles which move the throat upward are:

Mylo-hyoideus.

XL. The MYLO-HYOIDEUS, a flat and broad muscle, which arises from the whole semicircle of the lower jaw, *i. e.* from the alveoli of the backmost grinders to the point of the chin. It rises from a line on the inner surface of the lower jaw-bone, goes down to the basis of the os hyoides, proceeds with very regular, straight, distinct, and orderly fibres, from the jaw to the os hyoides, is plainly divided in the middle from the symphysis of the jaw to the middle of the os hyoides, by a middle tendinous and white line. And though Cowper denies the authority of Vesalius, who divides it thus, it is plainly two distinct muscles one belonging to either side.

Or. from the line or ridge on the inside of the jaw.

In. 1. lower edge of the body of the os hyoides. 2. its fellow, by a white line.

Genio-hyoideus.

XLI. The GENIO-HYOIDEUS is a small neat pair of muscles, arising from the chin at a rough point which is easily distinguished within the circle of the jaw. The mylo-hyoideus is named from the whole jaw. The genio-hyoideus is named from the chin, arising from a small tubercle behind the chin; its beginning is exceedingly narrow: as it proceeds downwards, it grows flat and broad; it is implanted into the basis of the os hyoides by a broad edge, and is a beautiful and radiated muscle. The submaxillary gland lies flat betwixt this muscle and the last, and in the middle the submaxillary duct pierces the membrane of the mouth, to open under the root of the tongue. The two muscles move the os hyoides forwards and upwards when the jaw is fixed; but when the os hyoides is fixed by the muscles coming from the sternum, these muscles of the os hyoides pull down the jaw.

Or. tubercle on the inside of the symphysis of the lower jaw.

In. the body of the os hyoides under the mylo-hyoideus.

Stylo hyoideus.

XLII. The STYLO-HYOIDEUS is one of three beautiful and slender muscles which come from round the styloid process, which all begin and end with slender tendons, and with small fleshy bellies; and one going to the pharynx or gullet, another to the os hyoides, and a third to the tongue, they coincide in one common action of drawing back the tongue, and pulling the throat upwards.

This one, the stylo-hyoideus, arises from about the middle of the styloid process, and, going obliquely downwards and forwards, is fixed into the side of the os hyoides, where the basis and horn are joined. Above its insertion, its fibres are split, so as to make a neat small loop, through which the tendon of the digastric muscle runs. This stylo-hyoideus is

Or. the lower half of the styloid process.

In. the os hyoides at the union of base and horn.

sometimes accompanied with another small fleshy muscle like it, and of the same name, which was first, perhaps, observed by Cowper, and has been named by Innes STYLO-HYOIDEUS ALTER; but it is not regular, nor has it ever been acknowledged as a distinct muscle.

Digastricus. *Or.* groove in mastoid pro. of temporal bone. *In.* fixed by a lig. to os hyoides, and turning up, is inserted into a rough surface under the chin.

XLIII. The DIGASTRICUS OF BIVENTER MAXILLÆ INFERIORIS muscle is named from its having two bellies. One belly arises from a rugged notch along the root of the mastoid process, where the flesh is thick and strong; going obliquely forwards and downwards, it forms a long slender tendon, which passes by the side of the os hyoides; and as it passes, it first slips through the loop or noose of the stylo-hyoideus, and then is fixed by a tendinous bridle to the side of the os hyoides; and then turning upwards towards the chin, it ends in a second fleshy belly, which, like the first, is flat and of a pyramidal shape, lying above the mylo-hyoideus; and is inserted into a rough part of the lower jaw, on the inside of the circle.

Though this muscle is often called biventer maxillæ inferioris, as belonging to the lower jaw, perhaps it does more regularly belong to the throat. No doubt, when the os hyoides is fixed by its own muscles, from the shoulder and sternum, the digastricus must act on the jaw; an office which we cannot doubt, since we often feel it taking a sudden spasm, pulling down the chin with severe pain and distortion of the neck. But its chief office is raising the os hyoides; for when the jaw is fixed, as in swallowing, the os hyoides pulls up the throat; and this is the true meaning of its passing through the noose of the stylo-hyoideus, and of its connection with the side of the os hyoides. Then the digastricus and stylo-hyoideus muscles pull the throat upwards and backwards.

The muscles which move the parts of the larynx upon each other are much smaller, and many of them very minute.

Hyo-thyroideus. *Or.* lower edge of thyroid cartilage. *In.* part of base and almost all the cornu of os hyoides.

XLIV. The HYO-THYROIDEUS goes down, fleshy and short, from the os hyoides to the thyroid cartilage. It arises from the lower border of the thyroid cartilage, where the sterno-thyroideus terminates, and goes up along the side of the thyroid cartilage, like a continuation of the sterno-thyroideus muscle. It passes the upper border of the thyroid cartilage, and is fixed to the lower edge of the os hyoides, along both its base and part of its horn.

Crico-thyroideus. *Or.* side and fore part of cricoid cartilage. *In.* 1. the base. 2. inferior cornu of the thyroid cartilage.

XLV. The CRICO-THYROIDEUS is a very short muscle, passing from the upper edge of the cricoid to the lower margin of the thyroid cartilage, chiefly at its side, and partly attached to its lower horn, which comes down clasping the side of the CRICOID ring, so that it is broader above, and a little pointed below.

These two small muscles must have their use, and they bring the thyroid cartilage nearer to the os hyoides, and the cricoid nearer to the thyroid cartilage; and by thus shortening the trachea, or compressing it slightly, they may perhaps affect the voice; but the muscles on which the voice chiefly depends are those of the RIMA GLOTTIDIS; for there are many small muscles which have their attachment to the arytenoid cartilages, and which, by their operation on the thyro-arytenoid ligament, govern the rima glottidis.

Arytenoideus transversus. *Or.* side of one arytenoid cartilage. *In.* side of the other ary. cart.

XLVI. The MUSCULUS ARYTENOIDEUS TRANSVERSUS is that delicate muscle which contracts the glottis by drawing the arytenoid cartilages towards each other. It lies across, betwixt them at their back part; it arises from nearly the whole length of one arytenoid cartilage to go across, and be inserted into the same extent of the opposite one.

Arytenoideus obliquus. *Or.* base of the one ary. cartilage. *In.* apex of the other ary. cart.

XLVII. ARYTENOIDEUS OBLIQUUS is one which crosses in a more oblique direction, arising at the root of each arytenoid cartilage, and going obliquely upwards to the point of the opposite one. These two muscles draw the arytenoid cartilages together, and close the RIMA: frequently we find only one oblique muscle.

Crico arytenoideus posticus. *Or.* broad part of cricoid cart. *In.* back and outer point of arytenoid cart.

XLVIII. The CRICO-ARYTENOIDEUS POSTICUS is a small pyramidal muscle, which arises broader from the back part of the cricoid cartilage, where the ring is broad and deep; and, going directly upwards, is implanted, with a narrow point, into the back of the arytenoid cartilage. This pair of muscles pulls the arytenoid cartilages directly backwards, and lengthens the slit of the glottis: perhaps they assist the former in closing it more neatly, and in producing more delicate modulations of the voice.

Crico-arytenoideus lateralis. *Or.* side of cricoid cart. *In.* side of the base of the arytenoid cartilage.

XLIX. The CRICO-ARYTENOIDEUS LATERALIS is one which comes from the sides of the cricoid cartilage where it lies under the wing of the thyroid, and being implanted into the sides of the arytenoid cartilages, near their roots, must pull these cartilages asunder, and (as the origin of the cricoid lies rather before their insertion in the arytenoid cartilages) it must also slacken the lips of the slit; for the lips of the slit are formed by two cords, which go within the covering membrane, from the tip of each cartilage to the back of the thyroid cartilage, and the crico-arytenoideus posticus must stretch these cords, and the crico-arytenoideus lateralis must relax them.

Thyro-arytenoideus. *Or.* back and under part of thyroid cart. *In.* nearly the middle of the ary. cartilage.

L. The THYRO-ARYTENOIDEUS is a muscle very like the last one, and assists it. It arises not from the cricoid cartilage, but from the back surface of the wing of the thyroid, from the hollow of its wing, or where it covers the cricoid; is implanted into the fore part of the arytenoid cartilage, and by pulling the cartilage forward and sideways, directly slackens the ligaments, and widens the glottis.

There is another muscle, the THYRO-EPIGLOTTIDEUS. It is composed of a number of fibres, which run from the concavity of the thyroid cartilage to the side of the epiglottis; it has been divided by Albinus into major and minor, but this we cannot expect to find always, as it is only in particular bodies that we see fibres running from the thyroid cartilage to the epiglottis. Along with this muscle may be classed the set of fibres which are seen sometimes running from the arytenoid cartilage to the epiglottis, and called *aryteno-epiglottideus*.*

These are all the muscles which belong to the larynx; and in our arrangement the muscles of the PALATE and PHARYNX come next in order.

When a morsel is to be thrown down into the œsophagus, or tube which leads to the stomach, the VELUM PALATI, or curtain of the palate, is drawn upwards; the opening of the throat is dilated; the morsel is received; then the curtain of the palate falls down again. The arch of the throat is contracted, the bag of the pharynx is compressed by its own muscles; and the food is forced downwards into the stomach.

Azygos uvulæ.

LI. The AZYGOS UVULÆ.—The VELUM PENDULUM PALATI is that pendulous curtain which we see hanging in the back part of the mouth, in a line with the side circles of the throat; and the uvula is a small pap, or point of flesh, in the centre of that curtain. The AZYGOS UVULÆ, or single muscle of the uvula, is a small slip of straight fibres, which goes directly down to the uvula in the centre of the curtain. It arises from the peak, or backmost sharp point of the palate bones, and pulls the uvula, or pap of the throat, directly upwards, removing it out of the way of the morsel which is to pass.

Or. posterior extremity of palatine suture. *In.* point of the uvula.

Levator palati.

LII. LEVATOR PALATA MOLLIS arises from the point of the os petrosum, and from the EUSTACHIAN tube, and also from the sphenoid bone.† These parts hang over the roof of the velum, and are much higher than it; so this muscle descends to the velum, and spreads out in it; and its office is to pull up the velum, to remove it from being in the way of the morsel which is about to pass, and to lay the curtain back at the same time, so as to be a valve for the nostrils, and for the mouth of the Eustachian tube, hindering the food or drink from entering into these passages.

Or. extremity of pars petrosa, and Eustachian tube. *In.* the velum palati.

Circumflexus palati.

LIII. The CIRCUMFLEXUS PALATI‡, and the constrictor isthmi faucium, have a very different use. The circumflexus palati is named from its fibres passing over, or rather under the hook of the PTERYGOID process; the muscle arises along with the levator palati, (*i. e.*) from the sphenoid bone at its spinous process; and from the beginning of the Eustachian

Or. 1. spin. process of sphenoid. 2. Eustachian tube.

* There is in Albinus a second set of fibres, which he calls thyro-arytenoideus alter, arising from the inner and upper part of the thyroid cartilage, and inserted into the arytenoid cartilage just above the insertion of the crico-arytenoideus lateralis; this muscle must have much the same action as the other.

† From the Eustachian tube, it was named SALPINGO-STAPHILINUS; from the sphenoid bone, SPHENO-STAPHILINUS; from the pterygoid process, PTERYGO-STAPHILINUS; from the petrous process, it was named PETRO-SALPINGO-STAPHILINUS; as if there were no science but where there were hard names, and as if the chief mark of genius were enriching the hardest names with all possible combinations and contortions of them.

‡ This also has got a tolerable assortment of hard names, as CIRCUMFLEXUS PALATI, TENSOR PALATI, PALATO-SALPINGEUS, STAPHILINUS EXTERNUS, SPHENO-SALPINGO-STAPHILINUS, MUSCULUS TUBÆ, VIZ. EUSTACHIANÆ NONUS. PTERYGO-STAPHILINUS of Cowper, &c.

tube, it runs down along the tube, in the hollow betwixt the pterygoid processes; it then becomes tendinous, turns under the hook of the internal pterygoid process, and mounts again to the side of the velum. Now the levator and circumflexus arise from the same points; but the levator goes directly downwards into the velum, and so is useful in lifting it up. The circumflexus goes round the hook, runs on it as on a pulley, turns upwards again, and so it pulls down the palate, and stretches it, and thence is very commonly named the TENSOR PALATI MOLLIS, or stretcher of the palate.*

3. root of intern. pterygoid process. *In.* runs through the hook inserted into the velum palati.

LIV. The CONSTRICTOR ISTHMI FAUCIUM arises from the very root of the tongue on each side, goes round the middle of the velum, and ends near the uvula.† This semicircle forms that first arch which presents itself upon looking into the mouth.

Constrictor isthmi faucium. *Or.* side of the tongue near its root. *In.* middle of the velum at the root of the uvula.

LV. The PALATO-PHARYNGEUS‡ again forms a second arch behind the first; for it begins in the uvula or middle of the soft palate, goes round the entry of the fauces, and ends in the wing or edge of the thyroid cartilage; and as the first arched line (that formed by the constrictor) belonged to the root of the tongue, the second arched line belongs to the pharynx or gullet; and between them is lodged the amygdala.§ The circumflexus palati makes the curtain of the palate tense, and pulls it downwards: the constrictor faucium helps to pull down the curtain, and raises the root of the tongue to meet it: the palato-pharyngeus farther contracts the arch of the fauces, which is almost shut upon the morsel now ready to be forced down into the stomach, by those muscles which compress the pharynx itself.

Palato-pharyngeus. *Or.* middle of the velum at the root of the uvula. *In.* edge of the upper and back part of the thyroid cartilage.

The PHARYNX, which is the opening of the gullet, that it may receive freely the morsel of food, is expanded into a large and capacious bag, which hangs from the basis of the skull, is chiefly attached to the occipital bone, the pterygoid processes, and the back parts of either jaw-bone. The œsophagus again is the tube which conveys the food down into the stomach, and this bag of the pharynx is the expanded or trumpet-like end of it; or it may be compared with the mouth of a funnel. Towards the mouth, the pharynx is bounded by the root of the tongue, and by the arches of the throat; behind, it lies flat and smooth along the bodies of the vertebræ; before, it is protected, and in some degree surrounded, by the great cartilages of the larynx; the horns of the os hyoides embrace its sides, and it is covered with flat muscular fibres,

* Some of its posterior fibres mix with the constrictor pharyngis superior and palato-pharyngeus.

† Named GLOSSO-STAPHILINUS, from its origin in the tongue, and insertion into the UVULA.

‡ The SALPINGO-PHARYNGEUS of Albinus is no more than that part of the palato-pharyngeus which arises from the mouth of the Eustachian tube.

§ In its passage down its fibres are fixed with the stylo-pharyngeus, and in its insertion they are mingled with the inferior constrictors.

which, arising from the os hyoides and cartilages of the throat, go round the pharynx in fair and regular order, and are named its constrictors, because they embrace it closely, and their contractions force down the food.

Stylo-pharyngeus. *Or.* root of the styloid process. *In.* side of pharynx and back part of thyroid cartilage.

LVI. The STYLO-PHARYNGEUS arises from the root of the styloid process. It is a long, slender, and beautiful muscle; it expands fleshy upon the side of the pharynx; extends so far as to take a hold upon the edge of the thyroid cartilage; it lifts the pharynx up to receive the morsel, and then straightens and compresses the bag, to push the morsel down, and by its hold upon the thyroid cartilage it commands the larynx also, and the whole throat.

The pharynx being surrounded by many irregular points of bone, its circular fibres or constrictors have many irregular origins. The constrictor might fairly enough be explained as one muscle, but the irregular origins split the fibres of the muscle, and give occasion of dividing the constrictor into distinct parts; for one bundle arising from the occipital bone and os petrosum, from the tongue, the pterygoid process, and the two jaw-bones, is distinguished as one muscle, the constrictor superior.* Another bundle arising from the os hyoides is named the constrictor medius.† A third bundle, the lowest of the three, arising from the thyroid and cricoid cartilages, is the constrictor inferior.‡ And it is remarkable that the lower edges of the superior divisions are clasped and covered by the upper edges of that which is inferior; so that these muscles are like three funnels, one within the other.

Constrictor superior. *Or.* 1. cuneiform process of the occipital b. 2. pterygoid process of the sphenoid. 3. alveolar processes. *In.* into its fellow.

LVII. The CONSTRICTOR SUPERIOR, arising from the basis of the skull, from the jaws, from the palate, and from the root of the tongue, surrounds the upper part of the pharynx; and it is not one circular muscle, but two muscles divided in the middle line behind, by a distinct rapha, or meeting of the opposite fibres.§

Constrictor medius. *Or.* appendix, cornu, and lig. of os hyoides. *In.* 1. cuneiform process of occip. bone,] 2. into its fellow.

LVIII. The CONSTRICTOR MEDIUS rises chiefly from the round point in which the os hyoides terminates; it also arises from the cartilage of the os hyoides (*i. e.*) where the horns are joined to the body. The tip of the horn being the most prominent point, and the centre of this muscle, it goes upwards and downwards, so as to have something of the lozenge-like shape; it lies over the upper constrictor like a second layer; its uppermost peak, or pointed part, touches the occipital bone, and its lower point is hidden by the next muscle.

Constrictor inferior.

LIX. The CONSTRICTOR INFERIOR arises partly from the

* These good opportunities of bestowing names have not been disregarded: this muscle has been named CEPHALO-PHARYNGEUS, PTERYGO-PHARYNGEUS, MYLO-PHARYNGEUS, GLOSSO-PHARYNGEUS.

† This one is named HYO-PHARYNGEUS, or SYNDESMO-PHARYNGEUS, from its origin in the cartilage also of the os hyoides.

‡ This, of course, is named THYRO-PHARYNGEUS, and CRICO-PHARYNGEUS.

§ It is connected with the buccinator, the root of the tongue, and palate.

thyroid and partly from the cricoid cartilage; and it again goes also obliquely, so as to overlap or cover the lower part of the constrictor medius. This, like the other two constrictors, meets its fellow in a tendinous middle line; and so the morsel admitted into the pharynx by the dilatation of its arches, is pushed down into the œsophagus by the forces of these constrictores pharyngis, assisted by its styloid muscles.

Or. sides of thyroid and cricoid cart. *In.* into its fellow.

The ŒSOPHAGUS is merely the continuation of the same tube. It lies flat upon the back-bone, and it is covered in its whole length by a muscular coat, which is formed, not like this of the pharynx, of circular fibres only, but of fibres running according to its length chiefly. And this muscle, surrounding the membraneous tube of the œsophagus, like a sheath, is named (LX.) VAGINALIS GULÆ.

MUSCLES OF THE TONGUE.

The muscles of the tongue are bundles of fibres, which come from the os hyoides, the chin, and the styloid process. Their thickness constitutes the chief bulk of the tongue. Their actions perform all its motions.

LXI. The HYO-GLOSSUS is a comprehensive name for all those which arise from the os hyoides. The muscles from the os hyoides go off in three fasciculi, and were once reckoned as distinct muscles. That portion which arises from the basis of the os hyoides was called BASIO-GLOSSUS; that which arises from the cartilaginous joining of the body and horn was called CHONDRO-GLOSSUS; and that which arises from the horn itself was named CERATO-GLOSSUS; or the terms were all bundled together in the perplexed names of BASIO-CHONDRO-CERATO-GLOSSUS.

Hyo-glossus. *Or.* 1. base, 2. cornu, 3. appendix of os hyoides. *In.* tongue.

The hyo-glossus, then, is all that muscular flesh which arises from the whole length of the os hyoides, and which, by the changing form of the bone in its basis, cartilage, and horn, has a slight mark of division, but which lie all in one plain, and need not have distinct names.

LXII. The GENIO-HYO-GLOSSUS arises from the rough tubercle behind the symphysis of the chin. It has a very narrow or pointed origin; it spreads out fan-like, as it goes towards the tongue and base of the os hyoides; and it spreads with radii, upwards and backwards, making the chief part of the substance of the tongue.

Genio-hyo-glossus. *Or.* process behind the symph. of lower jaw. *In.* 1. tip, middle, and root of the tongue, 2. base of os hyoides.

LXIII. The LINGUALIS is an irregular bundle of fibres, which runs according to the length of the tongue; it lies betwixt the genio-hyo-glossus and the hyo-glossus, and as it is in the centre, and unconnected with any bone, it is named lingualis, as arising in the tongue itself.

Lingualis. *Or.* root of the tongue. *In.* tip of the tongue.

LXIV. The STYLO-GLOSSUS arises from the styloid process of the temporal bone, and from a ligament that connects that process to the angle of the jaw; and it is inserted into the root

Or. styloid pro. and

lig. inter max. et process styloid. *In.* side and tip of tongue.

of the tongue, being insensibly lost on the side and tip of the tongue.

The genio-hyo-glossi muscles form by far the larger part of the tongue, and lie in the very centre. They go through the whole length, (*i. e.*) from the root to the tip of the tongue; and from the radiated form of their fibres they perform every possible motion; whence this was named by Winslow, musculus POLYCHRESTUS, for its rays proceed from one point or centre, and those which go to the point of the tongue pull the tongue backwards into the mouth. Those which go backwards thrust the tongue out of the mouth. The middle fibres acting, make the back of the tongue hollow, while the tip and the root of the tongue both rise.

The hyo-glossi muscles lie on either side of the genio-hyoidei, and make up the sides of the tongue; and their chief action would seem to be this, that the hyo-glossus muscle of either side acting, the edges of the tongue would be pulled downwards, and the back rounded; the opposite of which motion is from the genio-hyoidei acting, by which the middle of the tongue is made into a groove, the edges rising, and the centre being depressed. Lastly, The stylo-glossus is plainly intended for drawing the tongue deep into the mouth, particuly affecting the point of the tongue.

OF THE MUSCLES OF THE ARM.

INCLUDING THE MUSCLES OF THE SCAPULA, ARM, FORE-ARM, AND HAND.

MUSCLES OF THE SCAPULA.

THE great peculiarity of the arm is the nanner of its connection with the breast, to which it is fixed by the slight ligaments of the clavicle only: but its union to the body is secured by its strong and numerous muscles, by which indeed it may be said both to be fixed and moved. Though it were perhaps more regular to describe first the muscles of the trunk, it will be more easy and natural to describe first the broad muscles belonging to the scapula, which cover almost the whole trunk, and hide its proper muscles, viz. those which move the ribs and spine. For the muscles which move the scapula lie upon the trunk; those which move the arm lie upon the scapula; those which move the fore-arm lie upon the arm; and those for moving the hand and fingers lie upon the fore-arm. The leg requires but one chief motion, viz. backwards and forwards. flexion and extension. It has no other motions than those of the thigh and of the knee; but the arm requires an easy and circular motion, and its joints are multiplied: for it has the wrist turning round; it has the elbow for hinge-like motions; it has the shoulder-joint upon which the arm rolls; and to assist all these, the scapula, which is the centre of all these motions, is itself moveable; after a certain point of elevation, all the motion in raising the arm is performed, not by the motions of the shoulder-bone upon the scapula, but by the scapula upon the trunk. For whenever the shoulder-bone rises to the horizontal direction, it is checked by the acromion, which hangs over it; and if the arm is to be raised higher still, the scapula must roll; it turns upon the point of the clavicle, and, in turning, it glides upon those muscles, which are like a cushion betwixt it and the trunk.

The muscles which move the scapula come from the breast to move it forwards; from the neck, to move it upwards; from the spines of the vertebræ, to move it backwards; and from the side, that is, from the ribs, to move it downwards.

LXV. The TRAPEZIUS is named from its lozenge form; or is often named CUCULARIS, from its resembling the monk's cowl, hanging back upon the neck. It is one of the most beautiful muscles in the body; and the two muscles together cover all the shoulders and neck, with a lozenge-like form, with neat and sharp points, extending from the tip of one shoulder to the tip of the other, and from the nape of the neck quite down to the loins. It arises from the most pointed part of the occipital bone, and along the transverse spine quite to the mastoid process, by a thin membraneous tendon; from this point all down the neck, it has no hold of the vertebræ, but arises from its fellow in a strong tendon, which, extending like a bow-string down the neck, over the arch of the neck, and not touching the vertebræ, till it comes down to the top of the back, is named LIGAMENTUM NUCHÆ. The tendon begins again to take hold of the spines of the two last vertebræ of the neck, and arises from all the spinous processes of the back, downwards; from this long origin its fibres converge towards the tip of the shoulder: it also comes a little forward over the side of the neck. **Trapezius.** *Or.* 1. transverse ridge of occip. b. 2. ligament nuchæ. 3. the two last vert. of neck, 4. all the spin. processes of dorsal vert.

It is implanted into more than one third of the clavicle nearest the shoulder; into the tip of the acromion; into the whole length of the spine of the scapula, from which the acromion rises; and its fibres arising from along the neck and back, and converging almost into a point, must have various effects, according to the different fibres which act: for those which come downwards must raise the scapula; those which come from the middle of the back must carry it directly backwards; those which come from the lower part of the back must depress it; and those different fibres acting in succession, must make the scapula roll. The trapezius is a muscle which moves the scapula, but it must be also occasionally a muscle of the head, pulling the head backwards, and bending the neck. It is also a powerful muscle of respiration, as may be seen under the head of Respiration. *In.* 1. the clavicle. 2. Acromion. 3. spine of scapula.

LXVI. LEVATOR SCAPULÆ, named also LEVATOR PROPRIUS ANGULARIS, is a small thin slip of flesh, which arises from the **Levator scapulæ.** *Or.* trans.

pro. of 4 or 5 upper cervical vert.

four or five uppermost vertebræ of the neck, at their transverse processes, by three or four and sometimes five distinct heads. The heads join to form a thin and flat stripe of muscle, about three inches in breadth, which is fixed by a flat thin tendon to the upper corner of the scapula, to pull it upwards, as in shrugging the shoulders; whence it is named MUSCULUS PATIENTIÆ.

In. upper angle of scapula.

Rhomboideus major. *Or.* spinous pro. of 4 sup. dorsal vert. *In.* nearly the whole of base of scap. below the spine.

LXVII. and LXVIII. The RHOMBOID MUSCLE stretches flat, neat, and of a square form, betwixt the spine and the whole line of the base of the scapula. One part arises from the three lower spinous processes of the neck, and is implanted into the base of the scapula higher than the rising of the spine of the scapula; another portion arises from the spinous processes of the first four vertebræ of the back, runs exactly in the same plane with the other into the base of the scapula below the spine.* The part arising from the three vertebræ of the neck is slightly divided from that which arises from the four vertebræ of the back, though not distinctly, and often not at all. I would reckon this but one muscle, but it has been commonly distinguished into (LXVII.) the RHOMBOIDEUS MINOR, the uppermost portion, and (LXVIII.) the RHOMBOIDEUS MAJOR, the lower portion. These are seen after raising the trapezius; and the uses of the trapezius, levator scapulæ, and rhomboideus, are to raise the scapula or to carry it backwards. The muscles which move the scapula downwards and forwards, viz. the pectoralis minor and the serratus major anticus, lie upon the fore part of the breast.

Rhomboideus minor. *Or.* spinous pro. of 3 last cervical vert. *In.* base of scap. opposite the spine.

Serratus magnus anticus.

LXIX. The SERRATUS MAGNUS ANTICUS lies upon the side of the chest arising from the ribs; and as the ribs have interstices betwixt them, every muscle arising from the ribs arises by distinct portions from each rib: all such distinct and pointed slips are named digitations, tongues, or sometimes serræ, from their resembling the teeth of a saw: and every muscle arising from the ribs must be a serrated muscle. The serratus magnus anticus is that great and broad muscle, the chief part of which lies under the scapula; and nothing of which is seen but the fleshy tongues, by which it arises from the sides of the ribs. It is all fleshy, and is of a considerable breadth and strength: it arises from all the true ribs, (it sometimes misses the first rib) and from three of the false ribs: its indigitations, of course, spread all over the side of the thorax like a fan; its upper indigitations lie under the pectoralis major, and its lower indigitations are mixed with the beginning of the external oblique muscle of the abdomen; its middle indigitations are seen spreading upon the sides of the thorax: it lies thick and fleshy under the scapula, and is a part of that cushion on which the scapula glides: its fibres converge towards a narrow insertion; and the muscle ends thick and

Or. from the ribs. From the 2d to the 9th.

* We frequently indeed almost find that the rhomboideus major takes also an origin from the 7th cervical vertebra: it is so expressed in Albinus.

fleshy in the whole length of that line which we call the basis of the scapula, and is as it were folded round it; so that this muscle, which comes from before, is implanted along with the rhomboideus, which comes from behind. *In.* the base of the scapula.

One operation of this muscle is upon the scapula; when the whole acts, it pulls the scapula downwards and forwards; when only the lower portions act, it pulls the lower angle of the scapula forwards, by which the scapula rolls, and the tip of the shoulder is raised; when the upper part acts in conjunction with the little pectoral muscle, the tip of the shoulder is fixed and pulled towards the chest, and the lower corner of the scapula rolls backwards. But its most important action is in excited respiration, when its insertion is converted into its origin, and the scapula being fixed, it expands the ribs, and performs inspiration.

LXX. The PECTORALIS MINOR lies under the pectoralis major, close upon the ribs; and as it arises upon the third, fourth, and fifth ribs, it sometimes takes its origin from the second, third and fourth ribs, and sometimes only from the third and fourth; it also is a serrated muscle, and was named serratus minor anticus: its three digitations are very thick and fleshy; and soon converge so as to form a small, but thick and fleshy muscle, which, terminating in a point, is inserted into the very apex of the coracoid process: by pulling the coracoid process forwards and downwards, it will roll the shoulder. **Pectoralis minor.** *Or.* 3d, 4th, and 5th rib. *In.* Coracoid process of scapula.

LXXI. The SUBCLAVIAN MUSCLE is another concealed muscle of the scapula; for the clavicle is just the hinge upon which the scapula moves, and the subclavian muscle arises by a flat tendon from the cartilage of the first rib; it becomes flat and fleshy, and lies along betwixt the clavicle and the first rib, covered with a very firm fascia; it arises at a single point of the rib, flat and tendinous, but it is inserted into a great length of the clavicle; beginning about two inches from the sternum, and being inserted all along the clavicle, quite out to where it is joined to the acromion process, its chief use (since the rib is immoveable) must surely be to pull the clavicle, and consequently the shoulder downwards, and so to fix them. **Subclavius.** *Or.* cartilage of the 1st rib *In.* into the lower edge of the clavicle.

The scapula is thus moved in every possible direction: upwards by the levator scapulæ and the trapezius; backwards by the rhomboideus, assisted by the middle portions of the trapezius; downwards and backwards by the lowest order of fibres in the trapezius; downwards and forwards by the serratus magnus anticus; directly downwards by the serratus, balanced by the trapezius, and assisted by the subclavius; and directly forwards by the pectoralis minor.

MUSCLES OF THE ARM.

VIZ. THOSE MOVING THE OS HUMERI, OR ARM-BONE.

Pectoralis major. *Or.* 1. sternal half of the clavicle. 2. all the edge of sternum. 3. cartilages of 5th, 6th, and 7th rib.

LXXII. The PECTORALIS MAJOR is a large, thick, and fleshy muscle which covers all the breast. It arises from the half of the clavicle next the sternum; from all the edge of the sternum, the cartilaginous endings of the three lower true ribs.* Where it arises from the sternum, it is tendinous, and the fibres from the opposite muscle cross and mix, so as to make a sort of fascia covering the bone. It is fleshy where it arises from the ribs, and there it mixes with the external abdominal muscle. The fibres approach each other till they form a flat tendon about an inch in breadth; and as the fibres approach each other, they cross in such a way, that the lower edge of the muscle forms the upper edge of the tendon, which is still flat, but twisted; its implantation is into the edge, if I may call it so, of the groove or rut of the biceps tendon. That part which arises from the clavicle is a little separated from that which arises from the sternum; a fatty line makes the distinction; and they are sometimes described as two parts: it is those two bundles chiefly which cross each other to make the plaited appearance. The pectoralis, among others, has been made a muscle of respiration.†

In. outside of bicipital groove of humerus.

Latissimus dorsi.

LXXIII. The LATISSIMUS DORSI is the broadest, not only of the back, but perhaps of the whole body. It is a beautiful muscle, covering all the lower part of the back and loins, and reaching to the arm, to be the antagonist to the pectoral muscle. It arises by a broad flat, and glistening tendon, which covers all the loins, and which is in some degree the root of other muscles, especially of the longissimus dorsi. This broad silvery tendon begins exactly in the middle of the back; it arises from the lower vertebræ of the loins, from the spines and knobs of the back of the sacrum, and from the back part of the circle of the os ilium; this last is the only part that is fleshy. The flat tendon gradually passes into a flat and regular muscle, which wraps round the side of the body, and as it lies over the corner of the scapula, it sometimes receives a

Or. 1. poster. part of the os ilii, 2. all the spinous pro. of sacrum and lumbar. vert. 3. spines of six or seven

* We frequently find slips running as distinct muscles from the 7th and 8th rib to the humerus; they have been remarked, in the Windmill-street dissecting-room, more frequently in Lascars and Negroes than in Europeans. In December 1814, a body was dissected, in which there was found on both sides a slip of fibres 18 inches long, extending from the 4th and 5th rib to the fascia, between the triceps and brachialis internus, and a distinct slip of tendon might be traced even to the inner condyle.

† Haller tells us, that when, at any time, he had rheumatism in this muscle, his breathing was checked: and when he had difficult breathing, he found great relief by fixing his hands, raising the shoulders, and acting with the pectoral muscles. It seems confirmed by these facts, that asthmatics take this posture; women in labour fix their arms, by resting upon the arms of their chair; those who play on wind instruments raise the shoulders in straining.

small fleshy bundle from it; and as it passes over the four lower ribs, it has some tendinous slips sent into it, by which it is attached to the ribs. Its fibres converge: for the lower ones ascend; the upper ones go directly across. And these different orders not only meet to form this flat tendon, but they cross each other, like those of the pectoral muscle: here also the tendon is twisted, and the upper edge of the muscle forms the lower edge of the flat tendon; which, passing into the axilla, turns under the arm-bone, and is implanted into it, on the inner edge of the bicipital groove; so the tendons of the pectoralis and latissimus meet each other; they, in fact, join face to face, as if the one tendon ended directly in the other; and both united, make a sort of lining for the groove, or a tendinous sheath, for the long tendon of the biceps to run on.

inf. dorsal vert. 4. three inf. ribs; sometimes angle of the scapula.

***In.* inner edge of bicipital groove of the humerus.**

These two muscles form the axilla or arm-pit; and although each has its peculiar offices, their chief operation is when they coincide in one action; and that action is exceedingly powerful, both by the great strength of either muscle, and by their being implanted into the arm-bone, four inches below its head. The pectoralis major is for pulling the arm forwards, as in laying the arms across the breast, or in carrying loads in the arms; and it forms the border of the axilla before. The latissimus dorsi has a wider range; when the arm is raised, it brings it downwards as in striking with a hammer, or downwards and backwards, as in striking with the elbow, or in rolling the arm inwards and backwards, as in turning the palm of the hand behind the back, whence it has the obscene name of MUSCULUS SCALPTOR ANI, or TERSOR ANI; and it forms the back edge of the axilla. The edges of these two muscles receive the pressure of crutches, and defend the vessels and nerves; when both muscles act, the arm is pressed directly downwards, as in rising from our seat, or in holding a bundle under the arm; or when the arm is fixed, these muscles raise the body as in the example just mentioned, of rising from our seat, or in walking with a short stick, or in raising ourselves by our hands over a high beam.

LXXIV. The DELTOIDES is the first of those muscles which arise from the scapula, to be inserted into the shoulder-bone. It is named deltoid muscle, from its resembling the letter Δ of the Greeks; it is thick and fleshy, and covers the top of the shoulder, filling up the space betwixt the acromion process and the shoulder-bone; it arises from all that part of the clavicle which is not occupied by the pectoralis muscle, and is separated from it only by a fatty line; it arises again in another bundle, from the point of the acromion process, and this middle bundle is also insulated by a fatty line on either side of it. The third bundle arises from the spine of the scapula, behind the acromion process, and which is also attached to the base by a strong ligamentous fascia, which covers the infra spinatus muscle. And thus the muscle has three converging heads, viz. a head from the outer end of the clavicle, a head

Deltoides.

***Or.* 1. outer third of clavicle, 2. acromion, 3. spine and part of the base of scapula.**

from the acromion, or tip of the shoulder, a head from the ridge of the spine, each divided from the other by a fatty line.* These heads or bundles of fibres, meeting about one third down the humerus, form a short, flat, and strong tendon, which grasps or almost surrounds the shoulder-bone.

In. rough ridge on the fore part of the humerus.

These three distinct heads must be observed in speaking of the use of the muscle; for though the chief use of the muscle be to raise the arm, this is not the use of it in all circumstances; for the outer and inner heads, lying by the side of the shoulder-bone, and below the joint, do, when the arm is lying flat by the side, assist the pectoral and latissimus dorsi muscles in drawing it close to the side. But when the middle bundle raises the arm, in proportion as the middle bundle raises the arm, it loses its power; and in proportion as it loses of its power, the side portions having come into a new direction, begin to help; nay, when the arm is raised to a certain point, more power is still required, and the clavicular part of the pectoral muscle also comes to assist. It is in this succession, that the several bundles of fibres act; for if they began all at once to act, the arm should rather be bound down by the lateral portions, than raised by the middle one. It is still more surprising that authors have neglected the great and obvious use of these lateral portions, since they are the most powerful rotators of the arm, *e. g.* the guards in fencing are performed chiefly through the operation of these portions of the deltoid muscle.

Coraco-brachialis.

LXXV. CORACO-BRACHIALIS.—The coraco-brachialis, so named from its origin and insertion, is a long and rather slender muscle.

Or. fore part of coracoid process.

It arises from the coracoid process of the scapula, along with the short head of the biceps muscle, and it is closely connected with this head, almost its whole length; it is small at its beginning; it grows gradually thicker as it descends; it is all fleshy, and is inserted by a very short tendon into the os humeri, nearly about its middle, betwixt the brachialis and the third head of the triceps. It is perforated by the external cutaneous nerve. This was observed by Casserius, an Italian anatomist; and the muscle is often named MUSCULUS PERFORATUS CASSERII.

In. inner ridge of humerus near the middle.

Its action is very simple, to raise the arm obliquely forwards and upwards, and consequently to give a degree of rotation. It will also have a chief effect in pulling the arm towards the side of the body.

Supra Spinatus.

LXXVI. The SUPRA SPINATUS is so named from its occupying the hollow of the scapula above the spine.

Or. dorsum, spine, base, and superior costa of the scapula.

It arises from the back of the scapula reaching to the base, from the spine, and from the superior edge or costa; it is exceedingly thick and fleshy, filling up all the hollow between

* Albinus has distinguished it into seven fasciculi or bundles; a very superfluous accuracy.

the spine and superior costa; and it is firmly enclosed in this triangular hollow, by a strong tendinous expansion which passes from the superior edge of the scapula to the ridge of the spine: it is consequently a muscle of a triangular figure, thick and strong; it passes under the acromion, and degenerates into a tendon there, and going under the acromion, as under an arch, and over the ball of the humerus, it adheres to the capsule of the shoulder-joint, and is at last implanted by a broad strong tendon into the upper part of the great tuberosity on the head of the bone.

In. upper part of the great tuberosity of humerus.

It is evidently designed for raising the humerus directly upwards, and by its attachment to the capsule, the capsule is drawn up when the arm is raised, so that though lax, it cannot be caught in the joint. It exactly performs the same motion with the middle part of the DELTOIDES, lies in the same direction with it, and assists it.

LXXVII. INFRA SPINATUS is like the former in all respects, of the same use, and assisting it.

Infra spinatus.

This also is of a triangular shape, and is fully one half larger than the supra spinatus; and the supra spinatus arises from all the triangular cavity above the spine: this arises from almost all the triangular cavity below it.

It arises fleshy from all the back of the scapula below the spine, except that part giving origin to the teres major and minor, from the spine itself, and from all the base of the scapula, below the beginning of the spine, and also from the greater part of the lower costa of the scapula. It is very thick and strong, almost filling up the triangular cavity, and it is closed in, like the former, by a strong tendinous expansion; it begins to grow tendinous about its middle, but it continues also fleshy till it passes over the socket of the shoulder-joint: it also is connected with the capsular ligament, is inserted into the middle of the same tuberosity with the former, and has exactly the same uses, viz. preventing the capsule from being caught in the joint, and raising the arm upwards, and inclining it a little outwards, by a slight degree of rotation. And I do believe, that one great use of these two muscles is, when the arm is much extended backwards, to prevent the head of the humerus from starting out of its superficial socket.

Or. dorsum, spine, base, and inf. costa of scapula.

In. middle part of the large tubercle of the humerus.

LXXVIII. The TERES MINOR is a third muscle which cooperates with these. This and another are so named from their appearance, not from their shape, for they seem round when superficially dissected, because then their edges only are seen; but when fully dissected from the other muscles, they are rather flat. The teres minor is a small, fleshy muscle; it arises from the angle and all the lower edge of the scapula: it is like the infra spinatus; it becomes early tendinous; but the tendon is accompanied with fleshy fibres from below; its flat tendon, in passing over the joint, is attached to the capsule, and is finally inserted into the great tuberosity of

Teres minor.

Or. edge of the inferior costa scapulæ.

In. large tubercle of the humerus inferior to the last.

the shoulder-bone, so that it must have exactly the same uses as the two former muscles. It is separated from the infra spinatus by that tendinous expansion with which the latter is covered; it looks like a part of the same muscle in its origin, where it lies upon the scapula; but is very distinct in its tendon. The supra spinatus, infra spinatus, and teres minor, raise and roll the arm outwards.

Teres major.

LXXIX. The TERES MAJOR is in shape like the former, lies lower upon the edge of the scapula than the teres minor, and is thicker and longer than it.

Or. inferior angle, and part of the inferior costa of the scapula.

It arises chiefly from the angle of the scapula; partly from the lower edge of the scapula, at its back part; it is connected with the TERES MINOR and INFRA SPINATUS. It is a large, thick, and flat muscle, and forms a flat strong tendon, which passes under the long head of the triceps; it passes under the os humeri; turns round it, and is inserted into the ridge, on the inner side of the groove, and gives some tendinous fibres to line the groove. In short, it accompanies the tendon of the latissimus dorsi, is inserted along with it, and may be considered as the congener of the latissimus dorsi; and the two tendons are inclosed in one common capsule, or sheath of cellular substance.

In. the inside of the groove for the long tendon of the biceps.

Its use, then, is evidently to draw the humerus downwards and backwards, and to perform the same rotation of the arms, which the latissimus dorsi does.

Subscapularis.

LXXX. the SUBSCAPULARIS lines all the concavity of the scapula like a cushion. It is like the surface of the scapula on which it lies, of a triangular shape; and from the convergence of all the fibres it is completely radiated or fan-like; it is very fleshy, thick, and strong; the radii are each minutely described by Albinus; but Sabatier says, with good sense, that he cannot distinguish them, so as to describe them accurately; and he might have added, that there was not the shadow of a motive for wasting time in so trivial an employment as counting the bundles.

Or. 1. the concave surface of the scapula, 2. the base, 3. inferior costa, 4. sup. costa.

It arises from the two costæ, the base, and all the internal surface of the scapula. And indeed it is to favour this origin that the inner surface of the scapula is full of little risings and hollows, to every one of which the muscle adheres closely. Just under the coracoid process is the only part from whence it does not arise. That little space is filled up with cellular substance.

Its alternately tendinous and fleshy fibres are so rooted in the scapula, and so attached to its risings and depressions, that it is difficultly cleaned away from the bone.

The tendon and upper edge of the muscle is almost continuous with the supra spinatus; but from the manner of its insertion, its effect is very opposite from that of the supra spinatus, for it goes round the os humeri to its insertion, and it is fixed to the lesser tuberosity, therefore it both pulls the arm backwards and downwards, and performs the rotation like the

In. interna tubercle of the humerus.

teres major and latissimus dorsi. It is also like all the other tendons, attached to the capsule, so as to prevent its being caught; and it is particularly useful by strengthening the shoulder-joint.

OF THE MOTIONS OF THE HUMERUS.

HAVING thus described all the muscles which move this bone, I shall review the order in which they are arranged, and mark their place and effects.

To distinguish clearly the function of each muscle, we have but to mark the point to which it is attached.

1. Those implanted above the head of the bone must raise the arm. Now the supra spinatus, infra spinatus, and teres minor, are implanted into the great tubercle, and raise the arm; and the deltoides is implanted in the same direction, and still lower, so that it performs the same action with a still greater degree of power.

2. There is implanted into the opposite or lower part of the head, the subscapularis, which, of course, draws the arm directly downwards and backwards.

3. There is implanted into the outer edge of the bicipital groove, the pectoralis major, and also the coraco-brachialis, which comes in the same direction; and these two pull the arm inwards, towards the side, and forwards.

4. There are inserted into the inside, or lower side of the groove, the latissimus dorsi and teres major, both of which pull the arm directly backwards, as they bend under the arm, to reach their insertion. They also roll the palm inwards and backwards. And it is easy to observe in what succession those muscles must act, to describe the circular and rotatory motions of the arm.

Joints are more strengthened by the origin and insertion of muscles around them, than by elastic ligaments, which yield or tear; whereas the muscles, having a living power, re-act against any separating force. They contract, or, in other words, they are strong in proportion to the violence that the joint suffers. Thus, in the shoulder the capsule is so lax, that there is a mechanical contrivance to prevent its being checked in the joint, and it is moreover so weak, that, independent of its yielding easily, it is also very easily torn; but these muscles surround the joint so fairly, that their strength and their tendinous connections, with the head of the bone are more than a compensation for the looseness of its capsular ligament. Were not the muscles thus closely attached, the shoulders would be very often displaced, the glenoid cavity is so superficial, and the capsule so lax; and surely it is for some such purpose, that the muscles are planted so closely round the head; for when they are implanted at a distance from the centre, as one muscle the deltoid is, or as the biceps and triceps of the arm, or the hamstrings, or tendo Achillis, the power is much increased. Here, in the muscles arising from the scapula, power is sacrificed to the firmness of the joint, and they are all implanted closely round the head of the bone.

The connection of the bones in this joint is in a manner formed by these muscles, for the supra spinatus, infra spinatus, teres major and minor, and the subscapularis, surround the joint very closely, cover the joint with their flat tendons, and so thicken the capsule, and increase its strength.

The muscles of the fore-arm are only four, the BICEPS and BRACHIALIS for bending, and the TRICEPS and ANCONÆUS for extending.

Biceps.

LXXXI. BICEPS BRACHII FLEXOR is unversally named BICEPS, from its having two very distinct heads. It is an exceedingly thick and strong muscle, for when it contracts, we feel it almost like a hard firm ball upon the fore part of the arm, and at the upper and most conspicuous part of this ball is the union of the two heads.

Or. 1. coracoid process, 2. glenoid cavity.

The larger and thicker head arises from the coracoid process, by a tendon which extends three inches along the fore part of the muscle, in the form of an aponeurosis, but at the back part the tendon is short, and the muscle is attached there to the fleshy belly of the coraco-brachialis.

The second, or long head, arises from the edge of the glenoid cavity, at its upper part; it is exceedingly small and tendinous, and this long tendon runs down in its proper groove, till about the third part down the humerus the two heads meet. And though below this it is but one fleshy belly, yet here, as in other muscles, the common division betwixt its two origins may be still observed.*

In. 1. fascia of the fore arm, 2. tubercle of the radius.

It is earlier tendinous at the fore part and outer side; the tendon here sends off that aponeurotic expansion which covers all the arm below, and encloses the muscles as in a sheath. The tendon, at first flat and large, becomes gradually smaller and rounder; and turns a little in its descent, so as to lay one flat edge to the radius, and another to the ulna; and it is at last implanted into that round tubercle, which is on the upper part of the radius, a little below its neck; but it has also an insertion into the fascia of the fore-arm.

The great use of the biceps is to bend the fore-arm with great strength. But as it is inserted into the tubercle of the radius, when the arm and hand are turned downwards, it, by acting, will pull them upwards, *i. e.* it will assist the supinators. Since both its heads are from the scapula, it will occasionally move the humerus, as well as the fore-arm.

Brachialis internus.

LXXXII. The BRACHIALIS INTERNUS lies immediately under the biceps, and is a very strong, fleshy muscle, for assisting the biceps in bending the arm. It is called BRACHIALIS, from

* It is not uncommon to find a third head to this muscle, which takes an origin from the fore part of the humerus.

its origin in the fore-arm, and INTERNUS, from its being within the biceps.

It arises from two thirds of the os humeri at its fore part, by a sort of forked head; for it comes down from each side of the deltoid. It continues its attachment all the way down the fore part of the humerus to within an inch of the joint. It is very thick, fleshy, and strong; it is tendinous for about two inches in its fore part; and is inserted by a flat strong tendon into the coronoid process of the ulna. *Or.* the anterior flat surface of humerus. *In.* coronoid process of ulna.

Other uses are ascribed to it, as the lifting up the capsule to prevent its being pinched. But the chief use of it is to bend the fore-arm. In a strong man, it is exceedingly thick, and its edge projects from under the edge of the biceps, and is seen in the lateral view.

LXXXIII. TRICEPS EXTENSOR.—Upon the back part of the arm three muscles have been described: the extensor longus, the extensor brevis, and the brachialis externus; but there is, in fact, only one three-headed muscle. Triceps extensor.

The longest head of this muscle is in the middle. It arises by a flat tendon from an inch of the inferior edge or costa of the scapula, under the neck, and a little way from the glenoid cavity; and it is under this head that the tendon of the teres major passes to its insertion. *Or.* 1st head, neck of the scapula.

The second head is on the outside of the arm, and next in length to this. It arises from the arm-bone under the great tuber, and just below the insertion of the teres minor. The long and second heads meet about the middle of the humerus. 2d head, external ridge of the humerus.

The third, or internal head, is the shortest of all. It begins at the inner side of the humerus, just under the insertion of the teres major; and it arises from the inner part of the humerus, all the way down, and joins just where the second head joins (*i. e.* about the middle). All these heads still continue adhering to the humerus (as the brachialis does on the fore side), quite down to within an inch of the joint, and then a strong thick tendon is formed, by which it is implanted strongly in the projecting heel of the ulna, named olecranon, by which projection of the bone the muscle has great power, and the power is increased by an increased length of the process in dogs and other animals which run or bound. 3d head, internal ridge of the humerus. *In.* Olecranon.

The whole forms a very thick and powerful muscle, which covers and embraces all the back part of the arm; and its use is too simple to admit of any further explanation, than just to say that it extends the hinge-joint of the elbow with great power; and that by its long head it may assist also to bend the arm-bone outwards and backwards.

LXXXIV. The ANCONÆUS is a small triangular muscle, placed on the back part of the elbow. It arises from the ridge and from the external condyle of the humerus, by a thick, strong, and short tendon. From this it becomes fleshy, and after running about three inches obliquely backwards, it is in- Anconæus. *Or.* ridge and outer condyle of the humerus.

In. flat surface on the back of the ulna.

serted by its oblique fleshy fibres into the outer part of the ridge of the ulna.

It is manifestly designed for the extension of the fore-arm, and has only that one simple action.

THE FASCIA OF THE ARM.

Besides bones, there is also another source of attachment for muscles, that is, the tendinous expansions: for the expansions, which go on the surface like sheaths, also dive betwixt the muscles, and form septa, or partitions, from which their fibres arise.

One tendinous expansion begins from the clavicle and acromion process, or rather comes down from the neck: it is then strengthened by the tendon of the deltoid muscle; it descends, covering all the arm; and before it goes down over the fore-arm, it is again reinforced chiefly by the biceps, but also by the tendon of the triceps extensor. One remarkable process, or partition of this general fascia, is sent in from the sheath to be fixed to the outside of the humerus, all the way down to the ridge of the outer condyle. Another partition goes down, in like manner, to the inner condyle, along the ridge which leads to it; then the fascia, taking a firm hold on the condyles, is greatly strengthened about the elbow, and goes over the fore-arm, enclosing its muscles in a very firm and close sheath; and it sends partitions down among the several layers of muscles in the fore-arm, which gives each of them a firm hold.

The fore-arm is covered with this fascia, or strong tendinous web, which, like that which covers the temporal muscle, gives both origin and strength to the muscles which lie under it, which divides the several layers one from another. This fascia is said to proceed from the small tendon of the biceps muscle, though that were but a slender origin for so great a web of tendon, which not only covers the surface of the muscles, but enters among their layers. This fascia really begins in the shoulder, and has an addition and an increase of strength from every point of bone; it is assisted by each tendon, because the tendons and fascia are of one nature over all the body, and its connection with the tendon of the biceps is quite of another kind from that which has been supposed. I would not allow that the biceps tendon expands into the fascia, but rather that the web receives the biceps tendon, which is implanted into it, and for this wise purpose, that when the fore-arm is to strike, or the hand to grasp, the biceps first moves, and by making the fascia tense, prepares the fore-arm for those violent actions which are to ensue. Thus, it may be defined, a web of thin but strong tendon, which covers all the muscles of the fore-arm, makes the surface before dissection firm and smooth, sends down partitions which are fixed into the ridges of the radius and ulna, enabling those bones to give a broader origin to the muscles, establishing a strong connection among the several layers, and making the dissection more difficult.

The fascia of the fore-arm is continued to the wrist, where it is strengthened by the annular ligament, and passes over the back of the hand even to the fingers.

The fascia of the fore-arm, and its relation to the tendon of the biceps flexor, is of much importance as a piece of surgical anatomy. It has to be particularly considered in very many cases, as in wounds of the fore-arm, abscesses forming under it; as in the inflammation which follows bleeding, and in the aneurism which is consequent on the wound of the brachial artery.

MUSCLES OF THE FORE-ARM, CARPUS, AND FINGERS.

The motions to be performed by the muscles which lie upon the fore-arm are these three; to roll the hand, to bend the wrist, to bend the fingers.

1. The turning of the hand, which is performed by rolling the radius on the ulna, is named pronation and supination. When we turn the palm down, it is said to be prone; when we turn the palm upwards, it is supine. This is pronation and supination. The muscles which perform these motions are the PRONATORS and the SUPINATORS, and the motion itself is best exemplified in the turning a key in a lock, or in the guards of fencing, which are formed by a continual play of the radius upon the ulna, carrying the wrist round in the half circle. Now, all muscles which are inserted into the radius turn it or roll it. We have just seen that even the biceps does so. Therefore, when the student finds a muscle inserted into this bone, he knows by that mark that it is either a pronator or a supinator.

2. The wrist is called the CARPUS, and, therefore, those muscles which serve for bending or extending the wrist are the FLEXORS and EXTENSORS of the carpus.

3. The bending and extending of the fingers cannot be mistaken, and therefore the flexors and extensors of the fingers need not be explained.

These muscles are denominated from their uses chiefly; but if two muscles perform one motion, they may be distinguished by some accident of their situation or form. And thus, if there be two benders of the fingers, one above the other, they are named FLEXOR SUBLIMIS and FLEXOR PROFUNDUS, *i. e.* the superficial and deep flexors. If there be two flexors of the carpus, one is named FLEXOR RADIALIS CARPI, by its running along the radius, the other FLEXOR ULNARIS CARPI, from passing in the course of the ulna. And if there be two pronators, one may be distinguished PRONATOR TERES, from its round shape, the other PRONATOR QUADRATUS, from its square form. And this, I trust, will serve as a key to what is found to be a source of inextricable confusion.

It will be easy to make the origins and insertions still more simple than the names; for all the muscles arise from two points, and have but two uses.

This assertion shall be afterwards qualified with a few exceptions; but at present it shall stand for the rule of our demonstration; for all the muscles arise from two points; the external and internal condyles. The internal condyle is the longer one, and gives most power: more power is required for bending, grasping, and turning the hand inwards; therefore all the muscles which bend the hand, all the muscles which bend the fingers, and the principal pronator, or that muscle which turns the palm downwards, arise from the internal condyle.

The external condyle is shorter; it gives less power; there is little resistance to opening the hand, and little power is required in extending the fingers; and so all the muscles which extend the wrist or the fingers, or roll the hand outwards to turn it supine, arise from the external condyle. So that when we hear a pronator or a flexor named, we know that the origin must be the internal condyle, and the insertion is expressed by the name. Thus a pronator radii goes to the radius; a flexor carpi goes to the wrist; a flexor digitorum goes to the fingers; and a flexor pollicis goes to the thumb: and they all issue from the inner condyle as from a centre.

And, again, when a supinator or extensor is named, we know where to look for it; for they also go out from one common point, the external condyle; and the supinator radii goes to the radius; the extensor carpi goes to the wrist; the extensor pollicis goes to the thumb; and the extensor indicis to the fore finger.

A kind of artificial memory of the muscles of the fore-arm may be had by arranging them in numbers; for example, if we take the biceps flexor as supinator in this instance, which it truly is, and the mass of the flexor muscles as one great pronator, for such is their conjoint operation, then the muscles go in threes thus:—

For the motion of the wrist, *three flexors*, the ulnaris, radialis, and medius, commonly called palmaris longus.—*Three extensors*, ulnaris, radialis longior, and brevior.—*Three pronators*, the teres, quadratus, and the mass of flexor muscles.—*Three supinators*, the supinator longus, brevis, and biceps cubiti. There are *three extensors of the fingers*, extensor communis digitorum, extensor primi digiti, extensor minimi digiti.—*Three extensors of the thumb*, extensor primus, secundus, and tertius.—*Three flexors of the fingers and thumb*, flexor digitorum sublimis, flexor digitorum profundus, flexor pollicis longus. In the arrangement of the muscles of the fore-arm, it is correct to say that the flexors arise from the inner condyle, and the extensors from the outer condyle; but the supinators and pronators are better distinguished by their insertion:—thus, all muscles inserted into the radius turn the wrist, and thus the supinator longus, the supinator brevis, the pronator teres, the pronator quadratus, and the biceps, are employed in turning the hand.

MUSCLES INSERTED INTO THE RADIUS.

LXXXV. SUPINATOR RADII LONGUS. This muscle forms the very edge of the fore-arm: it arises by many short tendinous fibres, from the ridge of the humerus, above the external condyle, which origin is fully two inches in length above the condyle. It also arises from the intermuscular membrane; and, as it lies on the very edge of the fore-arm, it runs betwixt the flexor and extensor radialis. It becomes thicker as it passes the joint of the humerus, and there gives a very peculiar form to the arm: it then becomes smaller, and forms a flat tendon, which is quite naked of flesh from the middle of the radius, or a little below, down to the wrist. This tendon becomes gradually smaller, till it reaches the wrist, where expanding a little, it is inserted into the lower head of the radius on its outer side.

Supinator radii longus.

Or. ridge and outer condyle of the humerus.

In. lower head of the radius.

Its use is, perhaps, chiefly as a supinator, but it is placed just upon the edge of the arm; it stands as a sort of intermedium betwixt the two sets of muscles; it is fixed, indeed, rather upon the internal surface of the radius; but yet, when the supination is complete, when the hand is rolled very much outward, it will become a pronator.

It is at once supinator and pronator, and, for a most evident reason, a flexor also of the fore-arm, since its origin is at least two inches up the humerus, above the joint of the elbow.

LXXXVI. The SUPINATOR BREVIS is an internal muscle, which forms, with the muscles of the thumb and of the fore finger, a kind of second layer; and this one lies concealed, as much as the pronator quadratus does, on the inner side of the fore-arm. It is a short muscle, but very thick and fleshy, and of great power.

Supinator brevis.

It arises from the outer condyle of the os humeri, and from the edge of the ulna, and from the interosseous ligament: it is then lapped over the radius, and is inserted into its ridge; so that this supinator brevis is very directly opposed to the pronator teres, the insertion of the two muscles almost meeting on the edge of the radius. It is almost circumscribed to one use, that of performing the rotation of the radius outwards; but perhaps it may also have some little effect in extending the ulna, and of assisting the anconæus.

Or. 1. ext. condyle of the humerus, 2. back of the ulna.

In. ridge of the radius.

LXXXVII. The PRONATOR TERES RADII is of the outermost layer of muscles, is small and round; named pronator from its office of turning the radius, and teres from its shape, or rather to distinguish it from the pronator quadratus, which is a short square muscle, and which lies deep, being laid flat upon the naked bones.

Pronator teres.

The pronator teres arises chiefly from the internal condyle of the humerus, at its lower and fore part. It has a second

Or. inner condyle and ridge of the ulna.

origin from the coronoid process of the ulna; these form two portions, betwixt which passes the radial nerve. The muscle thus formed is conical, is gradually smaller from above downwards, is chiefly fleshy, but is also a little tendinous, both at its origin and at its insertion; and stretches obliquely across the fore-arm, passing over the other muscles to be inserted in the outer ridge of the radius, about the middle of its length.

In. near the middle of the radius.

Its use is to turn the hand downwards, by turning the radius; and it will also, in strong actions, be brought to bend the fore-arm on the arm, or the reverse, when the fore-arm is fixed, and we are to raise the trunk by holding with the hands.

Pronator quadratus.

LXXXVIII. The PRONATOR QUADRATUS, so named from its shape and form, is one of the most simple in its action, since it serves but one direct purpose, viz. turning the radius upon the ulna.

It lies flat upon the interosseous ligament upon the fore part of the arm, about two inches above the wrist; it is nearly square, and is about three inches in length and breadth. Its fibres go obliquely across, betwixt the radius and ulna. It arises from the edge of the ulna, adheres to the interosseous ligament, and goes to be implanted into the edge of the radius; it turns the radius upon the ulna. This muscle, and in some degree also the flexor pollicis, are the only muscles which do not come fairly under that arrangement by which I have endeavoured to explain the muscles of the fore-arm.

Or. edge of the ulna. *In.* edge of the radius.

Palmaris longus.

LXXXIX. The PALMARIS LONGUS, FLEXOR CARPI MEDIUS is a long thin muscle, which, although it seems to have another use in its expansion into the aponeurosis, yet is truly, by insertion into the annular ligament of the wrist, a flexor of the wrist, and, in some degree, a pronator of the radius.

It arises from the internal condyle of the os humeri, and is the first of five muscles, which have one common tendon going out, like radii, from one common centre, viz. the palmaris; the flexor radialis; the flexor ulnaris; the flexor digitorum sublimis; the flexor digitorum profundus.

Or. inner condyle, and fascia of the fore-arm.

The palmaris longus arises from the inner condyle of the os humeri, and also from the intermuscular tendon, which joins it with the flexor radialis and flexor digitorum sublimis, and from the internal surface of the common sheath. Its fleshy belly is but two inches and a half or three inches in length; and its long slender tendon descends along the middle of the fore-arm to be inserted into the fore part of the annular ligament of the wrist, just under the root of the thumb. This tendon seems to give rise to the very strong thick aponeurosis of the palm of the hand, (under which all the muscles of the hand run, and which conceals the arch of blood-vessels, and protects them,) thence the muscle has its name. But it is a very common mistake to think, that because tendons are fixed to the sheaths, the sheaths are only productions of the tendons; whereas the sheaths do as truly arise from bones. The

In. annular lig. and fascia palmaris.

fascia, which the deltoides is thought to form, arises from the acromion and clavicle; and the fascia, which the biceps is thought to produce, arises from the condyles of the humerus; and that great sheath of tendon which is made tense by the musculus fascialis of the thigh, does not arise from that muscle, but comes down from the spine of the ilium, strengthened by expansions from the oblique muscles of the abdomen; in the present instance, we have the clearest proof of fascia being derived from some other source than the tendons, for sometimes the palmaris muscle is wanting, when still the tendinous expansion is found, and some pretend to say, that the expansion is wanting when the muscle is found. The aponeurosis, which covers the palm, is like the palm itself, of a triangular figure; it begins from the small tendon of the palmaris longus, and gradually expands, covering the palm down to the small ends of the metacarpal bones. Its fibres expand in form of rays; and towards the end there are cross bands which hold them together, and make them stronger; but it does not cover the two outer metacarpal bones, (the metacarpal of the fore finger, or of the little finger,) or it only covers them with a very thin expansion.

Now this palmar expansion also sends down perpendicular divisions, which take hold on the edges of the metacarpal bones: and thus there being a perpendicular division to each edge of each metacarpal bone, there are eight in all, which form canals for the tendons of the fingers, and for the lumbricales muscles.*

Palmaris brevis. *Or.* fascia palmaris. *In.* os pisiforme and the skin and fat of the palm.

XC. The PALMARIS BREVIS is a thin flat cutaneous muscle, which arises properly from the edge of the palmar aponeurosis, near to the ligament of the wrist; whence it stretches across the hand in thin fasciculi of fibres, which are at last inserted into the os pisiforme, and into the skin and fat on the ulnar edge of the palm. This is the PALMARIS CUTANEUS of some authors, for which we can find no use, except of drawing in the skin of the hand, and perhaps making the palmar expansion tense.

Flexor carpi radialis.

XCI. The FLEXOR CARPI RADIALIS is a long thin muscle arising from the inner condyle, stretching along the middle of the fore-arm somewhat in the course of the radius, and is one of the five muscles which rise by one common tendon, and which are, for some way, tied together.

Or. inner condyle and fascia of the fore-arm.

It arises tendinous from the inner condyle; the tendon very short and thick. This tendon at its origin is split into many (seven) heads, which are interlaced with the heads of the sublimis, profundus, palmaris, &c.; consequently this muscle not only arises from the internal condyle, but also from the intermuscular partitions (as from that betwixt it and the sublimis):

* There is great irregularity in this muscle; it is frequently wanting, and it is not uncommon to find two. We have found more than once, that the tendinous part of the muscle was next to the condyle, and the fleshy part connected with the fascia palmaris.

it forms a long tendon, which, becoming at last very small and round, runs under the annular ligament; it runs in a gutter peculiar to itself; but in this canal it is moveable, not fixed: it then expands a very little, and is inserted into the metacarpal bone of the fore finger, also touching that which supports the thumb.

In. metacarpal bone of the fore finger and first of the thumb.

Its use is chiefly to bend the wrist upon the radius. But when we consider its oblique direction, it will also be very evident that it must have some effect in pronation; and this, like many of the muscles of the fore-arm, although designed for a different purpose, will also have some effect in bending the fore-arm at the elbow-joint.

Flexor carpi ulnaris.

XCII. The FLEXOR CARPI ULNARIS is a long muscle, much like the former; but as its course is along the radius, or upper edge of the fore-arm, this runs along the ulna or lower edge.

Or. 1. inner condyle, 2. olecranon, 3. the ridge of the ulna, 4. the interosseous lig. and 5. the fascia. *In.* os pisiforme.

It comes off tendinous from the inner condyle of the os humeri, by the common tendon of all the muscles; it has also, like the pronator teres, a second head, viz. from the olecranon process of the ulna, which arises fleshy, and the ulnar nerve perforates betwixt these heads. The flexor ulnaris passes all along the flat side of the ulna, betwixt the edge of the sublimis and the ridge of the bone: and here it has a third origin of oblique fibres, which come from the edge of the ulna, two thirds of its length. Its tendon begins early on its upper part, by which it has somewhat the form of a penniform muscle. It has still a fourth origin from the intermuscular partition, which stands betwixt it and the flexor sublimis; and is also attached to the internal surface of the common fascia of the arm. Its long tendon is at last inserted into the os pisiforme at its fore part, where it sends off a thin tendinous expansion to cover and strengthen the annular ligament; and also a thin expansion towards the side of the little finger to cover its muscles.

This is to balance the flexor radialis: acting together, they bend the wrist with great strength; and when this muscle combines in action with the extensor carpi ulnaris, they pull the edge of the hand sideways.

Flexor digitorum sublimis.

XCIII. The FLEXOR DIGITORUM COMMUNIS SUBLIMIS is named SUBLIMIS from being the more superficial of the two muscles; PERFORATUS, from its tendon being perforated by the tendon of that which lies immediately below. It lies betwixt the palmaris longus and flexor ulnaris: it is a large fleshy muscle; and not only its tendons, but its belly also, is divided into four fasciculi, corresponding with the fingers which it is to serve.

Or. 1. internal condyle, 2. coronoid pro. of the ulna, and 3. sharp ridge of the radius.

It arises from the internal condyle, along with the other four muscles; from the ligament of the elbow-joint; from the coronoid process of the ulna; and from the upper part of the radius, at the sharp ridge. By these origins it becomes very fleshy and thick; and, a little above the middle of the fore-arm, divides into four fleshy portions, each of which ends in a slender tendon. The tendons begin at the middle of the fore-arm, or near the division, but they continue to be joined to each other by fleshy fibres some way down: and indeed the fleshy fibres cease only when it is about to pass under the annular or transverse ligament of the wrist. At this place, a cellular stringy tissue connects the tendons with each other, and with the tendons of the profundus; but after they have passed under the ligament, they expand towards the fingers which they are to serve. They each begin to be extended and flattened, and to appear cleft; they pass by the edge of the metacarpal bones, and escape from under the palmar aponeurosis; and where it ends, viz. at the root of the fingers, a tendinous sheath begins, in which these tendons continue to be enclosed.

The tendons are fairly split just opposite to the top of the first phalanx; and it is at this point that the tendons of the deeper muscle pass through this splitting. The flattened tendon parts into two, and its opposite edges diverge; the back edges meet behind the tendons of the profundus, and form a kind of sheath for them to pass in; and then they proceed forward along the second phalanx, into the fore part of which they are implanted.

This muscle is exceedingly strong: its chief office is to bend the second joint of the fingers upon the first, and the first upon the metacarpal bone. And in proportion to the number of joints that a muscle passes over, its offices must be more numerous; for this one not only moves the fingers on the metacarpus, but the hand upon the wrist, and even the fore-arm upon the arm. **_In._ second phalanx of all the fingers.**

XCIV. The FLEXOR DIGITORUM PROFUNDUS vel PERFORANS has so nearly the same origin, insertion, and use, that the description of the last is applicable to this muscle in almost every point. This is of a lower stratum of muscles; it lies deeper, and under the former, whence its name: and by this deeper situation it is excluded from any hold upon the tubercle of the humerus. **Flexor digitorum profundus.**

It arises from the ulna, beginning at the coronoid process, and extending all along its internal surface, from the whole surface of the interosseous ligament, from the inner edge of the radius, and also, in some degree, from the intermuscular membrane, which separates this from the sublimis. **_Or._ 1. coronoid pro. 2. the ridge of the ulna, 3. interosseous ligament, and 4. edge of the radius.**

This muscle is small, we may say compressed above, but it grows pretty strong and fleshy near the middle of the arm; it divides above the middle of the arm into four portions, corresponding with the four fingers; and it is about the middle of the arm that the tendons begin, and continue to receive muscular fibres from behind, all down to the ligament of the wrist: at the wrist these tendons are tied to each other, and to the tendons of the sublimis, by loose tendinous and cellular fibres. They diverge from each other, after passing under the annular ligament; and going along in the hollow of the bones, under the tendons of the sublimis, they first pass through the bridges formed by the palmar aponeurosis, then enter the sheaths of the fingers, and finally pass through the perforations of the sublimis, a little below the second joint of the fingers: at this place the perforating tendons are smaller and rounder for their easy passage, and after passing they again expand and become flat. They also, above this, appear themselves split in the middle without any evident purpose; they pass the second phalanx, and are fixed into the root of the third. And every thing that is said of the use of the sublimis may be applied to this, only that its tendons go to the furthest joint.

In. last phalanx of all the fingers.

Lumbricales.

XCV. Lumbricales.—I shall here describe, as a natural appendage of the profundus, the LUMBRICALES muscles, which are four small and round muscles, resembling the earth-worm in form and size; whence they have their name. They arise in the palm of the hand, from the tendons of the profundus, and are therefore under the sublimis, and under the palmar aponeurosis. They are small muscles, with long and very delicate tendons. Their fleshy bellies are about the length of the metacarpal bones, and their small tendons stretch over two joints, to reach the middle of the second phalanx. The first lumbricalis is larger than the second, and the two first larger than the two last.

Or. tendon of the flexor profundus.

In. middle of the second phalanx.

The first arises from the side of the tendon of the fore finger which is next to the radius; the others arise in the forks of the tendons; and though they rise more from that tendon which is next the ulna, yet they have attachments to both. Their tendons begin below the first joint of each finger; they run very slender along the first phalanx, and they gradually wind around the bone; so that though the muscles are in the palm of the hand, the tendons are implanted in the back parts of the fingers, and their final connection is not with the bending tendons of the sublimis and profundus, but with tendons of the extensor digitorum, and with the tendons of the external interossei muscles, with which they are united by tendinous threads.

Hence their use is very evident; they bend the first joint, and extend the second; they perform alternately either office; when the extensors act, they assist them by extending the second phalanx or joint: when the flexors act, and keep the first and second joint bended, the extending effect of these smaller muscles is prevented, and all their contraction must be directed so as to affect the first joint only, which they then bend.

They are chiefly useful in performing the quick short motions, and so they are named by Cowper the musculi fidicinales, as chiefly useful in playing upon musical instruments.

Flexor longus pollicis.

XCVI. The FLEXOR LONGUS POLLICIS is placed by the side of the sublimis, or perforatus, and lies under the supinator and flexor carpi radialis. It runs along the inner side of the radius, whence chiefly it arises.

Its origin is from all the internal face of the radius downwards, from the place where the biceps is inserted, and from the interosseous ligament, all the length down to the origin of the pronator quadratus: nor does it even stop here; for the tendon continues to receive fleshy slips all the way down to the passage under the ligament of the wrist. It has also another head, which arises from the condyle of the humerus, and the fore part of the ulna; which head is tendinous, and joins that origin which comes from the radius.

Or. inner surface of the radius, and inner condyle of the humerus. ***In.*** the last phalanx of the thumb.

The muscle becomes again tendinous, very high, *i. e.* above the middle of the arm; and its small tendon passes under the annular ligament, glides in the hollow of the os metacarpi pollicis, and separates the short flexor into two heads, passes betwixt the two sesamoid bones in the first joint of the thumb, and running in the tendinous sheath, it reaches at last the end of the farthest bone of the thumb, to be inserted into the very point of it.

There is sometimes sent off from the lower part of the muscle a small fleshy slip, which joins its tendons to the indicator tendon of the sublimis.

Its uses, we conjecture, are exactly as of those of the other flexors, to bend the last phalanx on the first, the first on the metacarpal bones, and occasionally the wrist upon the radius and ulna.

EXTENSORS.

The muscles which lie upon the outer side of the fore-arm, the supinators, and the extensors of the fingers and wrist, all arise from one point, the external condyle of the humerus, and are all delivered in this list:

The EXTENSOR CARPI RADIALIS LONGIOR, The EXTENSOR CARPI RADIALIS BREVIOR, The EXTENSOR CARPI ULNARIS,	all extend the wrist.
The SUPINATOR LONGUS, The SUPINATOR BREVIS,	turn the palm upwards.

The EXTENSOR COMMUNIS DIGITORUM,—extends all the fingers, and unfolds the hand.

The EXTENSOR PRIMI INTERNODII POLLICIS, The EXTENSOR SECUNDI INTERNODII POLLICIS, The EXTENSOR TERTII INTERNODII POLLICIS,	extend the several joints of the thumb.

The EXTENSOR PRIMI DIGITI vel INDICATOR,—extends the fore finger.

The EXTENSOR MINIMI DIGITI vel AURICULARIS,—extends the little finger.

All these muscles arise from one point, the external condyle. They all roll the radius outwards, or extend the wrist, or extend the fingers. As the muscles which are flexors need more fibres, and greater strength, they arise from the internal condyle, which is the larger; they lie in a deep hollow, for the bones of the fore-arm are bent to receive them, and they form a very thick fleshy cushion: but the extensors, requiring less power, arise from the shorter process of the outer condyle, are on the convex side of the arm, and are thin, having few fibres; for though there is a large mass of flesh on the inner side of the arm, forming two big flexors of the fingers, there is only a thin layer on the outer side of the arm, forming one flat and weak extensor.

Extensor carpi radialis longior.

XCVII. The EXTENSOR CARPI RADIALIS LONGIOR has the additional name of longior or primus, to distinguish it from the next. It is almost entirely covered with the last muscle, the supinator.

Or. ridge and outer condyle of the humerus.

It arises from the ridge of the humerus above the external condyle, and just under the origin of the supinator; it descends all along the back of the radius; and after having become a thick fleshy belly, it degenerates, a little lower than the middle of the radius, into a thin flat tendon, which becomes slender and smaller as it descends; and turning a little more towards the back of the radius, it then passes over the wrist, and goes along with the tendon of the extensor, under the annular ligament, passing in a groove of the radius; at last it is inserted into the root of the metacarpal bone of the fore finger, in that edge next the thumb.

In. metacarpal bone of the fore finger.

It is chiefly an extensor of the wrist: in pronation, it pulls the wrist directly backwards; in supination, it moves the hand sideways. It is also a pronator, when the hand is turned back to the greatest degree; and from its origin, high upon the arm bone, it is also a flexor of the fore-arm.

Extensor carpi radialis brevior.

XCVIII. EXTENSOR CARPI RADIALIS BREVIOR.—This muscle is almost the same in description, name, and use, with the former. It arises from the external condyle; and here a common tendon for many muscles is formed, just as in the internal condyle; for from this point arise the extensor carpi radialis brevior, extensor digitorum, extensor minimi digiti, extensor carpi ulnaris.

Or. outer condyle of the humerus, and fascia of the fore-arm.

The extensor carpi radialis brevior arises from the outer condyle of the humerus, by the common tendon; it also arises from the aponeurosis, which lies betwixt the extensor digitorum and this; it grows a pretty large, fleshy body, and begins, like the last, to be tendinous below the middle of the radius; so that this muscle continues fleshy lower than the last one, and its tendon is also much larger and thicker; it runs under the annular ligament, in the same channel with the extensor longior; it expands a little before its insertion, which is into the back part of the metacarpal bone of the middle finger, a little towards that edge which is next the radius: some little fibres pass from this tendon to the metacarpal bone of the fore finger.

In. metacarpal bone of the middle finger.

All that was said concerning the extensor longus may be said of this; for all the three last muscles lie so ambiguously on the edge of the arm, that though they are regularly supinators and extensors, they become pronators and flexors in certain positions of the hand.

XCIX. EXTENSOR CARPI ULNARIS.—By the name merely of this muscle we know its extent and course, its origin, insertion, and use. **Extensor carpi ulnaris.**

It is one of the muscles which belong to the common tendon arising from the external tubercle of the os humeri: it lies along the ulnar edge of the arm: it also arises from the intermuscular membrane, which separates this from the extensor digitorum and the extensor digiti minimi; and chiefly it is attached to the internal surface of the common sheath: it arises also from the face and edge of the ulna, the whole way down. Its tendon begins in the middle of its length, and is accompanied all down to the wrist with feather-like fleshy fibres. ***Or.* 1. outer condyle, 2. fascia of the fore-arm, 3. back of the radius, and 4. of the ulna.**

It is fixed into the outside of the head of the metacarpal bone of the little finger. ***In.* head of the metacarpal bone of the little finger.**

Its use is to extend the carpus. And it may be now observed, that when the two extensors of the wrist, the radialis and ulnaris, act, the hand is bent directly backwards; that when the flexor radialis and extensor radialis act together, they bend the thumb towards the radius; and that when the flexor ulnaris and extensor ulnaris act, they draw down the ulnar edge of the hand.

C. EXTENSOR DIGITORUM COMMUNIS.—This muscle corresponds with the sublimis and profundus, and antagonises them, and resembles them in shape as in use. It covers the middle of the fore-arm at its back, and lies betwixt the extensor radialis brevior and the extensor minimi digiti. **Extensor digitorum communis.**

Its origin is chiefly from the outer condyle, by a tendon common to it, with the extensor carpi radialis brevior; it comes also from the intermuscular membrane, which separates it on one side from the extensor minimi digiti, and on the other from the extensor carpi radialis brevior; and lastly, from the back part of the common sheath. It grows very fleshy and thick as it descends, and about the middle of the fore-arm it divides itself into three slips of very equal size. But though the tendons begin so high, they continue, like those of the flexors, to receive fleshy penniform fibres all down, almost to the annular ligament. These tendons are tied together by a loose web of fibres, and being gathered together they pass under the ligament in one common and appropriated channel. Having passed this ligament they diverge and grow flat and large. And they all have the appearance of being split by a perpendicular line. They are quite different from the flexor tendons in this, that they are all tied to each other by cross bands; for a little above the knuckles, or first joint of the fingers, all the tendons are joined on the back of the hand by slips from the little finger to the ring finger, from the ring fin- ***Or.* 1. outer condyle, 2. fascia, 3. interosseous lig. 4. back of the radius.**

In. fore, middle, and ring finger.

ger to the mid finger, and from that to the fore finger. So that it seems to be one ligament running quite across the back of the hand. It would be foolish to describe them more minutely: for the cross bands change their places, and vary in every subject, and in some they are not found.

After this, the tendons pass over the heads of the metacarpal bones, along the first phalanx of the fingers, and being there joined by the tendons of the interossei and lubricales, they altogether form a strong tendinous sheath, which surrounds the back of the fingers.

Now it is to be remembered, that this muscle serves only for the fore, middle, and ring fingers: that if it moves the little finger, it is only by a small slip of tendinous fibres, which it often gives off at the general divergence, but sometimes not: sometimes it gives one slip; sometimes two; often none at all. And so the little finger has its proper extensor quite distinct from this.

The use of the muscle is to extend all the fingers; and when they are fixed, it will assist the extensors of the wrist, as in striking backwards with the knuckles.

Extensor minimi digiti.

CI. The EXTENSOR MINIMI DIGITI, named also AURICULARIS, from its turning up the little finger, as in picking the ear, should really be described with the last muscle; if we see the origin, course, and use of this muscle exactly the same with it, why should we not reckon it as a slip of the common extensor, appropriated to the little finger?

Or. 1. outer condyle, 2. fascia, 3. inteross. ligament, 4. back of the ulna.

Its origin is from the outer condyle, along with the other tendons. It also adheres so closely both to the tendinous partitions, and to the internal surface of the common fascia, that it is not easily separated in dissection. It begins small, with a conical kind of head; it gradually increases in size; it is pretty thick near the wrist; it adheres all along to the common extensor of the fingers; it begins to be tendinous about an inch above the head of the ulna: it continues to receive fleshy fibres down to the annular ligament, and it passes under the annular ligament, in a channel peculiar to itself, which is indeed the best reason for making this a distinct muscle.

In. last phalanx of the little finger.

This channel has a very oblique direction, and the tendon, like all the others, expands greatly in escaping from the ligament of the wrist. It is connected with the other tendons, in the manner I have described. Close to the wrist, it is connected with the tendon of the ring finger, by a slip which comes from it; and at the knuckle, and below it, it is again connected with the tendons both of the ring finger, and of all the others, by the cross bands or expansions.

Whatever has been said of the use of the last muscle, is to be understood of this; as its extending its proper finger, assisting the others by its communicating band, and in its extending the wrist, when the fist is clenched. Its insertion is into the back of the second joint of the little finger, along with the interossei and lumbricales. Its tendon has also a small slit; for the head of the proper extensor of the little finger, and the heads of the common extensors of the others, are inserted into the top of the second phalanx, just under the first joint. They send off at the sides tendinous slips, which, passing along the edges of the bones, do, in conjunction with the tendons of the interossei and lumbricales, form a split tendon, which meets by two curves at the foot of the last bone of the fingers, to move the last joint.

CII. The EXTENSOR PRIMUS POLLICIS, or extensor primi internodii pollicis, is the shortest of the three. It is named by Albinus and others ABDUCTOR LONGUS; but since every muscle that extends the thumb must pull it away from the hand, every one of them might be, with equal propriety, named abductors. **Extensor primus pollicis.**

The extensor primus lies just on the fore edge of the radius, crossing it obliquely.

It arises about the middle of the fore-arm, from the edge of the ulna, which gives rise to the interosseous membrane itself, and also from the convex surface of the radius. ***Or.* 1. edge of the ulna, and 2. convex surface of the radius.**

The fleshy belly commonly divides itself into two or three, sometimes four fleshy slips, with distinct tendons, which, crossing the radius obliquely, slip under the external ligament of the carpus, and are implanted into the trapezium and the root of the first metacarpal bone, or rather of the first phalanx of the thumb, towards the radial edge, so that its chief use is to extend the thumb, and to incline it a little outwards towards the radius. It has also frequently a tendon inserted into the abductor pollicis. It must also, like the extensors of the fingers, be an extensor of the wrist: and it evidently must, from its oblique direction, assist in supination. ***In.* 1. trapezium, and 2. metacarpal bone of the thumb.**

CIII. The EXTENSOR SECUNDUS POLLICIS is longer than the first. It is named by Douglas the extensor secundi internodii pollicis; by Albinus, the extensor minor pollicis. **Extensor secundus pollicis.**

This muscle lies close by the former. It arises just below it, from the same edge of the radius, and from the same surface of the interosseous membrane, it runs along with it in the same bending course; and, in short, it resembles it so much, that Winslow has reckoned it as part of the same muscle. ***Or.* 1. edge of the ulna, 2. inteross. lig. and 3. the radius.**

Its origin is from the edge of the ulna, the interosseous ligament, and the radius. Its small round tendon passes sometimes in a peculiar channel, sometimes with the extensor primus. It goes over the metacarpal bone of the thumb; it expands upon the bone of the first phalanx; and it is inserted just under the second joint. ***In.* 1st and 2d phalanges of the thumb.**

It extends the second bone of the thumb upon the first; it extends the first bone also; and it extends the wrist, and by its oblique direction, contributes to supination.

CIV. EXTENSOR TERTIUS POLLICIS.—This, which bends the third joint, is called in common the extensor longus pollicis, or extensor tertii internodii pollicis. And here is a third **Extensor tertius pollicis.**

muscle, which, in form, and place, and function, corresponds with the two former ones.

Or. 1. ridge of the ulna, and 2. interosseous lig.

Its origin is from the ridge of the ulna, and from the upper face of the interosseous membrane; and it is a longer muscle than the others, for it begins high, near the top of the ulna, and continues the whole way down that bone, and is very fleshy and thick. It is penniform all the way down to the ligament of the wrist; and its small tendon passes the ligament in a peculiar ring. This tendon appears split, like those of the fingers; it goes along the ulnar side of the first bone of the thumb, reaches the second, and is implanted there by a small slip of tendon; and being expanded, it still goes forward to be inserted once more into the third bone of the thumb at its root.

In. last phalanx of the thumb.

Its use is evident, after describing the others: for we have only to add another joint for motion. It moves the last joint of the thumb, then the second, then its metacarpal bone upon the carpus; and if that be held firm, it will extend the carpus; and it will, in its turn, contribute to supination, though in a less degree than the others.

Indicator.

CV. Indicator.—The extensor indicis proprius has very nearly the same origin, and exactly the same course with the last, and lies by the side of it.

Or. 1. ridge of the ulna, 2. inteross. lig.

Its origin is from the ulna, by the side of the extensor longus pollicis. It has also some little attachments to the interosseous membrane. It, like the others, is feathered with fibres in an oblique direction down to the ligament of the wrist.

This muscle lies under the extensor communis digitorum: its tendon passes along with the common tendon, through the annular ligament; and near the top of the metacarpal bone, or about the place of the common junctions of all these tendons, this one joins with the indicator tendon of the common extensor.

In. last phalanx of the fore finger.

Its use is in extending all the three joints of the fore finger; assisting the common extensor in pointing with that finger; in acting independently of the common extensor; and in helping to extend the wrist, when the fingers are closed.

MUSCLES SEATED ON THE HAND.

Besides these muscles which bend and extend the fingers, there are other smaller ones seated on the hand itself, which are chiefly for assisting the former, and for quicker motions, but most especially for the lateral motions of the fingers, and which are named adductors, abductors, and flexors, when they belong to the thumb and to the little finger.

That they are chiefly useful in assisting and strengthening the larger muscles, is evident from this, that much power being required for flexion, we find many of these smaller muscles added in the palm of the hand; but as there is little power of extension needed, no more almost than to balance the power of the flexors, there are no small muscles on the back of the hand, the interossei externi excepted, which are chiefly useful in spreading the fingers.

The short muscles in the palm of the hand are for bending the thumb, the fore finger and the little finger; and the little finger and the thumb have each of them three distinct muscles; one to pull the thumb away from the hand, one to bend it, and one to pull it towards the hand, opposing it to the rest of the fingers, and so of the little finger, which has also three muscles.

All the muscles of the thumb are seated on the inside, to form the great ball of the thumb; and it is not easy at first to conceive how muscles having so much the same place should perform such opposite motions; yet it is easily explained, by the slight variation of their places; for the ABDUCTOR arises from the annular ligament near the radius, and goes towards the back of the thumb.

The flexors arise deeper, from bones of the carpus, and from the inside of the ligament, and go to the inside of the thumb. The ADDUCTOR arises from the metacarpal of the mid finger, and goes to the inner edge of the thumb.

CVI. The ABDUCTOR POLLICIS is only covered by the common integuments. It begins a little tendinous from the outside of the annular ligament, just under the thumb, and by some little fibres from the trapezium; and, from the tendon of the long abductor or extensor primus, it bends gradually round the thumb, and is at last inserted in the back of the first joint, just above the head of the metacarpal bone. But it does not stop here; for this flat tendon is now expanded into the form of a fascia, which, surrounding the first bone of the thumb, goes forward upon its back part, quite to the end, along with the common tendon of the extensor. This muscle, like the others, is covered by a thin expansion from the tendon of the palmaris, as well as by the common integuments.

Abductor pollicis. *Or.* 1. annular lig. 2. trapezium. *In.* back part of second bone of the thumb.

Its only use is to pull the thumb from the fingers, and to extend the second bone upon the first.

Albinus describes a second muscle of the same name, having the same course, origin, insertion, and use: it also arises from the outer side of the ligament of the wrist, and is fixed into the side of the thumb, and lies upon the inside of the former muscle.

These two are inserted into the first bone of the thumb; but the next is inserted into the metacarpal bone.

CVII. The OPPONENS POLLICIS is often called the flexor of the metacarpal bone of the thumb. It is placed on the inside, and implanted into the side of the thumb: its office is to draw the thumb across the other fingers, as in clenching the fist; and from its thus opposing the fingers it has its name of opponens.

Opponens pollicis.

It lies immediately under the last described muscle, and is like it in all but its insertion.

Or. 1. annular lig. and 2. trapezium. *In.* metacarpal bone of the thumb.

It arises from the trapezium, and from the ligament of the wrist. It is inserted into the edge and fore part of the metacarpal bone of the thumb; and its use is to turn the metacarpal bone upon its axis, and to oppose the fingers; or, in other words, to bend the thumb; for I can make no distinction. Therefore, this muscle and the next, which lies close upon it, may be fairly considered as but two different heads of one thick short muscle.

Flexor brevis pollicis.

CVIII. The FLEXOR BREVIS POLLICIS is a two-headed muscle, placed quite on the inside of the thumb, betwixt the fore finger and the thumb, and extends obliquely across the two first metacarpal bones. It is divided into two heads by the long flexor of the thumb.

The edge of this muscle lies in close contact with the edge of the last, or opponens; and indeed they may fairly be considered as one large muscle surrounding the basis of the thumb.

Or. 1. trapezium, 2. magnum, and 3. unciforme.

One head arises from the os trapezium, or base of the thumb, and from the ligament of the wrist. The other head comes from the os magnum and unciforme, and from the ligaments which unite the bones of the carpus.

In. ossa sesamoidea.

The first head is the smaller one: it terminates by a pretty considerable tendon in the first sesamoid bone. The second head runs the same course: it is implanted chiefly in the second sesamoid bone, and also into the edge of the first bone of the thumb close by it. The second head is exceedingly muscular and strong. The heads are completely separated from each other by the tendon of the flexor longus passing betwixt them.

The office of this muscle is to bend the first joint upon the second, and the metacarpal bone upon the carpus; and indeed the office of this, and of the opponens, is the same. It is in the tendons of this double-headed muscle that the sesamoid bones are found.

Adductor pollicis. *Or.* Metacarpal bone of the middle finger. *In.* root of the second bone of the thumb.

CIX. The ADDUCTOR POLLICIS arises from the metacarpal bone of the middle finger, where it has a flat extended base. It goes from this directly across the metacarpal bone of the fore finger, to meet the thumb. It is of a triangular shape, and flat: its base is at the metacarpal bone; its apex is at the thumb: it is inserted into the lower part or root of the first phalanx: its edge ranges with the edge of the flexor brevis: it concurs with it in office; and its more peculiar use is to draw the thumb towards the fore finger, as in pinching.

Thus do these muscles, covering the root of the thumb, form that large ball of flesh which acts so strongly in almost every thing we do with the hand.

The ball of the thumb is fairly surrounded; it is almost one mass, having one office; but as the deltoides will, in some circumstances, pull the arm downwards, some portions of this fleshy mass pull the thumb outwards obliquely; some directly inwards: but the great mass of muscle bends the thumb, and opposes it to the hand: and as this one muscle is to oppose the whole hand, the ball of flesh is very powerful and thick.

The short muscles of the little finger surround its root, just as those of the thumb surround its ball.

CX. The ABDUCTOR MINIMI DIGITI is a thin fleshy muscle, which forms the cushion on the lower edge of the hand, just under the little finger. It is an external muscle: it arises from the os pisiforme, and metacarpal bone of the little finger, and from the outer end of the annular ligament. It is inserted laterally into the first bone of the little finger; but a production of it still goes forward to the second bone of the little finger.

Abductor minimi digiti. *Or.* 1. os pisiforme. 2. metacarpal bone, and 3. annular lig. *In.* root and outside of the third phalanx.

Its use is to spread the little finger sideways, and perhaps to assist the flexors.

CXI. The FLEXOR PARVUS MINIMI DIGITI is a small thin muscle which rises by the side of the last, and runs the same course, with nearly the same insertion.

Flexor parvus minimi digiti. *Or.* 1. annular lig. and 2. os unciforme. *In.* root and side of the first phalanx.

Its origin is from the ligament of the wrist, and in part from the crooked process of the unciform bone. Its use is to bend the little finger. And indeed the office and place of both is so much the same, that I have marked the last as a flexor; the little difference there is, is only that this performs a more direct flexion.

CXII. The ADDUCTOR MINIMI DIGITI is sometimes called the metacarpal of the little finger. It lies immediately under the former muscle. Its origin is from the hook of the unciform bone, and the adjoining part of the carpal ligament.

Adductor minimi digiti. *Or.* 1. annular lig. and 2. os unciforme. *In.* outside of the metacarpal bone.

It is inserted into the outside of the metacarpal bone, which it reaches by turning round it. Its use is to put the little finger antagonist to the others: it is to this finger what the opponens is to the thumb. It also, by thus bending one bone of the metacarpus, affects the whole, increases the hollow and external convexity of the carpus, and forms what is called Diogenes's cup.

CXIII. The ABDUCTOR INDICIS is a flat muscle of considerable breadth, lying behind the adductor pollicis, and exactly resembling it, being like the second layer. It arises from the os trapezium, and from the first bone of the thumb; and it is inserted into the back part of the first bone of the fore finger, and pulls it towards the thumb.

Abductor indicis. *Or.* 1. trapezium, and 2. metacarpal bone of the thumb. *In.* back of the first bone.

The INTEROSSEI are situated betwixt the metacarpal bones. They are small, round, and neat, something like the lumbricales in shape and size, and in office resemble the adductors and abductors. Four are found in the palm which bend the fingers, and draw their edges a little towards the thumb; three are found on the back of the hand, for extending the fingers; they at the same time perform the lateral motions of the fingers.

CXIV. The INTEROSSEI INTERNI arise from betwixt the metacarpal bones. They are also attached to the sides of these bones. They send their tendons twisting round the sides to

Interossei interni. *Or.* sides of the metacarpal bones.

In. with the lumbricales.

the backs of these bones. And they are inserted along with the tendons of the lumbricales and extensors, into the back of the finger. They are thus flexors of the first joint, and extensors of the second joint, as the lumbricales are.

Interossei externi. *Or.* roots of the metacarpal bones, having two heads. *In.* tendinous expansion of the extensor communis.

CXV. The INTEROSSEI EXTERNI are three in number. They arise, like the interni, from the metacarpal bones and their interstices, and from the ligaments of the carpal bones. They are peculiar in having each two heads, therefore named interossei bicipites. They join their tendons to those of the extensor and lumbricales; they have therefore one common office with them, that is, extending all the joints of the fingers. Many have chosen to describe the origin and insertion with most particular care, marking the degree of obliquity, and ascertaining precisely their office, and giving particular names to each, as prior indicis for the first external; all which I forbear mentioning, because they must be more liable to perplex than assist: if we but remember their common place and office, it is enough. The tendons of the flexor muscles bend round the finger, along with the interossei and lumbricales, for a surer hold; consequently the tendons of the lumbricales, of the interossei interni, of the extensors, and of the interossei externi, meet upon the backs of the fingers, which are by them covered with a very strong web of tendinous fibres.

MUSCLES OF RESPIRATION, OR, OF THE RIBS.

THE whole back is clothed with strong muscles, and all its holes, irregularities and spines, are crossed with many smaller ones. These muscles are related either to the arm, to the ribs, or to the spine, *i. e.* the vertebræ, whose motions they perform; and from this we obtain an arrangement not inconsistent with the regular order of their office, and yet corresponding with the best order of dissection.

The first, or uppermost layer of muscles, viz. the trapezius, the levator scapulæ, the rhomboidei, the latissimus dorsi, belong principally to the arm. The serrated muscles which lie next under these are muscles of respiration, and belong to the ribs; while the splenius and complexus, the muscles of the neck, the longissimus dorsi, sacro-lumbalis, and the quadratus lumborum, which are muscles of the back, and the innumerable smaller muscles which lie betwixt the vertebræ, belong entirely to the spine.

The muscles of respiration properly which are appropriated to the ribs, performing no other motion, are,

1. The SERRATUS POSTICUS SUPERIOR, { which comes from the neck, and lies fleshy over the ribs, to pull them upwards.

2. The SERRATUS INFERIOR POSTICUS,	which comes from the lumbar vertebræ, and lies flat on the lower part of the back, to pull the ribs downwards.
3. The LEVATORES COSTARUM,	which are twelve flat muscles arising from the transverse process of each vertebra, and going down to the rib below: they raise the ribs.
4. The INTERCOSTAL MUSCLES,	which lie betwixt the ribs, and fill up all the space betwixt rib and rib; they also raise the ribs.

And there may be added to these, that muscle, which, lying under the sternum, and within the thorax, is called triangularis sterni, and pulls the ribs downwards.

CXVI. The SERRATUS SUPERIOR POSTICUS lies flat upon the side of the neck, under the trapezius and rhomboideus, and over the splenius, and complexus muscles. It arises by a flat and shining tendon from the spines of the three lower vertebræ of the neck, and the two uppermost of the back. It goes obliquely downwards under the upper corner of the scapula, and is inserted into the second, third, fourth, and fifth ribs, by three or four neat fleshy tongues. *Serratus sup. post. Or. 3 inf. spines of the neck. 2 of the sup. of the back. In. 2d, 3d, 4th, 5th, ribs.*

The ligamentum nuchæ is chiefly formed by the meeting of the trapezii muscles; but the flat tendons of these upper serrated muscles help to form it. They are purely levators of the ribs; their effect upon the vertebræ, if they have any, must be very slight.

CXVII. The SERRATUS INFERIOR POSTICUS is a very broad thin muscle, situated at the lower part of the back, under the latissimus dorsi, or over the longissimus dorsi muscle. *Serrat. inf. post.*

It arises, in common with the latissimus dorsi, from the spines of the two lower vertebræ of the back, and the three uppermost vertebræ of the loins. Their origin, like that of the latissimus, is by a thin tendinous expansion; it soon becomes fleshy, and, dividing into three, sometimes four, fleshy strips or tongues, each of them is inserted separately into the ninth, tenth, eleventh, twelfth, lower ribs, near their cartilages. So that this muscle, spreading so wide out from the centre of motion, has vast power; for it has the whole length of the rib as a lever. *Or. 2 lower vert. of the back, 3 sup. of the loins. In. 4 inferior ribs.*

The office of it is to pull the ribs downwards and backwards, the effect of which must be to compress the chest, and in certain circumstances to turn the spine.

CXVIII. The LEVATORES COSTARUM are twelve muscles on each side, for the direct purpose of raising the ribs; they lie above or upon the ribs, at their angles, and are thence named, by some, SUPRA COSTALES. *Levatores costarum.*

Or. transverse process of the vertebræ. *In.* sup. margin of the rib. Longiores.

They are almost a portion of the external intercostal muscles. The first of the levators arises from the transverse process of the last vertebra of the neck, and goes down to be inserted into the first rib, near its tuberosity; and so all that follow arise from a transverse process, and go to the rib below, being very small and tendinous at each end: but the three last levators arise from the second process, above the rib to which they belong: they pass one rib to go into the one below it; they are consequently twice as long as the nine first are, and are therefore named LEVATORES COSTARUM LONGIORES, from the ninth downwards.

Thus, the levatores costarum are a succession of small muscles, arising from the transverse processes of the vertebræ, and going to the angles of the ribs, beginning from the last vertebra of the neck, and ending with the last but one of the back. They lie under the longissimus dorsi, and sacro-lumbalis; and often they have connections with these muscles, sometimes very close.

Intercostales externi. *Or.* lower edge of the rib. *In.* sup. edge of next rib. Intercost. interni. *Or.* sup. margin of the rib. *In.* Inf. margin of next rib.

CXIX. CXX. The INTERCOSTALES EXTERNI run obliquely from the lower edge of one rib, downward and forward, or in a direction from behind forward, beginning from the spine, to be inserted into the upper edge of the rib below; the muscle is not continued into the space betwixt the cartilages of the ribs. The internal, again, are perfect betwixt the cartilages of the ribs, but they proceed no further back than the angles of the ribs. They are further different from the internal muscles, inasmuch as they pass obliquely backward and downward from the margin of the one rib to the other.

These two rows were thought to antagonize each other; the one to pull the ribs downwards, the other to raise them; but I shall not stop to explain this, nor to refute it; it is sufficient to declare their true use, which is (both external and internal) to raise the ribs and assist inspiration.*

The ninth, tenth, eleventh, and twelfth ribs, have a freer motion; and it appears to me that this is the true reason of the levatores longiores; and for the same reason, we find, that from the sixth rib and downwards there are certain slips of the internal intercostals, which pass over one rib, and go to the second below; and as the levatores longiores were called supra-costales, these have been named INFRA-COSTALES, and COSTARUM DEPRESSORES PROPRII. They were discovered by Verhein, and bear his name; they were explained as depressors of the ribs by Haller; but they are little different from the intercostals in form, and not at all in office, for they raise the ribs, along with the intercostal muscles.

Triangularis sterni.

CXXI. The TRIANGULARIS STERNI, or STERNO-COSTALIS, is a depressor of the ribs; an internal muscle lying chiefly on

* I remember, many years ago, to have heard Dr. Monro explain the office of the intercostal muscles by a diagram, deducing from that argument the more powerful effect of all muscles having the oblique fibres.

the inner face of the sternum, and the cartilages of the ribs. It is very generally considered as a triangular muscle on each side, but some consider it as three or four muscles, under the title of sterno- costales.

There are generally four slips lying on the cartilages of the third, fourth, fifth, and sixth ribs. The lower portion of the triangularis arises from the ensiform cartilage, and is inserted into the third or fourth rib ; the third arises from the middle of the sternum, and goes off from the edges of that bone, to be inserted into the third rib.

Or. edge and body of sternum. *In.* 3d, 4th, 5th, and 6th rib.

The fourth or uppermost portion is often wanting ; it goes off in part, also, from the inner surface of the sternum, but more commonly from the third rib, and goes to the second rib.

In a dog they are much larger than in a man. Their office is to depress the ribs ; and these portions are all conjoined at their roots, which gives the whole muscle the triangular shape.

The true uses of the intercostales, infracostales, and triangularis sterni, have been disputed ; but if the first rib be more fixed than the other ribs, then the intercostals, proceeding downwards from the first rib, must raise all the thorax ; and if the sternum be more fixed than the ribs, then the sterno-costales muscles, going upwards from the sternum, must pull down the ribs.

These muscles of the ribs are the appropriate muscles of respiration, and are united in office with the diaphragm and abdominal muscles. But it must be observed that there are many other muscles brought into action when the respiration is excited, as well as when the organs of respiration are brought to be subservient to other offices, as in coughing, sneezing, speaking, smelling, &c.

Such is the usual arrangement of the muscles of the thorax ; and it may serve the purposes of dissection, or to aid the memory of the student. But if we were fully to enter into this subject, it would be necessary to consider the various conditions of the respiratory muscles. There is common, equable, and gentle breathing, as when we are at rest or asleep. This is sufficient for the oxygenating of the blood, in the ordinary state of the circulation. But when the respiration is excited, the thorax rises higher, and subsides lower ; and the action is not limited to the chest ; for then the shoulders are elevated, the neck and throat are violently drawn, and even the nostrils and face are affected.

And this excited state of the organs of respiration is not only attendant on exercise or bodily activity, but also on excitement of the mind, as in passion. Moreover, when the act of inspiration or expiration has become a part of another function, as smelling, sneezing, coughing, yawning, &c. this more universal excitement takes place.

The principal agents in this high and excited state of respiration are the STERNO-CLEIDO-MASTOIDEUS, the TRAPEZIUS, and the SERRATUS MAGNUS ANTICUS. These powerful muscles cover the others; and although in the common exercise of the arms they are voluntary muscles, in the excited condition of the respiratory organs they become powerful agents of inspiration.

MUSCLES OF THE HEAD, NECK, AND TRUNK.

THE serratus superior posticus being raised, the splenii come into view, and the splenii being also lifted, the complexus is fully exposed.

Splenius.

CXXII. SPLENIUS.—The two splenii are so named from their lying like surgical splints, along the side of the neck; both together they have the appearance of the letter Y; the complexus being seen betwixt them in the upper part of the angle. They lie immediately under the trapezii, and above the complexus.

Or. 4 sup. spines of the back, and 5 inf. of the neck. *In.* 5 sup. transv. processes of the vert. of the neck, the mastoid process, the os occipitis.

Each splenius is a flat and broad muscle, which arises from the spinous processes of the neck and back, and is implanted into the back part of the head. It arises from the four upper spines of the back, and the five lower of the neck; it parts from its fellow at the fifth vertebra of the neck, so as to show in the interstice two or three of the uppermost spines of the neck, with the upper part of the complexus muscle; each splenius goes obliquely outwards to be inserted into the occipital ridge, and all along to the root of the mastoid process. At the third vertebra of the neck, where the two splenii muscles part from each other, the tendons of the opposite splenii are closely connected both with each other and with the common tendon, which is called ligamentum nuchæ.

This is the SPLENIUS CAPITIS; but there is a portion of this same muscle which lies under this, and which has the same common origin, but which terminates by four or five distinct tendons in the transverse processes of the upper vertebræ of the neck. This portion may be dissected apart, and has been considered by many as a muscle, the SPLENIUS COLLI of Albinus; who has distinguished as splenius capitis all that part arising from the spines of the neck, and implanted into the head; and as the splenius colli, all that part which arises from the vertebræ of the back, and is implanted into the transverse processes of the neck.

These splenii are the right antagonists of the mastoid muscles; both the splenii acting, pull the head directly backwards; one acting turns the head and neck obliquely to one side; one acting along with the corresponding mastoid muscle, lays the ear down upon the shoulder.

CXXIII. The COMPLEXUS is named from the intricacy of its muscular and tendinous parts, which are mixed; from the irregularity of its origins, which are very wide, it has the names of COMPLEXUS IMPLICATUS TRIGEMINUS, by which the student is warned of the difficulty of understanding this muscle. **Complexus.**

It lies immediately under the splenius; arises by distinct tendons, with ten or more tendinous feet, from the four lower transverse processes of the vertebræ of the neck, and from the seven uppermost of the back; having also some less regular origins, as from two spines of the back and from four oblique processes in the neck. It grows into a large muscle, which is not like the splenius, flat and regular, but thick, fleshy, composed of tendon and flesh mixed, filling up the hollow, by the sides of the spines of the neck, and terminating in a broad fleshy head, which is fixed under the ridge of the occipital bone; and this is the part which is seen in the angle or forking of the splenii.

_Or._ 7 sup. transv. processes of dorsal vert. 4 inf. of the neck; spinous process of the 1st of the back. _In._ the occipital bone in the line from the tuber to the mastoid process.

This may stand as the general description of the muscle considered as one. But Albinus has chosen to describe it as two muscles, under two different names, with a minuteness which, far from clearing the demonstration of any difficulties, make it less distinct; and if any thing could complete the confusion, it was his humour of calling that BIVENTER, which had been hitherto named COMPLEXUS, and naming the lower part of the muscle COMPLEXUS, though it had never been distinguished from the rest.

The BIVENTER of ALBINUS is the upper layer of the muscle, that part which appears in the fork of the splenii: and if we have hitherto named it complexus, from its mixture of tendons and flesh, it was particularly improper to transfer that name to another part of the muscle which is less complicated. This upper layer, the BIVENTER CERVICIS, is attached by a large broad head to the occipital bone; in the centre of this belly there is a confusion of tendon; then there is a middle tendon about the middle of the arch of the neck, and the lower part of the biventer arises from two parts; first, by one slip of flesh from the two uppermost spines of the back; and, secondly, by a larger fleshy portion which comes from the fourth, fifth, sixth, and seventh transverse processes of the back. And it is from the upper and lower fleshy heads and the confused middle tendon that it is called biventer.

The COMPLEXUS of ALBINUS lies below this one. It arises, by three tendinous and fleshy slips, from the three upper transverse processes of the back. Then it has four other slips from four oblique or articulating processes of the neck; which various origins are gathered into one thick irregular fleshy belly, which is implanted into the occiput under the great head of the biventer, and mixed with it. This I have chosen to explain, lest the student should be embarrassed by false names;

referring him to the first paragraph for the true and simple description of this muscle.

Trachelo-mastoideus.

CXXIV. TRACHELO-MASTOIDEUS.*—The last muscle is often named COMPLEXUS MAJOR, and this COMPLEXUS MINOR; but a fitter name is the TRACHELO-MASTOIDEUS, from its origin in the neck, and its insertion in the mastoid process.

Or. the 3 uppermost transverse processes of the verteb. of the back, and the 5 lowest of the neck. *In.* back of the mastoid process.

Its origin is from the three first vertebræ of the back, and from the five lowest of the neck at their transverse processes. Its origins are by distinct tendons, and its belly is in some degree mixed of tendon and flesh, whence its name of complexus minor. It is inserted into the mastoid process, just under the insertion of the occipital part of the splenius; and indeed its long and flat belly lies all along under that muscle, so that the order of dissection is this: 1. The TRAPEZIUS. 2. The SPLENIUS CAPITIS. 3. The SPLENIUS COLLI. The TRACHELO-MASTOIDEUS.

It is needless to speak of its use, since the use of all these muscles is to draw the head backwards directly, when both act; obliquely, when one acts alone.

The RECTI MUSCLES are two deep-seated muscles, which go immediately from the vertebræ to the occiput, to be inserted into its lower ridge. They are called major and minor.

Rectus minor. *Or.* tuber of the atlas. *In.* edge of os occipitis.

CXXV. The RECTUS MINOR is the shorter of the two, arising from the first vertebra of the neck. Its place of origin is a small tuber which stands in the place of the spinous process of the first vertebra; and from that point, where it is tendinous, it goes up to the occipital ridge, and is inserted fleshy.

Rectus major. *Or.* spinous pro. of the dentatus. *In.* os occipitis.

CXXVI. The RECTUS MAJOR is larger. It arises, in like manner, tendinous, from the second vertebra of the neck at its spinous process, and mounting from that, is inserted fleshy into the lower ridge of the occiput without the former. These are so placed that the recti minores appear in the interstice of the recti majores. And though we call them both recti, yet they cannot truly be so; for the recti minores must be, in some degree, oblique, and the recti majores still more so; and, consequently, although their chief use be conjointly to draw the head directly backwards, yet one acting must turn the head to its side. And indeed the same may be said of all the muscles of the neck.

The OBLIQUUS SUPERIOR and OBLIQUUS INFERIOR correspond very closely in all things with the recti, but in their oblique direction; the uppermost, as being much shorter, has been named obliquus minor, the lower one obliquus major.

Obliquus superior. *Or.* trans. pro. of the atlas.

CXXVII. The OBLIQUUS SUPERIOR arises from the transverse process of the atlas, and is inserted into the end of the lower occipital ridge. Its use, notwithstanding its oblique position, is not to turn, but to bend, the head backwards, for the

* It is the TRACHELO-MASTOIDEUS, the MASTOIDEUS LATERALIS, the CAPITIS PAR-TERTIUS, the COMPLEXUS MINOR; by some it is considered as a part of the COMPLEXUS.

occipital condyles, standing obliquely, do not permit the rotatory motion of the head on the first vertebra. Its insertion into the occiput is under the splenius and complexus; but one edge of it is above the insertion of the rectus major.

In. end of the lower occip. ridge.

CXXVIII. The OBLIQUUS INFERIOR arises from one vertebra and goes to another. It arises from the spine of the second vertebra: it goes to the transverse process of the first, and it meets the superior oblique muscle; and this one obtains great power, by the lateral projection of the atlas giving it a lever power. The first vertebra or atlas rolls on the tooth-like process of the dentatus; and while the great and slow motions of the neck in general are performed by other muscles, there is a presumption, that the short and quick turnings of the head are performed by these oblique muscles.

Obliquus inferior. *Or.* spinous pro. of the dentatus. *In.* trans. pro. of the atlas.

MUSCLES OF THE TRUNK.

The great muscles which move the back and loins are the QUADRATUS LUMBORUM, SACRO-LUMBALIS, and LONGISSIMUS DORSI.

The sacro-lumbalis and longissimus dorsi run by the side of the spine, and lie immediately under the latissimus dorsi, which is the outer layer; the quadratus lumborum lies again under these, and next to the abdominal cavity. Although the quadratus lumborum lies deep under the longissimus dorsi muscle, I shall describe it first, for the sake of a connection which will be presently understood.

CXXIX. The QUADRATUS LUMBORUM is a flat square muscle, named quadratus from its square, or rather oblong form. It arises fleshy from two or three inches of the back part of the os ilium, and from the ligaments of the pelvis which tie the back part of the ilium to the side of the sacrum, and to the transverse processes of the loins. As it goes upwards along the side of the lumbar vertebræ, it takes hold of the points of the transverse processes of each, by small tendinous slips; so that we are almost at a loss whether to consider these as new origins or as insertions: but its chief insertion is into the lower edge of the last rib; and a small production of it slips under the arch of the diaphragm, to be implanted into the body or fore part of the last vertebra of the back.

Quadratus lumborum. *Or.* 1. spine of ilium. 2. trans. pro. of lumbar vert.

In. last rib, and last dorsal vert.

The LONGISSIMUS DORSI and SACRO-LUMBALIS have their origin in one common and broad tendon coming from the sacrum, ilium, and loins: the two muscles lie alongside of each other: the longissimus dorsi is nearer the spine, and keeps its tendons closer by the spine. The sacro-lumbalis is farther from the spine, and spreads its tendinous feet broader upon the sides of the thorax; and if one be a little under the other, it is the outer edge of the longissimus dorsi, which is a little under the edge of the lumbar muscle.

The common tendon and muscle (for there is for some way but one muscle) begins thus; it may be said to have two kinds of adhesion: for, first, externally it appears a broad, flat, and shining tendon, which arises tendinous from all the spines of the lumbar vertebræ; from the spines of the sacrum, and from the back part of the os ilium: but the inner surface of this broad tendon is strongly fleshy; for it arises fleshy from the back part of the ilium; from the deep hollow betwixt the ilium and sacrum; from the sides of the long spines of the lumbar vertebræ; and from their articulating processes, and the roots of their transverse processes. In short, its origin is all tendinous without, and all fleshy within; and its flesh arises from all that irregular surface which is on either side of the spine betwixt the os ilium and the vertebra of the loins; and thus it continues one strong tendinous and fleshy muscle, filling up all the hollow of the loins. There is an appearance of separation, something like a split in the tendon, which shows in the loins what part of the tendon belongs to each muscle; but it is only in the back that they are fairly divided.

Just opposite to the lowest rib, the longissimus dorsi and sacro-lumbalis break off from the common tendon; and the longissimus keeps close by the vertebræ, while the sacro-lumbalis is implanted into the ribs.

Longiss. dorsi. *Or.* 1. the os sacrum, 2. spine of the os ilii, 3. spinous and transverse processes of the loins. *In.* 1. the transverse processes of the vert. of the back, 2. the lower edge of all the ribs except the two lowest.

CXXX. The LONGISSIMUS DORSI is a muscle of the spine. It is not a flat muscle, but round, thick, and firm, filling up all the hollow betwixt the spine and the angle of the ribs. It is of a long form, as its name implies, terminating towards its top almost in a point. It has two distinct sets of feet by which it is inserted; one set of feet more fleshy, but small and neat, go outwards from the side, as it were, of the muscle, to be implanted near the heads of the ribs; the lower ones farther out than the heads of the ribs; the upper ones close to the head, and consequently closer to the spine. These heads are nine or ten in number, corresponding with the nine or ten uppermost ribs. Another set of heads, which are not so well seen as this set, because they lie more under the muscle, are small, neat, and tendinous; they go in an opposite direction, viz. inwards and upwards; keep closer by the spine, and are inserted into the transverse processes of the vertebræ of the back. This set of heads is thirteen in number, implanted into the transverse processes of all the back, and of one vertebra of the neck.

Sacro-lumbalis. *Or.* in common with the last. *In.* all the ribs at their curvatures. N. B. The accessorii arise from the six or

CXXXI. The SACRO-LUMBALIS separates from the longissimus dorsi at the last rib, and is a flatter and less fleshy muscle; its twelve tendons are flatter than those of the longissimus dorsi, and go out wider from the spine. The tendons next to the longissimus dorsi run highest up, and are the longest; those farthest from the spine, *i. e.* farthest out upon the chest, are the shortest. It has a flat tendon for each rib, which takes hold upon the lower edge of the rib. But it has another order of small muscles which mix with it; for as the longissimus dorsi has a double row of insertions, this has another set of attachments, for there arises from the surface of each rib, at least of the six or seven lowest ribs, a small slip of flesh, which runs into the substance of the sacro-lumbalis, and mixes with it; and these fleshy slips go by the name of the ADDITAMENTUM AD SACRO-LUMBALEM, or MUSCULI ACCESSORII.

eight lower ribs, and run into its substance.

Both these muscles, viz. the longissimus and sacro-lumbalis, terminate in points which reach towards the neck, and under the point of each there lie the roots of two small muscles, which go up to move the neck. Many have referred these slips going up into the neck entirely to the muscles I am now describing, calling one an ascending slip of the longissimus dorsi, and the other a slip of the sacro-lumbalis, while others have described them as distinct muscles, having but slight connections with the longissimus and sacro-lumbalis. Their proper names are CERVICALIS DESCENDENS, and TRANSVERSALIS COLLI.

Cervicalis descendens. *Or.* 5 lowest transv. processes of the neck. *In.* six uppermost ribs.

CXXXII. The CERVICALIS DESCENDENS is connected with the sacro-lumbalis muscle; it cannot be entirely referred to it, for the cervicalis descendens arises as a distinct muscle from the five lower vertebræ of the neck, at their transverse processes, goes downwards very small and slender to be inserted into the six uppermost ribs, to get at which it slips under the longest tendons of the sacro-lumbalis; but that the cervicalis descendens does not belong to the sacro-lumbalis may be inferred from its having distinct tendons from six ribs, and from five transverse processes of the neck, and from these tendons being in a direction which does not at all correspond with the heads of the sacro-lumbalis. Indeed the longissimus dorsi has a better claim to this muscle; for a long slip, partly tendinous and partly fleshy, runs upwards from the longest tendon of the longissimus dorsi, to join itself to the cervicalis descendens. Perhaps it would be better to consider it a continuation of the accessorii ad sacro-lumbalem.*

Transversalis colli. *Or.* transverse processes of 5 upper dorsal vert. *In.* trans. processes of all the cervic. vert.

CXXXIII. The TRANSVERSALIS COLLI is that which Sabatier refers to the longissimus dorsi; but it is a distinct muscle arising, partly tendinous and partly fleshy, from the five upper transverse processes of the back; lies betwixt the trachelo-mastoideus and the cervicalis descendens; goes from the transverse processes of the back to the transverse processes of the neck, and has no more than a confused and irregular connection with any other muscle.

The QUADRATUS LUMBORUM keeps the trunk erect, by the action of both muscles at once; inclines it to one side, or turns it upon its axis, when one only acts; and by its insertion into the ribs, must assist in high breathing, by pulling down the

* Hence it is plain that the sacro-lumbalis and longissimus dorsi have nearly an equal claim to this cervicalis descendens. For, first, the longissimus dorsi sends its longest tendons fairly up into the cervicalis descendens so far, that the slip is implanted into the transverse processes of the neck. And, secondly, the feet of the cervicalis descendens begin under the last tendons of the sacro-lumbalis, so as to have the appearance of arising from its supplementary muscle, the additamentum, and being a part of it; and indeed Sabatier has described it according to this view.

ribs. The LONGISSIMUS DORSI has no power but over the spine, which it bends backwards, acting continually in keeping the trunk erect. This is also the chief use of the sacro-lumbalis; but the SACRO-LUMBALIS, going out further upon the ribs, takes such hold upon them, that besides its common action of raising the trunk, it may on occasions pull them down, assisting the quadratus and the lower serrated muscle. And it will have greater power in turning the trunk of the body upon its axis than the longissimus dorsi, which pulls almost directly backwards. The CERVICALIS DESCENDENS co-operates with the trachelo-mastoideus, and others, which turn the head to one side; and the cervicalis descendens bends the neck to one side, both the one and the other being independent muscles.

These two muscles bring us to mention that intricate set of muscles which fills up all the hollows and interstices among the spines and irregular processes of the vertebræ, which might be fairly reckoned as one muscle, since they are one in place and in office, but which the anatomist may separate into an infinite number, with various and perplexing names; an opportunity which anatomists have been careful not to lose.

The surface of the back, from the bulge of the ribs on one side, to the bulge of the ribs on the opposite side of the thorax, is one confused surface, consisting of innumerable hollows, processes, and points of bone; and it is tied, from point to point, with innumerable small muscles, or unequal bundles of mixed tendon and flesh. There are many points, as the spinous, transverse, and oblique processes of the vertebræ, and the bulging heads and angles of the ribs: and each process, or at least each set of processes, has its distinct set of muscles and tendons.

1. There is one long continuity of muscular and tendinous fibres going from spine to spine, and lying on the side of the spinous processes along the whole length of the back and neck. This is divided into the SPINALIS CERVICIS and the SPINALIS DORSI.

2. There is a similar continuation of fibres, with less tendon and more flesh, belonging one half to the spinous and the other half to the transverse processes, whence it is named SEMI-SPINALIS DORSI.

3. There is a great mass lying all along the hollow of the back, on each side of the spinous processes, which, passing alternately from the transverse process of one vertebra to the spinous process of the next above, is of course split into many heads, but yet having such connection as to give it the form and name of a single muscle, the MULTIFIDUS SPINÆ.

4. and 5. There are yet smaller muscular fasciculi which stand perpendicularly betwixt every two transverse and every two spinous processes; thence they are named INTER-TRANSVERSARII and INTER-SPINALES.

Semi-spinalis cervicis. CXXXIV. The SPINALIS CERVICIS is that which is implanted into the spines of the cervical vertebræ; but because it does not go from spine to spine, like the spinalis dorsi, but from transverse processes to spines, it has been named by Winslow SEMI-SPINALIS, or TRANSVERSO-SPINALIS COLLI. It arises from the transverse processes of the six upper vertebræ of the back, and is inserted into all the spinous processes of the vertebræ of the neck, except the first and last; and it extends the neck, or by its obliquity may contribute to the turnings of the neck, or to bending it to one side.*

Or. trans. process of the 6 upper dorsal vert. *In.* all the spinous process of neck except the 1st and 7th.

CXXXV. The SPINALIS DORSI arises from two spinous processes of the loins, and from the three lower spines of the back, and passing two spines untouched, it is implanted into all the spines of the back, except the uppermost. This muscle is very slender and long, and consists fully more of tendon than of flesh: it has five feet below, rising from the lower spines of the back and loins; and nine feet above, implanted into the upper spines of the back. Its action must raise the spine, but perhaps it may be equally useful, as a muscular and tendinous ligament.

Spinalis dorsi. *Or.* 2 upper lumb. vert. 3 lower dorsal vert. *In.* 8 or 9 sup. dorsal vert. except the 1st.

CXXXVI. The SEMI-SPINALIS DORSI arises from the transverse processes of the seventh, eighth, ninth, and tenth vertebræ of the back, and is implanted into the six or seven upper dorsal spinous processes and into the two last of the neck.†

Semi-spinalis dorsi. *Or.* trans. process of the 7th, 8th, 9th vert. of the back. *In.* spines of 6 or 7 upper dorsal, and two lowest cervical.

CXXXVII. The MULTIFIDUS SPINÆ runs from the sacrum along all the spine to the vertebræ of the neck; and is a comprehensive and true way of describing many irregular portions of flesh, which authors have divided into distinct muscles.‡ It is a continued fleshy indentation, from transverse process to spine, through all the vertebræ of the back, neck, and loins.

It begins both tendinous and fleshy, from the upper convex surface of the os sacrum, which is rough with spines, from the adjoining part of the ilium; and in the loins, it arises from oblique processes: in the back, from transverse processes; and again from oblique processes, among the cervical vertebræ.

Its origin in the loins is close to the spine, being from the oblique processes, and from the root of the transverse processes. In the back it arises from the transverse processes, and therefore arises there by more distinct heads. In the neck again, it arises from the lower oblique processes, more confusedly.

Its bundles or fasciculi are inserted into the spinous processes, sometimes into the second, or even into the third or fourth spine, above that from which the bundle arises: for the tendons do not stop at that spinous process which they first touch,

* The TRANSVERSALIS COLLI (*vide* p. 275.) is that which goes from the transverse processes of the back to the transverse processes of the neck; while this, the SPINALIS CERVICIS, goes from the transverse processes of the back to the spines of the neck.

† This is of course the TRANSVERSO-SPINALIS DORSI of Winslow.

‡ TRANSVERSO-SPINALIS LUMBORUM, SACER, SEMI-SPINALIS INTERNUS, sive TRANSVERSO-SPINALIS DORSI, SEMI-SPINALIS, sive TRANSVERSO-SPINALIS COLLI, pars interna.—Winslow. TRANSVERSALIS LUMBORUM, vulgo SACER, TRANSVERSALIS DORSI. TRANSVERSALIS COLLI.

but go upwards, taking attachments to other two or three, and mixing their tendons with those of the fasciculi, above and below; and these tendons reach from the first of the loins to all the vertebræ up to the atlas, which is the only one not included.

The use of the multifidus spinæ is to retain the spine from being too much bent forward; for these muscles serve (as I have observed) the purpose of a ligament, and the best of all ligaments; having a degree of strength exactly proportioned to the necessity for strength. It also moves the spine backwards, though perhaps it is less useful in this than as a ligament; for we find it as strong in the vertebræ of the back, which have little motion betwixt the individual bones, and what little there is, must consequently be general. It seems rather intended to moderate the lateral motions of the vertebræ than to produce them: when it acts, its chief use is either to resist the spine being bent forward by a weight, or to erect the spine.

Inter-spinales.

CXXXVIII. The INTER-SPINALIS COLLI, DORSI, and LUMBORUM, have varieties so little interesting that they need hardly be described. The INTER-SPINALES COLLI are stronger, because the neck has many and quick motions, and the bifurcated spines of the neck give broader surfaces for these muscles. The INTER-SPINALES DORSI are almost entirely wanting, because the spines of the back are close upon each other, and the vertebræ are almost fixed. The INTER-SPINALES in the LOINS are rather tendons or ligaments than proper muscles.

Inter-transversales.

CXXXIX. The INTER-TRANSVERSALES are again stronger and fuller in the neck, because of the lateral motions of the neck being free, and its transverse processes forked. They are in more numerous bundles, where the motion is greatest, viz. betwixt the atlas and dentata; and it is there that Albinus counts his INTER-TRANSVERSALES CERVICIS, PRIORES, LATERALES, &c. The inter-transversales are wanting in the BACK, giving place to the ligaments, by which they are tied to each other, and to the ribs; but in the LOINS, the inter-transversales are again strong, for the lateral or twisting motions of the loins.

The muscles on the fore part of the head and neck will complete the catalogue of those belonging to the spine, and they are the chief antagonists to the muscles which I have been describing.

Rectus major.

CXL. RECTUS INTERNUS CAPITIS MAJOR.—There are three muscles on each side, lying under the œsophagus, trachea, and great vessels, flat upon the fore part of the vertebræ; and this is the first and longest.

Or. 4 or 5 lower trans. process. of cervic. vert. *In.* cuneiform process.

Although this be called rectus, it is oblique, and running rather on one side; for it arises from the transverse processes of the five lower vertebræ of the neck, and it is inserted into the cuneiform process of the occipital bone, just before the foramen magnum.

CXLI. Rectus internus minor.—This is an exceedingly small muscle. It lies immediately under the rectus major: it arises from the fore part of the body of the first vertebra, the atlas, and going (like the other rectus) obliquely inwards, it is inserted into the occipital bone, near the condyle.

Rectus minor internus. *Or.* fore part of the atlas. *In.* occipital bone near the condyle.

CXLII. And the rectus capitis lateralis is another small muscle like the former, which arises from the transverse processes of the first vertebra, and is inserted into the side of the cuneiform process of the occipital bone. It lies immediately under the exit of the great jugular vein.

Rectus cap. lateralis. *Or.* trans. process of the atlas. *In.* side of the cuneiform pro.

CXLIII. Longus colli.—This is the chief of those muscles which lie upon the fore part of the neck; it is very long, arising from the flat anterior surface of the vertebræ of the back, to go up along those of the neck.

Its origin is first within the thorax, from the three uppermost vertebræ of the back, from the flat part of their bodies, and then from all the transverse processes and bodies of the neck, except the three upper ones. It is inserted tendinous into the fore part of the second vertebra of the neck, where the opposite large muscles meet in one point almost.*

Longus colli. *Or.* 1st, bodies of 3 upper dorsal vert. and 2d, bodies and trans. proc. of all the cerv. vert. excepting the 3 upper. *In.* body of dentata.

All these muscles, which lie thus flat upon the plain surface of the vertebræ of the neck, pull the head and neck directly forwards; or when one acts, they are of use in pulling it towards one side; though I rather suppose this motion is performed by the external muscles chiefly.

CXLIV. The scalenus I consider as one muscle; for it is one in origin, insertion, and office. Its origin is from the whole upper surface of the first rib, from its cartilage backwards, and also from the second rib; and its insertion is into the transverse processes of the vertebræ of the neck. But by its broad origin, and its very long insertion, it gives opportunity for dividing it into several fasciculi; and accordingly it has been so divided; but these divisions are entirely modern, artificial, and unnatural. The ancients considered it as one triangular muscle: Winslow divided it into two, the primus and secundus; Cowper into three; Douglas into four; and Albinus divides it into five muscles. The ancients called it scalenus, from its resemblance to the scalene triangle; and the true anatomy is, to consider it as one great triangular muscle, flat, and stretching from the ribs to the neck, closing the thorax above, and giving passage to the nerves and vessels of the arm.

If it were to be described in distinct portions, it would be in three parts. The anterior portion arises from the transverse processes of the fourth, fifth and sixth vertebræ of the neck, and is inserted into the flat part of the first rib hard by its cartilage. The middle portion from the transverse processes of all the vertebræ of the neck goes to the outer edge of the rib, and extends along all its length. The posterior portion arises

Scalenus anticus. *Or.* trans. proc. of 4th, 5th, and 6th cerv. vert. *In.* 1st rib near its cartilage.

Scalenus medius. *Or.* trans.

* The longus colli muscle is in part covered by the rectus major.

proc. of all the cerv. vert. *In.* large portions of 1st rib. Scalenus posticus. *Or.* trans. process of 4th, 5th, and 6th cerv. vert. *In.* 2d rib.

from the transverse processes of the fourth, fifth, and sixth vertebræ. It is inserted into the upper edge of the second rib, about an inch or more from its articulation with the spine.

The first head is tendinous and fleshy at its insertion into the rib; but the second and third heads are tendinous, both in their origins and insertions.

The subclavian artery and the nerves pass in the interstice betwixt the first and second portions.

The office of the scalenus muscle is to pull the neck to one side, or to bend the head and neck forward, when both act; and when the neck is fixed backwards, they may perhaps raise the ribs; for asthmatics are observed to throw the head backwards, in order to raise the chest with greater power.

OF THE MUSCLES OF THE ABDOMEN AND OF THE DIAPHRAGM.

The abdominal muscles cover in the belly, contain the bowels, and take a firm hold upon the pelvis and the trunk. The diaphragm, again, is a moving partition betwixt the thorax and the abdomen, and the diaphragm pressing down the bowels upon the abdominal muscles, enlarges the thorax, and the abdominal muscles re-acting push the bowels back upon the diaphragm, and compress the thorax. Thus, the alternate yielding and re-action of the abdominal muscles and diaphragm perform breathing, agitate the bowels, promote the circulation, expel the fæces and urine, assist the womb in the delivery of the child; and, with all these important uses, the abdominal muscles bend and turn the trunk, and fix it for the stronger actions of the limbs. They steady the body in lifting weights, in bearing loads, in all our more violent exertions. They often give way under this double office of breathing and of straining, along with the rest of the body; and the bowels coming out through their natural openings, or by bursting through the interstices of their fibres, form herniæ of various kinds. Whence the anatomy of these muscles is most interesting to the surgeon.

The muscles of the abdomen are five on each side. 1. The outer oblique muscle, to which the names of DESCENDENS, DECLIVIS, and MAJOR are added, because it is the outermost of all the abdominal muscles, because it is the largest, covering all the side of the abdomen with its fleshy belly, and all the fore part of the abdomen with its broad expanded tendon; and it is called declivis, or descendens, because its fleshy belly begins above, upon the borders of the thorax, and because both its muscular and tendinous fibres, which lie parallel to each other, run obliquely from above downwards and inwards.

2. The OBLIQUUS INTERNUS is named from its being within the first, and has the names of ASCENDENS vel MINOR superadded, because its fleshy belly is smaller than that of the first, arises below chiefly in the haunch-bone, and all its fibres go from below upwards.

3. The TRANSVERSALIS lies under all the others, and next to the cavity of the abdomen, and has but one name, which also is derived from the direction of its fibres running across or round the abdomen.

4. The RECTUS, so named because of its running on the fore part of the abdomen, in one straight line from the os pubis to the sternum.

5. The PYRAMIDAL muscle is the only one named from its shape. It is a small, neat, conical muscle, which arises from the os pubis, by a broad basis, and has its apex turned upwards; but it is not always found, for it is only as a supplement to the recti muscles, and as a part of them, whence it has been named MUSCULUS SUCCENTURIATUS, or supplementary muscle.

CXLV. The EXTERNAL OBLIQUE muscle arises from the ribs, and, like all the others which arise from ribs, is a serrated muscle. It comes from the eight lower ribs, by distinct fleshy tongues, one from each rib. Four of these serræ are mixed with the indentations of the serratus magnus anticus muscle, which goes off in an opposite direction, and the rest with the origins of the pectoralis major and latissimus dorsi; indeed sometimes there is a mixing of the fibres of this muscle with those of the pectoralis major. The origin of the muscle, lying broad upon the border of the chest, is its thickest and most fleshy part, whence its fibres go down all in one direction, parallel with each other, but oblique with respect to the abdomen. Its fleshy belly ceases about the middle of the side, at the linea semilunaris. Its flat sheet of tendon goes over the fore part of the belly, till it meets its fellow exactly in the middle, so that one half of the back part of the abdomen is covered by its fleshy belly, and the fore part by its tendinous expansion. Obliquus externus descendens. *Or.* 8 inf. ribs.

The muscle meets its fellow in the middle of the belly; and this meeting forms (along with the other tendons) a white line from the pubes to the sternum, which is named LINEA ALBA. It also, before it reaches the middle, adheres to the flat tendon of the internal oblique. This meeting is about four inches on either side of the linea alba, and is a little inclined to the circular, whence it is named linea semilunaris. And, finally, this muscle is implanted into the spine of the ilium, fleshy about the middle of the ilium, tendinous at the fore part or spinous process of the ilium, and still tendinous into the whole length of that ligament, which extends from the spine of the ilium to the crest of the pubes. *In.* 1. linea alba. 2. spine of the ilium. 3. Poupart lig. 4. os pubis.

This is the whole of its insertions, viz. all the length of the linea alba, from the pubes to the sternum, the fore part of the spine of the ilium, and the ligament of Poupart, which, though it is commonly thought to be but the tendon of the external oblique stretching from point to point, is, in truth, a distinct ligament, independent of the tendon, and stronger than it.*

Obliquus internus.

Or. 1. spine of the ilium, 2. the sacrum, and 3. the fascia lumborum. 4. half of Poupart's lig.

CXLVI. OBLIQUUS INTERNUS ABDOMINIS.—The chief part of this muscle arises thick and fleshy from all the circle of the spine of the ilium, with its fibres directed upwards. But, to be accurate, we must describe it as arising from the whole length of the spine of the ilium, from the joining of the ilium and sacrum, from the spines of the sacrum itself, and from the three lower spinous processes of the loins†; and, lastly, it arises from nearly half of the ligament of the thigh, at its end next to the ilium; but still the chief belly is at the iliac spine. From that it spreads upwards in a radiated form; the central fibres only are direct, going across the abdomen to the linea alba; the higher fibres ascend and go towards the sternum, and the lower ones go obliquely downwards to the pubes. Its flat tendon is like that of the external oblique, and it is inserted into the cartilages of the seventh and all the false ribs, into the ensiform cartilage of the sternum, and into the linea alba, through its whole length, and the os pubis.‡

In. 1. cartilago ensif. 2. cartilages of 7th and all the false ribs. 3. linea alba, 4. os pubis.

Transversalis abdominis.

Or. 1st, the 7 lower ribs, 2d, trans. process of last dorsal vert. 3d, the four trans. processes of the lumbar vert.

In. 1. cartilago ensif. 2. linea alba, and 3. os pubis.

CXLVII. The TRANSVERSALIS ABDOMINIS forms the internal layer, it runs directly across the belly. It arises fleshy from the inner surface of the seven lower ribs, where its digitations mix with those by which the diaphragm arises; tendinous from the transverse processes of the four lower lumbar vertebræ, and last of the back; from the whole spine of the os ilium internally, and from a part of the Poupart ligament. Upon the whole its origin is like that of the inner oblique muscle; its fibres go across the abdomen, and its tendon is inserted into the sheath of the rectus, the whole length of the linea alba, cartilago ensiformis, and os pubis.

The succession in which these three muscles arise from the chest is this: the external oblique muscle lies broad upon the outside of the chest, and so its tongues mix with the tongues of the serratus anticus magnus. The internal oblique muscle again rises lower down the thorax, from its edge, from the cartilages of the ribs. The transverse muscle arises within the thorax, from the internal surface of the ribs, opposite to where the tongues of the external oblique lie; and the diaphragm arising from the same ribs, mixes its indigitations with the transversalis, so that Gaspar Bartholin, observing this indigitation to be very curious in the larger animals, believed the diaphragm and transverse muscles to be but one great trigastric or three bellied muscle, surrounding all the abdo-

* See *post*, page 286.

† This origin from the spinous processes of the loins and sacrum is a thin tendon, common with the serratus posticus inferior and latissimus dorsi muscles.

‡ See the description of the sheath of the rectus muscle, *post*, p. 283.

men. But the transversalis, with the other abdominal muscles, are the antagonists of the diaphragm.

CXLVIII. The RECTI muscles cover the abdomen on its fore part, in a line from the pubes to the sternum; and they belong so equally to the sternum and to the os pubis, that it is indifferent which we call their origin, and which their insertion. The origin (as I should call it) of each rectus muscle is in the sternum, is broad and fleshy, lies upon the outside of the sternum, covering part of it, and all the xiphoid cartilage, and touching and mixing its fibres with the great pectoral muscle, and likewise taking part of its origin from the cartilages of three of the ribs. It is about four inches broad all down the abdomen, and terminates at the side of the symphysis pubis, with a flat and pointed tendon about an inch in length, and about an inch broad. This muscle is crossed at intervals by four tendinous intersections, which divide it into five distinct bellies. Commonly there are three bellies above the umbilicus, and two below; but the recti muscles are the least regular of all the muscles of the abdomen. Vesalius, Albinus, and Sabatier were thought to have found the recti abdominis extending up to the throat. But it is now found that Vesalius had only represented the muscles of a monkey, or of a dog, which are very long, upon the thorax of a human subject. Sabatier, upon revising his notes, retracts what he had said: and Albinus also is supposed to have seen only a production of the mastoid muscle extending down the breast; for irregularities of this kind have been found.

Rectus.

***Or.* first, from 3 inf. true ribs, 2d, ensif. cart. of sternum.**

***In.* symphysis pubis.**

CXLIX. The PYRAMIDAL muscles are as a supplement to the recti. There is a small neat pyramidal muscle on each side, or rather a triangular muscle, fleshy through its whole extent and length, with its base turned towards the pubes, and its apex towards the umbilicus; so that its origin is in the crest of the pubes, and its pointed insertion in the linea alba: and though the recti muscles have been supposed by Massa to relate to the penis, or by Fallopius to belong to the urinary bladder, their true use is only to assist the rectus to draw down the sternum, and tighten the linea alba, and so to give greater power to the oblique and transverse muscles. The pyramidalis is so irregular a muscle, that sometimes two are found on one side, and none at all on the other. Sometimes two on each other; sometimes there is but one, and very often they are wanting, the belly of the rectus coming quite down to the pubes.

Pyramidalis.

***Or.* crest of the os pubis. *In.* linea alba.**

The effects of the abdominal muscles in moving the trunk cannot be mistaken. The RECTI pull the ribs downwards in breathing, flattening the belly, and bending the body forwards. The two OBLIQUE MUSCLES of one side acting, turn the trunk upon its axis; but the oblique muscles of the opposite side acting, co-operate with the rectus in flattening the belly and bending the body; and the TRANSVERSE MUSCLES tighten the linea alba, so as to give effect to all the others; and particularly they brace the sheath of the recti muscles, so as to give them their true effect.

1. The LINEA ALBA is the common meeting of all the thin flat tendons, and therefore we call it their insertion, being the common point towards which they all act; it is white, by the gathering of all the colourless tendons.

2. The LINEA SEMILUNARIS is a line of the same white appearance, of a circular form, and produced by the meeting of all the tendons on the edge of the rectus muscle, to form a sheath for it.

3. The SHEATH for the RECTUS MUSCLE does not admit of so brief a definition as this: it has been commonly supposed to be formed in a very curious manner, chiefly by the broad tendon of the obliquus internus, which being the central muscle, betwixt the two other layers, is supposed to have its tendon split into two thin sheets; that the outermost sheet adheres to the outer oblique muscle, forming the outer part of the sheath, while its inner sheet adheres to the tendon of the transverse muscle, forming the inner part of the sheath; but this is too intricate, and can hardly be proved by dissection. Cowper expresses his doubts about this doctrine of the tendon of the inner oblique muscle being split into two layers; and I think the truest description is this, that all the tendons meet, and adhere to the semilunar line; that they immediately part and form this sheath; that the flat tendons of both the oblique muscles go upon the outer surface of the rectus to form that side of the sheath; that the tendon of the transverse muscle only lies under the rectus, forming the lower part of the sheath, and that it is unassisted by any lamella of the inner oblique muscle; that the sheath is complete at the fore part, or over the muscle; but that under the muscle the sheath stops about five or six inches above the pubes, and that there the recti muscles (or in their place the pyramidal muscles) lie bare upon the viscera, lined only by some scattered fibres of the fascia transversalis and the peritonæum.* And that this back layer of the sheath is thinner and more delicate, and but little attached to the back part of the rectus muscle, which is easily raised in dissection, while the fore part of the sheath adheres firmly to the fore part of the muscle, forming those cross bands or tendinous intersections which divide the rectus into bellies, and the sheath where it lies over the muscle cannot be dissected without a degree of violence, either to the sheath, or to these tendinous intersections.

4. The UMBILICUS is that opening in the centre of the abdomen, in the middle of the linea alba, through which the nutritious vessels of the fœtus pass. The vessels have degenerated into ligaments in the adult, and the umbilicus is closed

* Cowper had never observed this but once, that the lower part of the rectus was not lined by the tendon of the transversalis. He concluded that in this instance it was a sporting of nature: "so much a lusus naturæ, that accidents like this might be the cause of certain ruptures."

in the form of a ring; but sometimes it is forced by violent action, and the viscera come out by it, forming umbilical hernia.

5. The RING of the ABDOMINAL MUSCLES is that opening near the lower part of the abdomen, just over the pubes, through which the spermatic cord passes in men, and the round ligament of the womb in women.

Cowper (p. 5.) says that the spermatic cord passes through separate rings, in each of the three abdominal muscles; and, like older authors, he makes nature exceedingly wise, in placing the rings not opposite to each other, but one high, and another lower, and a third lower still, so as to prevent the bowels falling out. But the truth is, that neither the internal oblique nor the transverse muscles have any share at all in the ring, which belongs entirely to the external oblique muscle, and is formed in this way: all the tendinous fibres of the external oblique are, like the muscle itself, oblique, running from above downwards; and the tendinous fasciculi are in some places wider, a little disjointed from each other, and resembling stripes, crossed by small threads of tendon, as if the long fibres were in danger of parting from each other, so as to leave a gap, and were held together by these cross threads; and it is, in fact, a wider and perfect separation of two fibres that forms the ring, and a stronger interlacement of cross fibres that secures it from splitting farther up. But the chief security of the ring is by the form of the opening; for it is not a ring, as we call it, but a mere split in the tendon, which begins about an inch and a half above the pubes, is oblique, and looking towards the pubes, like the fibres which form it, and consists of two legs, or pillars of the ring, as they are called; for the upper slip, which forms the upper part of the opening, goes directly towards the crest or highest point of the pubes; the lower pillar, or the slip which forms the lower line of the slit, turns in behind, gets under the upper one, and is implanted into the pubes, within and behind the upper pillar: this lower slip forms at once the lower pillar of the ring and the edge of the femoral ligament. But Cowper was not far from the truth, when he said the bowels were prevented from falling down by the obliquity of the spermatic passage. The spermatic cord is flat and spread out when it begins to pass down through the abdominal walls, and it is only when it has emerged from this proper ring that it assumes the round and cord-like form. Besides, it comes out under the transversalis muscle considerably higher up and more towards the ilium than the ring, and in its further descent it splits the fasciculi of the internal oblique muscle, and carries one of these fasciculi along with it, which constitutes the cremaster muscle. First its veins and arteries are gathered together, then it is joined by the vas deferens, and, finally, it is embraced by the cremaster muscle; and thus perfected, as it were, it glides obliquely through the ring of the external oblique muscle. Where it comes out it is covered by the fascia superficialis, a process of which goes down upon the cord. When the cord is passing under the transversalis muscle it passes the fascia transversalis, the fibres of which are strong upon one side: the cellular membrane too here is dense, and, although there be in the natural condition of the parts no proper ring, yet when a *rupture* takes place, a portion of the peritonæum is thrust through the spermatic passage, and presses the cellular membrane and fascia so together, that a ring is formed; this is what meant by the INTERNAL RING.

Cremaster. *Or.* 1. lower edge of intern. obliq. 2. the os pubis. *In.* tunica vaginalis.

CL. The CREMASTER MUSCLE of the TESTICLE, which is a thin slip of fibres from the internal oblique muscle of the abdomen, designed for suspending the testicle, and for drawing it up, is very thick and strong in the lower animals, as in bulls, dogs, &c.; is easily found in man, but not always, being sometimes thin and pale, and hardly to be known from the coats upon which it lies. It appears to grow more fleshy in old age, and to be thickened in enlargements of the testicle, the better to support the weight.

Crural arch.

6. The LIGAMENT of the THIGH* is a distinct ligament, and not merely the tendon of the external oblique, rounded and turned in. It passes from the ilium obliquely across to the pubis. It receives the external oblique muscle, for the tendon is implanted into it. Part of the flesh of the internal oblique muscle and transversalis arise from the outer end of the ligament. It forms an arch over the psoas and iliacus internus muscles, where the crural artery vein and nerve pass out, and it is tied down at both sides of the passage for the vessels by the fascia of the thigh. But this ligament requires a more particular description. It appears outwardly to have a round edge, but in fact it is here turned in, its lower margin shelves inwards, and at the pubic end it spreads horizontally upon the os pubis, as far as to the brim of the true pelvis, and the spermatic cord lies upon it. The angle where it turns inwards is attached to the fascia of the thigh, while the edge, which is turned in, is continued inwards under the cord in the form of a fascia or ligament, and is connected with the linea ilio-pectinea. So this ligament of the thigh is said to have three principal attachments to bone, viz. the anterior superior spinous process of the ilium, the spine of the os pubis, and the linea ilio-pectinea. The attachment of the ligament to the fascia of the thigh demands a little more attention. When the glands and fat of the groin are taken away, the connection of the fascia of the thigh and the Poupart ligament presents the form of an inverted funnel; and if an attempt be made to pass the finger to the bottom of it, towards the abdomen, it is stopped by a strong net-work of fibres: the meshes of this net-work permit

* This ligament of the thigh is named also the INGUINAL LIGAMENT; the CRURAL ARCH; the LIGAMENT of POUPART; the LIGAMENT of FALLOPIUS, &c.

the lymphatics of the thigh to pass upwards, whilst the stronger processes of the fascia take the form of a crescent. Thus, besides the proper strong Poupart or inguinal ligament, there is an arch or crescent formed of less dense and shining substance, which goes down from the edge of the ligament, and terminates on each extremity in the fascia of the thigh. This is the part under which the crural hernia comes out; round which, indeed, the tumour turns, and it is the sharp edge of this crescent which nips, and causes the strangulation of this kind of hernia.

It often happens, that in vomiting, in violent coughing, in straining at stool, or in lifting heavy weights, the natural openings are forced, and the bowels descend. The UMBILICUS is very seldom forced by sudden exertion, for it is a very firm ring; but it is slowly dilated in pregnancy, and hernia of the navel is infinitely more frequent with women than with men. The opening of the RING is often kept dilated by the bowels following the testicle when it descends, forming the congenital hernia; most frequently of all, the ring is forced in strong young men by hard and continued labour, or by sudden straining; but women are safer from this kind of hernia, because the round ligament of the womb is smaller than the spermatic cord, and the ring in them is very close.—ABDOMINAL VENTRAL HERNIÆ are those which come not through any natural opening, but through the interstices of the muscles, or their tendons; sometimes hernia follows a wound of the abdomen; for a wound of the abdominal muscles may not heal so neatly as not to leave some small interstice, through which the bowels protrude. Thus, any point may be forced by violence; any of the openings, or all of them, may be relaxed by weakness, as in dropsical or other lingering diseases: for it is from this cause that herniæ are more frequent in childhood and in old age, by the laxity which is natural to childhood, or by the weakness natural to the decline of life. Often there seems to be a hereditary disposition to herniæ in certain houses, the form of the openings of the abdomen being wider in a whole family, just as the features of the face are peculiar. And I have seen a child with all these openings so particularly wide, that upon the slightest coughing or crying, herniæ came down at every possible point, at the navel, the scrotum, the thigh, and in the sides of the abdomen, all at once; or as one tumour was reduced another arose.

CLI. The DIAPHRAGMA is a Greek word, translated interseptum, the transverse partition betwixt the abdomen and the thorax, the midriff; but it is not merely a transverse partition, it is a vaulted division betwixt the thorax and abdomen; and not only is the middle raised into a vaulted form, but its obliquity is such, that though its fore part be as high as the sternum, its lower and back part arises near the pelvis from the lowest vertebra of the loins. Diaphragm.

It is a circular muscle, which is fleshy towards its boarders, and tendinous in the centre; which is convex towards the thorax, and concave towards the abdomen; becoming plain, or almost so, when it presses against the abdominal muscles in drawing the breath; and returning to its convex form, when the abdominal muscles re-act in pushing it back into the thorax.

Greater muscle.

The diaphragm arises, by one broad fleshy attachment, from all the borders of the chest, forming the upper or greater muscle of the diaphragm; and it arises below, by many small tendinous feet from the fore part of the loins, which meeting, form what is called the lesser muscle of the diaphragm. 1st, The GREAT OR UPPER muscle arises, first, from under the xiphoid cartilage, and from the lower surface of the sternum. 2dly, From all the false ribs; from the cartilage of the seventh, eighth, and ninth ribs; and from the bony parts of the tenth and eleventh ribs, and from the tip of the twelfth rib. All these origins are, of course, fleshy digitations or tongues which intermix with those of the transverse muscle of the abdomen. 3dly, From the tip of the twelfth rib to the lumbar vertebræ, there is a ligament extended, which, going like an arch over the psoas and quadratus lumborum muscles, is named LIGAMENTUM ARCUATUM; and from this another part still of the great muscle of the diaphragm arises. Thus, the upper muscle of the diaphragm has four chief origins, viz. from under the sternum and xiphoid cartilage; from all the false ribs; from the ligamentum arcuatum; and, in short, from all the borders of the chest, from the xiphoid cartilage quite round to the vertebræ of the loins.

Or. 1. xiphoid cart. 2. seventh and all the false ribs. 3. the lig. arcuatum. *In.* cordiform tendon.

Lesser muscle. *Or.* 2d, 3d, and 4th lumb. vert. *In.* back part of cordiform tendon.

2. The LESSER MUSCLE of the DIAPHRAGM, which arises from the spine, begins by four small slender tendinous feet on each side. The first of these, the longest one, arises from the second vertebra above the pelvis: it goes from the flat fore part of its body, and adheres to the fore part of the third and fourth lumbar vertebræ as it mounts upwards. The second rises from the third vertebra, but farther out towards the side of the vertebra. The third arises from the side of the fourth vertebra. And the fourth tendon of the diaphragm arises from the transverse process of the same fourth vertebra of the loins. But indeed we ought, in place of this minute demonstration, to say, that it arises from the four uppermost lumbar vertebræ by four tendinous feet, flat and glistening, and adhering closely to the shining ligament with which the bodies of the vertebræ are strengthened; that these tendons soon join to form two strong round fleshy legs, which are called the crura diaphragmatis; of which crura, the left is the smaller one: and these crura having opened to admit the aorta betwixt them, and then joining, mixing, and crossing their fibres, form a fleshy belly, the lesser muscle of the diaphragm.

3. The TENDON in the centre of the diaphragm is determined in its shape by the extent of these fleshy bellies; for the

great muscle above almost surrounds the central tendon. The smaller muscle below meeting it, the two divisions give it a pointed form behind; the tendon has the figure of a trefoil leaf, or of the heart painted upon playing cards. The middle line of this tendinous centre is fixed by the membrane which divides the thorax into two; the two sides go upwards into the two sides of the chest, each with a form like the bottom of an inverted basin: their convexity reaching within the thorax, quite up to the level of the fourth true rib: the proper centre of the diaphragm is fixed by this connection with the mediastinum, that its motion might not disorder the actions of the heart, which rests upon this point, and whose pericardium is fixed to the tendon: but the convexity of either side descends and ascends alternately as the diaphragm contracts, or is relaxed; so that it is chiefly these convexities on either side which are moved in breathing.

Thus is the diaphragm composed of one great and circular muscle before; of one smaller circular muscle behind; and of the triangular tendon, as the centre betwixt them: and, both in its fleshy and tendinous parts, it is perforated by several vessels passing reciprocally betwixt the thorax and the abdomen.

First, The AORTA, or great artery of the trunk, passes betwixt the crura or legs of the diaphragm, which, like an arch, strides over it to defend it from pressure. The thoracic duct passes up here also.

Secondly, The ŒSOPHAGUS passes through the diaphragm, a little above this, and to the left side: its passage is through the lower fleshy belly, and through the most fleshy part of the diaphragm: and the muscular fibres of the crura diaphragmatis first cross under the hole for the œsophagus; then surround it; then cross again above the hole; so that they form the figure of 8; and the œsophagus is so apparently compressed by these surrounding fibres, that some anatomists have reckoned this a sort of sphincter for the upper orifice of the stomach.

Thirdly, The great VENA CAVA goes up from the abdomen to the heart, through the right side of the diaphragm; and this hole being in the firm tendon, there is no danger of strangulation, or of the blood being impeded in the vein.

The tendon is composed of fibres which come from the various fasciculi of this muscle, meeting and crossing each other with a confused interlacement, which Albinus has been at much pains to trace, but which Haller reports much more sensibly: "Intricationes variæ et vix dicendæ;" irregular and confused, crossing chiefly at the openings, and especially at the vena cava, the triangular form of which seems to be guarded in a most particular way.

The lower surface of the diaphragm is lined with the peritonæum, or membrane of the abdomen; and the upper surface is covered with the pleura, or membrane of the chest. The hole for the vena cava is so large that the peritonæum and pleura meet, and nearly touch each other through this opening, all round the vein.

The chief use of the diaphragm is in breathing, and in this office it is so perfect, that though there be a complete anchylosis of the ribs (as has often happened), the person lives and breathes, and never feels the loss. The diaphragm is in its natural state convex towards the thorax; when it acts, it becomes plain, the thorax is enlarged, and by the mere weight of the air, the lungs are unfolded, and follow the diaphragm. No vacuum is ever found betwixt the diaphragm and the lungs: but the lungs follow the ribs and diaphragm as closely as if they adhered to them: and indeed when they do adhere, it is not known by any distress. So we draw in the breath, and when the abdominal muscles re-act, the diaphragm yields, goes back into the thorax, and grows convex again, by which we blow out the breath; and while the diaphragm is acting, the abdominal muscles are relaxed, yield, and are pushed out, and leave the ribs free, to be raised by their levator muscles. And again, when the abdominal muscles re-act, the diaphragm in its turn yields so, that they at once force up the diaphragm, and pull down the borders of the thorax, assisting the serrated muscles which depress the ribs.

There is also in every great function, such a wonderful combination of actions conspiring to one end, as cannot be even enumerated here. But the alternate action and re-action of the abdominal muscles draw in and expel the breath, promote the circulation, and gently agitate the bowels, while their more violent actions discharge the fæces and urine, and assist the womb; and vomiting, yawning, coughing, laughing, crying, hiccup, and the rest, are its stronger and irregular actions. The diaphragm might well be named by Haller, "Nobilissimus post cor musculus." And Buffon, who affected the character of anatomist with but little knowledge of the human body, might mistake its central tendon for a nervous centre, the place of all emotions, and almost the seat of the soul. For the ancients confounded the names and ideas of tendon and nerve. And, in sickness and oppression, lowness and sighing, in weeping or laughing, in joy or in fear, all our feelings seem to concentrate in this part.

THE MUSCLES OF THE PARTS OF GENERATION, AND OF THE ANUS, AND PERINÆUM.

THE muscles of the perinæum and parts of generation follow the division of the abdominal muscles more naturally than any other. On looking to the skeleton, we see that the viscera of the abdomen and pelvis would fall out from the lower opening, if this space was not guarded in a particular manner. It is therefore closed, 1. by fascia; 2. by muscles, now to be enumerated; and 3dly, by fat and cellular texture; the nature and quantity of which is a matter of no mean interest to the surgeon.

Before reading the account of the muscles of the perinæum, the reader should peruse that part of the last volume which treats of the structure of the penis, &c.

FASCIA, OR APONEUROSIS.—Before dissecting the muscles of the perinæum, the student should examine that web of membrane which covers them. It comes across from the tuberosity and ramus of the ischia, and, running forward, terminates at the scrotum. It is a subject very important to the operating surgeon.

CLII. The ERECTOR PENIS is a delicate and slender muscle, about two inches in length. It lies along the face of the crus penis on each side. And when the crura penis are inflated, the erectors are seen of their proper length and form. The erector of each side rises by a slender tendon from the tuberosity of the os ischium. It goes fleshy, thin, and flat, over the crus penis, like a thin covering. It ends in a delicate and flat tendon, upon the crus penis, about two inches up; and the tendon is so thin and delicate, that it is hardly to be distinguished from the membrane of the cavernous body.

Erector penis. *Or.* tuber. of the ischium. *In.* sheath of the crus penis.

The erectors lying thus on the sides of the penis, have been called COLLATERALES PENIS, OR ISCHIO-CAVERNOSI, from their origin in the ischium, and their insertion into the cavernous bodies.

CLIII. The TRANSVERSALIS PERINÆI is often named transversalis penis; but its origin being in the tuberosity of the os ischium, by a delicate tendon, and its insertion into the very backmost point of the bulb of the urethra, where it nearly touches the anus, and where there is a meeting of several muscles, its course is directly across the perinæum, and its relation to the perinæum and anus is very direct and evident, while its relation to the penis is rather doubtful. Often there is a second muscle of the same origin and insertion, running like this, across the perinæum, named TRANSVERSALIS PERINÆI ALTER.*

Transversalis. *Or.* tuber. of the ischium. *In.* common centre of union.

* There is a great irregularity in this muscle. There is very frequently

This transvere muscle may, by bracing up the bulb to the arch of the pubis, have some effect in stopping the vein on the back of the penis, and so producing erection; but its chief use must be in preventing the anus from being too much protruded in discharging the fæces, and in retracting it when it is already protruded.

Ejaculator. *Or.* side of the body and bulb, and triang. fascia. *In.* middle of the bulb, and spongy body.

CLIV. The EJACULATOR muscle is not a single muscle, as it is often described. It is manifestly a pair of muscles surrounding the whole of the bulb of the urethra. They arise on each side from the side of the bulb, and crus of the penis, and from the triangular ligament of the urethra. From their arising from this ligament, they have been frequently described as arising from the ramus of the pubes. There is along the lower face of the bulb a white and tendinous line, corresponding with the outward line or seam of the perinæum. This line distinguishes the bellies of the two muscles, and is formed by their tendinous insertions; or sometimes this central line is considered as the origin of the muscle: in that case, the fibres of each side surround their proper half of the bulb with circular fibres, winding obliquely round the bulb; and each muscle ends in its separate tendon, which is delicate and small, and which, leaving the bulb of the urethra, turns off obliquely to the side, so that the tendon of each side goes out flat and thin upon the crus penis of its own side, a little higher than the insertion of the erector penis. We know and feel its convulsive, involuntary action in throwing out the seed; and we are conscious that we use it as a voluntary muscle in emptying the urethra of the last drops of urine.

Sphincter ani. *Or.* os coccygis. *In.* 1. round the anus, 2. spongy body of the urethra, and 3. common angle of union.

CLV. The SPHINCTER ANI muscle is a broad circular band of fibres, which surrounds the anus. It arises from the point of the os coccygis behind. It sends a neat small slip forwards, by which it is attached to the back part of the ejaculator muscle; but the great mass of the muscle is inserted into the common angle of union of the ejaculator, transversales, and this muscle. It is of a regular oval form, and is, for a very obvious reason, stronger in man than in animals. Some choose to enumerate two sphincter muscles, of which this is the external, or cutaneous; what they describe as the internal one, is merely the circular fibres, or muscular coat of the intestine, strengthened considerably towards the anus, but not a distinct muscle. Its effect is to shut the anus.

Levator ani.

CLVI. The LEVATOR ANI muscle is described as a pair of

a slip called transversalis alter, which, however, would be better named obliquus. In some bodies the transversalis is hardly perceptible, while in others it is very strong: there is also a great variety in the size of it, on comparing the two sides of the same body: thus we see frequently in Lascars and Negroes, that on one side there is a very large muscle, while on the other there is a small transversalis, and a large obliquus.

We may also frequently see a muscle, the transversalis profundus; it has exactly the same origin and insertion with the other, but lies deeper. At first view it appears to be part of the levator ani, but the fibres run directly across, while those of the levator run in a descending direction.

muscles, one from each side; but it is properly one broad and thin muscle, which arises from the internal surface of all the fore part of the pelvis, and from its breadth, it has been named MUSCULUS ANI LATUS. It continues its origin from the internal surface of the pubes, from the edge of the foramen thyroideum, from the thin tendinous sheath that covers the obturator internus and coccygeus muscles, and from the body and spine of the os ischium. It grows gradually smaller, as it goes downward to surround the anus. So it is inserted into the circle of the anus, into the point of the os coccygis, and is mixed with the sphincter ani muscle. The whole pelvis is lined with it like a funnel, or inverted cone, the wider part representing its origin from the pelvis, the narrower part its insertion into the anus. The whole bladder is surrounded, and covered by this muscle; the urethra passes through a split in its fibres, and no operation of lithotomy can reach the bladder from below without cutting through this muscle. It raises the anus, and at the same time dilates it, opening the anus for the passage of the fæces, and supporting it, so as to prevent its being protruded. Thus, it is not for shutting the anus, as some have supposed, but is the direct antagonist to the sphincter ani muscle. By enclosing the bladder, the levator ani acts upon it also; for the neck of the bladder passing through a slit in its fibres, while the levator ani is acting, this slit is drawn, as it were, round the neck of the bladder, and so the urine is for the time prevented from flowing. It is as a sphincter to the bladder, which prevents our passing the urine and fæces at the same moment. By surrounding the lower part of the bladder, and enclosing the prostate gland, and the vesiculæ seminales, which lie upon the back of the bladder, this muscle affects these parts also, and is, perhaps, the only muscle which may be supposed to empty the vesiculæ, or to compress the gland, pulling upwards at the same time, so as to press the back of the penis against the pubes, to maintain the erection, and to assist the accelerator muscles. By enclosing the bladder, vesiculæ, prostate, and anus, this muscle produces that sympathy among the parts, which is often very distressing, as in gonorrhœa, the stone in the bladder, constipation, piles, and other diseases of these parts; for piles, constipation, or any cause which may excite the action of the levator muscles, will cause erections, a desire to pass the urine, and an obstruction in the discharge of it.*

Or. 1. os pubis, thyroid hole, 2. the spine and body of the ischium.

In. 1. verge of the anus, and 2. the two last bones of the os coccygis.

CLVII. The MUSCULUS COCCYGEUS is a thin, flat muscle, Coccygeus.

* There is a muscle described by Mr. Wilson, as a levator, or compressor urethræ. The origin of this muscle is from the arch of the pubes, and its fibres run round the membranous part of the urethra, being inserted on the lower part into each other: it is situated between the Cowper's gland and the levator ani, being separated from the last muscle by a thin fascia, and some small veins. In order to make out this muscle distinctly, and with as large a tendon as Mr. Wilson describes it, it is necessary to sacrifice several of the fasciæ.

Or. spine of the ischium and the ligament. *In*. side of the os coccygis.

which arises by a narrow point, from the inside of the pelvis, at the spine of the os ischium; is implanted, expanded and fleshy, into the whole length of the os coccygis; can be useful only by pulling up the point of the os coccygis; which is just equivalent to raising the circle of the anus; so that from every circumstance of its form and use, it might be fairly enough described as being merely the back part of the levator ani muscle.

The perinæum, where the bulb begins, is the point into which all the muscles are united; for the ejaculator muscle, and the sphincter ani muscle, touch at the beginning or point of the bulb; and a small pointed slip of the sphincter ani, going upon the bulb, connects them firmly together. The transversales perinæi come across the perinæum from either side; and the levator ani muscle comes down to meet the sphincter, so that the sphincter ani, the levator ani, the transversalis perinæi, and the ejaculator muscles, all meet in one point, viz. the back of the bulb. They secure the perinæum, and support the heavy viscera of the abdomen; if they be unskilfully cut in performing lithotomy, it will be difficult to extract the stone. In that operation, the incision passes by the side of the anus, and on the inside of the tuber ischii; and our knife accordingly cuts clean across the transverse muscles, which stand as a bar across the perinæum; it passes by the side of the erector muscle, need not touch it, or touches it slightly, and by a sort of chance: it must not touch the ejaculator muscle; for whoever says he cuts the ejaculator, cuts too high, and performs his operation ill.* After the first incision we get deep into the pelvis, and cut the levator ani. The surgeon does not observe these muscles, on account of any danger which may attend wounds of them, but takes them as marks for the true place of his incision; and a good operator will be careful to have them fairly cut, that they may be no hindrance to the extraction of the stone.†

We find, of course, a difference in the muscles in the female perinæum. There is an erector clitoridis, which has the same origin as in the male, and it is inserted into the crura clitoridis, in the same manner that the erector penis is inserted into the crura penis. The next muscle is the sphincter vaginæ, which is a large muscle, taking an origin from the sphincter ani and posterior side of the perinæum; it is inserted into the union of the crura clitoridis. We find, likewise, a transversalis, which, though taking the same origin as in the male, is a very small

* Those anatomists who describe the origin of the ejaculator to be from the ramus ischii object to this.

† The Detrusor Urinæ is but the muscular coat of the bladder; the Sphincter Vesicæ is but a denser fasciculus of this common coat of the bladder. I should no more think of describing them here than of describing the coats of the intestines or stomach. These muscles of internal parts, with the muscles of the internal ear, &c. I reserve for that part of the system which describes the organs and viscera.

muscle ; its insertion is into the union between the sphincter vaginæ and sphincter ani : in the two next muscles, viz. sphincter ani and levator ani, there is no difference, except that they are attached to the vagina instead of the penis.

The muscles of the FEMALE PERINÆUM, are,

ERECTOR CLITORIDIS.—*Or.* From the ramus of the os ischium : in its ascent it covers the crus of the clitoris, as far up as the os pubis.

In. Into the upper part of the crus, and body of the clitoris.

Use. To erect the clitoris, by pushing the blood into its cavernous substance.

SPHINCTER VAGINÆ.—*Or.* From the sphincter ani and from the posterior side of the vagina, near its external orifice, opposite to the nymphæ, and covers the corpus cavernosum vaginæ.

In. Into the body, or union of the crura clitoridis.

Use. Contracts the mouth of the vagina, and by compressing the corpus cavernosum, pushes the blood into the clitoris and nymphæ.

TRANSVERSALIS PERINÆI.—*Or.* As in the male, from the fatty cellular membrane which covers the tuberosity of the os ischium.

In. The upper part of the sphincter ani, and into a white tough substance in the perinæum, between the lower part of the pudendum and anus.

Use. To sustain the perinæum.

SPHINCTER ANI.—*Or.* As in the male, from the skin and fat surrounding the extremity of the rectum.

In. Into the white tough substance in the perinæum, and below, into the front of the os coccygis.

LEVATOR ANI.—*Or.* As in the male, within the pelvis. It descends along the inferior part of the vagina and rectum.

In. Into the perinæum and sphincter ani.

MUSCLES OF THE THIGH, LEG, AND FOOT.

MUSCLES MOVING THE THIGH-BONE.

THE muscles belonging to the thigh-bone arise all from the pelvis or trunk. The PSOAS MAGNUS, and ILIACUS INTERNUS, come from within the pelvis, at its fore part, and, passing under the femoral ligament, go down to be implanted into the trochanter minor ; and by this obliquity of their insertion, they turn the toes outwards, and bend the thigh. Other muscles come from the lower and fore part of the pelvis, as the PECTINALIS, TRICEPS, and OBTURATOR EXTERNUS, which arise from the arch of the os pubis, and go down to be implanted into the linea aspera and lesser trochanter ; and, they pulling the thigh towards the body, are called the ADDUCTORS. Others arise from the sacrum and back part of the pelvis, as the GLUTÆI, which, coming directly forwards to be implanted into the greater trochanter, pull back the thigh ; and a fourth set coming also from the internal surface of the pelvis ; viz. the OBTURATOR INTERNUS and the PYRAMIDALIS come out through the back opening, turn round the pelvis, as round a pulley, and roll the thigh, and draw it back. This completes the catalogue of those muscles which move the thigh.

1. The PSOAS MAGNUS, ILIACUS INTERNUS, PECTINEUS, TRICEPS, OBTURATOR EXTERNUS, which, coming from before, are inserted into the line of the minor trochanter and the femur, and bend the thigh.

2. The GLUTÆI, GEMINI, PYRIFORMIS, OBTURATOR INTERNUS, and QUADRATUS, which come from behind, are implanted into the line of the great trochanter, and extend the thigh ; and it hardly need be remembered, that as, when the arms being fixed their muscles raise the weight of the body, as in climbing or in turning over a bar, by grasping with the hands, so the muscles of the thigh move that thigh only which is loose, and free from the weight of the body, while the muscles of the other thigh, which is fixed by the weight of the body, move not the thigh, but the trunk upon the thigh ; so that our walking is performed not so much by the muscles of the thigh moving the limb, as by their moving the pelvis, *i. e.* rolling the trunk upon the limb.

MUSCLES MOVING THE THIGH.

1. The thigh is moved backwards and outwards.

By the glutæus maximus,	which are	linea aspera,
——— medius,	implanted	trochanter major,
——— minimus,	into the	top of trochanter.

2. The thigh is moved backwards, and rolled upon its axis,

By the pyriformis,		root of the trochanter,
gemini,	which are	———————
obturator externus,	implanted	———————
——— internus,	into the	———————
quadratus,		betwixt the trochanters.

3. The thigh is moved forwards, and the toe pointed outwards,

By the psoas magnus,	which are	trochanter minor,
iliacus internus,	inserted	———————
pectinalis,	into the	linea aspera.
triceps,		———————

In the dissection of these muscles, a sort of artificial arrangement may be made of the muscles of the thigh, by taking off the fascia, the fascialis muscle, the sartorius, and the gracilis, and then dividing the remaining twelve muscles into groups of four; as, four inserted into the patella, to extend the leg; four to bend the leg, and four adductors to bring the thighs together.

OF THE FASCIA OF THE THIGH.

The thigh is enclosed in a very strong sheath, which, like that of the arm, sends down among the muscles strong tendinous septa or partitions, and the muscles are enclosed in these septa, and supported by them.* The tendinous fascia of the thigh arises chiefly from the spine of the ilium, and from the Poupart ligament. Every fascia has something added by each muscle, and takes a new increase and adhesion at each bone which it passes. It is always strengthened by adhesions to joints, and comes down from them thicker upon the muscles below; and so this fascia of the thigh, which arises chiefly from the spine of the ilium, descends, covering all the muscles of the thigh: it sends partitions down to the linea aspera and trochanters; it has a new adhesion and a new source of tendinous fibres at the knee; it adheres most remarkably at the inner side of the tibia, and then descends to the calf; it covers all the leg, and is again reinforced at the ancle; and this is a juster history than the common idea of making it an expansion of the small tendon of the small muscle which I am now to describe; for the fascia is too essential to the strength of the leg, and would be found there, though this muscle were away, as is the case with the palmar expansion.

This fascia rightly consists of two plates; one is that which comes down from the crest of the ilium and from the muscles of the belly; the other, that which arises purely from the tendon of the musculus fascialis, and which is at the same time connected with the capsular ligament of the femur and with the trochanter; and so the muscle called FASCIALIS lies betwixt the two plates of the fascia; and as the fascia, at this part, takes at least a reinforcement from the capsular ligament and from about the trochanter major, the fascialis muscle may be said to be inserted into the trochanter.

* The peculiar connexion of the fascia femoris with the muscles of the thigh and with the capsular ligament of the hip-joint, is very interesting, and worthy of the special attention of the student of anatomy. Each muscle is included by two processes of the fascia, and the sheaths thus formed are successively united to the capsular ligament, so that in raising them therefrom, we gradually thin this ligament until we arrive at the synovial membrane. This has induced us to consider the capsular ligament as formed by successive additions from the processes of the fascia lata; being thickest where the greatest number of these layers are united, and thinnest where fewer muscular sheaths are attached. It is certain, that these attachments of the muscular sheaths to the capsular ligament, have considerable influence upon them, and enable the muscular contractions to affect the joint in a manner advantageous to its free motion and strength, whatever opinion may be entertained relative to the formation of the capsule. For the opinions and observations of the editor on this and some similar subjects, see his "Anatomical Investigations, &c." Philad. 1824.
J. D. G.

So this great tendinous fascia has these connections: the crest of the ilium; the ligament of Poupart, at the rim of the belly; the crest and arch of the os pubis; the tuber ischii, and so back along the coccyx, to the ridge and processes of the sacrum; the ligament of the joint, the great trochanter; and the linea aspera, all the way down to the knee, where its last adhesion is very strong, and from whence it comes off again, much strengthened. It is thicker on the outer side and back part, and very thin on the inner side of the thigh; it splits to embrace the sartorius, and it dives with perpendicular divisions among the muscles of the thigh, and is even connected with the sheath of the great vessels.

The USE of this tendinous membrane has been quite overlooked. While it gives attachment to muscles, and embraces them like the other fasciæ, it performs a much more important office. Its connections enable us to throw the weight of the body on one limb, and, as it were, to hang the weight of the body on the pelvis, independent of muscular exertion. When a soldier, from a constrained and stiff position in the ranks, is standing equally on both legs, his joints are kept straight by muscular exertion; but when at the words, stand at ease, he throws himself on one leg, and relaxes the other, the body, supported by the spine, and the spine by the pelvis, weighs behind the centre of the acetabulum; then the fore part of the ilium rises; the fascia is stretched; the muscles of the thigh become braced; the patella is drawn up; the knee grasped by the membranes, and the leg extended. The whole limb is thus embraced and extended by the *weight* of the body thus operating on the fascia, to the relief of muscular exertion.

This is a very beautiful mechanical provision for saving muscular power; and while the body rests alternately on one leg or the other, it throws the whole body into a position of ease and grace. But when there is weakness, as in young people, or when there comes to be a habit of standing on one foot, the necessary obliquity of the pelvis produces an obliquity of the spine, and at last permanent distortion of the spine.*

In a surgical point of view the fascia of the thigh is a subject of the utmost consequence, as it regards hernia, aneurism, and abscess.

Fascialis.
Or. sup. ant. spine of the ilium.

CLVIII. The FASCIALIS MUSCLE.—This muscle is named also tensor vaginæ femoris. It arises from the upper spinous process of the ilium, *i. e.* from the fore part, or very point of its spine, by a tendon of about an inch in length. It is very small at its origin, and at its termination. It is thick and fleshy in the middle, swelling out; it extends downwards, and obliquely backwards, almost to the middle of the thigh,

* The consequences of this obliquity of the pelvis in young people is very fully treated of in Mr. Shaw's folio work on the Distortions of the Spine.

and there it terminates obliquely, betwixt the two lamellæ of the membrane to which it belongs.

In. fascia lata.

Its use is chiefly as an abductor, and to make the fascia tense, to prepare the muscles for strong action; and, perhaps, by its adhesions about the trochanter, it may have some little effect in rolling the thigh, so as to turn the toes inwards, and oppose the Gemini.

Psoas magnus.

CLIX. Psoas magnus. — This and the following muscle come from within the body to move the thigh forwards. This is a very long and fleshy muscle, of considerable strength, of constant use, perpetually employed in moving the thigh forward, or in supporting the pelvis upon the thigh-bone, so as to preserve the equilibrium of the body.

Or. 1. body of last dorsal vert. 2. bodies and trans. process of all the lumbar vert.

The psoas is a large round muscle, very strong, of great length, filling up all the space upon either side of the spine, and bounding the pelvis at its side. It comes from under the ligamentum arcuatum of the diaphragm; for it arises first by its uppermost head from the last vertebra of the back, then successively from each of the vertebræ of the loins. It sticks close to the lumbar vertebræ; for it arises not only from the transverse processes, but from the sides of the bodies. These heads do not appear, for they are covered by the body of the muscle, which goes down thick and round, till it reaches the sacro iliac symphysis, and then being united to the internal iliac muscle, they descend through Poupart's ligament. It is inserted into the lesser trochanter of the thigh-bone, and into the body of the bone, a little below the root of the process.

In. trochanter minor.

Psoas parvus. *Or.* last dors. vert. and 1 or 2 of loins.

CLX. The psoas parvus does not, like this, belong to the thigh, but is a muscle of the loins, which arises along with this one from the last vertebra of the back and the first of the loins.

It is a small and delicate muscle, ends in a slender tendon, which goes down by the inner side of the great psoas, but does not go out of the pelvis along with it: it stops short, and is implanted into the brim of the pelvis, into the os ilium near the place of the acetabulum: it bends the spine upon the pelvis. This muscle is more regular in the monkey: in the dog it is seldom wanting. It is said to be more frequently found in women than in men; in both, it often is not to be found: but sometimes, in strong and big men, three psoas muscles have been found. This muscle is so small, and so powerless, in regard to the motion of the trunk, that looking to the connection of its tendon with the Poupart ligament, I regard it rather as closing the opening to the thigh, and strengthening the abdominal tendons in their insertion into the os pubis.

In. brim of the pelvis.

Iliacus internus.

CLXI. The iliacus internus is a thick, very fleshy, and fan-like muscle, which occupies the whole concavity of the os ilium.

Or. 1. internal lip of the crista

Its origin is from the internal lip of the crista ilii and transverse process of the last lumbar vertebræ: it adheres to all the ilii, 2. the hollow and fore part of the same, 3. trans. pro. of the last lumb. vert. *In.* trochanter minor.

concave surface of that bone, down to the brim of the pelvis; to the fore part of the bone under the spinous process; and to a part also of the capsular ligament of the joint: all its radiated fibres are gathered together into a tendon at the ligament of Poupart. This tendon is longer on the lower than on the upper surface: for below, it slides on the pubes as upon a pulley, and continues tendinous that it may bear the friction; but above it is unconnected, or it is connected only by loose cellular substance; and there it is quite fleshy. Just under the ligament the two tendons are joined, whence they bend obliquely round, to be implanted into the lesser trochanter.

The psoas magnus and iliacus internus are two very powerful muscles. Their chief use is to bend the thigh, whilst the psoas, as arising from the vertebræ, is more particularly for supporting the body.

We must not pass from the study of these muscles, without paying attention to the ILIAC FASCIA, which is very important in a surgical point of view.

Although the term origin of the fascia is used in description, it is incorrect; for there is no resemblance betwixt the connections of fascia with the spines of bone, and the origin of muscles from bone. From the inside lip of the spine of the ilium, a strong tendinous membrane or fascia stretches over the iliacus internus muscle. This fascia continues upwards over the psoas magnus, and may be traced over the lateral parts of the lumbar vertebræ. Downwards and forwards it connects itself with the inner edge of the Poupart ligament, from which it may be traced into the APONEUROSIS, which lines the inside of the muscles of the abdomen.

This fascia extends betwixt the iliac and psoas muscles and the peritoneum; and by its connections to the os ilii and os pubis, and to the tendon of the abdominal muscles, at the part called Poupart ligament, it completes and secures the *walls* of the abdomen. But if matter should be formed by the side of the vertebræ, or in the cellular membrane, which is around the psoas muscle, it has an easy descent behind this fascia, and under the Poupart ligament, into the thigh, by a canal posterior to that which admits the descent of hernia.

We return to the muscles of the thigh.

Pectineus.

CLXII. The PECTINEUS or PECTINALIS, so named from its arising at the pecten or os pubis, is a broad, flat, square muscle: it lies alongside of the last described muscles, and is inserted with their common tendon. It arises flat and fleshy from that part of the os pubis which is bounded on the upper part by the linea ileo pectinea, and on the lower by a ridge running from the tuberous angle of the pubes to the upper part of the acetabulum, and is implanted into the linea aspera, immediately below the trochanter minor, by a tendon flat and long, pretty nearly of the same extent and shape with its origin.

Or. upper and fore part of the os pubis, above the foramen. *In.* linea aspera below the trochanter minor.

This muscle lies immediately under the skin and fascia lata: and by its bending round under the thigh-bone, it has three actions; to close the knees together; to pull the thigh forward; to perform rotation, turning out the toe; and, in certain positions of the limb, it will pull the thigh back, assisting the extensor muscles.

CLXIII. The TRICEPS FEMORIS is a broad flat muscle, with three heads, arising from the os pubis, also in part from the ischium, and inserted into the whole length of the linea aspera down to the condyle, and serving for pressing the knees together; when the thigh is behind, they must assist in bringing it forward; when the thigh is forward, they must carry the body perpendicularly over the thigh-bone, so that, besides being adductors, these muscles are in incessant operation in walking.

The triceps consists of three heads, which lie in different layers, one above the other; and have so little connection among themselves, that they have been more commonly, and I think properly, described as three muscles. These three parts of the muscle are, indeed, for one common use: but they are of very different forms; for they do not even lie on the same plane: one is long, another shorter by one half, a third larger than both the other two; so that they have been commonly described under the names of ADDUCTOR PRIMUS or LONGUS; ADDUCTOR SECUNDUS or BREVIS; ADDUCTOR TERTIUS or MAGNUS.

1. The ADDUCTOR LONGUS is the uppermost layer; its border (for it, like the pectinalis, is a flat muscle,) ranges with the border of the pectinalis. It arises from the upper and fore part of the os pubis and the ligament of the symphysis by a short roundish tendon, very strong: it swells into a thick fleshy belly, not round, but flattened; the belly grows flatter as it goes down towards the thigh-bone; it ends in a flat and short tendon, which is inserted into the linea aspera in all its middle part, viz. about four inches. Thus, the muscle is of a triangular form, with its base in the linea aspera, and its apex on the os pubis. Its head or origin lies betwixt the pectinalis and the gracilis: its upper edge ranges with the pectinalis; its lower edge lies upon the triceps magnus. It is called longus, because it is longer than the next muscle.

Adductor longus.

Or. upper and fore part of the os pubis and ligament.

In. middle and back part of the linea aspera.

2. The ADDUCTOR BREVIS lies under the adductor longus, and is of another layer of muscles; for as the first layer consists of the pectinalis, adductor longus, and gracilis, this layer consists of the obturator externus, adductor brevis, and adductor magnus. The adductor brevis is exceedingly like the former, in rising near the symphysis pubis, by a thick and flattened tendon, swelling like it into a strong fleshy belly; like it, it grows flat, and is inserted by a short flat tendon into the inner trochanter and upper part of the linea aspera. But it differs in these points: that it is less oblique, for this muscle being shorter goes more directly across betwixt the pelvis and the thigh; that it is placed higher than the last, so that

Adductor brevis.

Or. os pubis below the last.

In. linea aspera, from the root of the lesser trochanter to the commencement of the insertion of the next. whereas the layers are inserted into the middle of the thigh-bone, this one is inserted into the lesser trochanter, and only the upper part of the linea aspera; and the triceps longus is a superficial muscle, while this is hidden under it, and behind it. The longus takes its rise from the very crest of the os pubis; this takes its origin from the fore part of the os pubis, from the ramus just under the crest, so as to be immediately under the head of the longus.

Adductor magnus. *Or.* the ramus pubis, and ramus ischii. *In.* linea aspera, and inner condyle of the femur.

3. The ADDUCTOR MAGNUS, the third head of the triceps, is a very long and flat muscle, lying behind the other heads. It arises by a short tendon, just under the tendon of the adductor brevis; it continues to have a fleshy origin all down the ramus of the pubes and the ramus ischii to the tuber, *i. e.* from the flat edge of the thyroid hole. From this broad origin, it goes to be implanted into the thigh-bone the whole length of the linea aspera, its fibres having various degrees of obliquity, according to their insertion, for the uppermost fasciculi go almost directly across, to be inserted flat into the upper part of the linea aspera; the succeeding fasciculi go more and more obliquely as they descend, the lower part of the muscle following that rough line which leads to the condyle, and the last fibres of all are implanted, by a tendon of considerable length, into the condyle itself. This adductor magnus makes as it were a flat partition betwixt the fore and the back parts of the thigh; and it is about three inches above the condyle that the great artery passes betwixt this tendon and the bone perforating the triceps, to get from the fore to the back part of the thigh, and down into the ham.

The use of all these muscles is entirely the same, making allowance for their various degrees of oblique insertion; and they must be very powerful, by the great distance of their origins from the centre of that bone which they move, so that while other muscles pull in a direction very oblique, these three heads of the triceps must pull more at right angles, and, therefore, at a more favourable direction.

Obturator externus. *Or.* crus pubis, and ischii, membrana obturatoria. *In.* cavity under the trochanter major.

CLXIV. The OBTURATOR EXTERNUS is named after the obturator ligament, from which it arises. The ligament and the muscles shutting up the foramen thyroideum are named OBTURATORS, and this is sometimes named ROTATOR FEMORIS EXTRORSUM, from its turning the thigh outwards. It arises from the ramus of the ischium and os pubis, where they form the margins of the thyroid hole; and from the outer surface of the ligament, which it occupies entirely, leaving only room for the obturator vessels and nerves. It is a short muscle: its origin is broad, and its insertion narrow, so that it is of a conical form; for the flesh of its muscles is gathered very soon into a round short tendon, which twists under the thigh-bone betwixt it and the pelvis; so that it is in a manner rolled round the thigh-bone, being inserted into the root of the great trochanter. It pulls the thigh forwards, but is more peculiarly a rotator of the thigh. This muscle is of the second layer, and the succession of all the muscles is this; the upper layer consists of the psoas and iliacus, where they come out from the abdomen, of the pectinalis, and of the long head of the triceps; the second layer consists of the short head of the triceps; and the third layer consists of the obturator externus at the upper part, and the triceps magnus, or third head of the triceps, all down to the condyle.

GLUTÆI.—There are three glutæi muscles, each under the other, and each smaller than the muscle which covers it. The FIRST, arising from the back part of the ilium, the back of the sacrum, and the sacro-sciatic ligament, forms the whole hip, and descends so low as to be inserted into one third of the length of the linea aspera, and into the root of the great trochanter.

The SECOND arises from all that portion of the ilium which is before this one, and from the back of the bone, and goes down to be inserted into the very top of the great trochanter.

The THIRD arises from the back of the bone below the last; and it is inserted into the root betwixt the apex of the great trochanter and the neck of the bone.

CLXV. The GLUTÆUS MAXIMUS arises from the back of the ilium nearly one half its length; from the joining of the ilium and sacrum; from all the spines and irregularities of the sacrum; and from the sacro-sciatic ligament and os coccygis. Its thick fleshy fasciculæ come in a winding and oblique direction down to the thigh-bone; and, being gathered into a flat and pretty broad tendon, it is inserted into the root of the trochanter major, and down three inches of the outside of the linea aspera. This is one of the largest and most fleshy muscles of the body; covers all the other muscles of the hip; forms the contour of the hip; pulls the thigh backwards, or the body forwards upon the thigh, when the thigh is fixed: and being a wide-spreading muscle, which, in a manner, surrounds its joint, its different portions act with different effects; not only according to their natural direction, but according to the accidental position of the pelvis with regard to the thigh-bone. A large bursa lies under the broad tendon of this muscle.

Glutæus maximus. *Or.* 1. back part of the spine of the ilium; 2. os sacrum; 3. sacro-sciatic ligament; 4. os coccygis. *In.* linea aspera, at the upper part.

CLXVI. The GLUTÆUS MEDIUS OR MINOR is smaller than the former, but like it. It arises from all the outside of the ilium not occupied by the glutæus major. It, like the other, is a fan-formed muscle; for its fibres converge from its broad origin in all the back of the ilium, to form a short flat tendon which is inserted into the back, or into the very top of the great trochanter. It lies in part under the glutæus maximus; but its chief part lies before the glutæus maximus; and as certain portions of the muscle are before the thigh-bone, there are positions of the pelvis and thigh-bone in which it will pull the thigh forwards, although its proper office is to assist the glutæus magnus in pulling the thigh backwards, and moving it outwards from the body.

Glutæus medius. *Or.* anterior sup. spinous process, spine and dorsum of os ilii. *In.* trochanter major.

Glutæus minimus.
Or. 1. dorsum ilii, 2. the ridge, and 3. the edge of the great notch.
In. fore part of trochanter major.

CLXVII. The GLUTÆUS MINIMUS is a small radiated muscle, which lies deep, and quite under the former. It has, compared with the former, a very narrow origin; for it arises chiefly from the lowest part of the back of the ilium, viz. that part which forms the socket for the thigh-bone, and a little higher up, and from the border of the sciatic notch. Its origin from the dorsum ilii is bounded by a ridge, which extends from the upper part of the acetabulum to the notch. It forms a short, flat, and strong tendon, which is fixed to the fore part of the trochanter major, betwixt the trochanter and the neck of the bone; so that these muscles are inserted in this succession; first, the great glutæus, below the root of the trochanter, and into the linea aspera; the middle glutæus into the back and top of the trochanter; and the smallest of the glutæi is implanted into the roughness on the fore and upper part of the trochanter.

Gemellus sup.

GEMINI.—The gemini are two muscles, or rather one biceps muscle; but the heads are so distinct, that they are reckoned two, and so much alike, that they are named GEMINI.

Or. spinous process of the ischium.

CLXVIII. The uppermost, the larger, and stronger muscle, arises from the spinous process of the os ischium.

Gemellus inferior.
Or. tuber ischii.
In. root of the trochanter.

CLXIX. The second or smaller head arises in like manner from the tuber ischii, upon its ball or outer end. They are fleshy in their whole length. They meet, and unite their tendons at the great trochanter. They are inserted firmly along with the tendon of the obturator internus, at the root of that process.

Pyriformis.

CLXX. The PYRIFORMIS, or pyramidalis, comes from the hollow of the sacrum, runs in the same line with the lesser glutæus, and is inserted with the two last named muscles in the root of the great trochanter.

Or. from 3 bones of the sacrum, from the os ilii.
In. cavity under the great trochanter.

Its origin is from the hollow of the sacrum, rising from the vertebræ of that bone, by three or four small fleshy digits, and from the sacro-sciatic notch; it runs over the sacro-sciatic ligament betwixt the glutæus minor and the gemellus superior, and its round tendon is inserted betwixt them, somewhat connected with each.*

The pyriformis, gemini, obturator internus, and quadratus, form what some anatomists have called MUSCULI QUADRIGEMINI: and they are so much alike in insertion and use, that it would be waste of time to repeat what has been said of the gemini and obturator.

This muscle, the pyriformis, like the others, rolls the thigh outwards. Its name is from its shape.

Obturator intern.
Or. all the edge of the thyroid hole and obturator lig.

CLXXI. The OBTURATOR INTERNUS, once named MARSUPIALIS or BURSALIS, arises from all the internal surface of the obturator ligament, and from all the edges of the thyroid hole, from the ilium, ischium, and pubis. Its origin is therefore circular and fleshy. It runs along the inside of the os

* This muscle is frequently divided by the great sacro-sciatic nerve.

ischium, turns round that bone betwixt the spinous process and the tuber. The hollow there is guarded with cartilage, and this tendon runs in the hollow, like a rope round a pulley; passing this, it runs betwixt the two legs of the gemini, and its tendon is united to theirs; and the three appearing almost like one tendon, are inserted together into the root of the trochanter major. These, then, might with some propriety be named one muscle; all the three, viz. the two gemini muscles, and the obturator muscle passing between them, were once accounted as one muscle, and then, it seemed to be a muscle with two bellies, and an intermediate tendon: and this intermediate tendon, with two fleshy ends, gives it the appearance of a purse, thence named MARSUPIALIS or BURSALIS. *In.* root of the trochanter.

CLXXII. The QUADRATUS FEMORIS is a thin flat muscle, passing in a transverse direction betwixt the tuber ischii and the thigh-bone. Quadratus femoris.

It arises from the lower and flattened surface of the TUBER ISCHII by a short tendinous beginning. It goes a little obliquely upwards and outwards, and is inserted into the back of the great trochanter, in that roughness which is found just where the trochanter is joined to the bone, and goes obliquely betwixt the trochanter major and the trochanter minor. *Or.* tuberosity of the ischium. *In.* intertrochanteral line.

It rolls the thigh-bone, so as to turn the toe outwards, and pulls it almost directly backwards.

The MOTIONS of the THIGH must be performed by many very strong muscles, as it moves under the weight of the whole body; and it seems to be curiously contrived, that the muscles fit for moving the thigh forward should in certain positions of the thigh move it backwards; also giving an increase of strength to that motion of the thigh in which most strength is required.

There are but two, or chiefly two points for insertion; the trochanter major and trochanter minor. These two points are so oblique, that no one muscle, nor set of muscles, performs any direct motions; for they all twist round the bone's axis, to get at their insertion. The glutæi, the pyriformis, the gemini, the quadratus, the obturator internus, and obturator externus, all bend round the axis of the thigh-bone, to reach the TROCHANTER MAJOR. These now may be called the abductors of the thigh, to pull it outwards; but we should conclude from this direction, that they could not pull the thigh backwards, for the thigh-bone would turn on its axis and elude their action.

The psoas magnus, the iliacus internus, the pectinalis, and the triceps, do in the same manner go round the inner side of the bone: the two first to be implanted into the trochanter minor, the two latter into the linea aspera, just below it. These are justly named adductors of the thigh; their chief use is to draw the thighs together, and this is their combined effect: when the adductors act by themselves, they pull the thigh forwards, moving the leg, rolling the thigh-bone, and turning the toe out in a graceful step; which is most peculiarly the effect of the pectinalis and triceps. But when we are to finish the motion, by pulling forward the body, which is the same with pulling back the thigh, it is not merely the antagonists of these muscles, as the glutæi, the gemini, &c. which must act. Were the glutæi to act alone, they would rather turn the thigh upon its axis outwards than pull it back; but the triceps, &c. act again in conjunction with the glutæi, &c. and by the action of the triceps the inner trochanter is fixed; the further rolling of the thigh is prevented; the full effect is given to the glutæi muscles. When the glutæi act, they pull the thigh directly backwards, assisted by the triceps, pectinalis, and others: for now the thigh-bone is so far advanced before the body, that those muscles, as the triceps which were benders of the thigh in its first position, are extensors when it is advanced a step before the body; or perhaps, it will be more explicit to say, that when the thigh is moved one step before the body, the iliacus internus, psoas magnus, and triceps muscles, agree with the glutæi muscles in bringing the trunk forwards to follow the limb, and then in fixing and stiffening the trunk upon that limb, till the other thigh is advanced again a step before the body.

The consideration of the uses and actions of the muscles are very necessary to the surgeon. If we suspect that the lameness we perceive in a patient is arising from the hip-joint, we make him throw out the thigh in abduction, because the glutæi are abductors, and they press the hip-joint in that operation, and give pain, and thus prove the seat of the complaint. In the same manner, when there is disease in the course of the psoas magnus, the patient stoops, and he cannot extend his thigh, because that stretches the psoas muscle.

The MUSCLES moving the LEG are the most simple of all; for the knee is a mere hinge, at least it is so in all our ordinary motions, so that there is no action to be performed, but those of mere flexion and extension, and there are only two classes of muscles to be described, the extensors and the flexors of the leg.

1. The EXTENSORS of the LEG.—The only muscles which extend the leg are those four, which may be very fairly reckoned a quadriceps extensor cruris. Indeed the French anatomists arrange them so. Sabatier calls them the triceps femoris. These muscles, which all converge to the patella, and are inserted in it, are RECTUS FEMORIS,—CRURÆUS or FEMORÆUS,—VASTUS EXTERNUS,—VASTUS INTERNUS.

And these are all implanted by one tendon; because the joint being a hinge, bending only in one direction, its muscles could have given but one motion, however oblique their origin and course had been.

2. The FLEXORS of the LEG are two on the outside and four on the inside of the thigh; the tendons of the outside

being implanted into the upper knob of the fibula, and those in the inside into the rough head of the tibia, forming the hamstrings, and extending their tendons or aponeurotic expansions downwards upon the leg.

INSIDE FLEXORS.

Sartorius,	Gracilis,
Semitendinosus,	Semimembranosus.

OUTSIDE FLEXORS.

Biceps.	Poplitæus.

EXTENSORS OF THE LEG.

CLXXIII. The RECTUS FEMORIS, sometimes RECTUS CRURIS, is so named from its direction; it arises by two heads. The first or greater head arises from the lower spinous process of the ilium by a short round tendon; its second head is in a different and somewhat of a curved direction: for it comes from the edge of the acetabulum, and from the capsular ligament. These join together, and form a flat tendon of four inches in length, which becomes gradually fleshy and larger down to its middle, and then again contracts towards the patella. There is a middle tendinous line, running the whole length of the muscle, especially conspicuous on its back part, and towards that central line all the muscular fibres converge. Rectus femoris. *Or.* infer. ant. spin. pro. of the ilium, and upper edge of the acetabulum.

The rectus is united at the sides to the vasti, at the back part to the cruræus; and its tendon, along with that of the cruræus, goes to be directly implanted into the rotula or patella. *In.* upper part of the patella.

The rectus cruris is the first of those muscles which Sabatier calls the TRICEPS FEMORIS; they may be more properly named the QUADRICEPS CRURIS.

This large mass of muscle or flesh enwraps the whole of the thigh-bone behind as well as before; for, first, the CRURÆUS arises fleshy from all the fore part of the bone; the VASTUS EXTERNUS from the great trochanter, and all the back part and outer side of the bone; and the VASTUS INTERNUS arises, in like manner, from the lesser trochanter, and all the inner side of the bone, from the trochanter major all round to the origin of the cruræus.

CLXXIV. The CRURÆUS arises from the fore part of the femur, between the two trochanters, and it continues its origin from the fore part of the femur, the whole way down to within two inches, or little more, of the patella. About three inches from its origin it is joined by the VASTUS EXTERNUS, which unites with it at the outer edge and fore part; and the VASTUS INTERNUS comes into it about five inches below its origin, and it joins it at the inner edge and fore part. At its lower part it is joined to the tendon of the rectus, to form but one large tendon, which is inserted into the rotula. By Albi- Cruræus. *Or.* fore part of the femur. *In.* the patella under the rectus.

nus, the plate of this muscle is given in union with the two vasti, which is the best method of describing the muscle, as it is very seldom to be made out distinct from these two muscles.

Under the cruræus are sometimes found two little muscles, or rather two little slips of this muscle, which are quite distinct. They arise on the fore part of the thigh-bone, two or three inches above the capsule of the joint; and they are inserted into the capsule on each side of the patella, evidently for the purpose of pulling it up to prevent its being caught; and when these two (SUBCRURÆI) are not found as distinct muscles, some fibres of the cruræus supply their place.

Vastus externus.

CLXXV. The VASTUS EXTERNUS is the largest of these three muscles.

***Or.* root of the troch. major, and the linea aspera.**

Its origin is, by a pretty thick and strong tendon, from the lower and fore part of the trochanter major; and it continues its origin from the root of the trochanter all down the linea aspera, to that rough line which goes to the outer tuberosity of the thigh-bone.

***In.* the patella laterally, and the fascia of the knee-joint.**

It touches the end of the cruræus about four inches below its origin, and continues attached to it the whole way down; and then it forms a flat tendon which connects itself with the tendon of the RECTUS FEMORIS, and then embraces, in a semicircular manner, the outside of the patella. And several of the fibres of this aponeurosis not only cross over the rotula, but go down over its opposite side to glide along the head of the tibia, and to be inserted into the inner side of the knee.

Vastus internus.

CLXXVI. The VASTUS INTERNUS is neither so large nor so fleshy as the VASTUS EXTERNUS; but it is exceedingly like it in all other respects.

***Or.* 1. root of troch. minor. 2. linea aspera. 3. fore part of the bone.**

It arises from the fore part of the trochanter minor, just under the insertion of the psoas magnus, and from the fore part of the thigh-bone; it continues its origin from the linea aspera the whole way down to the inner condyle, exactly opposite to the origin of the vastus externus; they leave merely a channel betwixt them. The vastus internus, very soon after its origin, joins itself to the cruræus, or middle portion, and accompanies it in all its length; and, at the distance of two inches from the rotula, it unites itself with the tendon of the cruræus at its internal edge; and this tendon completes that junction which unites the four muscles into a quadriceps cruris. This vastus internus descends much lower, in a fleshy form, than the external vastus does, and forms that fleshy cushion which covers the inner side of the knee-joint.

***In.* inside of the patella, and into the fascia.**

Its tendon embraces the rotula, somewhat in the same circular form with the vastus externus; and, like the externus, it sends some fibres across the knee-pan, to be inserted in the outer part of the head of the tibia.

The RECTUS, and the VASTUS EXTERNUS, INTERNUS, and CRURÆUS, form one large mass of flesh, which embraces and encloses all the thigh-bone; and they are so connected, that the cruræus cannot be separated, and cannot be neatly distinguished.

The use of these four muscles is evident; to extend the leg, and to bend the thigh on the trunk, or reciprocally to bend the trunk on the thigh. This, or these two motions alternately, is the common use of these muscles, as in walking; and they are most peculiarly useful in running and leaping.

After describing a large mass, conjoined in one tendon, and concurring in one simple action, it is superfluous to say that its power must be great. This power must be still farther increased by the rotula, which removes the force from the centre, and gives the advantage of a pulley, which it really and truly is: without this pulley, these muscles could be of no use in certain situations; for instance, in the recumbent posture: for then the extending muscles, being in the same line with their bones, could have no further power; but the rectus, by the pulley of the rotula, and by its attachment to the pelvis, raises the trunk, or at least helps the psoas, the iliacus, and the muscles of the belly.

The rotula is again attached to the tibia by a strong ligament, to sustain the pulling of these great muscles.*

The surgeon would do well to remember the attachment of the rectus to the pelvis in the case of fractured patella, and to see the necessity of raising the body of the patient, to keep the broken parts of the bone in contact.†

FLEXORS OF THE LEG.

CLXXVII. The SARTORIUS OR TAILOR'S MUSCLE, is so named from its bending the knees, and drawing the legs across. It is the longest muscle, and a very beautiful one; extends obliquely across the whole length of the thigh, crossing it like a fillet or garter, about two inches in breadth. **Sartorius.**

It arises from the upper spinous process of the os ilium, by a tendon about half an inch in length; its thin flat belly extends obliquely across the thigh, like a strap, and is inserted in the same oblique form into the inner tubercle of the head of the tibia; its aponeurosis spreads widely, going over the whole joint of the knee, a thin sheet of tendon. ***Or.* supant. spin. process of the ilium. *In.* inner tubercle of the head of the tibia.**

* These muscles are in continual action; for their office is to resist the bending of the knee, which would happen by this incumbent weight of the body; so that the continual support of the body depends wholly on these muscles; and they are the great agents in running, leaping, walking, &c. Since by extending the knee they raise the weight of the pelvis and trunk, and of all the body, they must be very powerful; and accordingly, when they are weighed against their antagonist muscles, we find them greatly to exceed, for the QUADRICEPS, *i. e.* the rectus cruræus, and vasti, weigh four pounds, while the BICEPS, &c. their antagonists, weigh but two pounds. This experiment was often repeated by the great Cowper, for Mr. Brown, who was delivering lectures on muscular motion.

† The action of the muscles and the position of the limb in fractures of the Femur, are considered in my Observations on Injuries of the Spine and Thigh-bone.—C. B.

From the oblique position of the muscle, it might in action change its place; but it is so far embraced by the fascia lata, and is tied by such adhesions, as to form something like a peculiar sheath of itself.

It turns the thigh like the quadratus, gemini and obturator muscles. It also bends the leg upon the knee; and when the leg does not yield, it bends the thigh upon the pubes; or where the thigh is also fixed, it bends the body forwards; but in performing that action, whence it has its name, it does all these; for first the leg and thigh are rolled, then the thigh is raised, then the leg is bent to draw it across. Though a small muscle, yet it is of great power from its origin, and, in some degree, its insertion also, being much removed from the centre of motion.

Gracilis.

CLXXVIII. The GRACILIS, sometimes called RECTUS INTERNUS FEMORIS*, is a small, flat, thin muscle, in its general shape somewhat like the sartorius.

Or. ramus pubis.

It arises by a flat tendon of two inches in length from the ramus of the os pubis, and near the symphysis; and it passes immediately under the integuments down to the knee; it passes by the inner condyle of the knee, in the form of a short round tendon, and, as it bends behind the head of the tibia, it is bound down by a bundle of tendinous fibres, which, crossing it, go to the back part of the leg. After passing the head of the tibia, it turns obliquely forwards and downwards; it here runs behind the tendon of the sartorius, and before that of the semitendinosus. It is inserted with the sartorius into the side of the tuberosity, at the top of the tibia.

In. below the sartorius.

This muscle runs also in a line so wide from the centre of motion, that its power is very great. It serves chiefly as a flexor of the leg: when the leg is fixed, it must by its origin from the pubes be a flexor of the thigh, and an adductor in nearly the same direction with the pectineus and triceps; and it is worth observing, that while the knee is straight, the sartorius and the gracilis cannot bend the knee; they, on the contrary, keep it steady and firm; but when the knee is bent, they come into action; for, in proportion as the muscles which have made the flexion are contracted, they are less able to contract farther, and therefore it is desirable that more muscles should come into play.

Semitendinosus.

CLXXIX. The SEMITENDINOSUS is so named from its lower half being composed of a small round tendon; and as tendon was once misnamed nerve, this is the SEMINERVOSUS of Winslow, Douglas, and others.

Or. tuber ischii.

Its origin is from the tuberosity of the ischium, (along with the semimembranosus, and touching the biceps,) by a short thick tendon. It also arises, by many oblique fasciculi of fibres, from the posterior portion of its opposite muscle the biceps

* GRACILIS, is from its smallness; RECTUS INTERNUS, is from its straight direction.

cruris. This cross connection betwixt the two muscles continues for three inches down from the tuber ischii; it then departs from the biceps, goes obliquely inwards, and is flattened and contracted into a tendon, six inches from the knee, and getting round the head of the tibia, it comes forward to be inserted into the tuber, at the head of that bone. At this place, the tendon grows broad and flat; it is expanded, and as it were grasps the inner side of the knee; its upper edge is joined to the lower edge of the tendon of the gracilis, so that the sartorius, gracilis, and semitendinosus are implanted like one muscle; and this tendinous expansion seems like a capsule, for enclosing the heads of the tibia and femur, and for strengthening the knee-joint. The semitendinosus bends the leg. *In.* into the tibia below the gracilis.

CLXXX. The SEMIMEMBRANOSUS has its name from the muscle, which is flat, thick, and fleshy, beginning and ending with a flattened tendon, somewhat like a membrane, but infinitely thicker and massier than such name should imply. Semimembranosus.

It arises from the tuber ischii, before the semitendinosus and biceps. It arises a broad, thin, and flat tendon, of about three inches in length. It becomes fleshy and thick in its middle, but it soon becomes thinner again, and terminates in a short tendon, which, gliding behind the head of the tibia, is inserted there.* *Or.* tuber ischii. *In.* head of the tibia.

This muscle has little connection with any other. It lies under, or, more particularly speaking, on the inside of the semitendinosus, and the two together form the inner hamstrings. The hamstring muscles contribute also to another motion. Though when extended the tibia cannot roll, yet when we sit with our knees bent, it can roll slightly; and such rolling is accomplished by these muscles. All these muscles which bend the leg, and which consequently extend the thigh at the same time, are muscles of great power, because they arise in one common point; the tuber ischii and that point is very far distant from the centre of motion.

There is still one small muscle, a flexor of the leg, which performs this rotation during the bent state of the knee, with most particular power.

CLXXXI. The MUSCULUS POPLITÆUS, which is so named from its lying in the ham, is a small triangular muscle, lying across the back part of the knee-joint, very deep under the hamstrings, and under the muscles of the leg. Poplitæus.

Its origin is from the outer condyle of the thigh-bone, and from the back part of the capsule of the joint; its tendon is short and thick, but of no great extent. It passes fleshy behind the knee-joint; and it is inserted broad into a ridge on the back part of the tibia; so that by its small origin and broad *Or.* ext. condyle. *In.* triangular surface on the back of the tibia.

* The two tendons of this muscle, the membranous tendon at the head, and this smaller one by which it is inserted, stand so obliquely, that the muscular fibres betwixt them must be very oblique; for the membranous tendon descends low upon the back part or edge, and the tendon of insertion begins high upon the fore edge of the muscle.

insertion, it is a fan-like muscle, its upper fibres being almost transverse, and its lower fibres nearly perpendicular. Besides bending the leg, it is useful by pulling aside the capsule to prevent its being caught.

Biceps cruris.

CLXXXII. The BICEPS FLEXOR CRURIS, so named from having two heads, a long and short one, lies immediately under the skin, in the back part of the leg, running down from the pelvis to the knee, to form the outer hamstring.

Or. tuber ischii.

It is the single flexor on the outside of the thigh. It origin is from the outer part of the tuber ischii, by a tendon of an inch and a half in length. And this tendon is, in its origin, closely united with that of the semitendinosus for two inches, or at least the whole length of the tendon. After a short, but very thick fleshy belly, it degenerates into a tendon, especially on its back part; and this tendon, which begins above the middle of the thigh, is continued the whole way down.

2. linea aspera.

About one third down the bone is the beginning of the second, or short head, which has its origin all the way down the linea aspera, to the line above the outer condyle of the thigh-bone; and here it is somewhat connected with the origin of the vastus externus muscle, and the insertion of the glutæus maximus. The tendons of the two heads are joined a little above the outer condyle, and go outwards to be inserted into the outer part of the head of the fibula forming the outer hamstring.

In. head of the fibula.

Its insertion surrounds the head of the fibula, and a small portion also sinks betwixt the bump of the fibula and the inner head of the tibia, to be implanted into it also.

This muscle, like the opposite ones, serves for bending the leg. The short head simply bends the leg. The long head assists the short one in bending the leg, and is also a muscle of the thigh.

FASCIA. We must not relieve our attention from these posterior muscles of the thigh without considering the manner in which the great fascia comes down on the back part of the thigh to cover them, and to form the POPLITEAL CAVITY. The fascia, strengthened as it were by its connection with the LINEA ASPERA, stretches down over the hamstring muscles and their tendons, embraces them, and holds them together; and betwixt the flat part of the femur, the hamstring tendons laterally, and the fascia behind, there is a cavity, (if we may call that a cavity which is filled with loose cellular membrane and fat,) which transmits the popliteal artery and vein and nerve. This cavity is particularly important to the surgeon, because the artery here is subject to disease or rupture; and then the popliteal aneurism is formed.

The muscles of the foot are six EXTENSORS and two FLEXOR MUSCLES.

EXTENSORS.

GASTROCNEMIUS vel GEMELLUS, PLANTARIS, GASTROCNEMIUS INTERNUS, vel SOLEUS, TIBIALIS POSTICUS,	lying on the back part of the leg.
PERONÆUS LONGUS, ——— BREVIS,	on the outside of the leg.

FLEXORS.

The TIBIALIS ANTICUS, The PERONÆUS TERTIUS,	lying on the fore part of the leg.

CLXXXIII. The GASTROCNEMIUS is often divided into two muscles, named GASTROCNEMII or GEMELLI. But, far from counting thus, we should rather favour the arrangement of Douglas, who couples this with the next muscle, as forming a quadriceps, or two muscles joined with two heads each; and he calls it the EXTENSOR SURALIS. Gastrocnemius.

The GASTROCNEMIUS is the great muscle of the calf of the leg; its two heads are two very large and fleshy bellies, which arise from the tubercles of the thigh-bone. The inner head is the larger, and arises by a strong tendon from the back of the inner condyle, and a little way up the rough line; and it has also a strong adhesion to the capsular ligament of the knee. *Or.* the condyles of the femur. *In.* os calcis.

The outer head is shorter than this: it arises in the same way, from the outer tubercle of the thigh-bone; and the two muscles meet and run down together, forming the appearance of a rapha, by the direction of their fibres; but the two bellies continue distinct till they meet in the middle of the leg. They are distinct at their back part, but at their fore part they are connected by a tendinous aponeurosis, or strong but flat tendon; and the two bellies being, about the middle of the leg, united firmly, they form a large flat tendon, very broad at its beginning, which unites with that of the soleus a little above the ancle.

CLXXXIV. SOLEUS.—This name is from its resemblance to the sole fish; and it is often named GASTROCNEMIUS INTERNUS. This, like the last muscle, has two HEADS, which arise from either bone. Soleus.

One head arises from the head of the fibula, and continues to adhere to one third of the upper part of the bone; another head arises from about three inches of the part of the tibia, immediately below the insertion of the poplitæus. The first of these heads is large and round; the second is smaller and flat: they unite immediately; and a large fleshy belly is formed, with still a conspicuous division betwixt the flesh of the two heads. The great tendon begins about half-way down the leg, but still is intermixed with fleshy fibres till it approaches the heel. A little below the middle of the leg, this *Or.* head of the fibula, and back part of the tibia.

tendon is united with the tendon of the gastrocnemius, to form the great back tendon named tendo Achillis; and sometimes, though very rarely, chorda magna.

In. os calcis. The tendon is large; it grows smaller as it approaches the heel; when it touches the extremity of the heel-bone, it expands to take a firmer hold.

In running, walking, leaping, &c. this muscle, with the extensors of the leg, are the principal agents. The external gastrocnemius has double power; for, arising from the tubercles of the thigh-bone, it is both an extensor of the foot and a flexor of the leg; but the gastrocnemius internus is a mere extensor of the foot; and both together have such strength as often to break the tendo Achillis.

Plantaris. CLXXXV. PLANTARIS.—This muscle is named from a mistaken notion of its going to the planta pedis, or sole of the foot, to form the plantar aponeurosis, like the palmaris of the hand; but, in fact, it does not go to the sole, but is a mere extensor of the foot, inserted along with the tendo Achillis.

Or. extern. condyle. This long and slender muscle is situated under the gastrocnemius externus. It arises from the external condyle of the femur wholly fleshy; it also has an attachment to the capsular ligament of the joint; after an oblique fleshy belly, of about three inches, it forms its small flat tendon. The tendon runs betwixt the inner head of the gastrocnemius and the soleus; and when the tendo Achillis begins, the tendon of the plantaris attaches itself to the inner edge and fore part of the Achillis tendon; it accompanies it down to the heel, running in a

In. inside of the os calcis. groove which seems made to receive it; and it is implanted, with the tendo Achillis, into the inner side of the heel-bone. It is often wanting.

The use of this muscle is to tuck up the capsule, in the great bendings of the knee-joint, and to assist the gastrocnemii muscles.

The PERONÆI muscles are those which arise from the fibula. They are named from their length being different; the PERONÆUS LONGUS being as long again as the BREVIS, for it is one half longer in its origin, the one rising at the head, the other at the middle of the bone; and again, it is one half longer at its insertion, going fully round under the foot to the opposite side, while the shorter peronæus stops at the side of the foot to be inserted.

Peronæus longus. *Or.* 1. head and almost all the fibula, 2. head of the tibia. CLXXXVI. The PERONÆUS LONGUS is so named from its lying along the fibula. It arises partly tendinous, chiefly fleshy, from the upper knob of the fibula, and from the ridge of the bone down to within three inches of the ancle. It has another small slip of a head from the upper part of the tibia, above where the fibula joins; it has also adhesions to the tendinous partition, which separates this from the EXTENSOR DIGITORUM COMMUNIS and the SOLEUS.

Its tendon begins very high above the middle of the leg, and it continues to receive the fleshy fibres, almost at right angles in the penniform manner. The tendon is concealed down to about or below the middle of the leg. Then it is seen immediately under the integuments, and we can easily distinguish it through the skin, being that acute line or string which runs down behind the outer ancle, and which gives shape to that part.

In passing the outer ancle it runs down through a cartilaginous pulley, or annular ligament, which also transmits the peronæus brevis: it leaves the peronæus brevis on the side of the foot; and passing by itself in a groove of the heel-bone, it bends obliquely across the arch of the foot, goes quite down to the opposite side, and is inserted into the metatarsal bone of the great toe, and the great cuneiform bone on which it is founded. Under the eminence of the os CUBOIDES, it suffers great friction, so as to be thickened to a degree of ossification, and to resemble a sesamoid bone. It is also thickened in a lesser degree, as it passes the outer ancle; and in all this length, it is tied down by a strong ligamentous expansion.

_In._ cuneiforme intern. and the metatarsal bone of the great toe.

It is a powerful extensor of the leg; it also gives that obliquity to the foot, which is so handsome and natural, and useful in walking. This muscle particularly turns down to the ground the inner edge of the foot; so it presses to the ground the ball of the great toe, and that is the part which touches the ground, and which feels sore after long walking, or violent leaping or running: it is by that part we push, in making a step; so that this muscle is perceived to be continually active in all motions of walking, leaping, running, and more particularly in dancing.

Peronæus brevis. _Or._ ridge of the fibula, more than its lower half.

CLXXXVII. The PERONÆUS BREVIS is like its fellow, except in length and insertion. Its origin is from the ridge of the fibula, beginning about one third down the bone, and continuing its adhesion the whole way to the ancle. It also has adhesions to the tendinous partition which is betwixt it and the common extensor; so that these two muscles are, by such adhesions, very difficult to dissect. It is smaller at its origin, but increases in its fleshy belly as it descends; and it is fleshy lower down than the peronæus longus. It is, like it, a penniform muscle. The tendons of the two peronæi pass together, by the outer ancle, in the same ring; but the tendons cross each other; for the peronæus longus is in its belly more forward. The brevis lies under and behind it, quite covered by it, and yet the tendon of the brevis, by creeping under the longus, gets before it, just under the outer ancle: and from that it runs in a separate groove, superficially upon the outer edge of the foot, to be inserted into the metatarsal bone of the little toe. In both muscles the tendon is upon the outer edge, and begins almost as high as the upper head of each muscle. This tendon of the peronæus brevis, the shorter one, is small where it passes through the pulley, and expands when it reaches its insertion, that it may grasp the metatarsal bone firmly. The tendon of the longer muscle also expands a lit-

_In._ metatarsal bone of the little toe, and the os cuboides.

tle, and somewhat in the form of a hand and fingers, taking hold of two bones by three little heads.

This muscle assists the former in extending the foot, and coincides well in its oblique action with the last; for, as the last turned down the inner edge of the foot, this turns the outer edge upwards, which is exactly the same motion.

Peronæus tertius.

CLXXXVIII. The PERONÆUS TERTIUS is a third muscle, having its origin from the fibula; but as its tendon passes before the malleolus externus, and as it is inserted into the outside of the foot, it has a contrary action to the peronæus longus and peronæus brevis. The peronæus tertius lies on the fore part of the fibula, and rises from the middle of that bone, and down to near its lower head. Its tendon does not pass into the same sheath with the peronæus longus and brevis, but goes under the annular ligament on the fore part of the ancle-joint, to be inserted into the root of the metatarsal bone, which sustains the little toe. It is so much connected with the extensor communis digitorum, that there is often great difficulty in dividing the two. The action of this muscle balances the connection of the tibialis anticus, and the two together bend the foot, that is, bring it to an angle with the leg.

Or. lower half of the fibula.

In. metatarsal bone of the little toe.

Tibialis posticus.

CLXXXIX. The TIBIALIS POSTICUS is a penniform muscle; its tendon goes round the cartilaginous pulley of the inner ancle.

It is named TIBIALIS from its origin, and POSTICUS from its place.

Or. 1. back of the tibia, 2. and fibula, 3. fore part of the tibia, and 4. interosseous ligament.

It arises from the back part and ridge of the tibia, from the opposite part of the fibula, and from the interosseous membrane below these. Some fibres pass between the bones at the upper part, and take an origin from the fore part of the tibia; and it continues its attachment to the interosseous ligament, quite down to the ancle. It has also strong attachments to the surrounding tendinous partitions.

Its fibres are all oblique, and go to the middle tendon, which is in the heart of the muscle. About the middle of the tibia, this tendon begins to emerge from the fleshy belly; it grows gradually smaller, but still continues to receive flesh quite down to the ancle. It passes in the groove of the inner ancle, and is retained there by such a ligament as holds the peronæi. After passing the ligament, it expands in the hand-like form, to grasp the bones of the tarsus; and it is expanded much more than the peronæus, for it sends roots down among the bones both of the tarsus and metatarsus, so as to take hold first on the lower rough part of the naviculare in passing over it. Then it is implanted into the middle metatarsal bone, then into the calcaneum, into the os cuboides cuneiforme internum and medium; and where it passes over the os naviculare, it is hardened into a sort of sesamoid bone. In short, it is implanted in the sole of the foot by a tendon like a hand, which sends down its fingers among the tarsal and metatarsal bones, to take the surest hold. This muscle pulls the foot

In. almost all the bones of the tarsus. 1. os calcis, 2. cuboides, 3. cuneiforme med. internum, 4. metatarsal of the middle toe.

in, so as to put the toes together, and when balanced by the peronæi, it directly extends the foot.

CXC. The TIBIALIS ANTICUS crosses obliquely the fore part of the leg. It arises from the fore part and outside of the tibia, part of the fibula, and interosseous ligament. It begins just under the outer tuber, and continues its adhesion down two thirds of the bone; then the tendon begins to be formed: and this muscle, like almost all the smaller ones of the leg, adheres to the tendinous partitions, and to the fascia, with which they are covered. The tendon begins almost with the origin of the muscle, but continues covered by the flesh, and not appearing till within four inches or so of the ancle, when it begins to pass obliquely over the leg, and having completed the crossing above the ancle, it goes under the annular ligament in a peculiar ring, runs along the side of the foot, and is implanted into the os cuneiforme internum, and a small production of the tendon goes forwards to be inserted into the metatarsal bone of the great toe.

Tibialis anticus. *Or.* 1. head and fore part of the tibia, 2. interosseous lig. 3. head of the fibula.

In. cuneiforme internum and metatarsal bone of the great toe.

This muscle turns the great toe towards the leg, and when assisted by the peronæus tertius directly bends the foot.

MUSCLES OF THE TOES.

The long muscles of the toes are just four, two FLEXORS, and two EXTENSOR MUSCLES. The flexor muscles lie upon the tibialis posticus, or behind, betwixt it and the soleus. The extensor muscles again lie under the tibialis anticus, or at least their heads are under it, and their bellies only appear from under it, about the middle of the leg.

The flexor tendons follow the tendon of the tibialis posticus, over the pulley of the inner ancle into the hollow of the foot. The tendons of the extensor muscles keep with that of the tibialis anticus, and cross over the fore part, or prominence of the ancle, where the tibia is united with the astragalus. And in dissection we must follow these in an opposite order to that in which they are described, for next to the fore part of the soleus is, 1st, the FLEXOR POLLICIS; 2dly, the FLEXOR DIGITORUM; and 3dly, the TIBIALIS POSTICUS.

CXCI. The FLEXOR LONGUS POLLICIS is small and pointed at its origin, and arises fleshy from three fourths of the fibula, to within an inch of the outer ancle and interosseus ligament. It grows thicker and larger as it descends, and adheres to the tendinous partitions of the tibialis posticus, and of the peronæi. Its tendon can be seen only about an inch above the joint of the ancle. It passes down behind the inner ancle, where it is bound in a sort of annular ligament. It there passes under the heel-bone, in the arch of the foot, betwixt the bones and the abductor pollicis; it then glides into the channel made by the two heads of the flexor pollicis brevis; it then passes betwixt the two sesamoid bones at the root of the great toe; it then goes forward in a sheath, to be inserted into the

Flexor longus pollicis. *Or.* three-fourths of the fibula, inteross. lig.

In. last

phalanx of the great toe. last bone of the great toe, at which implantation it is enlarged. Sometimes it sends a small tendinous insertion into the os calcis.

Its office is to bend the great toe; but it is also continually useful at every step in extending the foot, or in keeping the toe firm to the ground, while the gastrocnemii raise the heel; and, therefore, we should not be rash in cutting away the great toe, for in it consists not the strength of the foot only, but of the leg.

Flexor longus digitorum. CXCII. The FLEXOR LONGUS DIGITORUM PEDIS is named in addition the PERFORANS, because, like the perforans of the hand, it runs its tendons through the split tendon of a smaller muscle, which is lodged in the sole of the foot. It is named also FLEXOR COMMUNIS, although there be less reason here, where there are no flexors for the individual toes, than in the hand, where there are separate flexors for the individual fingers.

Or. 1. back part of the tibia, 2. septum. It arises from the back and inner part of the tibia, its whole length, that is, from the end of the poplitæal muscle, and from the septum tendinosum, by which it is divided from the tibialis posticus, which lies immediately before it; and it continues this origin from the tibia down to within three inches or so of the ancle. About the middle of the muscle we find fibres coming across to join it from the outer edge of the tibia, and between these two sets of fibres the tibialis posticus passes. Its origin is not easily separated before from the tibialis posticus, nor behind from the flexor pollicis.

The tendon is not formed till near the ancle, (within two inches of it,) and the flesh still accompanies it quite down to the joint. It crosses the tendon of the tibialis posticus behind the ancle-joint, and goes forward in the groove of the os calcis, tied down by a sort of capsule, or annular ligament. In the arch of the foot, it crosses the tendon of the flexor pollicis, from which it receives a slip of tendon; and thus the office of either is assisted by the other, and could be wholly supplied by it: it then passes over to the middle of the sole, and growing flatter and thicker, divides into four flat tendons. These go forward, diverging till they arrive at the ends of their metatarsal bones; then they emerge from the aponeurosis plantaris, along with the common short flexor. Now both these tendons run under a ligamentous sheath, and are included in it under the first and second bones of the toes; and having perforated the short flexor opposite to the second joint, they are finally inserted into the root of the third or last bone of each toe. *In.* the base of the third phalanx of four toes. These tendons, like the corresponding ones of the hand, seem to be slit with a sort of longitudinal fissure.

The proper use of this muscle is to bend the four lesser toes, to bend all their joints, but more peculiarly the last bone; and also to extend the foot, keeping the point of the toes to the ground, consequently assisting the gastrocnemii, and all the muscles used in walking, &c.

CXCIII. The MASSA CARNEA JACOBI SYLVII, or PLANTÆ PEDIS, flexor accessorius, lies in the sole of the foot; it is a small body of flesh, naturally connected with the flexor longus. The massa carnea arises from the lower part of the heel-bone, in two divisions, one (the external one) tendinous, the other fleshy. It is, upon the whole, pretty nearly of a square form; it joins the tendon of the flexor longus, before its division into tendons for each toe, and by the advantage with which it acts in consequence of its origin from the heel-bone, it must be of great assistance to the flexor. It is more generally considered in the light of a supplementary muscle; by some, it is considered as a distinct muscle, and by others, as the orgin and first beginning of the lumbricales pedis.

Flexor accessorius.

Or. sinuosity of the os calcis.

In. tendon of the flexor longus.

Thus Cowper considers the massa carnea, and the lumbricales, as one and the same: that the massa carnea joins the tendon, covers it with its flesh, continues fleshy along the common tendon, till at the bifurcation it also parts, along with the four tendons, into four small fleshy muscles, which are called lumbricales.

Albinus, again, paints the massa carnea, distinctly, terminating at the common tendon, and the lumbricales as arising distinctly from each of the divided tendons.

CXCIV. The FLEXOR BREVIS DIGITORUM is also named the flexor sublimis or perforatus. It arises from the lower part of the heel-bone, or the bump upon which we stand. It arises by very short tendinous fibres, and, being placed immediately under the plantar aponeurosis, it takes hold of it, and also of the tendinous partitions betwixt it and the two abductors of the small and of the great toe, which are on either side of it. Under the metatarsal bones, it divides itself into four heads; their tendons begin earlier upon the side next the foot; they grow round, emerge from betwixt the dentations of the plantar aponeurosis; they then pass into the vagina, or sheath of each toe; and on this, the first phalanx, they lie over the tendons of the long extensors. About the root of the first bone, they divide into two little bands, which form a split (like the perforatus of the fingers) for the passage of the long tendon.

Flexor brevis digitorum.

Or. lower part of the os calcis, and the plantar aponeurosis.

The long tendon passes through it upon the second joint of the toe, and immediately after, the perforated tendon fixes itself by the two forks to each side of the second bone, or phalanx of the toe.

In. the second bones of four toes.

Its use is to bend the first and second joints of the toes, but most peculiarly the second. The obliquity of the long flexor is exactly balanced by a corresponding obliquity of the short flexor; for the tendon of the long flexor coming round the inner circle, runs obliquely outwards to reach the toes, while the short flexor, coming from the heel, which is towards the outer edge of the foot, runs in a like degree obliquely inwards, and meets the other at an acute angle near the toes.

CXCV. The LUMBRICALES must be dissected after the short flexor. They need no description, since they exactly

Lumbricales.

Or. tendon of the flexor longus.

In. side of the first phalanges.

correspond with those of the hand. They rise, like them, in the forks of the flexor tendons. They, like them, pass through the digitations of the aponeurosis. They pass on to the first bone of the toes, and, like the lumbricales of the hand, creep over the convexity of the bone, to be united along with the tendons of the extensors. Their insertion is always at the side of the toe next the great toe, and their use is to bend the first joint of the toes, and to draw them towards the great one, making an arch in the foot, and assisting the transversalis pedis. The FLEXOR BREVIS lies most superficially upon the sole of the foot, having its origin from the inner surface of the aponeurosis. The MASSA CARNEA lies deeper, having no origin but from the tip of the heel-bone, and being soon implanted into the tendon of the long flexor. The LUMBRICALES again rise from the tendons of the long flexor, beginning just where the massa carnea ends in it; and the LUMBRICALES are the flexores primi internodii; the SHORT FLEXOR MUSCLE, the flexor secundi internodii; the LONG FLEXOR, the flexor tertii internodii digitorum.

EXTENSORS OF THE TOES.

Extensor longus digitorum.

Or. 1. upper and outer part of the head of the tibia, 2. almost the whole length of the fibula, 3. interosseous ligament, 4. the fascia.

CXCVI. The EXTENSOR LONGUS DIGITORUM PEDIS is very difficult to dissect, from its numerous adhesions.

It arises properly from the head of the tibia, at its outer and fore part, just under the knee; but it has also strong adhesions to the inner surface of the fascia, to the tendinous partitions betwixt it, and the tibialis anticus before and betwixt it, and the peronæi behind, and also to the interosseous ligament, and to the edge of the fibula. Its small origin soon becomes thick, and is divided even from the beginning very perceptibly into three distinct portions. These soon form three round tendons, which go obliquely inwards, pass under the annular ligament of the ancle, and run in a ring of it, peculiar to them and the peronæus tertius. They then traverse the two bands of the annular ligament, upon the fore part of the foot, and now they change their direction a little, and go from within outwards, and diverge towards their proper toes. There are three portions of muscle, and four toes to be moved; the first portion divides its tendon into two, at the joint, so that the first portion serves both the first and second toe, the second the third toe, and the third serves the fourth toe. Here the tendon of the long extensor receives four other tendons; first, of the interossei externi; secondly, of the interossei interni; thirdly, of the long flexor; fourthly, of the lumbricales; and these form a very large sheath, quite surrounding the toe.

In. base of the first phalanx of four toes, continued over the toes.

Extensor digitorum brevis.

CXCVII. The EXTENSOR DIGITORUM BREVIS is so connected with the extensor longus, that it is natural to describe them together. It is placed just where the buckle lies, upon the rising of the foot, having its origin from the heel-bone, and running obliquely inwards.

Its origin is from the outer side, and fore part of the heel-bone, and also from part of the annular ligament. It is smaller where it arises by a short tendon from the heel-bone, but it gradually increases in size: it divides early into four heads, which are muscular, and very distinct; the two inner of which are larger, the two outer more slender: each head has already formed an oblique tendon under its flesh, which begins to appear naked about half way down the metatarsal bones. These tendons cross those of the long extensor, and pass under them nearly about the end of the metatarsal bones. Then one is implanted into the first bone of the great toe, on the inside of the long tendon under which it had turned. The second, third, and fourth tendons are inserted into their respective next toes, and the little toe is left without one. The three last of these tendons form a sort of slit, the two sides of which pass along the sides of the toes, surrounding the long tendon, something like a perforatus; so that the three last tendons are inserted along with the long tendons into the last bone of the toes.

Or. 1. outer and fore part of the os calcis. 2. annular ligament.

In. phalanges of all except the little toe.

The obliquity of this short muscle counteracts the obliquity of the long; and it serves to extend and to spread the toes, and to pull them away from the great toe.

CXCVIII. The EXTENSOR POLLICIS PROPRIUS is a very slender muscle, running from the top of the leg to the second joint of the great toe. It arises from the fibula, a little below its head, takes fibres from the interosseous ligament, grows tendinous as it approaches the foot, then, passing under the annular ligament, and the cross ligament of the foot, it goes onwards to the second joint of the toe over the first.

Extensor pollicis.

Or. from the two thirds of the spine of the fibula, and inteross. lig.

In. last phalanx of the great toe.

The succession in which these muscles lie, under and behind each other, is this: first, the tibialis anticus, the outermost muscle, arises from the fore part of the tibia, nearest the fore part of the leg, at the ridge of the tibia; secondly, the extensor pollicis lies immediately behind and under the tibialis anticus; thirdly, the extensor digitorum communis lies behind that; and, fourthly, the peronæus tertius lies behind the common extensor, like a part of that muscle.

These extensor tendons are bound down by cross bands, resembling the annular ligaments of the wrists. The general fascia of the thigh is continued over the knee, and down the leg; it is much strengthened at the knee, where it adheres to each point of bone; it descends very thick and strong over the leg, binding down and strengthening the tibialis anticus and extensor muscles. The sheath grows thinner towards the ancle, but where it passes over the joint it is so remarkably strengthened by its adhesions to the outer and inner ancles, that it seems to form two distinct cross bands, which, going from the point of the outer ancle, across the extensor tendons, to the point of the inner ancle, forms a strong crucial ligament, resembling the annular ligament of the wrist; so that this, which is called the CRUCIAL LIGAMENT of the ancle or foot, is plainly but a strengthening of the common sheath.

The remaining muscles in the foot are the INTEROSSEI, which, in the foot, are found single on the lower surface or sole, but double, and two-headed, upon the upper part of the foot. The ABDUCTOR, FLEXOR, and ADDUCTOR POLLICIS, which surround the great toe, something like those of the thumb; and the ABDUCTOR and FLEXOR MINIMI DIGITI, surrounding the little toe; and there is a small slip of muscle, the TRANSVERSALIS PEDIS, which goes across the sole of the foot.

Abductor pollicis. *Or.* os calcis and lig. of the naviculare.

CXCIX. The ABDUCTOR POLLICIS arises, by very short tendinous fibres, from the knob of the os calcis, and also from a ligament which stretches from this knob to the sheath which belongs to the tibialis posticus; and it arises also from the tendinous partition betwixt it and the short flexor of the toes; and although it forms a tendon beginning opposite to the cuneiform bone, the tendon is not naked, till it has reached the middle of the long metatarsal bone. It unites with the short flexor of the same toe, and is inserted into the first bone or phalanx of the toe at its root, and os sesamoideum. Its use is to pull aside the toe, and at the same time to bend it a little; it also curves the foot itself, for a joint, or any loaded part, is much better supported by muscles than by ligaments; and this arch requires support more than almost any other part.

In. sesamoideum intern. and 1st phalanx.

Flexor brevis pollicis.

CC. FLEXOR BREVIS POLLICIS. This muscle is much shorter than the last, and lies betwixt the ABDUCTOR and the ADDUCTOR; it lies immediately upon the metatarsal bone.

Or. os calcis and cuneiforme extern.

Its origin is by a pretty long tendon from the heel-bone, and from the os CUNEIFORME EXTERNUM, by two separate slips from the heel-bone, being a full inch in length; it also adheres to the membranous partitions on either side of it. It is soon divided into two heads; one goes to the abductor, and the other goes to the adductor, to have the tendons inserted with theirs into the root of the first bone or phalanx. These tendons contain the sesamoid bones; and the parting of the two heads makes a channel for the tendon of the long flexor to run in.

In. ossa sesamoida.

Its use is to bend the first joint of the great toe.

Adductor pollicis.

CCI. The ADDUCTOR POLLICIS is the third and last portion of the muscle which encircles the great toe.

Or. os calcis, cuboides, and cuneiforme externum.

It arises from the heel-bone by a tendon as long almost as that which it gives the abductor: it does not immediately arise from the heel-bone: but there is a ligament extended from the heel-bone to the os cuboides, and it arises from that ligament: this is the ligament under which the tendon of the peronæus longus glides. It takes likewise an origin from the cuneiforme externum. The adductor is divided into two fleshy fasciculi or heads; these unite, and, going obliquely inwards, are inserted either into the sesamoid bone, or directly into the first bone of the great toe.

In. sesamoideum externum.

Transversalis.

CCII. The TRANSVERSALIS PEDIS extends transversely across the sole of the foot, at the head of the metatarsal bones; it is a very small muscle, and resembles a good deal the palmaris brevis.

It arises from the fore part of the metatarsal bone of the great toe, and the sesamoideum internum, and is inserted into the under and outer part of the anterior extremity of the metatarsal bone of the little toe and ligament of the next toe. *Or.* metatarsal bone, and os sesamoideum of the great toe. *In.* metatarsal bone of the little toe, and ligament of the tarsus.

Its use is said to be, to make a sort of gutter in the foot, by drawing the heads of the metatarsal bones together; but is it not evident that this is one of many instances of muscles being a more perfect support than ligaments?—It is a support, having a sort of intelligence, contracting or relaxing, according to the necessity or degree of force; indeed, except this use, it is not easy to assign any, for there is very little occasion for hollowing the foot in this direction.

CCIII. The ABDUCTOR MINIMI DIGITI, like the abductor pollicis, is a pretty long muscle, but very slender, lying on the outer side of the foot. Abductor min. dig.

Its origin is from the knob of the heel-bone, and from the tendinous septum, which covers the flexor brevis; it forms two small tendons in the same direction: one small and shorter tendon is fixed in the metatarsal bone, at its root: the other goes forward to be inserted into the root of the first bone of the toe, so that this muscle clearly performs both the offices ascribed to the other flexors. It bends the toe to which it belongs, and it extends and supports the tarsus in walking; and it carries the toe a little outwards, from which it has its name. *Or.* os calcis and lig. *In.* root of the first bone of the little toe.

CCIV. The FLEXOR BREVIS MINIMI DIGITI is next, and is almost the same muscle in place and office: it is an exceedingly small muscle; it just measures the length of the metatarsal bone, and arises from it. Its origin is from the root of the metatarsal bone of the little toe, and from the ligament by which that bone is connected with the os cuboides; its small belly runs the length of that bone, and it is implanted by a short tendon, into the root of the first bone of the little toe. Flexor brevis min. dig. *Or.* 1. metatarsal bone of the little toe. 2. os cuboides. *In.* root of the first bone of the little toe.

Its use is to bend the toe.

CCV. The INTEROSSEI INTERNI are three small muscles seated in the planta pedis, as the interossei manus are in the palm of the hand. Their slender tendons pass through the openings of the aponeurosis plantaris, and, going on the inside of the toes, are, like the lumbricales inserted along with the extensor tendons. Interossei interni. Same as in the hand.

These pull the toes towards the great toe, bend the first joint, and extend the second and third.

CCVI. The INTEROSSEI EXTERNI are, like the corresponding muscle of the hand, four in number, and double headed, and have been named bicipites. They rise from the metatarsal bones, on each side of them: each has some little variety in its origin or course; but it is far from being worth our while to describe each individually, as many do: it is sufficient to observe their origin, and that their tendons all meet the tendons Interossei externi. Same as in the hand.

of the long and short extensors of the LUMBRICALES, and of the INTEROSSEI INTERNI, upon the backs of the toes; so that the whole forms a web, aponeurosis, or sheath, which covers the upper part of the toe, and adheres to its point.

The office of these muscles is to extend the toes.

FASCIA OF THE LEG.—The dissection of these muscles on the fore part of the leg and foot is somewhat difficult from the relations of the fascia. This fascia is a continuation of that of the thigh, for we trace that membrane over the knee-joint, as I have said, into the tibia. But from the spine of the tibia it takes a new origin, and, as it were, renews its strength. It not only covers the tibialis anticus and extensor muscles, but sends strong septa betwixt them. Its obvious use at this point is to give attachment to the muscles, and to afford that origin which the bone cannot do but through its intervention. Here, during the dissection, it will be seen, that the FASCIA is very erroneously described as a COVERING to the limb, since it dives betwixt the muscles, and gives off connections to the bones and deeper membranes. While a superficial fascia covers the gastrocnemius and the tendo Achillis on the back of the leg, another layer slips under these, and, having connection with the bones, covers the tibialis posticus and flexors.

Towards the ancle on the fore part, the fascia is strengthened by strong tendinous fibres, so as to form the annular ligament at this point; and from this it is stretched over the dorsum of the foot to the toes.

PLANTAR APONEUROSIS.—The palm and the sole are much exposed, and are especially defended by a thick tendinous aponeurosis. In the palm, there is the more reason to suspect expansion to proceed from the tendon of one muscle, because the tendon of the palmaris is inserted into it; yet that is not probable; for the tendon is very slender, and quite unfit for the generation of so broad a sheet of aponeurosis. In the foot, such an origin is still less probable; for the plantaris tendon does not terminate in the plantar aponeurosis, but is inserted into the heel-bone.

The plantar aponeurosis arises most distinctly from that part of the tuber of the heel-bone upon which we stand; it is divided into three sheaths. Sabbatier makes a middle, external, and internal portion of the same aponeurosis. Albinus also describes it as three distinct aponeuroses; one for the middle of the foot; one for the abductor of the great toe; and one the aponeurosis of the abductor of the little toe; all connected together only by their edges. Cowper considers it as a general expansion from the plantaris; and it is from this prejudice that the muscle has its name.

But its true origin is from that part of the knob of the heel-bone on which we stand. The middle and more pointed tendon arises from the very point of the knob. The inner fascia arises from the inside of this; and the outer one from the outside. And though thus divided into three heads, yet the whole origin is from the heel-bone. From this point the aponeurosis goes forward expanding till it is as broad as the roots of the toes; so that the whole has the shape of a sandal; and as it expands, its fibres are scattered, so as to have a radiated appearance. Accordingly, the part nearest the heel is thicker, while the broader part is thinner.

It goes forward like the sole of a shoe, till having approached the heads of the metatarsal bones, it is divided into five heads, corresponding with the five knobs; and each of these heads again subdivides itself into two bands, which, passing on each side of the heads of the metatarsal bones, is fixed into the sides, so as to leave room for the passing of the tendons, and nerves, and arteries.

Now this middle aponeurosis sends down a deep strong partition on each side of it; which is the best reason that I know for making these three distinct aponeuroses; for by these perpendicular partitions, the hollow of the foot is separated into three distinct chambers: under the middle one are concealed the tendons of the long flexors, with the lumbricales and short flexor muscles: under the outer one the flexor and abductor of the little toe: and under the inner one the abductor, flexor, and the abductors of the great toe.

The uses of this great and very strong aponeurosis are: that it protects all the parts, the blood vessels, muscles, and nerves that lie under it: that it supports the arch of the foot, both in standing and in motion, passing from heel to toe like a bow-string across its arch: that it binds down the muscles, and consequently supports and assists them in their strong actions; that it gives origin, or part of their origin, to many of the muscles; which, by their frequent and irregular adhesion to it, are very difficult to dissect: that it forms openings or rings, in which the tendons of the other muscle pass.

OF THE MUSCULAR POWER.

That contractile power which resides in the muscular or living fibre, is a phenomenon the most wonderful and perplexing of all. When we cannot reach the true point, the mind too often condescends to the most trifling pursuits; and so, when the older physiologists could not understand the intrinsic nature of this muscular power, they endeavoured to discover the size, the colour, and other external properties of the fibre: foolishly desiring to know what, if known, could be of no avail. Colour was believed to be essential to the constitution of a muscle: but in fowls, in amphibious animals, in fishes, in worms, and insects, through all the gradations of animals of different species or different sizes, the colours of the muscular fibre change. In fishes and in insects, it is entirely white; even in the human body, it is not essentially red: the blood which makes the fibre red may be washed away. Then why should we define a muscle by that accidental property which it so often wants, and of which it may be so easily deprived, while we may define it more truly by its contractile power, the only evidence of its nature, and its chief distinction in the system? for the contraction of the iris constitutes its nature; it is a muscle by truer marks than by its colour: and, by the same rule, the muscles of the least insect are as perfect as the muscles of a man.

Philosophers of the last age had been at infinite pains to find the ultimate fibre of muscles, thinking to discover its properties in its form; but they saw just in proportion to the glasses which they used, or to their practice and skill in that art, which is now almost forsaken. Some found the fibres to be of one equal size in all creatures, however various: other found them proportioned to the size, or age, or strength of their subject; but even such discrepancies are trivial to those which, in one of the greatest of these minute philosophers, are found almost in the same page; sometimes affirming the ultimate fibre to be greater or smaller, according to the strength of the subject, and again making them of equal size in the whale and in the insect.

Others, less troubled about the size of these ultimate fibres, had conceived notions of their form, which, in the credulity of the times, rose into the importance of doctrines, and, from the first raw conceptions of their authors, were finally proved by the microscope, forsooth; and while one author was drawing his rhomboidal fibres, all conjoined in regular succession; and another describing them also from the microscope, as consisting of six cylindrical fibres, involved in a spiral one, a third was reckoning the fibres as a succession of spherical bodies: and Cowper thought that he was injecting with quicksilver chains of bells jointed with each other. For the honour of the age, these vanities are forgotten now.

Physiologists have, by a late sense of their own weakness, been at last humbled to this becoming, but unwilling acknowledgment, that this contractility of the muscles is an original endowment of this living matter derived from the Creator, imparted in a way which we cannot know, and so attached to the organization of the muscular fibre, that where its organization is destroyed this power is lost. We have resigned the search after a mechanical or physical cause, and seek only to learn the properties of this living power, and the excitements by which it is moved. To this end it is necessary to define this power, distinguishing it from these feelings or motions which result from the nerves. The vis insita is that power which belongs to muscles, and is the source of motion. The vis nervea is that property which is peculiar to nerves, and is the cause of voluntary motion. They convey the will to the muscles, but are incapable of motion.

This irritable power residing in muscles may be defined to be the property by which muscles feel and re-act, upon certain stimuli being applied; and that, while certain orders of muscles are obedient to their own stimuli only, as the heart to the blood, the bladder to the urine, other orders of the muscles are ready to receive the commands of the will. This power, inherent in the muscular fibre, belonging to its constitution, and not derived from without, is the vis insita, or irritability of Haller*, the vis vitalis of Goerter, the oscillation of Boerhaave, and the

* The irritability of a muscle is, perhaps, more properly the vis insita, or inherent power, called into immediate action by the presence of stimuli; and as for the names of Tonic Power, Vital Power, and the rest, the terms are quite undefined, and may,

tonic power of Stahl. It is seen in the spontaneous and tremulous contractions of muscles when lacerated, as in wounds, when cut in operations, when entirely separated from the body; as in experiments upon animals, like that tremulous motion which we often feel in various parts of the body, without any evident cause, and independent of the will. Even when the body is dead to all appearance, and the nervous power gone, this contractile power remains; so that if a body be placed in certain attitudes, before it be cold, its muscles will contract, and it will be fixed in that posture till the organization yields and begins to be dissolved; it is the same inherent power by which a cut muscle contracts and leaves a gap. This is but a faint indication of that latent power, which can be easily excited to the most violent motions, and on which all the strength of the muscles depends: for the ligaments, tendons, bursæ of joints, and all those parts which have no such power, are capable of bearing the same weight when dead as when alive. But such is the dependance of the muscle on this vital endowment, that the moment it dies its power is gone; and the muscle which could lift a hundred pounds while alive, cannot bear the weight of a few pounds when dead. This latent power may be brought into full action by various stimuli. The latent power itself is called vis insita; the acting power put into action, or the proof of the vis insita, upon applying stimuli, is called the irritability of muscles.

Authors have doubly confounded the power of the muscles and the nervous system, by observing that the muscle continues to act when separated from the brain by the division of its nerves. It would be easy to shew that there can be no such separation of the muscular and nervous systems, and that when the muscle is even cut out, and exhibits contractions, these phenomena do not belong to the muscle, exclusively of the nerves. Anatomy teaches us that the nerves meet every where with the muscular fibre, and to separate them is impossible. Have we not learned that every fibre of muscle has its sheath, and that it lies insulated from every other fibre: what then is the influence which combines a million of fibres in one simultaneous action? If a muscle so cut out be pricked, and acts, does it not imply that every fibre sympathizes; and what other bond can unite them but the nerves?

Upon stimulating any muscle by touching it with a caustic, or irritating with a sharp point, or driving the electric spark through it, or exciting with the metallic conductors, as of silver and zinc, the muscle instantly contracts; although the nerve be cut so as to separate the muscle entirely from all connection with the system, although the muscle itself be separated from the body, although the creature upon which the experiment is performed may have lost all sense of feeling, and have been long apparently dead. Thus, a muscle cut from the limb trembles and palpitates long after; the heart separated from the body contracts when irritated; the bowels when torn from the body continue their peristaltic motion, so as to roll upon the table, ceasing to answer to stimuli only when they become stiff and cold. And thus the eye is sensible,

perhaps, have referred rather to the combined effect of all the powers of life, and of all the properties of inanimate matter, of nervous sympathy, elasticity, and of muscular power combined.

and the skin is sensible; but their appointed stimuli produce no motions in these parts; they are sensible, but not irritable. The heart, the intestines, the urinary bladder, and all the muscles of voluntary motion, answer to stimuli with a quick and forcible contraction; and although they feel the stimuli by which these contractions are produced, they do not convey that feeling to the brain. The muscular parts have all the irritability of the system; while nerves have all the sensibility of the system, and have the power of exciting motion without the power of motion.

The VIS INSITA is a power that is in continual force, preserving the parts ready for their proper stimuli, whatever these may be; one set obeying their own peculiar stimuli, while others are obedient to the influence of the will. The heart is stimulated by the quantity of its blood; the stomach by the presence of food; the intestines by their contents; the urine stimulates the bladder; the venereal appetite stimulates the genital system; the fœtus stimulates the womb; and the voluntary muscles (if we may be allowed to guess at a thing so little known) are excited by the voluntary nerves, and so are obedient to the will; for, to our limited view, the nerves seem to be the sole messengers of these commands, and any stimulus to the nerves moves the muscles like the commands of the will. The absence of the due stimulus to each, or the presence of the ordinary stimuli in too great power, will excite irregular motions, as fulness of blood in the heart, poisons in the stomach, acrimonies in the intestinal canal, or the passions of anger or fear in the system of the voluntary muscles. The due stimuli preserve their right tone and action; but these violent stimuli hurt their irritability, or moving power; the heart acts weakly after fevers; the appetite is languid after debauch; the limbs are weakened by labour; and the whole system is ruined by excess. Thus, the functions by which the system lives, the heart, the stomach, the bowels, and the womb, the various sorts of vessels by which the fluids are conveyed, are providently removed from the influence of the will; for these are the machines of the system, whose motions could not stop, must not be interrupted, nor lowered, nor raised, but must move and act according to the needs of the system. Not left to the irregularities or carelessness of voluntary motions, they are governed each by its own peculiar stimulus, and act in a continued and equal course.

Thus, there are in the body two living powers, which are as cause and effect in all the motions of our system. The NERVES stand as an intermedium betwixt all external objects and our general sense; by the impressions through these come pleasure and pain, and all the motives to action; by the will, returned through other nerves, all voluntary motions ensue. Thus are the nerves, as internuncii, betwixt the external impression and the moving power. But nerves were never known to move under the influence of stimuli; the moving power is another property of a distinct part of our body, having its own arrangement of particles, and its own peculiar form. All motion, then, proceeds from the joint operation of either power; the nerves convey the impressions, while the muscles contain the power; and it is here, as in other natural effects, the external cause changes, while the inherent property, the subject of its operation, remains the same. Some have, with reason, supposed that the nervous power is the regulator of the system; it is the property suited to all the supports of life, upon which they act, and by which they maintain their power over our body; but is subject to continual changing: it rises and it falls, is perfect or low; but the energy of the muscle, which is to answer to this power, remains ever the same, while its organization remains: the nervous power is exhausted and languid; but the muscular power is always perfect, always ready for the excitement of stimuli, or for the commands of the will.

The irritability, or inherent power, not only keeps the muscles ready, each for its peculiar stimulus, but preserves a balance over the whole system of the muscles. We know that muscles maintain a constant action. The muscles of one side balance the opposite muscles; and if the muscles of one side be relaxed by palsy, the action of the opposite muscles instantly appears; or if a limb be luxated, and its muscles displaced, they persevere in a violent and spasmodic action, till they be restored each to its place. Have we not reason to believe, that if muscles were absolutely and entirely quiescent, they could not be so instantaneously called into action; but that by this continual tension or tone, they more readily follow the commands of the will.

We naturally revert in this place to the sound opinions of Mr. Hunter, who, speaking of life, distinguishes the properties or actions of parts into two, those which regard their own preservation, and those which regard the general economy. These latter may be interrupted as by suffocation; but if the powers of the separate parts remain, we may produce resuscitation and reanimation, by restoring the corresponding sympathies. It is the remains of contractile power which fixes the dead body in whatever posture it is placed: it is this remains of irritability, which preserves freshness in the animal which seemed dead; but which is really dying still: for the moment this lingering portion of life is gone, the body dissolves, and falls down; and so we judge of freshness, by the rigidity of the flesh, and foresee approaching putrefaction, by its becoming soft. The fish, which is allowed to struggle till it be dead; the ox, over-driven before it be brought to the slaughter; the animal killed by lightning, which suddenly explodes (if we may be allowed the expression) all the powers of life; in these the contractile power is effectually destroyed or lost by the entire death. The life stopped all chemical decomposition, but now putrefaction comes quickly on. In those who die of the plague, of poison, of fevers, or of any sudden and violent disease, which at once extinguishes life in the vulgar sense, and robs the system of that remnant of life, which the physiologist could produce to view; in all these cases, the body becomes putrid in a few hours.

And here we are led to observe a fact of great consequence to the Pathologist; the muscles are not equally under the influence of the sensorium; some are prompt and exact, under the guidance of the will, whilst over others we have no command at all; and there are not a few which we command indirectly, that is, we put a certain class of muscles into operation, which are followed by the combination of others, over which we have no direct power. And as the muscular system is thus connected with the sensorium in different degrees, so we might be led to expect that these muscles might be differently influenced when the mind is oppressed. In fact, in proportion as the muscles are more or less immediately under the guidance of the will, so they are affected when the brain is oppressed. This we may see in the approach of natural sleep, or in the effects of intoxication. The influence steals over the eyes, the countenance, and the limbs, until the vital operations of respiration and circulation are all that remain.

But, before dismissing this subject, we must present the muscular system in a different view from what has hitherto been taken of it. The voluntary nerves, which controul the muscular system, are sensible of the degree of activity assumed by these muscles, and there is thus a universal sense spread over the body, which ministers to the proper organs of sense, and is, itself, more important than them all. It is by this property in the voluntary nerves and muscles, that we are enabled to balance the body in standing, walking, or running; adjusting the muscular action, and the state of tension of the limb, to the gravitation of the body, and so sustaining it in every variety of posture. We see with what pains, and after repeated efforts, the child acquires this power; and we see how a man is deprived of it in sickness or inebriety: whilst the utmost perfection of the same power is exhibited in the rope-dancer. And what we are thus led to contemplate in the whole body, may be noticed in the hand, in subserviency to the sense of touch; in the tongue, as subservient to mastication; in the eye, in aid of vision. It is this faculty which gives us the impression of resistance, and consequently of weight, of solidity, of fluidity, roughness, smoothness, angularity, &c. Thus, a man deprived of his sense of touch in his arm and hand, has continued in possession of the muscular power, and of the sense of muscular exertion, and, therefore, he could form an estimate of the weight of what he held in his hand. Here then is truly that power which gives us the most accurate perception of things external to the body, and of all those qualities which would induce us to call this the geometrical sense; a term which has hitherto been given with little propriety to the sense of touch.*

As for the MECHANICAL POWERS, by which the contractions of the muscular fibre is forwarded or retarded, they are not what they have been believed; for we find few circumstances in the origin, insertion, or forms of muscles, to favour their power, but many by which their power is abridged. There are certain points where the length of the lever gives an increase of power. The mastoid process, and the occiput are as levers for the head; the spines of the vertebræ, for the back; the olecranon, for the arm; and the pisiform bone, for the hand. The pelvis and the jutting trochanters are as the levers for the thigh; the patella is a lever for the leg; the heel-bone is a lever for the whole foot; and the arch of the foot is as a lever for the toes. These are not the whole, but they are, perhaps, the chief levers in the human body. In all the other implantations the muscle is fixed, not behind the joint, but betwixt the joint and the weight that is to be moved. There is a greater loss of power, when inserted near to the joint: there is less loss of power, when the tendon is inserted far from the joint, and though we call such insertion a longer or shorter lever, there is always some loss of power, and the

* See the organs of the senses.

true levers in the body are very few; far from providing mechanical forms to increase the power, nature has provided such a quantity of contractile power as to compensate for any loss of effect: so, in place of increasing the effect of muscles by levers, pulleys, and hinges, there is in almost every muscle a great abatement of its force, by the form of the bones which it is destined to move: for muscles lose of their effect, by their being implanted, not behind the joint, but betwixt the joint and the body to be moved; by the insertion of almost all muscles being very oblique, with respect to the motions which they are to perform, so that half their force is lost upon the immoveable end of the bone. Much force is lost by a muscle passing over many joints: one set of fibres in a muscle hinders the action of adjoining fibres, and every degree of contraction takes from that muscle an equal proportion of its power. Thus, every where in the human body is power sacrificed to the form and fitness of the parts, that the joints may be smaller than the limbs; that the limbs may be proportioned to the body: and beauty, convenience, and velocity of movement are gained by the sacrifice of that power, which is not needed in the system, since the wisdom and goodness of the Creator has appointed a degree of force in the muscles, more than proportioned to all this loss of the mechanical power. Those who will admire the ways of Providence, should know how to admire! Nature is not seeking to compensate for want of power, by the advantages of pulleys, and levers, and mechanical helps; nor is it in the forms of the parts, that the Infinite Wisdom is to be found: for among other gifts, such a portion of this spirit is given to man, that he has used the pulleys and levers, accelerations of motion, and all the mechanical powers that result from it; he has invented valves of infinite variety, each perfect and true, to its particular office; he has anticipated all that he has found in the mechanism of the human body; but the living power which compensates for the want of levers, which allows every where power to be sacrificed to the beauty of form, which has strength, in convulsive and violent actions, to break the very bones,—this is the act of Infinite Wisdom, on which our admiration should chiefly dwell. It is but the very elements of so deep a subject that can be delivered here.

OF THE CELLULAR SUBSTANCE.

OF THE MEMBRANES, &c.

The subject of this chapter offers some very interesting facts to our observation, and is both curious and useful. It is necessary to a correct notion of physiology, and forms the very foundations of pathology. The offices of the cellular substance is so important to life, the changes which it undergoes in the natural course of life, the remarkable alterations wrought upon it by inflammation, render it an important part of any general system of anatomy.

In treating of it, we have an opportunity of doing justice to our countrymen who have left their reputation to be guarded by us, and of correcting that disposition of our youth, who, in search of foreign novelties, lose sight of the brighter examples they have at home.

As we advance in our knowledge of the animal economy, it becomes every day more difficult to define the difference of solid and fluid; since in a living body they are continually alternating; and since part of that which is fluid in the living body becomes solid in the dead.

Before describing what a membrane is, we must point to the peculiarities of the *cellular membrane.*

In cutting through the skin the cellular membrane appears with its most common properties. First of all, let the student distinguish it from the fat or *adipose membrane.* The cellular substance or cellular tissue (*tela cellulosa*) consists of thin membraneous processes, which constitute cells or little cavities. The sides of these cells are bedewed with a fluid, which, like that of a joint, lubricates, and produces a fitness for motion, the intention being that the membranes forming these cells should shift, and stretch, and accommodate themselves to the motions of the frame. These cells communicate freely together. The anatomist traces this cellular tissue every where: it is distinct under the skin; it is still more loose and free among the muscles; it enters into the composition of every part: for as there must be every where a capacity of motion, as even the solid viscera must have their pulsating vessels, they must possess elasticity, and their mobility and resiliency is given to them by the proportion of cellular texture which enters into their composition.

These membranes, thus forming a continuous series of cells, may be traced into every part; we have seen it in the bones, around the earth of bone; we have seen it forming the sheath for the muscles; and in a similar manner, though more delicate in its texture, it enters into the brain and the eye, and the nerves; giving support to all the most delicate organs of the body.

The cellular substance is common to animal and vegetable bodies; and whatever notions we find to have prevailed in any age with the physiologists of one department, the same is expressed by the authorities in the other. Du Hamel asserts that the membranes of vegetables are composed of organic fibres arranged parallel to each other, and united by a glutinous substance. Haller's first word is *fibra*, the element. As the length is to the geometrician, the fibre is to the physiologist,—out of it he constructs the other parts. At present there is an attempt, which I consider equally trifling, to describe the elementary fibre of the animal body, and to make this fibre to be formed of globules of a certain diameter, ($\frac{1}{300}$ of a millimetre.) The error I apprehend to be in supposing the fibre to be the elementary part, instead of the membrane.

Fluids precede the formation of the solids; we would liken it to a soap bubble, which assumes a solid and concrete form, and which by maceration may be again dissolved. A principle of vitality preserves the membrane in its state of aggregation, and with the loss of life it dissolves — not into mechanical constituents, but into its chemical elements. This vital quality in membranes is shown by the property of the membranes to retain and keep separate juices or coloured fluids of an opposite quality. In the living body there is no transuding of smell or colour. The intestine, in hernia, does not taint the fingers, as the same intestine will do in the dead body. The bile in the living body is retained within the membrane of the gall bladder; in the dead body it stains every surrounding part by transudation. So, if we cut across a living plant, we see the juice, of the most opposite nature and perfectly different colour, flowing from distinct tubes or cells, and separated by their membranes. I state this circumstance to show that the simplest form of membrane has life inherent in it; qualities which do not result from the fineness of its texture, but from possessing a quality different from dead matter; the same quality which retains it in its proper state of aggregation and organization, and which when deprived, leaves it to resolve into its elements.

In opposition to the continental authorities, headed by the celebrated Bichat, I would teach, that instead of original molecules and elementary fibres being traced into membranes, membranes are the original and simplest form of the animal frame; and that the parts which the French physiologists call fibrous parts, are really not so, but are, on the contrary, resolvable into membranes. They would have us to believe the tendons to be fibrous; whereas nothing is easier than to resolve them by maceration into cellular texture.

Besides, instead of witnessing any thing like the weaving and intertexture of their fibres, as if there were a warp and a woof in the membranes of the body, we see them, in fact, formed very differently; we see a fluid effused, as upon the lungs, coagulating; we see this coagulum becoming vascular; we soon discover it to have become a mass of cellular texture formed of membranes; and we find, if it continue, that this texture will at length form cords of adhesion and connection betwixt the surfaces, as firm as any cord, and of the texture of a true tendon or ligament.

In the same way we may see the membranes formed by incubation in the egg; or we may see the gradual change taking place as the embryo advances. At first, it looks like a transparent jelly, in which there are no distinction of parts; and gradually we see in the mass white membraneous partitions, as afterwards we see bones and muscles, &c.; but in all this there is nothing to countenance the idea of an original fibre wrought into the several textures of the body.

If any thing more were wanting, we have it in the degeneration of the fine provisions and proportions of a joint. Let this joint become inflamed, or merely stopped in its motion, as in anchylosis, and instead of ligament and tendon, fascia and cartilage, synovia and bursa, and all the fine mechanism of the articulation, you find nothing but the loose cellular texture. Or, refusing this analytical procedure, we may view it synthetically; for if a bone be broken, and that bone, instead of uniting, be permitted to dangle loose, it will become an artificial joint; and out of the common cellular membrane, and the coagulable lymph discharged by the inflamed vessels, there will be formed membranes and ligaments, and even cartilages and the other appurtenances to a joint.

These considerations make me reject this weaving system, as unsuitable to the taste of this country, and quite at variance with what pathology as well as the natural anatomy discloses to us.

We shall resume this subject in speaking of the membranes of the different cavities. At present we have only to understand, that these extended sheets of animal matter called membranes, have this common character through the whole body: 1. That they have one surface smooth, and bedewed with a secretion that prevents the surface adhering, and which is favourable to the motion of that surface. 2. That the other surface of the membrane is adhering and rough, being in truth of the nature of the common cellular texture. 3. That these membranes have no termination, but, on the contrary, you may trace them on from one part of the body to another interminably, unless where they form the shut sacs, that is, the lining membranes of cavities, when, of course, they are continuous with themselves.

OF THE TENDONS, LIGAMENTS, BURSÆ, AND FASCIÆ, AND ALL THE PARTS WHICH BELONG TO THE BONES OR MUSCLES, OR WHICH ENTER INTO THE CONSTITUTION OF A JOINT.

The bones and muscles themselves are but the smallest part of that beautiful mechanism by which the motions of the human body are performed; for the parts by which the bones are joined to each other, or the muscles fixed into the bones, are so changed, and varied in their forms, according to the uses of each part, as to give a natural and easy shape to the limbs, security and firmness to their motions, and lubricity and smoothness to the joints by which these motions are performed; and this apparatus deserves our attention, not merely that we may know the forms of these joinings, but that we may learn something of the nature and uses of each part, and the various degrees of sensibility with which each is endowed; for, from this kind of study, conclusions will arise, which may lead us to the knowledge of their diseases, suggesting the means of their prevention and cure.

There is a difference in the parts of the human body, according to the several uses for which they are designed; some are vascular and soft, others bony and hard; some sensible, and very prone to inflammation and disease, others callous and insensible, having little action in their natural state, and little proneness to disease.

The active parts of the system, as we have stated in the introduction, are the muscles and nerves; the muscles to move the body, and perform its offices, each muscle answering to its particular stimuli, and most of them obeying the commands of the will; the nerves to feel, to suffer, and to enjoy, to issue the commands of the will, and to move the muscles to action: but there is a substance which joins these parts and connects arteries, veins, nerves, and muscles, and performs for them every subservient office, forms coverings for the brain, coats for the nerves, sheaths for the muscles and tendons, ligaments and bursæ, and all the apparatus for the joints; unites them by a continued tissue of CELLULAR SUBSTANCE. The tendons, ligaments, periosteum, and bursæ, may be considered as composed of this cellular substance.

OF THE FORMS OF THE CELLULAR SUBSTANCE.

Under various modifications and shapes, the cellular substance performs most important offices among the living parts :—1. It forms CELLS over all the body, which allow the parts to glide and move easily, which contain the fluid that makes all the motion of parts more easy and free. This cellular substance is peculiarly useful to the muscles, dives in among them, keeps their fibres at such due distance that each may have its action, supports and lumbricates them ; so that perhaps the difference of strength, in health and disease, depends, at least, in some degree, upon this support. The interstitial cellular substance surrounds the fat cells also. This structure, which is called the adipose membrane, consists of small bags which do not communicate with each other, but are for the deposit of oil or fat. The fat is lodged betwixt the muscles and fill up every interstice ; a want of it is a defect, while a superabundance of it encumbers the body and limbs. And Haller seems to have believed, that a diseased increase of it might not only oppress, but almost annihilate the muscular fibre.

2. But it is still further essential to a muscle, that while it moves, it should neither be hurt itself, nor harm the surrounding parts. Therefore, where one muscle moves over another muscle, soft flesh upon soft flesh like itself, there can be no hurtful friction, and the cellular substance is loose and natural, preserving its common form. But where tendons rub upon tendons, or bones upon bones, or where tendons rub upon muscles, or upon each other, some defence is needed, and the cellular substance assumes a new form. The cells are run together into one large cell, with thicker coats, and a more copious exudation, so that, being more liberally bedewed with a gelatinous mucus, it prevents the bad effects of friction, and is called a BURSA MUCOSA, or MUCOUS bag. These mucous bags are placed under rubbing tendons, and chiefly about the greater joints ; some are large, and others small ; their glairy liquor is the same with that which bedews the cellular substance, or the cavities of the joints, and the provision of nature is so perfect, that the occasions which require bursæ seem to form them by friction, out of the common cellular substance.

3. It is often useful that an individual muscle should be enclosed in a tendinous sheath, to give it strength and firmness, and to preserve it in its shape, or to direct its force. All muscles, or almost all muscles, form for themselves individual sheaths, such as are seen enclosing the supra-spinatus and infra-spinatus of the scapula, the biceps humeri, the sartorius, and most of the muscles of the leg and thigh ; but it is especially necessary that the whole muscles of the limb should be enclosed in some stronger membrane than the common skin, both to give form to the limb, and strength to its muscles, and to keep the individual muscles in their proper places, which otherwise might be luxated and displaced. And so some parts of the trunk of the body, the arm, the thigh, the leg, are bound each with a strong, smooth, and glistening sheath, formed out of the cellular substance, condensed and thickened by continual pressure. It is hardly to be distinguished in the child ; grows thicker and stronger as we advance in years and in strength, and in the arms of workmen it grows particularly thick and strong, increasing in the back,

shoulder or limbs, according to the particular kind of labour. These are the membranes, which, by enclosing the muscles like sheaths, are called the VAGINA, or FASCIA of the arm, the leg, the thigh, &c.

4. TENDONS or ropes were needed, for the muscles could not be implanted thick and fleshy into each bone, without a deformity of the limbs, and especially of the joints, which would have been not unshapely only, but which must have abridged them of their motions and uses. Where a muscle is not implanted directly into a bone, tendons are seldom required; and so there are no tendons in the heart, the tongue, the œsophagus, the stomach, intestines, or bladder. But where tendons pass over bones, or traverse the joints, their force is concentrated into narrower bounds; and long tendons are fixed to the ends of the muscles, to pull the bones. These tendons were once believed to be but the collected fibres of muscles gathered into a more condensed form: by which condensation, their properties of feeling and motion were lost, while they became hard, white, and glistening; and it was believed, that parts which were fleshy in the child, became tendinous in the adult. But we know by the microscope, that the tendon is not truly continued from the flesh; that the fibres of the tendon, and of the flesh, are not in the same line, the fibres of all penniform muscles running into their tendon, in a direction more or less oblique: and good anatomists have been able to separate the tendon from the flesh, without any violence, and with the bluntest knives. Muscles are irritable, and have nerves; tendons have no visible nerves, have neither feeling nor self-motion, nor any endowment by which we should believe them to be allied to the muscles or nerves; and many tendons, as the expansion of the palmaris, may be unravelled into mere cellular substance.*

The TENDON, then, is nothing more than the cellular membrane, which is in the interstices of the muscular fibres condensed together. The tendinous origin of a muscle, for example, may be traced through the muscle from one extremity to the other till it is again gathered and twisted into the tendinous insertion. They may be resolved into loose cellular membranes by maceration, and many tendons may be stretched out into a web even without maceration.

5. The PERIOSTEUM is merely a condensation of the common cellular substance, formed in successive layers: and the tendons are inserted into the substance of the periosteum; they mix with the periosteum, and through it are implanted into the bone. In dissecting a young bone, we tear up the periosteum along with tendons and without hurting the bones: but in process of time, the periosteum, and, consequently, the tendons, are inseparably fixed to the bones. The periosteum, tendons, fasciæ, and bursæ mucosæ, are all of one substance, and of one common nature; they are various modifications of cellular substance.

6. These tendons must be bound firmly down, for if they were to rise from the bones, during the actions of the muscles to which they belong, the effect of contraction would be lost, and they would disorder the joint, starting out in a straight line from bone to bone, like a bow-string over the arch of a bow. The same substance still performs this office also;

* The tendons are the continuation of the interstitial cellular membrane of the muscle; and I have succeeded in unravelling them into a web.

for the tendons of one muscle often split to form a sheath or ring for the next, or their tendons, after taking hold of the bone, spread their expansion out over all the bone, so as to form an entire sheath for the finger and toe; or there is a wide groove in the bone which receives the tendons, and it is lined with a cartilage, and with a lubricated membrane; the membrane comes off from the lips of the groove, or from corners or edges of the bone, passes over the tendons, so as to form a bridge, or often it forms a longer sheath, as in the fingers, or where the peronæi muscles pass behind the ancle, and thus the VAGINA or SHEATHS of the TENDONS are connected with the tendons, periosteum, and other modifications of the common cellular membrane.

7. The periosteum which has run along one bone, leaves it at the head, and, forming a bag for the joint, goes onwards to the next bone. Thus, the periosteum of all the bones is one continued membrane, passing from point to point; each bone is tied to the next by its own periosteum, and this membrane, betwixt the end of one bone and the beginning of the next, is so thickened into a strong and hard bag, as to form the capsule of the joint; and the periosteum is assisted in performing this office by the tendons, fasciæ, bursæ, and all that confusion of cellular substance which surrounds the joint. The CAPSULE of the JOINT is then a firm and thick bag, which, like a ligament, binds the bones together, keeps their heads and processes in their right places, contains that glairy liquor with which the heads of moving bones are bedewed, and prevents the adjacent parts falling inwards, or being caught betwixt the bones in the bendings of the joints. The capsule of every joint proceeds from the periosteum, and is strengthened by the tendons; it is formed like these parts out of the cellular membrane; and when a bone is broken, or its periosteum destroyed by any accident or disease, when a tendon snaps across, when a joint is luxated, and the capsule torn, the injury is soon repaired by a thickening of the cellular substance round the breach; and wherever a bone, being luxated, is left unreduced, a new socket, new periosteum, new ligaments, and new bursæ, are formed out of the common cellular substance: and though the tendons may have been torn away from the head of the bone, they are fixed again, taking a new hold upon the bone.

8. There are other LIGAMENTS of a JOINT which prevent its luxation, guarding it at its sides, or round all its circle, according to its degree of motion; and those ligaments are of the same nature with the first, or bursal ligaments, arise, like them, from the periosteum chiefly, or indeed are truly but a thickening of the bursal ligament at certain points.

The universal connection of these parts is now sufficiently explained, since we have followed the several forms of cellular substance: 1st. Clothing the bones with a thick membrane, which, though insensible, as contrasted with the skin, conveys blood-vessels, the means of life, to the bones, and is named periosteum: 2dly, The same periosteum, thickened and strengthened by the adhesion of surrounding parts, so as to form the capsules for the joints: 3dly, The tendon also continued from the periosteum, and not growing from the muscle, but formed of the cellular membrane: 4thly, We see that smaller tendon, expanded into a thinner tendinous sheet, as in the brawn of the leg where the ham-strings (whose expansion strengthens the knee-joint) go down over the muscles of the leg: 5thly, We see the perpendicular partitions of this fascia going down among the muscles, and dividing them from each other; and the cellular substance, which lies under the fascia, and immediately surrounds the muscle, cannot be distinguished from the inner surface of the fascia itself: 6thly, And as for the bursæ we see that they are formed wherever a tendon rubs over a bone. The upper surface of the bursa is formed by the tendon which rubs over the bone: the lower surface of the same bursa is formed by the periosteum of the bone which it defends: the sides are formed by the common cellular substance. Its cavity appears to be merely an enlarged cell: and the bursæ mucosæ and capsular ligaments are plainly of one and the same nature: their liquors are the same, they often open into one another naturally, or if not naturally, at least it is no disease, since no bad effects ensue.

I must now explain more fully the constitution and nature of all the less feeling parts: for what I have said might be thought to imply absolute insensibility and total exemption from disease or pain: whereas the sensibility of tendons, ligaments, bursæ, and joints, stands on the same footing with the feeling of bones: they are insensible in health; not easily injured; entering slowly into disease; but their diseases are equally dreadful from their duration and from their pain: for by inflammation, their organization is deranged, their healthy consistence destroyed, and their sensibility excited in a dreadful degree.

The tendons of animals have been cut or pierced with embowelling needles; they have been cauterised, they have been burnt with a lighted stick, while the creatures neither struggled nor shrunk from the irritation, nor ever gave the smallest sign of pain. Oil of vitriol has been poured upon each of the parts belonging to a joint, and a piece of caustic has been dropped into its cavity, but still no pain ensued; nay, some have been so bold, may I not say so vicious, as to repeat these experiments upon the human body. Without such cruel and inhuman practices, we do not want opportunities of knowing, that, in the human body also, the tendons and bursæ have no acute feeling. When we cut open a fascia or tendinous membrane, there is little pain: when (as in amputation) we cut the ragged tendons even and neat, there is no pain: when we snip with our scissars the ragged tendons of a bruised finger to cut it off, the patient does not feel: when we see tendons of suppurating fingers lying flat in their sheaths, we draw them out with our forceps, or touch them with probes, without exciting pain. In the old practice of sewing tendons, there was some danger, but no immediate pain: when we cut down into the cavity of a joint, still the pain is but slight. There is very little pain when the ligament of the patella is broken away from the tibia, nor when the great Achillis tendon is torn. There is but little pain in the moments of those accidents which appear slight in the time, but which turn out to be the most dreadful sprains. Yet, after rupture of the patella, the knee inflames and swells: after rupture of the Achillis tendon, there is swelling and inflammation, with such adhesion of the parts as makes the patient lame: after the slightest sprain, such inflammation sometimes comes on as destroys the joint. There is but little pain when we first make an opening into any joint; yet it often brings on such pain and fever, that the patient dies. In short, every thing conspires to prove, that though in wounds of the less feeling parts, there is indeed future danger, there is no immediate pain. Still there are many accidents which prove to us, that even in health, the joints are not entirely exempted from pain: a smart stroke on the knuckles, or a blow on the elbow, or a fall upon the knee, are not perhaps the purest instances of feeling in joints: for such blow may have hurt some external nerve; but when a small moveable cartilage forms within the joint of the knee, though it be small and very smooth, and lodged fairly within the cavity of the joint, it often gets betwixt the bones, causing instant lameness; the moment it causes this lameness, it brings dreadful pains: the pain, the lameness, and all the feeling of inconveniency subside the instant that this cartilage is moved away from betwixt the bones; and the joint continues easy till this moving cartilage chances again to fall in betwixt the heads of the bones. Even the pain from a blow upon the knee, for example, is plainly within the joint, and is caused by the force with which the patella is struck down against the ends of the bones; what indeed is a sprain, but a general violence and twisting of all the parts which compose the joint? These parts are of one common nature, and may be arranged and enumerated thus: a joint is composed of the heads of the bones swelling out into a broader articulating surface, and of a thin plate of cartilage, which covers and defends the head of each bone; sometimes of small and moveable cartilages which roll upon the bones, and follow all the motions of the joint, and, like friction wheels in machines of human invention, abate the bad effects of motion. There is a secreting apparatus within every joint, which pours out a lubricating fluid called synovia; and there is a bursal membrane reflected from the cartilages that tip the head of one bone to the edges of the cartilages of the opposite bone: this membrane confines the lubricating fluid, and serves at the same time to separate what is properly called the joint from the surrounding parts. This fine bursal or synovial membrane is surrounded and strengthened by a membrane of a more ligamentous character, which serves to bind the bones together. Sometimes this is called membrana capsularis, and sometimes more appropriately, LIGAMENTUM CAPSULARE: there are lesser ligaments on the outside of this, going along the sides of the joint, and passing from point to point: there are great tendons moving over the joint, and bursæ, or mucous bags, which accompany these tendons, and prevent the violence which their continual rubbing might do to the bones.

It is remarkable how slowly physiologists have come to the right knowledge of this matter. The fact is that all the apparatus of the joint is sensible cartilage, ligament, and tendon; but they do not possess the same kind or degree of sensibility with the skin and some other parts. They have just the degree and the kind of sensibility which is suited to their function; that is to say, which permits the performance of their office, yet gives us token of violence by pain. Their sensibility, like the sensibility of other parts, being obviously designed as a guard upon them that we may be careful of such accidents, and avoid such exertions, as would be injurious to their texture. Though seemingly insensible to the common modes of inflicting pain, yet are the ligaments and tendons and sheaths sensible to sprains and bruises, and such kind of injury as they are naturally exposed to. And when once the process of inflammation is set up in them, they become the seat of excruciating agony. The inflammation of joints, and of all the parts belonging to them, breaks up the organization of the part, evolves the feeling, and then in them also comes disease and violent pain. They are slow in entering into action, but once excited, they continue to act with a perseverance quite unknown in any other part of the system. Their mode of action, whatever it may be at the time, is not easily changed: if at rest, they are not easily moved to action, and their excessive action once begun is not easily allayed. The diseases are infinite to which these parts are subject. They are subject to dropsical effusions; they are subject to gelatinous concretions; they are subject to slight inflammation, to suppuration, to erosions of their cartilages, and to exfoliation corresponding with the dropsies, suppurations, and mortifications of the softer and more feeling parts. Rheumatism is an inflammation round the joints, with a slighter effusion which is soon absorbed: chronic rheumatism is a tedious and slow inflammation, with gelatinous effusions round the tendons, and permanent swelling and lameness of the joints. Gout, in a joint, is a high inflammation, with a secretion of earthy matter into its cavity. The inflammation of tendons attends sprain: effusion of gelatinous matter round them forms ganglion: suppurations in the tendinous sheaths is whitlow: the inflammation of bursæ is false white swelling, not easily distinguished from the true: the disease of the joint itself is either a dropsy, where the joint, though emptied by the lancet, is filled up again in a few hours, showing how continual, and how profuse, both the exhalation and absorption of joints naturally are: or it is white swelling, which, next to consumption, is the most dreadful of all scrofulous diseases, which begins by inflammation in the joint itself, is marked by stiffness, weakness, loss of motion, and pain; which goes on through all the stages of high inflammation, dreadful pain, destruction of cartilages, suppurations and spontaneous openings of the joints; which sometimes stops by an effusion of callus and concretion of the bones, forming a stiff joint, but which oftener ends in hectic fever, diarrhœa, morning sweats, and extreme weakness; so that the patient dies, exhausted with fever and pain.

OF THE JOINTS.

Almost every thing relating to the heads and processes of the bones, and every proposition concerning the motions which they have to perform, has been already explained, anticipating much of the anatomy of the joints: and the principles of motion mentioned in describing the bones, shall form the chief propositions on which my descriptions of joints shall be arranged, seeking that method chiefly by which the joints may be easily and rapidly explained; for it is a subject on which volumes might be bestowed, and not in vain.

I should not wish the readers of this book to be ignorant of terms, which it is, however, bad taste to introduce into our discourse, as they are useless and pedantic, viz.

Diarthrosis is the free articulation, or proper joint.

When the globular head of a bone rolls in a socket, it is *Enarthrosis*.

When plain surfaces meet, as in the bones of the tarsus, we have the term *Arthrodia*.

The hinge joint is called *Ginglimus*.

When a bone turns by rotation it is termed *Trochoides*.

When there is a firm union by cartilage, admitting no motion, or very little, the term *Synchondrosis* is appropriate.

LIGAMENTS OF THE HEAD AND SPINE.

We may compare, in the following order, the chief motions of the head and trunk. The head is so placed upon the oblique surfaces of the atlas, that it cannot turn in circles; but at that joint all the nodding motions are performed. The atlas rests so upon the vertebra dentata, that there all the turning motions are performed. The neck and loins have their vertebræ so loosely framed, with such perpendicular processes and easy joints, that there all the bending motions are performed, while the back is fixed, or almost fixed, by its connection with the ribs, and by the obliquity and length of its spines; and though, upon the whole, the spine turns many degrees, yet it is with a limited and elastic motion where the whole turning is great, but the movement of each individual bone is small.

To secure these motions, we find the occipital condyles received into hollows of the atlas, where the oblique position of the condyles secures the joint, the occipital condyles looking outwards, the articulating surfaces of the atlas looking towards each other, the occiput set down betwixt them, so as to be secured towards either side, and the obliquity of the joint being such withal as to prevent the head from turning round. These joints of the occiput, with the atlas, are, like the greater joints of the body, secured with regular capsules, or bag-like ligaments, for each condyle, each rising from a rough surface on the vertebræ, and being fixed into a roughness at the root of the condyle. We find a flat membraneous ligament, which extends from the ring of the atlas to the ring of the occipital hole, closing the interstice betwixt the occiput and the atlas: it is confounded at the sides with the capsules of the articulating processes; is very strong before; and at the middle short point of the atlas it seems a distinct ligament,* which is strong only at this point, and very lax and membraneous behind.

We find the atlas tied to the dentata by a more complete order of ligaments. These are, 1st, (as betwixt the atlas and dentata,) regular capsules, or bags, fixing the condyles of one vertebra to the condyles of the other. 2dly, A cross ligament† which, crossing the ring of the first vertebra, makes a bridge, embraces the neck of the tooth-like process, and ties it down in its place. 3dly, A smooth and cartilaginous surface

* This is part of what Winslow called LIGAMENTUM INFUNDIBILIFORME, a FUNNEL-LIKE LIGAMENT, joining the first vertebræ to the occiput.

† Viz. LIGAMENTUM TRANSVERSALE, or TRANSVERSUM; and what are called the APPENDICES of the TRANSVERSE LIGAMENT, are merely its edges, extending upwards and downwards, to be fixed into the dentata, and into the occipital hole, so as to enclose the tooth-like process of the dentata in a capsule.

all round the root of the tooth-like process, where this tooth of the dentata turns in the ring of the atlas, and is bound by the ligament; and this rolling of the atlas upon the axis of the dentata is so fair and proper a joint, that it also is all included in a capsular ligament. 4thly, The point of the tooth-like process having threaded the ring of the atlas, almost touches the occipital hole; and there another ligament ties it by its point to the occipital hole.*

All the other vertebræ have another kind of articulation; to which the occiput, atlas, and dentata are the only exceptions, for their motions are particular, and quite different from the rest. The atlas and dentata bend, turn, and roll by connections resembling the common joints of the body; but the other vertebræ are united, each by its INTERVERTEBRAL SUBSTANCE, to the bones above and below; they are also united by their articulating processes to each other: each articulating process is held to another by a distinct capsule; each intervertebral substance is secured, bound down, and strengthened by strong ligaments; for the intervertebral substance, which of itself adheres very strongly to the periosteum, and to the rough socket-like surface upon the body of each vertebra, is further secured by a sort of cross ligaments, which go from the rim or edge of one vertebra to the edge of the next, over the intervertebral substance; and so, by adhering to the intervertebral substance, they strengthen it. These ligaments cross each other over the interstice betwixt each vertebra, and are very strong in the lumbar portion. They are regular and shining, and are named INTERVERTEBRAL CRUCIAL LIGAMENTS.

The spine is further secured by a general ligamentous or tendinous expansion, which goes over the fore parts of all the vertebræ, from top to bottom of the spine. It begins at the fore part of the atlas; it almost passes the body of the dentata, or is but very slightly attached to it. It is at first pointed, small, and round; it begins to expand upon the third vertebra of the neck, so as to cover almost all its body. It goes down along the bones, chiefly on their fore parts, and is but little observed on their sides. It is weaker in the neck, where there is much motion: stronger in the back, where there is none; weaker again in the loins, where the vertebræ move; but still on the bodies of all the vertebræ it is seen white, shining, and tendinous. We can distinguish all along the spine interruptions and fasciculi, or firmer bundles going from piece to piece of the spine; which fasciculi are indeed very seldom continued, without interruption, further than the length of two or three vertebræ; yet the whole is so much continued, that it is considered as one uninterrupted sheath, and is called the EXTERNAL or ANTERIOR VAGINA, or LIGAMENT of the SPINE.†

* There are two flat ligaments which come from about the neck or root of the tooth-like process, and which go obliquely upwards, to be fixed into the groove just behind the lip of the occipital hole; but the ligament from the point of the tooth-like process is not what it has been supposed, a fair round ligament of some strength; there is nothing more than a few straggling fibres of ligament going from the point to the occiput, though Eustachius has drawn it round and strong.

† The LIGAMENTUM COMMUNE ARTERIUS, FASCIA LONGITUDINALIS ANTERIOR, FASCIA LIGAMENTOSA, &c. It is from this ligament in the loins that the crura diaphragmatis arise with tendons flat and glistening like the ligament itself, and hardly to be distinguished from it.

But still the canal of the spine were left open and undefended, rough and dangerous to the spinal marrow, if internal ligaments were not added to these. The rings of the vertebræ are held at a considerable distance from each other by the thickness of the intervertebral substance, and by the corresponding length of the oblique processes; but this space is filled up by a strong flat ligament of a yellow colour, which goes from the edge of one ring to the edge of another, and so extending from the articulating processes, backwards to the roots of the spinous processes, they fill up all the interstice, complete the canal of the spinal marrow, and bind the bones together with great strength*: these are assisted in their office of holding the vertebræ together, by a continuation of the same ligament, or of a ligamentous membrane connected with it, which runs all the way onwards to the ends of the spinous processes, where they are strengthened by accidental fasciculi†: and in the middle vertebræ of the back, but not of those of the loins or neck, similar ligaments are found also betwixt the transverse processes.‡

Next there is another internal ligament, which is not interrupted from bone to bone, but runs along all the length of the spine, within the medullary canal; and it corresponds so with the external vagina, or anterior ligament of the spine, that it is called the POSTERIOR or INTERNAL ligament.§ It begins at the occiput, lies flat upon the back part of the bodies of the vertebræ; at the interstice of every vertebra it spreads out broad upon the intervertebral substance, doing the same office within that the intervertebral crucial ligaments do without. It is broader above; it grows gradually narrower towards the loins. Although it is called a vagina, or sheath, it does by no means surround nor enclose the spinal marrow, but is entirely confined to the covering of the bodies of the vertebræ, never going beyond the setting off of the articulating surfaces, or the place where the nerves go out. It adheres firmly to the bones, and does not belong at all to the spinal marrow. It should rather be called a ligament for the bones, than a sheath for the medulla. The anterior ligament prevents straining of the spine backwards; this one prevents the bending of the spine too much forwards; and they enclose betwixt them the bodies of the vertebræ, and their intervertebral substances.

There is yet a third internal ligament, which belongs entirely to the neck; it is called APPARATUS LIGAMENTOSUS COLLI: it begins from the edge of the occipital bone, descends into the canal of the vertebræ, is thin and flat, and adheres firmly to the body of each vertebra, covering the tooth-like process. The irregular fasciculi, or bundles of this ligament, stretch from bone to bone; and the whole of the apparatus ligamentosus extends from the edge of the occipital hole to the fourth vertebra of the neck, where it ends. Its chief use is also as a ligament,

* They are named the LIGAMENTA SUBFLAVA CRURUM PROCESSUUM SPINOSORUM.

† These are named the MEMBRANÆ INTERSPINALES, and LIGAMENTA APICIUM SPINOSORUM or FUNICULI LIGAMENTOSI. The ligaments which tie the points of the spines, running from point to point, make a long ligament which stretches down all the spine.

‡ Called LIGAMENTA PROCESSUUM TRANSVERSORUM, and found only from the fifth to the tenth vertebra of the back.

§ FASCIA LIGAMENTOSA POSTICA, FASCIA LONGITUDINALIS POSTICA, LIGAMENTUM COMMUNE POSTERIUS.

merely fixing the head to the neck. The dura mater is within it, immediately enclosing the spinal marrow. The ligaments which I have just named may be well enough allowed to be "at once ligaments for the bones, and a sheath for the medulla." But there is no such sheath as that called ligamentum infundibiliforme by Winslow; for either they are peculiar and distinct ligaments for the bones, such as I have described, or they belong exclusively to the medulla, as the dura mater, which is indeed strengthened at certain points into the thickness of a ligament; but the only close connection of the spinal marrow with the ligaments of the spine, is just at the hole of the occipital bone; and for a little way down through all the rest of the spine, the connection is by the loosest cellular substance.

OF THE LOWER JAW.

The LOWER JAW is, by its natural form, almost a strict hinge, and the lateral motion in grinding is but very slight. The joint is formed by a deep hollow or socket in the temporal bone; by a ridge which stands just before the proper socket, at the root of the zygomatic process; and by the long small head, or condyle, of the jaw, placed across the long branch, or condyloid process. These form the joint: and the condyle, the hollow of the temporal bone, and the root of the zygomatic process, are all covered with articulating cartilage. The joint is completed by a capsule of the common form, which arises from the neck of the condyle, and which is so fixed into the temporal bone as to include both the proper socket and the root of the zygomatic process. Thence it is manifest, that in the motions of the jaw, this transverse ridge is required as a part of its articulating surface; that the common and lesser motions are performed by the condyle moving in the deepest part of its socket; that the larger and wider openings of the mouth are performed by such depression of the jaw as makes its condyle mount upon the root of the zygomatic process. When there is luxation of the jaw there is a starting forwards of the condyle, till it is lodged quite before and under the zygomatic process; and the condyle standing upon the highest ridge, is the dangerous position in which luxation is most easily produced.

To render these motions very easy and free, a moveable cartilage is interposed. We find such cartilages in the joints of the clavicle, wrist, knee, and jaw, because the motions are continual and rapid. The moveable cartilage is thin in its centre, and thicker towards its edges, by which it rather deepens than fills up the hollow of the joint. It corresponds in shape with the head or condyle of the jaw, and with the hollow of the temporal bone. It moves with every motion of the jaw, facilitates the common motions, and prevents luxation. Its edges all round are fixed down by ligaments, but the joint is still more strongly secured by lateral ligaments on the inside and outside, and by the strength of its pterygoid and temporal muscles, which are inserted close round the joint. It is the muscles which prevent luxation; and it is their action also that makes luxation, when it has happened, so difficult to reduce. We may mention here a ligament or strong band of fascia that passes from the styloid process to the angle of the jaw, and sends a slip downwards also to the body of the os hyoides, as it were to suspend it.

The Ligaments of the jaw are these:
1. Membrana Articularis.
2. Ligamentum Cartilaginis Intermediæ.
3. Ligamentum Maxillæ Laterale Internum.
4. Ligamentum Maxillæ Laterale Externum.
5. Ligamentum inter Maxillam et Processum Styloideum.

After these descriptions of the ligamentous connections of the spine the student may require some more precise table; for example:

LIGAMENTS OF THE VERTEBRAL COLUMN.

SEEN EXTERNALLY.

First, as standing by itself peculiar, the intervertebral substance.

1. Ligamentam Capsularia.
2. Ligamenta Crucialia ligamentorum intervertebralium.
3. Ligamentum Commune Anterius, or Fascia Longitudinalis Anterior.
4. Ligamenta Apicium Processuum Spinosorum, or Funiculi Ligamentosi.
5. Ligamentosæ Interspinales membranæ.
6. Ligamenta Processuum Transversorum.

LIGAMENTS SEEN ON MAKING THE SECTION OF THE SPINE.

1. Ligamentum Commune Posterius, or Fascia Longitudinalis Posterior.
2. Ligamenta subflava Crurum Processuum Spinosorum.

LIGAMENTS BETWIXT THE HEAD AND UPPER VERTEBRA.

1. Apparatus Ligamentosus.
2. Ligamentum Infundibiliforme.
3. Ligamenta Capsularia.
4. Ligamentum Perpendiculare.
5. Ligamentum Transversale — Appendices ejus.
6. Ligamenta Lateralia Moderatoria.

These ligaments of the spine, which strengthen and support bones of very delicate and spongy texture, are very subject to scrofulous inflammation.

The transverse ligament has been burst, and the tooth-like process of the second vertebra has crushed the spinal marrow, with instant death ensuing.

A diastasis, or partial separation of the vertebræ of the neck, with laceration of ligaments, is no unfrequent effect of falling from a height on soft ground.

A subluxation of the atlas from the vertebra dentata, has occurred from suddenly turning the head, and death has attended the attempts at reduction.

Subluxation of the lumbar vertebræ, that is displacement of the articulating processes, I have often seen.

Total dislocation of the bodies of the vertebræ is a very rare accident; yet there is an instance in my collection, where the child lived more than a year, and died at last of croup.

After all twists and injuries of the ligaments of the spine, although there may be no dislocation, we have reason to be apprehensive of inflammation of the ligaments or general sheath of the spinal marrow.

RIBS.

The ribs have two joints, and a hinge-like motion, rising and falling alternately, as we draw in or let out the breath. The two joints of the ribs are thus secured: First, the proper head of the ribs being hinged upon the intervertebral substance, and touching two vertebræ, it is tied to the bodies of each by a regular capsule; the bag is regular, is lubricated within, and is as perfect as any joint in the body; it is radiated without, so as to expand pretty broad upon the sides of the vertebræ, and has a sort of division, as if into two fasciculi, the one belonging to the vertebra above, the other to the vertebra below: they gradually vanish, and mix with the periosteum upon the bodies of the vertebræ; these are named LIGAMENTA CAPITELLORUM COSTARUM, as belonging to the little heads of the ribs.

The back of the rib touches the fore part of the transverse process, and is articulated there: consequently there is a small capsular ligament belonging to this joint also; but this joint is further secured by two small ligaments, which come from the transverse process of the vertebra, and take hold on the neck of the rib: one short ligament coming from the point of the transverse process, is behind the rib, and thence named LIGAMENTUM TRANSVERSARIUM EXTERNUM; another, rather longer, comes from the inner face of the transverse process above, goes down, and a little round the neck of the rib is implanted into the edge of the rib, and is named LIGAMENTUM TRANSVERSARIUM INTERNUM: another small ligament exactly opposite to this, going from the outside of the transverse process into the neck of the rib, upon its back part, and crossing the last, is also very regular; it is called LIGAMENTUM CERVICIS COSTÆ EXTERNUM: and other subsidiary ligaments from different points assist these or supply their place.

The ribs are fixed into the sternum by their cartilages, each of which has a round head, a distinct socket, a regular capsule, and ligaments which expand and are scattered upon the surface of the sternum, much in the same way that the ligamenta capitelli expand upon the bodies of the vertebræ: a tendinous membrane also binds the cartilages of the ribs one to another, crosses over the interstices, and so covers the intercostal muscles with a sort of fascia; and the whole surface of the sternum and that of the cartilages is covered with this tendinous expansion, which belongs confusedly to the origins of the pectoral muscles, to the ligaments of the ribs and sternum, and to the periosteum of that bone.

LIGAMENTS BETWIXT THE RIB AND THE SPINE.

1. Ligamentum Capitelli Costæ Anterius.
2. Ligamenta Capsularia Capitelli.
3. Ligamentum Capsulare (of the union with the transverse process).
4. Ligamentum Externum Transversarium.
5. Ligamentum Transversarium Internum.
6. Ligamentum Cervicis Costæ Externum.

ANTERIOR EXTREMITY OF THE RIBS AND STERNUM.

1. Ligamenta Radiatim Disjecta.
2. Ligamenta Transversa.
3. Membrana Sternalis.

JOINTS OF THE SHOULDER, ARM, AND HAND.

CLAVICLE—STERNUM—SCAPULA.

The joining of the clavicle with the sternum is the hinge upon which the whole arm moves, and is the only point by which the arm is connected with the trunk: the round button-like head of the clavicle rolls upon the articulating surface of the upper bone of the sternum: it is in such continual motion, that some particular provision is required; and accordingly it has, like the condyle of the jaw, a small moving cartilage, which rolls betwixt this head and the sternum. The cartilage is thin, and of a membraneous nature; it is moveable in some degree, yet it is fixed by its edges to the head of the clavicle and the socket of the sternum. This joint is enclosed in a strong capsule, consisting first of a bag, and then of an outer order of fibres, which go out in a radiated form upon the surface of the sternum, like the ligaments of the ribs; and they cross and cover the sternum, so that the ligaments of the opposite sides meet: and this meeting forms a cord across the upper part of the sternum, which is named INTERCLAVICULAR LIGAMENT. Thus is the clavicle fixed to the sternum, and another broad ligament also ties it to the first rib, viz. the LIGAMENTUM RHOMBOIDES.

The joining of the clavicle with the scapula is by the edge of the flat clavicle, touching the edge of the acromion process with a narrow but flat articulating surface: both surfaces, viz. of the acromion and of the clavicle, are covered with a thin articulating cartilage: in some subjects a moveable cartilage is also found here: it is a regular joint, and is very seldom obliterated; yet its motion, though continual, is not very free; it is rather a shuffling and bending of the scapula upon this bone, favouring the play of the other joints: it is secured first by a capsular ligament, which is in itself delicate and thin, but which is strengthened by many ligamentous bands, which pass (over the capsule) betwixt the clavicle and the acromion process: the clavicle, as it passes over the point of the coracoid process, is tied down to it by ligaments of considerable strength; one comes from the root of the coracoid process to the clavicle, and is called LIGAMENTUM COMMUNE CONOIDES; another from the point of the coracoid process, is implanted into the lower or inner edge of the clavicle, and is named LIGAMENTUM COMMUNE TRAPEZOIDES—trapezoid, on account of its square form, and commune, because it goes from the scapula to the clavicle: while other ligaments, going from one process of the scapula to another, are named proper or peculiar ligaments of the scapula.

The LIGAMENTUM PROPRIUM TRIANGULARE stretches from the coracoid process to the acromion process of the scapula. The LIGAMENTUM SCAPULÆ PROPRIUM POSTERIUS is of less importance, being that which completes the notch of the scapula into a hole, and gives attachment to the omo-hyoideus muscle.

The acromion scapulæ is sometimes separated from the end of the clavicle, and the accident may be mistaken for a dislocation of the humerus.

The sternal extremity of the clavicle is sometimes dislocated. A case presents to me while this is going to press. It is an accident very easily distinguished, for the great tubercle on the end of the bone rises like a tumor, and the part of the mastoid muscle arising from it is also raised, and seems as if, by its contraction, it pulled up the bone.

SHOULDER-JOINT.

The SHOULDER is one of the most beautiful joints, loose and moveable, very free in its motions, but very liable to be displaced. To form this joint, the humerus has a large round and flattened head ; the cavity of the scapula*, which receives this head, is oval, or triangular, small and very shallow ; it is eked out with a thick cartilaginous border, which increases the hollow of the socket, but still it is so shallow, that the humerus cannot be so truly said to be lodged in the glenoid cavity as to be laid upon it. Its capsule or bag is very loose and wide, coming from the edges of the glenoid cavity, and implanted round the neck of the bone : the joint is richly bedewed with synovia, which is partly secreted by a fimbriated organ, the common organ for this secretion through all the joints, and by a thinner exudation from those extreme arteries which terminate, with open mouths, upon the internal surface of the capsule.

By the shallowness of its socket, and the largeness of its head, by the looseness of its capsule, by all the forms and circumstances of its structure, the shoulder is exceedingly loose, and very liable to be displaced : it has this loose structure, and superficial socket, that its motions may be free, but seldom is there any great advantage gained in the human body, without a counterbalance of weakness and danger ; and every where in the limbs we observe that a joint is weak and liable to luxation in proportion as its motions are free and large. Yet the shoulder-joint is not without some kind of defence ; its socket is shallow, but it is guarded by the largest projecting processes in all the body, by the acromion projecting and strengthening it above, and by the coracoid process within ; its ligament is lax, easily torn, and useful rather for confining the synovia, and keeping the head of the humerus opposite to its proper cavity, than in securing the joint by any strength it has : therefore a ligament extends from the coracoid to the acromion process, (LIGAMENTUM PROPRIUM TRIANGULARE SCAPULÆ,) which completes the defences of the joint above, and at its inner side. The capsule is perforated by the long tendon of the biceps muscle†, to arrive at which it takes a long course through a sheath which passes over the groove in the

* It is called a glenoid cavity, from the Greek name of a joint, and the name is not absolutely appropriated to the scapula.

† The capsular membrane is perforated, while the thin synovial membrane is reflected upon the tendon.

bone which lodges the tendon; and there comes also from the point of the acromion process an additional ligament, which adheres to the capsule: but the circumstance from which the chief strength of the shoulder-joint is derived, is the insertion of the four muscles which come from the scapula close round the head of the bone, so that they adhere to the capsular ligament, pull it up to prevent its being checked in the motions of the joint, strengthen it by their thickness, for they are spread upon it: and the contraction of the muscles holds the humerus in its place: their total relaxation (as in certain cases of weakness) suffers the humerus to drop away from the scapula, without any fall or accident, forming what we are accustomed to call a luxation of the humerus, from an internal cause; and the shoulder cannot be luxated by a fall, without such violence as tears up the tendons of these muscles. We must add to this anatomy of the joint, that it is surrounded by numbers of bursæ or mucous bags: one under the tendon of the subscapularis; one under the short head of the biceps muscle; one betwixt the coracoid process and the shoulder-bone; and one under the acromion process of the scapula, exceedingly large: and these are so fairly parts of the joint, that very commonly they open into it with communications, either perfectly natural, or at least not hurtful, either originally existing, or formed by continual friction. It should also be remembered, that the long tendinous head of the biceps muscle comes from the margin of the socket, directly over the ball of the os humeri, and through the capsule, and answers the purpose of a ligament.

RECAPITULATION OF THE LIGAMENTS ABOUT THE SHOULDER.

(Between the clavicle, sternum, and first rib).

1. Membrana Capsularis.
2. Cohæsio Fibrarum Externa.
3. Connectio Cartilaginis Interarticularis.
4. Ligamentum Interclaviculare.
5. Ligamentum Rhomboides [betwixt clavicle and rib.]

(Between the clavicle and scapula).

1. Ligamentum Capsulare.
2. Ligamenta Radiata [on the point of the acromion].
3. Ligamentum Commune Trapezoides.
4. Ligamentum Commune Conoides.

(Ligaments proper to the scapula).

1. Ligamentum Proprium Triangulare, seu Deltoides.
2. Ligamentum Proprium Posterius.

(Ligaments of the shoulder joint).

1. Membrana Capsularis [strengthened by the tendons of muscles].

The most frequent dislocation is that of the humerus from the glenoid cavity of the scapula.

ELBOW.

The ELBOW-JOINT is formed by three bones; the humerus, radius, and ulna: the ulna bends backwards and forwards upon the shoulder-bone; the radius bends upon the shoulder-bone along with the ulna; it always must accompany the ulna, but it also has a motion of its own, rolling in circles; its round button-like head rolling continually with its edge upon a socket in the ulna, and with its flat face upon the tubercle of the humerus. The whole composes one joint, and is enclosed in one capsule; the bones accompany each other in their luxations, as well as in their natural motions; the ulna is never dislocated without the radius being also displaced; a circumstance which is but too little noticed, and, so far as I remember, hardly considered or known.

The radius and ulna are united principally by the INTEROSSEOUS LIGAMENT, which, as it extends in the whole length of the bones, has great strength. Towards the elbow this ligament is deficient for a space, and it is perforated by vessels. The CHORDA TRANSVERSALIS CUBITI is an oblique slip of ligament which passes from the tubercle of the ulna obliquely downwards and across to the tubercle of the radius.

LIGAMENTS OF THE ELBOW-JOINT.

The general CAPSULE arises from the humerus, from both the tubercles, and all round the two hollows which receive the olecranon and coronoid processes of the ulna; it is implanted again into the tip of the olecranon, and all round that sigmoid cavity of the ulna which receives the lower end of the humerus, and all round the edge of the coronary process. It is also fixed round the neck of the radius; it comprehends, in one bag, the humerus, radius, and ulna; and unites them into one joint, performing two motions, viz. flexion and extension by the ulna, and rolling by the radius; the joint is lubricated and protected by synovia and by fat*, which is found chiefly about the olecranon: and that the bones may be further secured, additional ligaments are spread out upon them, which are all without the common capsule of the joint, lying upon it, and strengthening it at the necessary points.

1. There is the common capsule enclosing the whole. 2. It is the form of every hinge-joint (and this is one of the purest) to have its capsule strengthened at the sides; and the sides of this, the elbow-joint, are strengthened by two fasciculi, or ligamentous bands, which, coming from the tubercles of the humerus, spread a little upon the capsule, and adhere to it like part of its substance. One, from the outer condyle, spreads upon the neck of the radius, and sends a strong division to be attached to the rough spine of the ulna, which is near the lesser sigmoid cavity of the ulna. This is of course the EXTERNAL LATERAL LIGAMENT. Another ligament, from the inner condyle of the humerus, goes upon the inside of the capsule and strengthens it there: it is implanted in the prominence on the inner edge of the coronoid process of the ulna, and is named the INTERNAL LATERAL LIGAMENT.† The continual rolling motion of the radius requires a peculiar ligament, and this peculiar

* The oil contained in the adipose membrane never exudes in the living body, and cannot lubricate.

† I see another ligament behind the internal lateral ligament, viz. arising from the internal condyle, and inserted into the side of the olecranon. There are in truth two internal lateral ligaments, and their operation is not merely to confine the motion of the joint laterally, but to check the flexion and extension of the arm; the one being made tense by the flexion, the other by the extension of the fore-arm.

ligament of the radius is named LIGAMENTUM CORONARIUM or ANNULARE, because it encircles the neck of the radius; ANNULARE or ORBICULARE, from its hoop or ring-like form; it is a very strong and narrow stripe or band, which arises from that part of the ulna where the radius rolls upon it, and surrounds the radius, making at least two thirds of a circle; and so, having turned over the neck of the radius, is inserted into the opposite side of the ulna. This is commonly described as a distinct ligament surrounding the neck of the radius, and having the common capsule implanted into its upper edge; but, in truth, it is like the others, a thicker band of the common capsule, but with a distinction much more particular here by the contrast of the great thickness of the coronary ligament, and the extreme thinness of the capsule at the fore part: for the capsule of every hinge-joint is strong only at its sides; other bands from the outer condyle, and from the coronary process of the ulna, strengthen this ligament of the radius, and are known by the general name of ACCESSORY LIGAMENTS of the coronoid ligament, as the lateral ones are known by the name of ACCESSORY LIGAMENTS to the capsule.*

RECAPITULATION.

1. Membrana Capsularis.
2. Ligamentum Laterale Internum.
3. Ligamentum Laterale Externum.
4. Ligamentum Orbiculare.
5. Ligamenta Accessoria.

The ulna is sometimes dislocated from the trochlea of the humerus. The head of the radius may be separated from the lesser sigmoid cavity of the ulna. But this part of the ligamentous apparatus of the joint is more apt to be sprained, to swell, and thence be mistaken for dislocation of the head of the radius.

WRIST.

The WRIST is one of the most moveable joints in the body, having the strength of a mere hinge-joint; (because it is almost a strict hinge, by the connection of the long ball of the carpus with the long hollow of the radius,) and having, at the same time, all the properties of the most moveable joint by the free turning of the radius, without the weakness which is peculiar to the circular and free moving joints. These distinctions divide the wrist-joint into its two parts.

1. The articulation formed by the scaphoid and lunated bones, which form an oval ball of articulation, and the great scaphoid cavity of the radius which receives this ball: the end of the ulna does not properly enter into the cavity of the wrist, but its end, or little round head, is covered with a moveable cartilage, and that cartilage represents the end of the ulna. It is called CARTILAGO INTERMEDIA TRIANGULARIS. Now,

* But the capsule ought to be called membrana capsularis; it is not a ligament, and these which are called accessory are proper ligaments. The ligament which is on the fore part of the joint, and which runs towards the *Ligamentum Annulare*, is properly called *Accessorium Annuli Anticum;* it crosses from the ulna to the external condyle; and another coming round from the olecranon, and being on the back of the joint, *Accessorium Annulare Posticum.*

this first joint, viz. of the scaphoid and lunated bones, the head of the radius, and the moveable cartilage which represents the head of the ulna, are surrounded by the general capsule or bag of the joint. The CAPSULE arises from the ends of the radius and of the ulna; from the styloid point of the one, round to the same point of the other; and is implanted near the lower rank of the carpal bones; though it adheres first to the scaphoid and lunated bones, it passes them going over all the bones of the carpus, especially in the palm, so as to add strength to their peculiar ligaments; and in the palm, the tendons for the fingers run over it: so it forms on one side an additional ligament for the carpus; on the other, it forms the floor of the tendinous sheath, a smooth and lubricated surface for the tendons to run upon. This general ligament is strengthened by particular ones coming from the styloid processes of the radius and of the ulna, which spread upon the bones of the carpus, and may be described as LATERAL ligaments; for although the wrist-joint is not accurately a hinge, yet it partakes most of that character, and the ligaments are strongest at the radial and ulnar edges of the wrist. But there are so many irregular points of bone about the wrist, that the little fasciculi, with which this capsule is covered and strengthened, are innumerable. Within this joint, and stretching from the groove betwixt the scaphoid and lunated bones, there is an internal ligament of a soft and pulpy nature; it is named LIGAMENTUM MUCOSUM; but the very name shows that it is less valuable as a ligament, (since the joint is already well enough secured,) than as a conductor for the lacunæ or ducts which secrete the synovia.

2. The articulation by which the hand performs all its turning motions is that of the radius with the ulna: this is set apart altogether from the general articulation of the joint. The lateral cavity of the radius receives the little round head of the ulna; they are enclosed in their own peculiar capsule, which is so loose about the bones, that although it is a regular capsule of the common form, it has the name of MEMBRANA CAPSULARIS SACCIFORMIS. Thus there is one joint within another; a moveable cartilage betwixt them, and the capsule of the one, the more moveable joint, peculiarly wide, and not so strong; all which should be considered in thinking about luxations of the wrist.

The carpal bones are connected with each other so very closely, that the name of joint can hardly be used. They are rather fixed than jointed together. Each bone has four smooth articulating surfaces, by which it is united to the adjoining bones. The first two bones form the great ball of the wrist; the second row again is united with the first, by a sort of ball and socket; for the os magnum, which is the central bone of the second row, has a large round head, which is received into the lunated hollow of the os lunare, which is the central bone of the first row. The first row is thus united to the second, by a distinct and general capsule, in addition to which each single bone is tied to the next adjoining, by a regular capsular ligament within, and by flat cross ligaments without, or rather by many bundles of ligaments, which cross each other in a very complicated manner, and the little flat and shining fasciculi give the whole a radiated or star-like form.* But there is a very particular

* These are the ligaments which are really so unimportant to the anatomist, or to

ligament which descends from the styloid process of the ulna to the carpus, the use of which will be understood, if we rest upon our hands, for then the whole weight of the body is sustained by it.

The metacarpal bones are also joined to the carpal in one row, by a line of joints, which are as one joint: besides their common capsule, the metacarpal of each finger has its peculiar ligaments proceeding in a radiated or star-like form from the carpal bones, and going out broad upon the metacarpal bones, and so numerous, that each metacarpal bone is securely tied by ligaments to one or two of the bones of the carpus*; and at their heads, where the fingers are implanted upon them, forming the knuckles, they are again tied by flat ligaments, which go from head to head of the metacarpal bones†, binding them together, permitting a slight bending towards each other, so as to make a hollow in the hand, but no such wide motion as might assist the fingers; they are but as a foundation upon which the fingers stand and move.

RECAPITULATION.

1. Funiculus Ligamentosus Ulnæ.
2. Membrana Capsularis.
3. Membrana Sacciformis.
4. Ligamentum Mucosum.
5. Ligamentum Cartilaginis Intermediæ.
6. Ligamentum Transversale Carpi Proprium.
7. Ligamentum Commune Carpi Dorsale.
8. Ligamentum Rhomboides.
9. Ligamenta Brevia.

FINGERS.

The joints of the fingers are formed by round heads in the upper end of one row of bones, and by hollow sockets on the lower ends of the next row; each joint is qualified, by the round form of its head, to be a circular and free moving joint; but it is restricted, by the forms of its ligaments, to the nature of a hinge-joint; for each finger-joint is included first in a fair round capsule, or bag, of the ordinary form, but that capsule is strengthened by very distinct lateral ligaments upon its sides, which lateral ligaments form the chief strength of the joints; above these lateral ligaments the joint is strengthened by a broad fascia, or sheath, which comes from the tendons of the interossei muscles, covers the backs of all the fingers, which is especially strong over the joints. One part of the apparatus of the wrist-joint is the smooth and lubricated SHEATH, in which the tendons of the fingers run. It is formed in part by the outer side of the capsule of the wrist, and in part by that bridge of ligament which proceeds from the four corner points of the carpal bones. This sheath is lined with a delicate and softer modification of the common tendinous membrane, is fully bedewed with mucus, and is

the surgeon, but which are so laboriously described under the titles of LIGAMENTA, BREVIA, OBLIQUA, TRANSVERSARIA, and PROPRIA ossium carpi; for they do in fact cross and transverse the carpus in every possible direction.

* And these also are named according to their several directions, LIGAMENTA ARTICULARIA, LATERALIA, RECTA, PERPENDICULARIA, &c.

† These are named the LIGAMENTA INTEROSSEA.

fairly to be ranked with the bursæ mucosæ, as it is indeed, like them, a shut sac. But it is farther crossed in such a manner by partitions belonging to each flexor tendon, that each of them may be said to have its appropriated bursa mucosa. And these bursæ, to prevent the bad consequences of friction, are put both betwixt the cross ligament and the tendons, and also betwixt the tendons of the uppermost muscle and of the deeper one, and again betwixt the tendons of the fingers and of the thumb.

In the same way the sheaths of the tendons, as they run along the fingers, may be considered as part of the apparatus of their joints; for the first set of bursæ, viz. those which lie in the palm of the hand, stop before they reach the first joints of the fingers, and then other longitudinal bursæ begin from the first joint of the fingers, and go all along them to the last joint, forming a sheath for the tendons to run in, which does at once the office of a strong ligament, binding them down in their places, and which is so lubricated on its internal surface, as to save the necessity of other bursæ. These sheaths are thicker in certain points, so as to form cross rings of strong ligament; but the common sheath, and these thicker rings, still form one continued canal; these are named the SHEATHS and ANNULAR LIGAMENTS, or CROSS LIGAMENTS* of the fingers, and are of the same nature with the bursæ. Besides these, there are no distinct bursæ on the fingers, but there is one of considerable size at the root of the thumb.†

JOINTS OF THE PELVIS, THIGH, LEG, AND ANCLE.

OF THE PELVIS.

THE ligaments of the pelvis may be divided into three distinct sets: —1st, those which unite the vertebræ and the sacrum: 2d, those which pass from the os ilium to the vertebræ: and 3d, those which are between the ilium and the sacrum. The ligaments which are at the upper part are of trifling importance, compared with those which form the outlet of the pelvis.

The ligaments connecting the last lumbar vertebræ to the sacrum are similar to those of the spine; so we need not describe them here.

The ilium is held in connection with the vertebræ, by two principal ligaments. The one passes from the crest of the ilium to the transverse process and body of the last lumbar vertebra, and is called LIGAMENTUM ANTICUM SUPERIUS. This ligament is often of a triangular form, owing to a small portion of it being prolonged up to the transverse process of the fourth vertebra. The other passes from the same point of the os ilium to the junction of the last vertebra with the os sacrum, and it is named LIGAMENTUM ANTICUM INFERIUS.

The principal bond of union between the os ilium and the sacrum is

* LIGAMENTA VAGINALIA, LIGAMENTA CRUCIATA, PHALANGUM, &c.
† Vide Monro's Bursæ Mucosæ.

at the sacro iliac symphysis. The scabrous surfaces of these two bones are joined by means of a ligamentous and cartilaginous substance, called the SACRO ILIAC LIGAMENT; it holds them firmly together, and allows of no motion between them. On the fore and back part there are accessory strengthening bands: those on the back part have been called generally LIGAMENTA DORSALIA VAGA; yet some have chosen to describe them separately, with the additional terms, longum, breve, laterale, annexed to them.

The LIGAMENTUM SACRO-ISCHIATICUM MAJUS OR POSTERIUS arises from the posterior part of the crest of the ilium, and from the sides and posterior part of the sacrum and os coccygis, and is attached to the tuberosity of the ischium. A portion of this ligament runs up towards the superior posterior spinous process of the ilium, and is called the superior appendix: but another more important portion, having connection with the fasciæ of the perineum, can be traced along the inside of the tuberosity of the ischium to the ramus of the os pubes: this is called the PRODUCTIO FALCIFORMIS OF WINSLOW. The LIGAMENTUM SACRO-ISCHIATICUM MINUS or ANTERIUS crosses the last; it arises from the os sacrum and os coccygis, and is inserted into the spinous process of the ischium. The tendon of the obturator internus muscle passes through the opening left between these two ligaments.

The os coccygis is united to the sacrum by ligaments resembling those of the spine, or by the continuations of those lying on the back of the sacrum: the LIGAMENTA LONGITUDINALIA.

The bones of the pubes are united by an intermediate cartilage, which has great strength, and has a considerable resemblance in its structure to the intervertebral substance which joins the bodies of the vertebræ together. This junction has the name of SYMPHYSIS or SYNCHONDROSIS OSSIUM PUBIS; and it is strengthened by a ligament which embraces it all round, and is called ANNULUS LIGAMENTOSUS. The connection of the ossa pubis is further strengthened by the TRIANGULAR LIGAMENT, which passes across from the ramus of each bone, and to which the urethra is suspended. The obturator foramen is closed by the MEMBRANA OBTURANS, except a small portion at its upper part, through which the obturator artery and nerve pass.

OF THE HIP-JOINT.

The acetabulum, which is rough in the naked bone, is naturally lined with a thick and very smooth cartilage. The head of the thigh-bone is covered with a similar cartilage, also very thick and smooth; and these cartilages almost fill up that deep dimple which is seen in the centre of the head of the thigh-bone, and smooth that hole which is formed in the centre of the socket, by the meeting of the several pieces of which it is composed. The socket is not only deep in its bones, but is further deepened by the cartilage which tips the edge of the socket, and which stands up to a considerable height. The socket is imperfect at that side which looks towards the thyroid hole; the bony edge is entirely wanting there, and the space is filled up by a strong cartilaginous ligament, which goes across this gap, from the one point to the other, and from its going across is named the LIGAMENTUM LABRI CARTILAGINEI TRANSVER-

SALE.* The capsular ligament of the hip-joint is the thickest and strongest of all the body. It is, like other capsules, a reflection and thickening of the periosteum; the periosteum coming along the outside of the bone, leaves it at the edge of the socket. The periosteum, or rather perichondrium from the inside of the socket, comes up to the edge, and meets the outer layer. They unite together, so as to form the general capsule enclosing the ring-like cartilage, which tips the edge of the socket between them. This ligament encloses all the bones from the edges of the socket to the roots of the trochanters, embracing not only the head, but the neck of the thigh-bone. The outer-plate, continuous with the periosteum, is thick and strong, and is assisted by much cellular substance condensed round it, and it is further thickened by slips which come from the iliacus, rectus, and other muscles which pass over the joint, while the external plate of the ligament lines the whole with a soft and well lubricated coat.

In addition to this general capsule, there are two internal ligaments, 1st, the round ligament, as it is called, which comes from the centre of the socket to be fixed into the centre of the ball of the thigh-bone. It is not round, but flat or triangular. It has a broad triangular basis, rooted in the socket exactly at that place where the several bones of the socket meet, forming a triangular ridge, which gives this triangular form to the central ligament. It has three angles, and three flat sides. It is broad where it arises from the bottom of the socket, is about an inch and a half in length, grows narrower as it goes outwards towards the head of the bone, and is almost round where it is implanted into the dimple in the head of the thigh-bone, at which point it is so fixed as to leave a very remarkable roughness in the naked bone. But round the roots of this ligament, and in the bottom of the socket, there is left a pretty deep hollow, which is said to be filled up with the synovial gland. It is wonderful how easily authors talk of the synovial gland, as if they had seen it; they describe very formally its affections and diseases, as when hurt by a blow upon the trochanter; yet there is no distinct gland to be found. There is a fringed and ragged mass lodged in the bottom of the socket, hanging out into the hollow, and continually rubbed by the ball of the thigh-bone in its motions: the fringes and points certainly are ducts from which we can squeeze out synovia; but it is by no means proved that they belong to a synovial gland, and it looks rather as if the ducts were themselves the secreting organ, like the lacunæ, or mucous bags in the tongue, or in the urethra, vagina, œsophagus, and other hollow tubes. Such a structure is fitter for suffering the strong pressure and continual action of the thigh-bone, than any determined gland. We see, then, nothing but mucous-like ducts of a fringed form, hanging down from this hollow in the cavity of the joint, a quantity of fat accompanying these fringes, and a pappy synovial membrane, which keeps these fringes and fatty membranes orderly and in their places, and which ties them so to the angles of the triangular ligament, that they must move with the motions of the joint. This mucous mem-

* This ligament is double, that is, there is one on the inside of the edge, and one on the outside; thence it is often reckoned as two ligaments, viz. LIGAMENTUM TRANSVERSALE INTERNUM et EXTERNUM.

brane, which keeps these fatty fringes orderly, has two or three small bridles in different directions, whence they are named the LIGAMENTA MUCOSA, or ligamentula massæ adiposæ glandulosa; and this may be considered as the continued inflection of the softer internal lamella of the capsule, which not only lines the socket, but is reflected over the central ligament, and over the globe of the thigh-bone, covering them also with a delicate synovial coat. Other fringes of the same kind are found at the lower part of the joint, lying round the neck of the thigh-bone, near the angle where the capsular ligament is implanted into the root of the great trochanter: the liquor from these fimbriæ, with the general serous exudations, are mixed and blended for lubricating the joint.

This capsule, which is naturally the thickest and strongest in the body, almost a quarter of an inch in thickness, is further strengthened by many additions; for a slip of very strong tendinous or ligamentous substance condensed, comes down from the lower spinous process of the os ilium, and spreads out over the capsule, and strengthens it very much on its fore part; the smallest of the glutæi muscles adheres to the capsule, and strengthens it behind; the psoas magnus and iliacus internus pass by the inner side of the capsule, and though they do not absolutely adhere to it, they deposit much cellular substance, which is condensed so as to strengthen the capsule, forming at the same time a large bursa mucosa, betwixt their tendinous fibres and the joint. That tendon of the rectus muscle which comes from the margin of the socket, lies upon the outer side of the capsule, adheres to it, and strengthens it. The security of the hip-joint seems to depend more upon the strength of its capsular ligament, than that of almost any other joint.

RECAPITULATION OF THESE LIGAMENTS.

1. Ligamentum Capsulare.
2. Ligamentum Accessorium Anticum.
3. Ligamentum Teres.
4. Ligamenta Labri Cartilaginei.
5. Ligamentula Massæ Adiposæ.

The head of the thigh-bone is subject to dislocation upward and outward, and also to displacement downward and forward.

THE KNEE-JOINT.

The knee-joint is one of the most superficial joints, and one of the weakest so far as relates to the bones, for the flat condyles of the thigh-bone are merely laid upon the flat head of the tibia. There is here no fair cavity, receiving a large head, as in the joint of the hip; no slighter ball and socket, as in the fingers; no strong over-hanging bones, as in the shoulder; no hook-like process, as in the ulna. This is not a hinge-joint, like the ancle, secured between two points of bone. We do not find the means of strength in its bones, but in the number, size, and disposition of the great ligaments with which its bones are joined; by virtue of these ligaments it is the strongest joint of the human body, the most oppressed by great loads, the most exercised in continual motions, yet less frequently displaced than any other. But this complication of ligaments, which gives it mechanical strength, is the very cause of its constitutional weakness, makes it very delicate, and very liable to disease.

The bones which compose this joint are the tibia, thigh-bone, and patella; and they are united by many ligaments, both within and without the joint.

1. The CAPSULE of the KNEE is naturally thin and delicate. This thin capsule comes from the fore part of the thigh-bone, all round the articulating surfaces, whence it goes downwards by the sides of the condyles: from this origin it is inserted into all the edge of the rotula, and in such a way as to keep the rotula properly without the cavity of the joint, the synovial membrane going over its inner surface, and lining it with a smooth and delicate coat. It is fixed below into all the circle of the head of the tibia, and thus completes its circle, embracing all the bones. This capsule, naturally so thin and delicate, is made up from all the surrounding parts to a considerable thickness; first, it is covered behind by the heads of the gastrocnemii; at the sides, by the biceps, and other muscles of the hamstrings; on its fore part, it is strengthened by the general fascia of the thigh, which goes down over the knee, and being there reinforced both by its adhesion to the bones, and by the broad expansion of the vastus internus, sartorius, biceps, and other muscles which go out over the patella, it adheres to the capsule, and makes the whole very strong; besides which, there is a ligament, which, lying in the ham, upon the back part of the capsule, is named, in compliment to Winslow, LIGAMENTUM POSTICUM WINSLOWII. It is a ligament somewhat resembling the lateral ligaments of the elbow. It arises from the outer condyle, goes obliquely across the back part of the joint, adheres to it, and strengthens it; but often it is not found at all, or in such straggling fibres as cannot be accounted a ligament.* It is manifest that the knee requires some such additional ligaments behind to serve as a check, and to prevent its yielding too far.

2. The knee, as being a hinge-joint, has strong ligaments at the sides, and here the lateral ligaments are particularly distinct, and can be raised from the capsule; on the inner side of the joint, there comes down from the internal condyle of the thigh-bone, a broad flat ligament, which is fixed into the inner head of the tibia, and is named the internal lateral ligament; on the outside of the knee, there descends from the tip of the outer condyle a much stronger ligament, not quite so flat, rather round: it extends from the condyle of the thigh-bone to the bump of the fibula which it embraces. It is a little conical from above downwards; it is from two to three inches in length, and is named LIGAMENTUM LATERALE EXTERNUM LONGIUS, to distinguish it from the next; for behind this first external ligament, there arises a little lower from the same condyle, along the outer head of the gastrocnemius muscle, a ligament which is called the LIGAMENTUM LATERALE EXTERNUM BREVIUS, and it is not shorter only, but so spare as not to be easily distinguished, not having the true form of a lateral ligament coming down from the con-

* Often it is irregular, or in straggling fibres; but I have never found it wanting.

dyle, but of a mere strengthening of the capsule, coming upwards from the knob of the fibula.*

3. The joint is still further secured by internal ligaments which are within the cavity of the joint; they are named the CRUCIAL LIGAMENTS of the knee. They arise betwixt the hollow of the condyles of the thigh-bone, and are implanted into the back part of the middle rising of the tibia: they lie in the back part of the joint, flat upon the back of the capsule, and the one crossing a little before the other (but yet in contact with each other, at the place of crossing); they are distinguished by the names of ANTERIOR and POSTERIOR CRUCIAL LIGAMENTS.

The POSTERIOR CRUCIAL ligament is more perpendicular; it arises from the hollow betwixt the condyles of the thigh-bone, and is implanted into a roughness on the back of the tibia, betwixt its two cup-like hollows, and behind the tubercle which divides these hollows from each other. While the posterior arises rather from the internal condyle, the ANTERIOR LIGAMENT arises properly from the external condyle, passes obliquely over the tuber, in the articulating surface of the tibia, and terminates in the cup-like hollow. The effect of these two ligaments is more particular than is commonly observed; for the one goes obliquely out over the articulating surface of the tibia, while the other goes directly down behind the joint; and of course when the knee is bended, the anterior ligament is extended; when the leg is stretched out, the posterior ligament is extended; they both are checks upon the motions of the joint: the posterior ligament prevents the leg going too far forwards, the anterior ligament prevents it being too much bent back upon the thigh.†

4. The most admirable part of the mechanism of this joint, is the two SEMILUNAR CARTILAGES. They are so named from their semilunar form; they lie upon the top of the tibia so as to fill up each of them one of the hollows on the top of that bone. They are thicker towards their convex edges, thinner towards their concave edges; they end by two very acute and long horns, named the CORNUA of the lunated cartilages. In short, they resemble the shape of the label which we put round a wine decanter; and the two horns are tied to the tubercle, or ridge that stands in the middle of the articular surface of the tibia, and consequently they are turned towards each other, so as to touch in their points. There are here, as in the other joints, masses of fat enclosing the fimbriated ends of the mucous ducts. These fimbriæ, and fatty bundles, are formed chiefly round the circumference of the patella, commonly surrounding it with a complete fringe; they are also found at the back of the cavity, about the crucial ligaments, and in all the interstices of the joint, the fatty bundles filling up the interstices; there is one principal bed of this fatty matter at the lower part of the patella and around the commencement of its ligament.

* Some strong, but irregular accessory ligaments go down to that part of the head of the tibia which is before the head of the fibula.

† There is not attention enough paid to the origins of these ligaments from the femur; for it is the origin from the thigh-bone which determines their operation. The posterior ligament comes from the root of the internal condyle, and depth of the semilunar notch, anterior to the centre of motion of the femur on the tibia; it is consequently stretched in extending the leg. The anterior ligament arises from the root of the external condyle, posterior to the centre of motion; it is consequently stretched in the flexion of the knee-joint.

These masses of fat lie covered by the delicate internal surface of the capsule, and the mucous fimbriæ are also covered by it.

The inner surface of the capsule is so much larger than the joint which it lines, that it makes many folds or lurks, and several of these are distinguished by particular names. Thus, at each side of the patella there are two such folds, the one larger than the other, whence they are named LIGAMENTUM ALARE MAJUS, and LIGAMENTUM ALARE MINUS. These two folds are like two legs, which join and form one middle fold, which runs across in the very centre of the joint, viz. from the lower end of the patella to the point of the thigh-bone, in the middle betwixt the condyles. It keeps the looser fatty bundles and fimbriated ducts in their place (viz. the hollow betwixt the condyles, where they are least exposed to harm); thence it has been long named the LIGAMENTUM MUCOSUM. The internal membrane of the joint covers also the semilunar ligaments, as a perichondrium; it comes off from the ridge of the tibia, touches the horns of the semilunar cartilages, moves over the cartilage, so as to give them their coat, and at the point where it first touches the horns, it forms four little ligaments, two for the horns of each cartilage. These tags by which the four points of the lunated cartilages are tied, are named the LIGAMENTA CARTILAGINUM LUNATARUM, or more simply named the four adhesions of the lunated cartilages. There is a little slip of ligament, which goes round upon the fore part of the knob of the tibia, and ties the fore parts of these two cartilages to each other. It is named LIGAMENTUM TRANSVERSALE COMMUNE because it goes across from the fore edge of the one cartilage to the fore edge of the other, and because it belongs equally to each; but for their further security, these cartilages also adhere to their outer circle, or thick edge, to the internal surface of the general capsule of the joint by the LIGAMENTUM CORONARIUM, and that again adheres to the lateral ligaments which are without it; so that there is every security for these cartilages being firm enough in their places to bear the motions of the joint, and yet loose enough to follow them easily.

This joint has the largest bursæ mucosæ of all, and these perhaps the most frequently diseased. There is one bursa above the patella, betwixt the common tendon of the extensor muscles and the fore part of the thigh-bone, which is no less than three inches in length. There is a smaller bursa about an inch below the patella, and under the ligament of the patella, protecting it from friction, upon the head of the tibia. These bursæ, I am persuaded, are often the seat of disease, when it is judged to be in the joint itself. But the truth is very easily known; for if a swelling appear under the patella, projecting at the sides, and raising the patella from the other bones, we are sure that it must be in the main cavity of the joint: but if swellings appear above and below the patella, then there is reason to believe that these belong to the great bursæ, which are placed above and below the patella, a complaint which is far less formidable than a swelling of the joint itself: I would almost say, easily cured; for openings into these bursæ, though they should be avoided, are less dangerous than openings into the joint. It is from mistaking such tumours for collections in the capsule itself, that authors speak of openings into the joint as a familiar or easy thing, or think that they have done such operations safely, when probably they were puncturing the bursæ only.*

These bursæ mucosæ lie under the tendon of the extensor muscles, and under the ligament of the patella: they are of the same substance with the capsule of the joint itself; they lie over the capsule, united to it by cellular substance; and the bundles of fat which are disposed irregularly about the joint belong partly to the bursæ and partly to the capsule; one end projecting into the cavity of the bursæ, while the other end of the same fatty bundles projects into the cavity of the joint.

Thus the knee-joint, which is the most important in all the body; the most oppressed by the weight of the trunk, and by the accidental loads which we carry; the most exercised in the common motions of the body, and the most liable to shocks and blows; which is the most superficial and the weakest in all that respects its bones, is the strongest in its ligaments, and the most perfect in all the provisions for easy motion.

1. The great CAPSULE, of the joint encloses the heads of the bone; its synovial membrane secretes and contains the synovia; lines the joint with a smooth and delicate membrane, and, by turning over all the parts, and adhering to them, it forms the perichondrium for the cartilaginous heads of the bones, and the covering for the moving cartilages of the joint.

2. This capsule, which is exquisitely thin, and which was formed for other uses than for giving strength to the joint, is surrounded on all sides with such continuations of the common fascia, and such particular expansions of the ham-string and other muscles, as by adding outwardly successive layers to the capsule, brings it to a considerable degree of strength.

3. The capsule, having no stress upon its fore part, is very thin upon its fore part, viz., at the sides of the patella, but is strengthened at the sides by fair and distinct ligaments, going from point to point of the three great bones, and so large and particular as to deserve, more than any others in the body, the name of LATERAL LIGAMENTS. At the back part of the joint the same strength is not required as at the sides; yet it must be stronger than at its fore part, wherefore it is strengthened by the additional bands, which are sometimes general and confused, but often so perfect and distinct as to be known by the name of the POSTERIOR LIGAMENT of WINSLOW; and as the lateral ligaments prevent all lateral motions, this strengthening of the capsule serves as a check-band behind.

4. It is only in the greatest joints that we find the additional security of INTERNAL LIGAMENTS; and the only joints where they are perfect, are the joints of the hip and of the knee; the former having its round, or rather triangular ligament, which secures the great ball of the thigh-bone, and fixes it in its place; the latter having its crucial ligaments, which, coming both from one point nearly, and going the one over the face of the tibia, and the other down the back of that bone, serve the double purpose of binding the bones firmly together, and of checking

* I believe that the great bursæ and the joint always communicate largely; and that being consequently one continuous surface, the opening of the bursæ would be highly improper.—C. B.

the larger and dangerous motions of the joint, the back ligament preventing it going too far forwards, and the fore ligament preventing it bending too much.

5. A MOVING CARTILAGE for facilitating motion and lessening friction is not common, but is peculiar to those joints whose motions are very frequent, or which move under a great weight; such are the inner head of the clavicle, the articulation of the jaw, and the joints of the wrist and of the knee; and it is in the knee that the moveable cartilages have their most perfect forms and use, are large, flat, and semilunar, to correspond with the forms on the head of the tibia; thicker at their outer edges, to deepen the socket; and though moveable, yet so tied with ligaments, as never to go out from their right place.

And, 6. The mucous folicular bundles of fat, and the bursæ mucosæ, which complete the lubricating apparatus of the joint, and the mucous frenulæ or ligaments, which both conduct the mucous fringes and keep them in their place, are more perfect in the knee, and greater in number and size, than in any other joint.

I may well call this the most complicated, and (by daily and melancholy proofs) it is known to be the most delicate joint of the body.

LIST OF THE LIGAMENTS OF THE KNEE-JOINT.

External to the capsule these:

1. Ligamentum Patellæ.
2. Ligamentum Laterale Internum.
3. Ligamentum Laterale Externum Longum.
4. Ligamentum Laterale Externum Breve.
5. Ligamentum Posticum Winslowii.

Within the capsule these:

6. Ligamentum Mucosum.
7. Ligamentum Alare Majus.
8. Ligamentum Alare Minus.
9, 10. Ligamenta Crucialia.
11. Ligamentum Coronarium.
12. Ligamentum Transversale.
13, 14, 15. Ligamenta Cornuum Cartilaginum Semilunarium.

The most frequent accident to this joint is the sprain of the internal lateral ligament.

FIBULA.

The FIBULA is a support to the tibia in its various accidents; it gives a broader origin to the muscles, and it is the chief defence of the ancle-joint. It has no motion upon the tibia. The best authors speak of it as a symphysis, which classes it with the joinings of the pelvis, and excludes it from the list of true and moveable joints. It is united with the tibia by a sort of flat cartilaginous surface upon either bone; it is merely laid upon the tibia, not sunk into it. It is tied by a close capsule: it has an anterior and posterior accessory ligament; and is strengthened by the external lateral ligament of the knee, which adheres to this knob, and by the insertion of the biceps tendon, which is implanted into this point, and which spreads its expanded tendon over the fore part of the tibia, and holds the bones together; and the firmness of the fibula is further secured by the great interosseous ligament, which goes from bone to bone. Towards the head of the bones the interosseous ligament is deficient.

ANCLE.

The ANCLE-joint owes less of its strength to ligaments than to the particular forms of its bones; for while the strong lateral ligaments of the knee guard it so that it cannot be dislocated till they are torn, the lower heads of the tibia and fibula so guard the foot, that when luxated these bones are often broken. First, the fibula is so connected with the tibia, at its lower end, that they form together one cavity for receiving the astragalus, with two projecting points, the fibula forming the outer ancle, and the tibia forming the process of the inner ancle; the joining of the fibula to the tibia here, is like that of its upper end, too close to admit of the smallest motion, and it is thoroughly secured by particular ligaments, one of which, passing from the fibula to the tibia on the fore part, is named the LIGAMENTUM SUPERIUS ANTICUM, consisting, in general, of one or two distinct flat bands. Another more continued and broader ligamentous membrane goes from the fibula to the tibia across the back part, and is named LIGAMENTUM POSTICUM SUPERIUS; the LIGAMENTUM POSTICUM INFERIUS being but a slip of the same. Next comes the capsule of the joint, which joins the astragalus to the lower heads of the tibia and fibula; it is thinner both before and behind than we should expect from the strength of a joint which bears all the weight, and the most violent motions of the body. But, in fact, the capsule every where serves other purposes than giving strength to the joint, and never is strong, except by additional ligaments from without; so it is with the ancle-joint, the capsule of which is exceedingly thin before; but it is strengthened at the back part, and especially at the sides, by supplementary ligaments: First, a strong ligament comes down from the acute point of the inner ancle, expands in a radiated form upon the general capsule; adheres to it, and strengthens it, and is fixed all along the side of the astragalus, to the os calcis and naviculare. This ligament, coming from one point, and expanding to be inserted into a long line, has a triangular form, whence it is named LIGAMENTUM DELTOIDES; and while the general ligament secures the joint towards that side, the oblique fibres of its fore edge prevent the foot being too much extended, as in leaping; and its oblique fibres on the back edge prevent its being too much bended, as in climbing. But the ligaments of the outer ancle, tying it to the outer side of the astragalus, are indeed distinct, one going forwards, one going backwards, and one running directly downwards; one goes from the point or knob of the fibula, obliquely downwards and forwards to be inserted into the side of the astragalus; it is square and flat, of considerable breadth and strength, and is called LIGAMENTUM INTER FIBULAM ET ASTRAGALUM ANTERIUS. Another ligament goes perpendicularly downwards, from the acute point of the outer ancle, to spread upon the side of the astragalus, and of the capsule, and is finally inserted into the heel-bone; this is named the LIGAMENTUM INTER FIBULAM ET OS CALCIS PERPENDICULARE. A third ligament goes out still from the same point, to go backwards over the back part of the capsule, adheres to the back of the capsule, and strengthens it, and is named LIGAMENTUM INTER FIBULAM ET ASTRAGALUM POSTERIUS. There is nothing very particularly worthy of notice in the ancle-joint, for it is covered with cartilages, lined with a soft synovial membrane, and lubricated with fimbriæ and masses of fat, such as are found in all the joints. It is stronger than the other joints; it can hardly be luxated, without a laceration of its ligaments, and breaking of the bones which guard it at either side; and it is the great violence which is required for completing this dislocation, and the terrible complication of dislocation, fracture, and laceration of the skin, which makes this accident so dangerous beyond any other luxation.

RECAPITULATION.

From the fibula to the tarsus:
1. Ligamentum Fibulæ Perpendiculare.
2. Ligamentum Fibulæ Anterius.
3. Ligamentum Fibulæ Posterius.

From the tibia to the tarsus:
4 Ligamentum Deltoides.
5. Ligamentum Capsulare.

Accidents to this joint are very frequent: the sprain of the deltoid ligament is very frequent; so is the partial laceration of the perpendicular ligament of the fibula. We have to distinguish this last case from the sprain of the tendons of the peronæi muscles, which is a very frequent accident.

UNION BETWIXT THE BONES OF THE TARSUS.

The ASTRAGALUS, OS CALCIS, OS NAVICULARE, and all the bones of the tarsus, are united to each other by large heads, and have distinct and peculiar joints; besides which, the bones are cross-tied to one another by ligaments, so numerous and complicated, that they cannot nor need not be explained. They pass across from bone to bone, in an infinite variety of directions, some longitudinal, some transverse, and some oblique. There is a curious complication, which we may call a web of ligaments, covering the dorsum of the foot with shining and star-like bundles; these are called LIGAMENTA DORSALIA: each bone has its capsular ligaments for joining it to the next; each joint of each bone has its articulating cartilages always fresh and lubricated; each joint has, besides its capsule, flat strips of oblique, longitudinal, and transverse ligaments, joining it to the nearest bones. On the inside of the sole of the foot a strong ligament of a gristly nature passes across from the projecting point of the os calcis to the os naviculare, and forms an elastic spring, upon which the articulating head of the astragalus rests: this is called LIGAMENTUM CARTILAGINEUM, the central gristly part being the trochlea cartilaginea. In the centre of the sole of the foot there are irregular bands, distinguished as PLANTARE MAJUS and MINUS, PLANUM and TERES. On the outside there is a principal ligament extending from the os calcis to the os cuboides: this is divided into two, both of them being called LIGAMENTUM INTER OS CALCIS ET OS CUBOIDES, but one is the long and the other the oblique.

The metatarsal bones have their capsular ligaments joining them to the tarsal bones; and they have ligaments strengthening their capsules, and tying them more strongly to the tarsal bones; and as in the metacarpal bones, the several ranks are tied one to another by cross ligaments which pass from the root of one bone to the root of the next; so we have ligaments of the same description and use, holding the metatarsal bones together, both on the upper and on the lower surface of the foot; and all the ligaments of the foot are of great strength and thickness. The lower ends of the metatarsal bones have also transverse ligaments by which they are tied to each other. The toes have hinge-joints formed by capsules, and secured by lateral ligaments, as those of the fingers are; and, except in the strength or number of ligaments, the joinings of the carpus, metacarpus, and fingers, exactly resemble the joinings of the tarsus, metatarsus, and toes.

But these ligaments, though helping to join the individual bones, could not have much effect in supporting the whole arch of the foot. It is further secured by a great ligament, which extends, in one triangular and flat plate, from the point of the heel to the roots of each toe. This is named the APONEUROSIS PLANTARIS PEDIS, which is not merely an aponeurosis for covering, defending, and supporting the muscles of the foot; that might have been done on easier terms with a fascia very slight, compared with this; but the chief use of the plantar aponeurosis is in supporting the arch of the foot. It passes from point to point, like the bow-string betwixt the two horns of a bow, and after leaping, or hard walking, it is in the sole of the foot that we feel the straining and pain; so that, like the palmar aponeurosis, it supports the arch, gives origin to the short muscles of the toes, braces them in their action, and makes bridges under which the long tendons are allowed to pass: it comes off from the heel in one point; it grows broader in the same proportion as the sole of the foot grows broad. It is divided into three narrow heads, which make forks, and are inserted into the roots of the second, third, and fourth toes; and the great toe and the little toe have two smaller or lateral aponeuroses, which cover their own particular muscles, and are implanted into the roots of the great toe and of the little toe.

The bursæ mucosæ surround the ancle and foot in great numbers. None of them having any very direct connection with the joint, and most of them accompanying the long tendons as they pass behind the ancle, or in the sole of the foot, are of that kind which we call tendinous sheaths. First, there are sheaths of two or three inches long, which surround the tendons of the tibialis posticus, and of the peronæi muscles, as they pass down behind the ancle. The sheaths of the peronæi begin from that point where the tendons first begin to rub against the bone, and are continued quite down into the sole of the foot; making first a common sheath for both tendons, and then a bursa peculiar to the tendons of the peronæus brevis muscle, and about an inch in length. When the peronæus longus begins to pass under the sole of the foot, the sheath which enclosed it behind the ancle is shut, and a new bursa begins; in the same manner where the tendons of the flexor pollicis, and flexor digitorum pedis, pass behind the inner ancle, a bursa of three inches in length surrounds them, and facilitates the motion. As the tendons of the flexor muscle go under the arch of the foot, they lie among soft parts, and rub chiefly against the flesh of the massa carnea, and the belly of the short flexor muscle: but whenever they touch the first joints of their toes, they once more rub against a hard bone. New bursæ are formed for the tendons; each bursa is a distinct bag, running along the flat face of the toe, and is of a long shape, and the tendon is carried through the centre of the lubricated bag, so that we see once more, that there is no true distinction betwixt bursæ mucosæ and tendinous sheaths; nor betwixt the tendinous sheaths and the capsules of joints.

Joints have been arranged under various forms, as shown in the beginning of this chapter, but not with much success; and I do not know that enumerating the joints in any particular order will either explain the motions of individual joints, or assist in recording their various forms; some joints are loose and free, capable of easy motions, but weak in proportion, and liable to be displaced; such is the JOINT of the SHOULDER, which rolls in every direction; other rolling joints, more limited in their motions, are better secured with ligaments of peculiar strength; such is the JOINT of the HIP, where the ligaments are of great strength both within and without; some wanting all circular motions, are hinge-joints, by the mere form of their bones; such are the LOWER JAW, the VERTEBRÆ, the ELBOW, and the ANCLE-JOINTS; some are hinges by their ligaments, which are then disposed only along the sides of the bones; such are the KNEE, the RIBS, the FINGERS, and the TOES. Some joints partake of either motion, with all the freedom of a ball and socket-joint, yet with the strength and security of the strictest hinge: thus the WRIST having one joint by which its turning motions are performed, and another joint by which it rolls, has the two great endowments so rarely combined in any joint, of the freest motion, and of great strength; so also has the HEAD, by the combination of two joints of opposite uses and forms; for its own condyles play like a mere hinge upon the atlas, and the axis of the dentata secures all the properties of a circular joint; this combination gives it all the motions of either joint, without their peculiar defects. But there is still a third order of joints, which have such an obscure and shuffling motion, that it cannot be observed. The CARPUS and METACARPUS, the TARSUS and METATARSUS, the TIBIA, with the FIBULA, have these shuffling and almost immoveable joints; they are not intended for much motion among themselves, but are appointed, by a diffused and gradual yielding, to facilitate the motions of other joints.

OF THE BURSÆ MUCOSÆ.

The BURSÆ MUCOSÆ are little bags or sacs, placed betwixt the tendons and bones, where there is much friction. By the smoothness of their inner surfaces, and the lubrication of their surfaces, by a fluid similar to the synovia, they act the office of friction wheels in machinery, and take off the too severe pressure or friction from the bone or tendon. As they are of a structure similar to the apparatus of joints, they are subject to similar diseases. This most common disease is a kind of dropsy, which produces a puffiness or compressible swelling around the joint. Although we have mentioned the principal bursæ, in treating of the joints and the muscles, yet we consider it right to enumerate them here.

In connection with the SHOULDER-JOINT, these:

1. A very large bursa under the acromion, and betwixt it and the head of the humerus.
2. Betwixt the head of the clavicle, and the coracoid process of the scapula.
3. Upon the capsule of the shoulder-joint, under the tendon of the subscapularis muscle.
4. Under the deltoid muscle.
5. Under the tendon of the latissimus dorsi.

The principal bursæ around the ELBOW-JOINT, are these:

1. Betwixt the tendon of the biceps flexor cubiti, and the radius.
2. Over the round head of the radius, and below the extensor muscles.
3. On the olecranon and end of the humerus, under the triceps tendon.

About the WRIST, these:

1. A large bursa betwixt the flexor tendons, and the carpus.
2. On the trapezium.
3. On the pisiforme.
4. On the back of the carpus, and under the extensor carpi radialis.
5. Betwixt the ligament of the wrist, and the tendon of the extensor carpi ulnaris.

Besides these sacs or proper bursæ, sheaths surround the tendons of almost all the muscles about the wrist-joint.

On the PELVIS, these:

1. A large bursa betwixt the glutæus maximus, and the vastus externus.
2. Betwixt the capsule of the hip-joint, and the psoas and iliacus internus.
3. Under the pectinalis.
4. A large one on the surface of the trochanter major, under the glutæus maximus.—Also, under the glutæus minimus.
5. On the os ischii, under the origin of the biceps.
6. Under the tendons of the rotators of the thigh-bone.

In the THIGH, and around the KNEE-JOINT, these:

1. Under the tendon of the quadriceps, and communicating with the knee-joint.
2. Under the ligament of the patella.
3. Betwixt the insertion of the semimembranosus, and the origin of the gastrocnemius.
4. Over the internal lateral ligament of the knee-joint.
5. Under the popliteus.

N. B. Several irregular bursæ around the tendons inserted into the tibia and fibula.

Around the ANCLE-JOINT.

All the principal tendons which cross the ancle-joint have bursæ under or around them, as the tendon of the tibialis anticus, the extensor proprius, the extensor digitorum, the peronæus longus and brevis. There is also a proper bursa betwixt the tendo Achillis and os calcis. Another under the flexor longus pollicis; and also under the flexor longus digitorum, and the tibialis posticus.

These bursæ it is necessary for the surgeon to know, because after sprain and injuries, effusion takes place in them, and they present a puffy swelling over the joint, not easily understood, without the recollection of the natural anatomy.

OF THE CIRCULATING SYSTEM.

We have already understood that a continual revolution or change of the material of the animal frame is necessarily connected with life. The living principle may be joined to the animal or vegetable matter, and remain in a latent state*; but when its presence is betrayed by action, it has begun a course of existence through certain defined stages, and during this active condition, all the material of the frame performs a continual revolution.

While solids are necessary to the constitution of the frame, fluids are necessary to these internal changes. From the fluids the solids are formed, and the solids are again broken down and change their condition of aggregation, and become fluid, and circulate in the vessels. The fluid blood and the blood vessels are therefore necessary to all the operations of life, since without them the revolution of solids into fluids, and fluids into solids, could not take place; the body would be stagnant and fixed, and no better than a machine, which being broken or wasted, possesses no power of reparation.

The Hunters began their demonstration of the system by exhibiting the condition of the blood, and the splendid consequences which attended this mode should incline us to follow their example.

QUALITIES OF THE BLOOD.

Blood is a fluid of a rich and beautiful colour: it is vermilion-coloured in the arteries, strong purple in the veins, and black, or almost so, at the right side of the heart, and varies somewhat in the depth of its colour in certain parts of the body; it feels thick and unctuous betwixt the fingers, and is of a slightly saline taste. The quantity of blood in the body is estimated to be thirty pounds in a man weighing one hundred and fifty pounds; or one fifth of his weight; and it is supposed that three fourths of this is in the veins, and the remaining fourth only in the arteries. In various individuals, but much more in different animals, it varies with their functions and manner of life; it is different in birds, in fishes, in insects; it is red or pale, warm or cold, in different classes of animals: and from this last variety comes our division of animals into those of warm and cold blood. When drawn from a vein, the blood spontaneously coagulates in about three or four minutes, and at this

* Mr. Hunter, in his lecture, illustrated the condition of life in the seed before vegetation, or in the egg before incubation, by the discoveries of Black, of the presence of heat in bodies in an insensible state.

time heat is evolved and the temperature is raised 7 or 8 degrees, and carbonic acid gas is evolved.*

It is by the most simple and natural methods that we examine the blood; since when drawn from a vein it almost spontaneously resolves itself into the CRASSAMENTUM, the SERUM, and the RED GLOBULES, suspended in the crassamentum, and forming a part of it. In a cup of blood, the crassamentum, or clot, the hepar sanguineum, as it was called long ago, floats in the serum; the red globules are engaged in this clot, and give it colour; the serum may be poured off; and the coagulum may be washed till it is freed of the red parts of the blood, and then the red particles are found in the water with which the coagulum was washed, and the coagulum remains upon the strainer, little reduced in size, pure and white, the proper fibrin. Or we may separate this part by a method which Ruysch first taught us; we may, while the blood is congealing, stir it with a bunch of rods, when the pure and colourless fibrin gathers upon the rods, and the serum, with the red particles suspended in it, remains behind. The coagulable part was called fibrin, from the fibrous appearance it assumed in this experiment, a name it has retained.

The red globules, as we have observed, are not universal; yet in all creatures, even in colourless insects, there seem to be formal particles in the blood.

The red globules of the human blood are easily seen; they are best examined with a simple lens, the globules being diluted in serum and laid upon an inclined plane, not in water, which dissolves them quickly, but in serum, which has the property of preserving their globular form. The watery solution of this part of the blood turns the syrup of violets green, and contains soda and albumen. The size of the particles of the blood varies in various creatures: it is asserted that, in the fœtus, they are bigger than in a grown animal; and although Leeuwenhoek thought it essential to his doctrine to say that they were alike in all creatures, there are, in respect to the size of the animals, the strangest reverses. The Skate has red globules much larger, and the Ox has globules much smaller than those of a Man. Fish have large globules, Serpents smaller ones, and Man smaller still. In Man the diameter of each globule has been estimated not to exceed the five thousandth part of an inch.

There is in the effect of lenses, or in the nature of these globules, some strange refraction, by which there seems a darkness in the centre of each globule, and thence a deception which has been universal; so that no single description has tallied with that which went before. Leeuwenhoek believed that he saw them consisting each of six well-compacted smaller globules. Hewson believed that they were bladders, which had within them some central body, loose and moveable; that often the central part might be seen rolling in its bag; and that sometimes the bladder was shrunk and shrivelled around the central body, and could by putting a drop of water upon it, be plumped up again. The Abbé Torre examined them with simple lenses too; but they magnified so highly, that from this cause all his noisy mistake has arisen; for he used not ground lenses but small sphericles of glass formed by

* *Brande.*

dropping melted glass into water; they magnified so much, that to him the central spot appeared much darker; he said that these were not globules, but rings. He sent his sphericles of glass and his observations from Italy, his own country, to our Royal Society; and for a long while, though nobody could see them, still the public were annoyed by Abbé Torre's rings. Falconer, with all the zeal of a friend, published Hewson's discoveries after he was dead; lamenting, as we all must do, the loss of a promising young man. Falconer thought he saw these globules, not as spheres, but as flattened spheres; he thought he saw them often as they rolled down the inclined plane upon which he placed them, turning their edges, their sides, their faces, towards the eye; he even compared their flatness with that of a coin. Many authors have conjectured that these globules are compressed when they come into narrow passages, and expand again when they get into wider arteries. This Reichell says he has seen, and Blumenbach believes; but Blumenbach, less easy of belief with regard to all these strange forms ascribed to the particles of the blood, pronounces his dissent in plain terms. "They appear," says he, "to my eye no other than simple globules apparently of mucus: that lenticular or oval form which authors speak of, I have not seen."

The following are their chief properties with regard to the rest of the blood. When blood stands, the red globules fall to the bottom, because they are heavier than the other parts of the blood; and although the fibrin entangles them while it is forming, still it is to be noticed that the cake is always redder at the bottom; and when by circumstances of constitution this coagulation is very slow, some globules escape the grasp of the coagulum, and the serum is tinged with red, and the cake, though coloured at the bottom, is white at the top, and thus the clot is said to have the buffy coat. The globules preserve their form only while in the blood, and seem to be supported more by the qualities of the serum than by their own properties; for if mixed with water, they mix easily, and totally dissolve; the water is red, but the globules are gone: when we mean to preserve their forms for experiment, we must keep them in serum. I have looked upon the vitality of the blood as the cause of its fluidity. It coagulates most slowly when inflamed, which of course permits the globules to gravitate and the buffy coat to be formed. Its quantity, in regard to the whole mass, varies so, that the appearance of the blood is an index of health or disease: in disease and weakness, the blood is poor and colourless; in health and strength, it is rich and florid; by labour, the fibrin and red particles may be accumulated; in hard working men they abound; they may be accumulated by exercise into particular parts, as in the wings of Moorfowl or Pigeons, and in the legs of common Hens. In short, the red globules are numerous in health; in large and strong creatures; and in the centre of the system. In fishes the flesh is colourless; in such a system, particular glands only, or viscera, as the liver, stomach, or spleen, are coloured with blood, and but a small proportion circulates in the other parts.

The redness of these particles is a peculiarity. The chemical physiologists ascribed it to iron contained in the blood. But the present opinion is, that there is not more iron in the red particles than in the other component parts of the blood.

COAGULUM OR CRUOR.

The self-coagulating part of the blood, the cake which is left when we wash away the red globules, that which has been called the gluten, and now the fibrin, is by far the most important part of the mass, the most universally diffused in the animal system, the most necessary for the supply and growth of parts. It spontaneously concretes, and neither heat nor cold, nor dilution, will prevent its coagulation. The proportion of crassamentum to serum is $56\frac{1}{3}$ per cent. It encreases with the vigor of the system. Circulating in the vessels, it furnishes the solids of the body; when washed, it is white, insipid, extremely tenacious, and very fibrous, and can be drawn out; and it is the coagulation of this part that makes the long fibrous strings which we find in the tub when bleeding a patient in the foot in very hot water. Being slightly dried, it shrinks into a substance like parchment; being hardened by heat, it becomes like a piece of horn or bone: when burnt, it shrinks and crackles, with a very fetid smell, like the burning of feathers, wool, flesh, or any other animal substance; by which we know it to be the part of the blood which is the most perfectly animalized, and the most ready to be assimilated with the living solids. When distilled, it gives ammoniacal salt and alkaline water, and a very thick heavy fetid oil, and much mephitis, which are the marks of the most perfect animal nature; and after burning it, the residuum is a phosphate of lime, or in other words, the earth of bones.

What takes place within the living and active blood vessels cannot be made matter of demonstration; but there is no reason to doubt that an important change is wrought upon the contained fluid in the moment of secretion, during that change, when from a fluid it becomes a component solid of the body. We see how the greater part of the body is composed of fibrin, and the analysis of any single part confirms this. A muscle being squeezed, and thoroughly cleansed of blood, washed in spirits of wine, and again cleansed, is seen plainly to be but a peculiar form of coagulable lymph or fibrin. A bone being infused in any mineral acid, or in vinegar, its earthy parts are dissolved even to its centre; it becomes soft and flexible, still retains the form of a bone; but what remains consists principally of coagulable lymph. Fourcroy has said that coagulable lymph is that part upon which nature fixes irritability, or the contractile power; he should have added, "but this substance is moreover, in the animal body, the basis of every part which possesses life." The membranes, ligaments, tendons, periosteum, and all the white parts of the animal body, consist chiefly of this. It is this part, then, which is secreted by the vessels for repairing the waste, and the accidents of the body.

THE SERUM.

The serum is the thinnest and most fluid of the parts of the blood, into which it spontaneously separates. It continues oozing from the crassamentum till the fourth day. It is a fluid like whey, of a yellowish, or rather greenish colour, of an unctuous or slippery feeling among the fingers; it is slightly saline, and contains various salts in solution, and turns vegetable reds to green. It coagulates with a heat much lower than that which makes it boil; being dropped into hot water it coagulates as it falls.

But by this influence of heat the whole serum does not coagulate, but only the albumen, a substance like the white of an egg; what remains fluid is the serosity. On cooling, the serosity coagulates like size or jelly. This coagulation is owing to the albumen dissolved in the water; and the water being evaporated it leaves the albumen in the form of size or glue, or it may be precipitated from the water by various re-agents, but especially by tanin, and by alcohol. After the separation of the albumen, there remain only the salts in watery solution; these are muriates of soda and of potash, muco-extractive matter, subcarbonate of soda, sulphate of potash, phosphate of soda, and phosphate of lime.*

We perceive that the materials, of which the body is constructed, are contained in the blood, or formed from that fluid. It is true that we find in the body various substances, which do not exist formally in the blood, but which are new compounds out of the materials, which, by the imperfect aids of chemistry, we discover in it.

LIFE OF THE BLOOD.

Mr. Hunter, in forming his suite of preparations of the incubated egg, was led to reflect on the freshness of the yolk and the white of the eggs which are fit for incubation, while placed in circumstances which should quickly have produced putrefaction. What can it be, he said, which thus counteracts the chemical decomposition and prevents putrefaction, but the principle of life? He was thus led to make experiments, which ascertained that the same principle which in the egg prevented putrefaction, resisted cold. Life, according to these suggestions, was not a result of organization, but a principle added to the material, which might be either fluid or solid. Philosophically considered it is equally intelligible, that life shall be united to a fluid as to a solid; but we are more familiar with the latter, though we do not understand the mode of union more perfectly. It will however reconcile us to the fact to remember, that, in regard to the animal frame, solidity and fluidity are terms referable to different conditions of aggregation of the same substances; all parts of the body being in that state of revolution whilst there is life, that they are at one time fluid and at another solid. A particular and permanent figure of parts in the animal body, is necessary to mechanical action, but not required for the mere presence of life; though the blood may have no motion in itself, and yet it may have the principle of life added to it. Thus Mr. Hunter argued, and then he said, Can we deny life to this fluid which becomes the means of life, conveying it to the other parts of the body, even to the nerves themselves? For nerves do not convey life, but only direct the motions of parts, and without the

* The late Dr. Marcet makes the serum give the following products:—*water*, 900 parts; *albumen*, 86.80; *muriate of potash and soda*, 6.60; *muco-extractive matter*, 4; *subcarbonate of soda*, 1.65; *sulphate of potash*, 0.35; *earthy phosphates*, 0.60.

blood the nerves themselves cease to be alive. Health, Mr. Hunter conceived, to consist in the harmony existing betwixt the solids and fluids, and betwixt the blood and its containing vessels, and in disease there is also a consent betwixt them; if solids are disordered, the blood also puts on a diseased appearance; if it circulates in inflamed solids, it acquires an inflammatory disposition, and the condition is marked by signs.

I have said, "that the blood is a fluid of a rich and beautiful colour; vermilion-coloured in the arteries, dark purple in the veins, and black, or almost so, at the right side of the heart." When we open the thorax of a living Dog, the lungs collapse, the heart soon ceases to play, the Dog languishes, expires, is revived again when we blow up its lungs:—then begins again the motion of the heart, the black blood of the right auricle is driven into the lungs; the blood goes round to the left side of the heart of a florid red; and this purple blood of the veins converted into the vermilion blood of the arteries, and the change happening so plainly from access of air, is a phenomenon of the most interesting nature, and binds us to look into the doctrines of chemistry for the solution of a phenomenon to which there is in all the animal economy nothing equal.

It is the study of air and aërial fluids that has brought to light all the beautiful discoveries of which modern chemistry can boast. The simplicity of the facts in chemistry, the correctness of the reasoning, the grandeur which now the whole science assumes, is very pleasing; and leaves us not without hope, that by this science, all others, and ours in an especial manner, may be improved.

The older chemists were coarse in their methods, bold in their conjectures, in theory easily satisfied with any thing which others would receive. They condescended to repeat incessantly the same unvarying process over each article of the materia medica; and among hundreds of medicinal plants which they had thus analysed, they could find no variety of principles, nor any other variety of parts and names than those of phlegm, and oil, and alkali, and acid, and sulphur, and coal. By this they disburthened their consciences of all they knew, pleased their scholars, and set the physicians to work, forming magnificent theories of salts, sulphurs, and oils; for such has ever been the connection of chemistry with physiology, that, good or bad, they have still gone hand in hand.

The older chemists thought that they had arrived at the pure elements, while they were working grossly among the grosser parts of bodies. They could know nothing of the aërial forms of bodies, for they allowed these parts to escape. When their subjects, by extreme force of heat, rose upwards in the form of air, no further investigation was attempted; it was supposed that the subject of their operation was consumed, annihilated, wasted into air, and quite gone. When they thus stopped at airs, they stopped where only their analysis became interesting or simple; stopping where they stopped, among their oils and sulphurs, they made their science a mere rhapsody of words. Philosophy they considered so little, as not to know that the lightest air is really a heavy body, and that with weight and substance other properties must be presumed.

Modern chemistry begins by assuring us, that these airs are often the densest bodies in the rarest forms; that airs are as material, as manifest to the senses, as fairly subject to our operations, as the dense bodies from which they are produced: that it is heat alone (a substance which irresistibly forces its way into all bodies) that converts any substance into the aërial form: that some bodies require for their fluidity merely the heat of the atmosphere, and so cannot appear on this planet in any solid form: that others require some new principle to be added, in order to give them the gaseous or aërial form: that others require very intense heat to force them into this state; but that all aërial fluids arise, or must be presumed to arise, from some solid body or basis, which solid basis is dilated by heat into an air. The solid basis of some airs can be made apparent, as of fixed air, which proceeds from charcoal; others, as oxygen or azotic air, (the great constituents of our atmosphere,) cannot be produced to view in any solid form. But those airs which cannot be exhibited in any solid form, can yet be so combined with other bodies as to increase their weight and give them qualities of a very peculiar nature; and these airs can be alternately combined with a body and abstracted again, adding or abstracting from its weight and chemical properties, not only in a perceptible, but in a wonderful degree; so that these abstractions and combinations constitute some of the most general and important facts. When the old chemists, then, neglected to examine these airs, they refrained from examining the first elements of bodies at the very moment in which they came within their power.

That these must be the most material and important facts in all the science, it is easy to explain; for chemistry, ever since it has been a science, has rested upon one single point. There are certain great operations in chemistry which we perceive to have the strictest analogy with each other, or rather to be the same: the operations are the combustion of inflammable bodies, the respiration of animals, the calcination of metals; and whatever theory explains one explains the whole. The older chemists observed, that when they burnt an inflammable body, the surrounding air was contaminated, the substance itself was annihilated, nothing remained of its former existence but the foul air; and they supposed that this inflammable body consisted of a pure inflammable principle, which was the substance which spoiled the air, lessening its bulk, and making it unfit for supporting any longer either combustion or animal life. When an animal breathed in confined air, they found the phenomenon still the same; the animal contaminated the air, and expired itself; left the air unfit for burning or breathing, loaded, as they supposed, with the inflammable principle or phlogiston. When they calcined a metal, (which is done merely by heating the metal and exposing it to air,) they found, as in these other operations, the air contaminated, the metal losing its metallic lustre, ductility, and all the marks of a metal,—acquiring (in certain examples) new qualities, like those of some mineral acid, and becoming, of course, a most caustic drug; but above all, they uniformly observed the metal to increase in weight.

To account for all these discordant changes was the most difficult part of all: it was indeed easy to say, that combustion was the giving out of an inflammable principle to the air; and to say concerning respiration, that it was the business of the air to take away continually the superabundant phlogiston of the blood; but how a metal should pass from a mild to a most acrimonious and caustic state; and above all, how by the loss of its inflammable principle it should not lose in weight, but increase in weight! This was the Gordian knot which they had to untie, and which they cut lustily, betaking themselves, in defiance of all philosophy, to the absurd project of a principle of absolute lightness. They all agreed to call the phlogistic principle, a principle of absolute levity; and thus their doctrine stood for many years, viz. that when phlogiston, or inflammable principle, was added to the calx of any metal, as to red lead, by roasting it with any inflammable body—the metallic lustre, tenacity, ductility, were restored, and the metal became lighter withal, because it now had within it the principle of levity. But that when by heat and air it was calcined, this principle was driven out, and then the metallic lustre, tenacity, ductility, &c. were lost by the absence of the inflammable principle upon which they all depended; but the weight of it was increased, for the principle of levity was gone. This is the brief abstract of the theory to which the very best chemists have addicted themselves down to the present times.

But the chief perfection of modern chemistry is, that its apparatus is so perfect, that it can employ exactly a certain quantity of air in calcining a metal; it can collect that air again to the twentieth part of a grain; it can prove whether the metal has really been giving out any inflammable principle to the air, or whether it has received matter from the air, and how much expressly it has gained or lost. Modern chemistry proves to us, that it is not the loss of any principle that endows a metal, for example, with negative powers; but the direct acquisition of a new principle, which endows it with positive powers.

Upon our atmosphere and its surprising harmony with all parts of nature; with animal and vegetable life; with water, metals, acids, and all the solid bodies into which it enters—much more depends than it is easy to conceive. Could we have supposed that it was the cause, not merely of life in all living creatures, but almost the cause of all the properties that reside in the most solid forms? Could we have supposed that air rendered heavy bodies heavier, changed metals into the most caustic substances, converted many bodies into acids, changed inflammable air into the pure element of water, which at least we have hitherto conceived to be pure.

The atmosphere contains various gases or airs; but one only, viz. vital air or oxygen gas, is useful to respiration, combustion, and animal life; that purer air must, like every other, arise from some solid basis: that basis cannot be shown in any substantial form, but it can be combined with many various bodies, so as to give them an increased weight and new qualities; and thence we presume to say, whenever we see a body, by such a process, acquiring such qualities, that it acquires them by absorbing the basis of pure air; for pure air is nothing but this presumed basis dilated into the form of air by heat; and when it combines with any body, it gives out its heat; so that in all these processes heat is produced. And although inflammable bodies, metals, acids, &c. seem very distinct from each other; although combustion, calcination, and the forming of acids, are processes seemingly very unlike; yet they are all in their essential points the same, viz. a change of qualities and a production of heat in consequence of the absorption of pure air; and there is a certain analogy betwixt breathing and these chemical processes, which, however, the chemists have carried too far.

First, when an inflammable body is BURNT, or consumed by fire, the basis of pure air is combining with the combustible body; the air is entering into a new combination, and therefore must give out its heat; it combines rapidly, gives out its heat rapidly, is wasted; the inflammable body burns and seems to be consumed; but if we catch that air which escapes from the inflammable body, we find it to be equal exactly to the whole weight of the air and of the burning body that have been consumed; and this air consists of two parts, viz. of the substance which was burnt, and of the basis of pure air. Thus, for example, when we burn charcoal or carbon, the whole substance of it, weight for weight, is converted into an air, which is called fixed or carbonic acid gas; the same which is discharged from stoves, the same also which is found in pits, the same which oozes through the ground in the Grotto del Cane, the same which floats upon the surface of fermenting vats, and which is so much heavier than common air that it can be taken out from a vat in basins, and poured from dish to dish. Combustion, then, is a process which consists in the rapid assumption of the basis of pure air, and a consequent conversion of the burning body into an air or gas endowed with peculiar qualities and powers.

So chemists have supposed that the function of respiration differs from these only in the rapidity of the process. So far it is true, that the carbon of the blood, secreted and thrown off from the lungs, unites to the oxygen of the atmosphere. But it is a mistake to suppose, as they have done, that the blood becomes oxydated like a metal; there is no proof that oxygen unites to the blood. It appears only to be the means of involving and extricating the carbon of the blood, and coverting it into carbonic acid gas. No doubt there is a balance preserved betwixt the function of the lungs in producing carbon and the condition of the atmosphere to receive it; for our atmosphere is so tempered that no more than twenty-seven parts of a hundred consists of pure air, as we term it, that is, of oxygen. This is the reason that even burning as well as breathing are slow processes, and that an animal, if made to breathe pure air, or vital air, as it is called, gets oxygen too rapidly supplied, is inflamed quickly, and dies.

As there are various marks of the influence of oxygen on the blood, there are terrible proofs of its importance in the system, and how miserable the person is who has imperfect organs, or an ill oxygenated blood. It signifies not to our present purpose, whether any thing is actually given to the circulating blood during respiration, or if only the carbonaceous matter be separated and carried away; the contact of blood with a certain portion of pure air or oxygen is absolutely necessary to the continuance of life.

Nature, disregarding all occasional supplies, as by the absorption of the skin, the assimilation of aliments, &c. has appointed one great organ for the oxygenation of the blood, viz. the lungs. In opening the breast of a living creature we best see the connection of respiration with the great system; but it is out of the body that we can best understand its particular effects upon the BLOOD.

The most obvious effect of air is its heightening the colour of the blood. If we expose blood to fixed air, or azotic air, it continues dark; these fluids communicate nothing, they have no effect on the colour of the blood: when we expose blood to atmospheric air, it assumes a florid colour; for in the atmosphere there is a large proportion of oxygen gas; if, lastly, we expose it to oxygen gas, the purest of all air, as chemists would formerly have expressed themselves, it grows extremely florid: and it must either be that the carbon in the blood is attracted, and floated off, and united to the oxygen, or oxygen is absorbed into the blood; and the former opinion prevails.

Blood, when exposed to the air, becomes red chiefly on the surface; it remains black beneath, but by turning up the clot to the air all the surfaces become red. If air be blown into a tied vein, the blood which was black in the vein becomes florid; and when the air is pressed out again, it becomes black. If the air-pump be exhausted over a dish of blood, the blood becomes dark in the vacuum; and it becomes florid when the air is allowed to rush in again. If you expose blood in a moist bladder, the blood is oxygenated through the walls of the bladder; which brings this experiment as close as may be to the phenomenon of blood oxygenated through the cells of the air vesicles of the lungs, and through the coats of the blood-vessels which circulate the blood upon those air vesicles.

When we open a Frog, or Newt, or other amphibious creature, we see a long and slender artery accompanied by a slender vein, running from top to bottom along the whole surface of their lungs; and while their heart continues to beat, we see this pulmonic artery black, the vein red, the lungs themselves most delicate and pellucid, like the swimming bladder of a fish: on the other hand, when we have an opportunity of seeing the extremities of the arteries and veins in the circulation through the body, the blood of the vein is dark and that of the artery red; so that surgeons distinguish venous and arterial blood in this way.

From these facts we may understand why the blood of the womb, of sinuses, of varices, and of all stagnant veins, is so dark; and why that blood is so very pure and florid which is coughed up from the lungs. Is not the face livid in apoplexies or strangulations, in hanging or drowning, in fits of passion or of coughing, or in any accident which interrupts the lungs? The face of a child during a paroxysm of the hooping cough, is it not black? Is not the hand livid when the arm is compressed or tied up, and its blood prevented from returning to the lungs and heart? Are not tumours dark coloured from dilated veins which return their blood too slowly? The first effect of oxygenation is a reddening of the blood. The blood of ecchymosis, the blood of aneurismal bags, are all black; and the blood of varices is so very black, that the ancients said they were filled with atrabilis or black bile. The stripes, inflicted on a soldier as a punishment, are at first of the most lively red, but soon become black.

If we open the breast of a Frog and stop its breathing, we observe, first, its pulmonic blood florid, and the heart beating strongly; secondly, in half an hour the pulmonic blood has become dark, and the heart's motion has grown languid; in a little while the pulmonic blood becomes black, and the pulsation of the heart ceases: and, lastly, the trachea of the Frog being untied, and the creature allowed to breathe again, the blood becomes florid, and the heart acts.

We have stated the facts regarding this matter, as they have been brought forward, and as they appear. But a closer inspection of the phenomena will probably show that the oxygen is not in these instances the stimulus. But that the change produced upon the blood in respiration, makes that fluid more capable of supplying the irritability of the muscular fibre, and, consequently, of adding power to the heart. The load of carbon which the venous blood carries back from the circulation of the body, makes it incapable of adding to the irritability or contractile power of muscles. But when by purification in the lungs that carbon is carried off in form of carbonic acid gas, the colour of the blood is restored, and with it new powers.

By these views the facts stated above have a new light thrown on them, the heart does not become weak, because the black blood is not stimulant, but because being black, and loaded with carbon, it is incapable of supporting the irritability of the muscular fibres of the heart.

OF THE HEART, ARTERIES, AND VEINS.

OF THE HEART.

OF THE MECHANISM OF THE HEART.

The heart is placed nearly in the centre of the human body, and is itself the centre of the circulating system. The system of vessels which it excites and moves consists of arteries and of veins;—the arteries act with great strength, with a pulsation like that of the heart itself, and convey the blood over all the body; the veins are in greater number, exceedingly large, pellucid almost in their coats, incapable of that energetic action with which all the functions of the arteries are performed; they return the blood to the heart with a slow, equable, and gentle motion, and deposit at the right side a quantity of blood equal to that which is at each pulsation driven out from the left. The heart is placed betwixt the arteries and the veins, to regulate and enforce their action; to receive the blood from the veins by a slow dilatation, and to restore, by a sudden contraction, that force which the blood loses in passing round the circle of the body. But the heart has also another and more important office to perform; for by having four great cavities and two orders of arteries, it performs in the same instant two circulations, one for the lungs and one for the body; it receives from the lungs nothing but pure blood, it delivers out to the body nothing but what is fit for its uses: and this purifying of the blood, and this excitement of the arteries, are two chief points of modern physiology, which every step of the following demonstration will tend to explain.*

* Professor Blumenbach reckons the whole mass of blood in the body to be 33 pounds. He takes 75 as the average number of pulsations of the heart in a minute:

It will be most easy to conceive at first the idea of a more simple heart, of one circle of actions, of one simple circulation; of one bag for receiving, and another joined to it for propelling the blood. Indeed a heart consists merely of these essential parts; a GREAT VEIN, an AURICLE, a VENTRICLE, and a GREAT ARTERY: of a vein which returns the blood from all the body; of an auricle or smaller bag, which receives that blood and retains it till the action of the heart is relaxed; of a ventricle (which is the proper heart), strong, muscular, very irritable, and easily excited, into which the auricle pours its blood; of an artery which is allied to the ventricle in strength and action, (as the auricle is to the vein in the delicacy of its coats,) and which carries on the blood to the extremities of the body;—and the vein and artery meeting at their extremities in the body, and uniting, the whole is a circle, and the heart is the central power.

If an animal were not to breathe, its system might be exactly what is now described; it would have but one vein, one auricle, one ventricle, one artery; it would have one simple heart: but with us, and other breathing animals, it is not so; and I am now to describe a more complex and curious circulation. For suppose this blood, so essential to our existence, to have in it some principle of life, which is continually lost, or in its passage through the body, to be impregnated with something which should be thrown off, that principle must be continually renewed, or an opportunity given to send off what is offensive to life: the heart which fills the arterial system must not be taken from its appointed office, nor disturbed; nature appoints a second heart, which belongs entirely to this most important of all functions, viz. renewing the blood; and it may be renewed in many various ways. It might, for example, circulate in some peculiar viscus; in the fœtus it does circulate in such a mass, for the placenta is a thick and flat cake, whose office we know to be equivalent to that of the lungs, but whose structure we imperfectly comprehend: in the chick we see its blood circulating over the yolk, (for the yolk is inclosed within the membranes of the unhatched chick,) and we perceive the blood redder as it returns to the heart, and plainly changed: in fish we find the blood circulated over the gills, exposed thoroughly to the water in which they swim, and thus the gills perform to them the function of lungs. But in all breathing creatures, the lungs do this office; the lungs are, next to the heart itself, essential to life; in those who die from bleeding, we can perceive from the livor of the face, from the sobbing and struggles of the chest, from the regular convulsive sighs of those creatures which are butchered, rather a desire for air than a want of blood. It is for the purpose of this second circulation that nature has appointed in all the warm-blooded animals two hearts, a heart for the lungs and a heart for the body.

and he supposes the heart expels two ounces of blood at every contraction. Proceeding upon these data, he calculates that the whole of the blood passes through the circulation in two minutes and a half.

There are other varieties which distinguish animals into creatures of cold or of warm blood; for there are certain constitutions which do not require that the blood should be thus continually renewed. It is not because animals are amphibious, or go into the water, that they have peculiar lungs; for the Land Tortoise, the Newt, the Cameleon, never go into the water; yet they have membraneous lungs: nor indeed can the amphibiæ, as the Seal, the Porpoise, the Sea-lion, &c. dive and exist under water more than a man can do, though for whole days they lie in herds basking upon the shore: it is their peculiar constitution to need less than other creatures the office of the lungs. The cold-blooded animals are generally creeping animals, sluggish, languid, cold, inert, difficultly moved, and tenacious of life to a wonderful degree. They can bear all kinds of stimuli; they can bear to have their heads, legs, bowels, cut away; and among other peculiarities of this constitution, they can live long without air: they will rise from time to time above water, if you allow them; they can bear again to be kept under water, if you force them: but if they can live long under water, they can also live at least as long after you have cut off their heads, or cut out their hearts. By all which it is clear that they cannot live without breathing. That this function is necessary to their existence: but that they are tenacious of life.

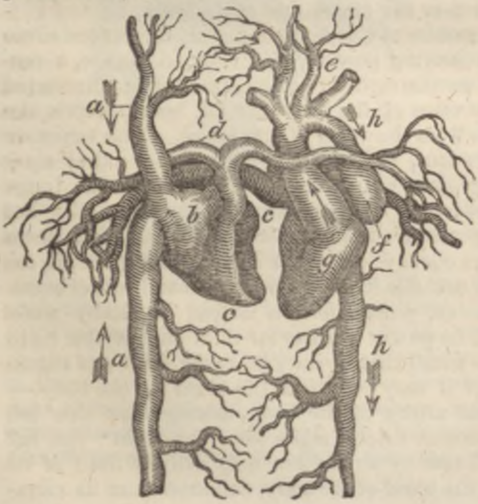
Of those cold-blooded creatures always either the heart or the arteries are peculiar; the heart is so in many amphibiæ, as in the turtle, where the heart seems to consist of three ventricles, but with partitions so imperfect betwixt them that they are absolutely as one: this one ventricle gives out both the great arteries; the blood of the lungs and the blood of the body are both mixed in the heart: and since there are two arteries conveying this mixed blood, if the two arteries be nearly equal in size, then it is just one half of the blood thrown out by the heart at each stroke that receives the benefit of the lungs. In many others, as the frog, the newt, the toad, the peculiarity is in the arteries alone; they have one single and beautiful heart; there is one large auricle as a reservoir for all the blood both of the body and of the lungs; there is one neat, small, and very powerful ventricle placed below the reservoir, having strength quite sufficient for moving both the blood of the lungs and the blood of the body; and this ventricle gives off an aorta, which soon divides into two branches, one for the body, and one for the lungs; and these of course have but half the blood of this heart exposed to the air: these also are cold-blooded animals, of which take this as an example.*

But all breathing creatures, such as are called animals of hot blood, have two hearts; the one heart is sending blood through the lungs, while the other heart is pushing its blood over the body; not the half only, but the whole blood which is sent by each stroke of the heart over the body must have first passed through the lungs; no blood can reach the heart for the body which has not been sent to it through the lungs, or, in other words, the veins of the lungs; and they alone feed the left side of the heart.

* See the figure on the next page.

Words alone will never explain any of the endless difficulties which concern the mechanism of the heart; but at every point, in every kind of difficulty, in explaining the form, the parts, the posture, even the coats or coverings of the heart, I shall have recourse to plans, such as cannot fail to make all this intricate mechanism be easily conceived.

The most simple form of the heart, which is represented in the plan on page 379, has a vein marked (a),—an auricle (b),—a ventricle (c),—an artery (d);—it has no provision for purifying the blood; it has no resemblance to that kind of heart which is connected with lungs; but the blood is received by the veins, falls into the auricle, is driven by its force into the ventricle, by the ventricle it is thrown into the artery, and courses round all the body, till at length, reaching the extremities of the veins, it passes by the veins to the auricle a second time, and so this single circle is perfect.



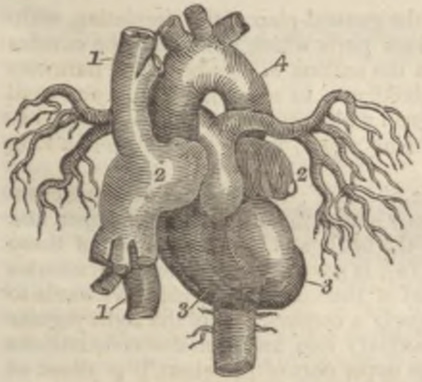
The heart of the amphibious creature is represented above: it is a frog's heart: it has the most simple form, and the fewest parts; it has the same vein, auricle, ventricle, and artery: but its great artery divides into two chief branches, of which—(d) the aorta goes to the body,—(e) the pulmonic artery goes to each side of the lungs.

The heart of a breathing creature is represented here in its most intelligible form; and the double circulation of the human body may be traced easily in the following way.—Here the heart of the lungs is set off from the heart of the body, being as distinct in office as in form and parts; on the right side is the heart of the lungs, on the left side is the heart of the body.—(*a*) Is the great vein called vena cava from its immense size;—there is an ascending and a descending cava; the one brings the blood from the head and arms, the other brings the blood from all the lower parts of the body: they meet, and form by their dilatation a chief part of that bag which is called the auricle,—in it they deposit all the returning blood of the body, and thus present it at the right side of the heart to be moved through the lungs.—(*b*) Is the right sinus, or RIGHT AURICLE; it is in part formed by a dilatation of these veins, but it puts on a strong and muscular nature as it approaches the heart; it is the first cavity of the heart, and, like all its parts, is strong and irritable; it is filled by the returning blood of the cavæ; it receives, dilates, is oppressed by this great quantity of blood; it is strongly excited to act; in its action the blood goes down into the ventricle or lower cavity of the heart.—(*c*) Is the RIGHT VENTRICLE, thick and strong in its walls, and of great muscular power; it is filled by the auricle, and is strongly stimulated both by the stroke of the auricle, and by the weight and quantity, and also, in some degree, by the qualities of the blood; its action is sudden and violent, and it drives the blood through all the system of the lungs.—(*d*) Is the PULMONIC ARTERY,—the artery of the lungs which receives all the blood of the right side of the heart; it is filled by the stroke of the right ventricle, from whose cavity it arises; it carries the blood in many branches through all the substance of the lungs; and thus that blood which had returned imperfect and robbed of its vital quality to the right auricle of the heart, is by this circulation through the pulmonic artery ventilated and renewed, and made fit for the uses of the system; and thus the lesser circulation, or the circulation of the lungs, the circulation of the right side of the heart, is completed, and the purified blood is brought round to the left side of the heart to undergo the greater circulation or the circulation of the body.

Thus it is from the extremities of this first circle that the second circle begins: it consists of like moving powers, of a vein, an auricle, a ventricle, and an artery; for as the right heart receives the contaminated blood of the body from the veins of the body, the left heart receives the purified blood of the lungs from the veins of the lungs. The VEINS OF THE LUNGS are sometimes four, sometimes five in number; they enter from each side of the lungs, and return the blood purified in the lungs to the left auricle of the heart.—(*f*) Is the LEFT AURICLE, smaller, but more muscular, and stronger than the right; it receives easily whatever quantity of blood the lungs convey to it; it is irritated, contracts, forces the mouth of the ventricle, and fills it with this purified and redder blood.—(*g*) Is the LEFT VENTRICLE, whose form is longer, its fleshy walls thicker, its cavity smaller, its power greater far than that of the right side; this ventricle is thus small that it may be easily filled and stimulated, and thus strong that it may propel all the blood of the body.—(*h*) Is the AORTA or great artery of the body, arising from this left ventricle, just as the pulmonic artery arises from the right: the left ventricle, by its strong and sudden stroke, not only delivers itself of its own blood, but propels all the blood of the body, communicates its vibratory stroke to the extremest vessels, and excites the whole; this is the greater circle or circulation of the body, as opposed to the shorter circulation or lesser circle of the lungs.

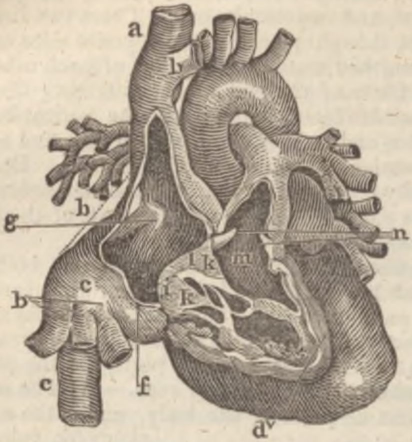
That there are strictly two hearts, is now clearly made out; they are different in office; there are two distinct hearts, two systems of vessels, two kinds of blood, and two circulations. These two hearts might have done their offices, though placed in the opposite sides of the breast; it is in order to strengthen mutually the effect of each other that they are joined; for the fibres of the two hearts intermix; they are both inclosed in one membraneous capsule, viz. the pericardium; the veins, auricles, ventricles, and arteries correspond in time and action with each other, and harmonize in a very beautiful manner. But this, I believe, will be more easily explained by marking the succession of motions, by a suite of figures placed upon the several parts of the heart, by which the successive motions are performed.

Here I have joined the right and the left hearts; both that it may be seen how the left heart locks in behind the right heart, how the right comes to be the anterior one, and how the aorta seems to arise from the centre of the heart, while its root is covered by the great artery of the lungs; and also that the synchronous parts, *i. e.* the parts which beat time with each other may be correctly seen.—(1) The CAVÆ are receiving the blood from all parts of the body, and in the same instant the pulmonic veins are receiving blood from the lungs. (2) The RIGHT AURICLE is gradually filling with the contaminated blood of the body; the left auricle, marked also with a second figure, is filling with purified blood from the lungs. (3) The RIGHT VENTRICLE is stimulated by its auricle, and throws its contaminated blood into the lungs; and in the same moment the left ventricle throws its purified blood over the body. (4) The PULMONIC ARTERY re-acts upon the blood driven into it by the heart; and in the same moment the aorta re-acts upon the blood thrown into it, and that re-action works it through all this great system of vessels from this the centre to all the extremities of the body.



Thus it is easy to perceive how the successive actions accompany each other in the opposite sides of the heart: (1) The two veins swell; (2) The two auricles are excited; (3) The two ventricles are filled with blood; (4) The two arteries take up and continue this pulsating action of the heart. It is thus that the two hearts assist and support the actions of each other, and there seems almost a physical necessity for their being joined; yet on the very best authority, and after deliberate dissection, we are entitled to affirm, that the heart is found, not with its apex sharp and conical, but cleft; the two ventricles plainly distinct from each other, and divided by a great space.*

OF THE PARTS OF THE HEART.



As yet I have explained only the general plan of the circulation, without having described those curious parts which are within the cavities of the heart, and which support the actions in this beautiful harmony and perfect order, each part subordinate to some other part, and each action succeeding some other action with perfect correctness, often without one unsteady motion or alarming pause, during the course of a long irregular life.

1. The VENÆ CAVÆ are two in number†; they are named venæ cavæ from their very great size; the one brings the blood from the upper, and the other from the lower part of the body, and they are formed of these branches: the upper vena cava (a), is properly termed the DESCENDING CAVA, because it carries the blood of the head and arms downwards to the heart: this great vein is properly a continuation of the right jugular vein which joins with the right axillary vein, and then descends into the chest a great trunk; and in the upper part of the chest it is joined at (b)—by a great branch, containing the axillary and jugular veins of the left side, which, in order to reach the cava, crosses the upper part of the chest, and lies over the carotid arteries. The lower VENA CAVA, or CAVA ASCENDENS, brings in like manner all the blood from the belly and lower parts of the body by two great branches. One, marked (c),—is the

* Latro, qui pœnas scelerum luebat, quando exenteraretur a carnifice, cor habuit singularis figuræ, mucrone non acuto, ut fieri solet, sed bifido; ut distincti ventriculi manifestius externa facie apparuerint, dexter nempe et sinister, interjecto magno hiatu.—Bartholini Epist. p. 170. There are examples in the lower animals, of the hearts being actually in distinct parts of the System.

† Let the reader observe, that the whole of this description of the various parts of the heart is, as it were, an explanation of the plans: of which the first shows the right side of the heart, or the heart of the lungs opened; while the second shows only the left heart, or the heart of the body opened.

vein which lies in the belly along the right side of the spine, and brings the blood from the legs, the pelvis, and parts of generation, the kidneys, &c.; it is named the VENA CAVA ABDOMINALIS, because of its lying in the abdomen. Others marked (b),—arise in three or four great branches from the liver; they are named the branches of the vena cava in the liver, or the VENÆ CAVÆ HEPATICÆ; and these make up the lower cava: and the lower and the upper cavæ now join themselves at (e),—to form the right sinus of the heart (f).

2. The RIGHT SINUS of THE HEART, marked (e), is of considerable extent; it is just the gradual dilatation of the two veins forming the auricle or reservoir which is incessantly to supply the heart; the veins grow stronger as they approach the sinus, and the sinus still stronger as it approaches the AURICLE or notched and pendulous part, and the auricle again approaches in its nature to the ventricle of the heart: for it is crossed with very strong muscular fibres, which make very deep risings and furrows upon its inner part. To say that these veins, or the sinus which they form, are not muscular, merely because they are not red nor fleshy, is very ignorant; for the ureters, arteries, intestines, the iris, and many other parts of the human body, are, at the same time, perfectly muscular and perfectly pale; and the heart of a fish is as transparent as a bubble of water, and yet is so irritable that after it is brought from market, if you lay open the breast, and stimulate the heart with any sharp point, it will renew its contractions, and in some degree the circulation.

3. The TUBERCULUM LOWERI should be looked for in this point, if it were not really an imagination merely of that celebrated anatomist. The whole matter is this; the two veins meet, not directly, but at a considerable angle within the vein, as at (g). Lower conceived a projection of the inner coats of the vein at this point much more considerable than what I have here represented. It was thought to do the office of a valve, to break the force of the descending blood, to defend from pressure that blood which is ascending from the lower cava, and to direct the blood of the upper cava into the right auricle of the heart; and in the place appointed for finding this tuberculum Loweri we can find nothing but on the inside the natural angle of the two veins, and on the outside some fat cushioned up in that angle in the line (h). Though generally wanting, I have found the tuberculum Loweri very distinct in the human heart. If we must assign a use for this angle and this inclination of the veins, it is certainly to direct the two streams of blood which meet here towards the opening of the ventricle.

4. The AURICLE is, as I have said, a small appendix to the great bag or sinus. It is small, semicircular, notched or scolloped, and somewhat like a dog's ear; whence its name. In general, we name the whole of this bag auricle; but by this plan the names of sinus and auricle must be easily understood. The point chiefly to be noted is this, that the veins, as they approach the auricle, are thin, delicate, transparent; that where they expand into the sinus they become fleshy, thick, and strong; that in the auricle itself the muscular fibres are very strong, have deep sulci like those of the ventricle; these strong fibres are what are named the MUSCULI PECTINATI AURICULÆ. Where these muscles run, as in cords, across the auricle, they are very thick and opaque; but in the

interstice of each stripe or muscular fibre, the auricle is transparent, like the membranes of the veins; and when you look on the inner surface of the auricle, they stand out so distinct, and get so regular, that they have a resemblance to the teeth of a comb; and thus they are named MUSCULI PECTINATI.

5. The VALVES of the AURICLE are placed at the circle (i), where the auricle enters into the ventricle, and the valves are marked (k): and how necessary these are for regulating the movements of the heart will be easily understood by considering the conditions in which the auricle and ventricle act. First, the cavæ pour in a flood of blood upon the sinus and auricle, with a continual pressure; the moment the auricle has contracted, it dilates, and it is full again; the pressure from behind excites it to act, and while it is acting, there is no occasion for valves to guard those veins whose blood is pressing forwards continually, because they are continually full, and have behind them the whole pressure of the circulating blood. But when the auricle acts, it throws its blood into the ventricle, fills it, and stimulates it; the auricle then lies quiescent for a moment, while it is gradually filling from behind with blood; but during this quiescent state the whole blood from the ventricle would rush back into it, were it not guarded by valves. The valves, then, which rise whenever the ventricle begins to act, are of this kind: there is, first, a tendinous circle or hole, by which the auricle communicates with the ventricle. It is called the ANNULUS VENOSUS, being that tendinous ring of the ventricle which is towards the venous system. The opening, OSTEUM VENOSUM*, is large enough to admit two or three fingers to pass through it; it is smooth, seems tendinous, is plainly the place of union betwixt the auricle and ventricle, which are in the fœtus (in the chick for example) distinct bags; and from all the circle of this hole arises a membrane, thin, and apparently delicate, but really very strong; not divided into particular valves at this root or basis, but as the membrane hangs down into the ventricle, it grows thinner and is divided into fringes. How these fringes can do the office of valves is next to be explained. The tags and fringes of this membrane are actually tied to the inside of the ventricle by many strings, which being, like the valves, of a tendinous nature, are called CORDÆ TENDINEÆ, or tendinous cords; and these cords being attached to little processes projecting from the muscular substance of the

* The figure represents the osteum venosum and tricusped valve cut out. The

heart, these processes are named COLUMNÆ CARNEÆ, or fleshy columns. Of these tyings of the valves there are three chief points; the whole circle seems to be divided into three sharp-pointed valves; they are named VALVULÆ TRICUSPIDES, or three pointed, or they are still sometimes called Triglochine Valves. The valves fall down easily when the blood goes down through them, and they rise readily and quickly whenever the blood gets behind them: when the ventricle is full, the valves are still open; but when the ventricle contracts, the blood throws up the valves, and closes the opening into the auricle; and now the tendinous cords and fleshy columns support the margins of the valves, so that they give them strength to support the heart's action.

6. The VENTRICLE of the RIGHT SIDE (ll) is, like its auricle, larger than the same parts on the left side; for this auricle and ventricle of the right side have the weight of the whole blood of the body pressing upon them. They are subject to occasional fulness, for they must be dilated by many accidents, as labour, violent struggles, &c., which send the blood too quickly upon the heart; while the left auricle and ventricle, on the other hand, can never be overloaded, as long as the pulmonic artery preserves its natural size, for that artery continues always the measure of the quantity of blood which they receive. The ventricle is thick, strong, fleshy. Its inner surface is extremely irregular; it puts out from every part of its surface very strong fleshy columns. These fleshy columns are irregular in size, big, strong, running along the length of the ventricle; some cross the ventricle, so as to connect its opposite walls together; some have the tendons of the valves fixed to them: all of them have perfect contractile power, and are, indeed, the strongest muscles of the heart. Betwixt the fleshy columns, there are, of course, very deep and irregular grooves; and among the confused roots of these fleshy columns the blood often coagulates, after death, into the form of what are called polypi of the heart. Yet still the walls of the right ventricle are thinner, the fleshy columns smaller, the cavity greater, than those of the left side; the right ventricle of the heart has also a peculiar form for the SEPTUM CORDIS, — a partition betwixt the right and left heart, is not, as generally supposed, a part common to both; but the left verticle is longer and more conical than the right one; the septum belongs almost entirely to the left ventricle; the right ventricle, which is much bigger, laxer, flatter, and thinner, in the walls, is, as it were, wrapped round the left; and thus the left ventricle alone forms the acute apex of the heart, and the left ventricle of necessity bulges very much into the cavity of the right, since the right ventricle is so much larger, and in a manner wrapped round it. In both ventricles, it is very remarkable, that towards the opening of the auricle, the surface of the ventricle is very rugged, irregular, and crossed with columnæ carneæ, while a smooth and even lubricated channel leads towards the artery.

7. The PULMONIC ARTERY arises from the right ventricle, to carry out the blood close by the great opening at which the auricle pours it in; the

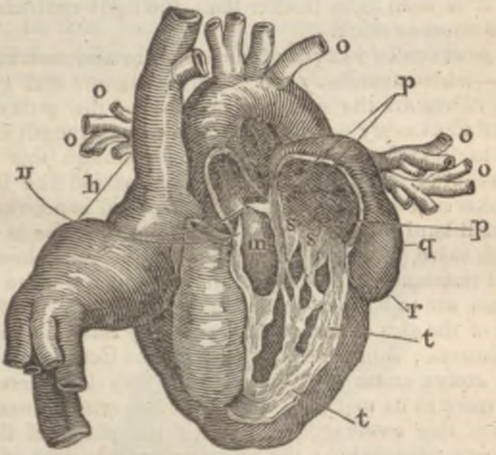
stringy appearance is formed by the cordæ tendineæ, and the pendulous portions are the columnæ carneæ, which in their natural place are connected with the substance of the ventricle.

artery arises at its root in a very bulging triangular shape. It is the valves within the mouths of the artery that give it this very peculiar shape without; for the bulging root is divided into three knobs, indicating the places of the three valves, the artery dilating behind each valve into a little bag, which, when it is described, is called its sinus.

8. This VALVE of the PULMONIC ARTERY has a more perfect and simple form than that of the auricle. The valves in the mouth of each of the great arteries are three in number; they are thin but strong membranes, rising from the circle of the artery, where it comes off from the heart: each valve is semilunar; its larger and looser edge hangs free into the cavity of the artery; the edge is a little thicker than the rest of the valve; the three valves together form one perfect circle, which closes the mouth of the artery so that no grosser fluid, nor hardly air, can pass. When they are filled till they become very tense, each valve forms a kind of bag; so that when you look at the mouth of a dried artery, they appear like neat round bags; and when they are likely to be forced, the little horns or tags by which each valve is fixed into the coats of its artery, becomes so tense as to do the office of a ligament; these are called the SEMILUNAR or SIGMOID VALVES.

Now, the condition of the ventricle while it is contracting is well understood: the auricle by its action lays down the tricuspid or auricular valve, and fills the ventricle; the ventricle cannot feel the stimulus of fulness till its valves rise, and its cordæ tendineæ begin to pull; and the ventricle could not be close for acting, nor its walls perfect, it could not in short be an entire cavity, till the tricuspid or auricular valves were completely raised. But there is another opening of the ventricle, viz. that into the artery, which must be also shut: this is one of the several instances of the subordination of these actions one to another; for, first, the auricle acts, then the ventricle, then the artery; so that the auricle and the artery are acting in the same moment of time; the artery by acting throws down its valve, and closes that opening of the ventricle, while the auricle is filling it with blood: and again, the moment that the ventricle is filled, both the auricle and artery are in a state of relaxation; the auricular valve rises so as to close the ventricle on that side, and the arterial valve falls down, both because the artery has ceased acting, and because the valve is laid flat by the whole blood of the ventricle rushing through it. Hence it is very obvious, that the right ventricle could neither be filled nor stimulated, unless the opening toward the artery were closed during the time of its filling; and again it is obvious that this valve cannot be laid down by any other power than that of the artery itself: who then can doubt that the artery has in itself (like the ventricle) a strong contractile power? That it is the stroke of the artery succeeding that of the heart that lays down this valve so closely, is proved by this, that in many animals, in fishes, for example, the aorta is as plainly muscular as the heart itself,—it is like a second heart; and in fishes the vessel returning from the gills, and often in human monsters, the artery alone, by its own muscular power, moves the whole circulation without any communication with the heart. In fishes there is no second heart for the circulation of the body; and in monsters the heart is sometimes wanting, and there is found nothing but a strong aorta to supply its place. This stroke of the pulmonic artery, then, (which the heart excites,) pushes the blood through the lesser circle or circulation of the lungs, and by the pulmonic veins it is poured into the left side of the heart.

9. The LEFT AURICLE of the heart is unlike the right auricle in these respects: the sinus, or that part which consists of the dilatation of the pulmonic veins, is smaller; while the auricula, which is the more muscular part, is larger; the pulmonic veins come in five great trunks from the lungs, three from the right side and two from the left; these great veins then enter at each side of the left auricle, by which it gets a more square form; the whole of the left sinus, which forms the chief bulk of this part, is turned directly backwards towards the spine, and is not to be seen in any common view of the heart; but I have here added a plate representing the back part of the heart*, showing, 1. How the left ventricle lies behind; 2. How the left auricle is turned still more directly backwards; 3. How the pulmonic veins enter into it in four great branches, so as to give a square or box-like form, compared with the gliding, gentle shape of the right auricle; 4. How the pulmonic artery comes out from under the arch of the aorta, dividing into its two great branches for each side of the lungs; and, 5. How the aorta arches over it, towers above all the other vessels, and is known always among the vessels of the heart by the carotid and subclavian arteries which come off from its arch.



On this plan are seen—(oo) the pulmonic veins entering from each side of the lungs—(pp) the opening of these into the auricle—(qq) the sinus formed in part by the dilatation of these veins, and,—(r)

* Explanation of the BACK VIEW of the HEART, in the adjoining pla'e.
1. The left Ventricle—2. The left Auricle—3 3 3 3. The four pulmonic Veins—4 4. The two great branches of the Pulmonic Artery—5. The Aorta—6. The Carotids and Subclavians—7. The Cava Descendens—8. The Cava Ascendens, with all its branches from the Liver—9. The great Coronary Vein running along the back of the Heart betwixt the Auricle and Ventricle in a groove surrounded by fat.

the auricula or little ear, from which the whole bag is named auricle.

10. The valves which guard the left auricle are seen here (ss) :— Now, it is to be remembered that the left auricle is smaller than the right; that the circle or opening of the left auricle is of course smaller than that of the right; that while it requires a valve divided into three points to fill the opening of the right auricle, a valve divided only into two points suffices for the opening of the left auricle: this is the reason of this slight variety of shape betwixt the two auricular valves, and is also the reason of the valve of the right side being called TRICUSPID or three-pointed, while this of the left side, from some very slight resemblance to a mitre, is named VALVULA MITRALIS, the MITRAL VALVE. In all other points this valve is the same with that of the right side; it has the same apparent thinness, for it is even transparent; the same real strength; the same COLUMNÆ CARNEÆ and tendinous strings to support it; and the VENTRICLE (tt) has the same rough irregular surface towards the opening of the auricle; the same smooth gutter—(m) leading towards the artery. The constitution of all these parts, in short, is expressly the same; so that even concerning the left ventricle there is nothing further to be observed, but that while it is much longer than the right ventricle, it is much smaller in its whole cavity, is much stronger in its COLUMNÆ CARNEÆ, and much thicker in its fleshy walls; as at (tt) where it is seen to be thicker than the right ventricle, it is indeed nearly three times as thick.

11. The SEMILUNAR VALVES of the aorta are also seen in this general plan at (u)—where manifestly the general structure and general intention of the valves are the same as in those of the pulmonic artery; but still we find at every point marks of superior strength and more violent action in the left side of the heart; for though this valve be expressly like that of the pulmonic artery, and named like it, semilunar, yet it is thicker and stronger in its substance, and is peculiarly guarded by three small hard tubercles, which being placed one in the apex or point of each valve, meet together when the valve is close, and give a more perfect resistance to the blood, and prevent the valve being forced open. These are to be seen chiefly in the drawing, (p. 391) and from their being of the size of sesamum seeds, they have the name of CORPORA SESAMOIDEA; sometimes they are named Corpuscula Aurantii.

12. The AORTA arises from its ventricle very large and strong; it swells still more at its root than the pulmonic artery does; the three subdivisions of this swelling, which mark the places of the semilunar valves, are very remarkable; the curvature at the arch of the aorta is called its great sinus, and these three smaller bags are called the three lesser sinuses of the aorta.

OF THE CORONARY VESSELS.

But there still remains to be explained that peculiar circulation by which the heart itself is nourished; and yet there is nothing in it very different from the usual form of arteries and veins: it is a part of the general circulation of the body; for the heart is nourished by the two first branches which the aorta gives off. The circulation destined for the nourishment of the heart is peculiar in this chiefly, that the forms of the arteries and veins of the heart are beautiful, and that the arteries rise just under the valves of the aorta, while the veins end with one great mouth in the right auricle. The coronary arteries are two in number, of the size of crow-quills; we see from the inside of the artery their mouths opening above the sigmoid valves. One artery comes from the lower side of the aorta; it lies towards the

right; it belongs chiefly to the right ventricle; it comes out first betwixt the roots of the aorta and pulmonic arteries; it passes in the furrow betwixt the right ventricle and auricle, and turning round arrives at the back part of the heart, and runs down along the middle of that flat surface which lies upon the diaphragm; and when it arrives at the apex of the heart, its extreme arteries turn round the point and inosculate with the opposite coronary. The other coronary belongs in like manner to the left side of the heart, and arises from the upper side of the aorta; it first goes out betwixt the pulmonic artery and the left auricle, and then turning downwards upon the heart, it runs along that groove which is betwixt the ventricles, and marks the place of the partition or septum ventriculorum; its chief branches turn towards the left ventricle, and branch out upon it; it belongs as peculiarly to the left side of the heart as the other does to the right side: after supplying the left ventricle, &c. it turns over the point of the heart to meet the extremity of the first, and inosculate with it. Both these arteries give branches not only to the flesh of the ventricles, but to the auricles, and also to the roots of the great arteries, constituting the VASA VASORUM, as such minute branches sent to vessels are called.*

* This is the aorta inverted, so as to show the semilunar valves.—(A) One of the valves—(B) Corpus sesamoideum—(C) Opening of the coronary artery.

The GREAT CORONARY VEIN which collects the blood of these arteries, arises in small branches all over the heart; these meet so as to form a trunk upon the fore part of the heart, where the septum or union of the ventricles is. While small, the veins accompany their respective arteries; but after the great trunk is formed, the vein takes its own peculiar route. When the trunk of the great coronary vein (accompanied by several lesser veins) arrives at the auricle, it runs in between the left auricle and left ventricle; it turns all round the back of the auricle till it gets to the right side of the heart; it lies in the deep groove betwixt the auricle and ventricle, surrounded with much fat; and having almost entirely encircled the heart, it discharges its blood into the right auricle, close by the entrance of the lower cava. The opening is very large; it lies just above the tendinous circle of the auricle, and it is guarded with a strong semilunar valve. This is the great coronary vein; all the veins which appear upon the heart are but branches of it; what are called the MIDDLE vein of the heart, the vein of the right auricle, the vena innominata, &c. are all but branches of the great coronary vein running along the right side or lower surface of the heart; if there were to be any marked distinction, it should be into the GREAT CORONARY VEIN belonging to the left side of the heart, and the VENA INNOMINATA belonging to the right side. But one thing more is to be observed, viz. that upon the inner surface of the right auricle may be seen many small oblique and very curious openings, which serve for the mouths of veins, while their obliquity performs the office of a valve. This name of coronary vessels is a very favourite one with anatomists, and is applied wherever vessels surround the parts which they belong to, however little this encircling may be like a crown; and it is thus that we have the coronary arteries of the stomach, coronary arteries of the lips, and coronary arteries of the heart. But these vessels of the heart are really very beautiful, and have some things very peculiar in their circulation: first, with regard to the coronary arteries, they lie with their mouths under the sigmoid valves; or at least, in so equivocal a manner that their pe-

culiar posture has given rise to violent disputes; viz. whether they be filled, like all other arteries, by the stroke of the heart, or whether they be covered by the valve so as to let the blood rush past them during the action of the heart.

We see the opening of the coronary arteries* rather, as I imagine, under the valve; though Haller says they are above the valve, and that the highest point to which the margin of the valve reaches in very old men is below the opening of the coronary artery, and half way betwixt it and the bottom of the sinus or little bag behind the valve. But let this be as it may, if the condition of the aorta be considered, it will be found to make no difference; for though the valves rise and fall, are at one time fully opened, and at another time closely shut, still in both these conditions of the valve the aorta is as full as it can hold; its contraction instantaneously follows that of the heart, but its contraction is not, like that of the heart, such as to bring its sides together; on the contrary, the aorta is full when the heart strikes, the action of the heart distends it to the greatest degree, the aorta re-acts so as to free itself of this distension, but still it remains in some degree full of blood; else how could this, like every other artery, preserve always its form and apparent size?†

In this condition of matters, it is obvious that the coronary branches are on the same footing with all the other branches of the aortic system; that, like all the other arteries, they first feel the stimulus of fulness from the push of the heart, and along with it the stroke of the aorta.

Secondly, with regard to the coronary veins a dispute has arisen more violent than this: for it has been doubted whether the coronary veins, large as they are, do actually convey the whole of the blood which the coronary arteries give out. Vieussens believed that some of the coronary arteries opened directly into the cavities of the heart, without the interposition of veins. Thebesius, after him, believed that there were some shorter ways by which the blood was returned; not by a long circle into the right auricle, but directly into the ventricles of the heart. Vieussens, Thebesius, and others who belonged to their party, pretended to prove this fact by injections: but what doctrine is there which such clumsy anatomy and awkward injections may not be made to prove? They used mercury, tepid water, and air; and they forced these, the most penetrating of all injections, till they exuded upon the inner surface of the heart; but if they had fixed their tubes, not into the coronary

* Sketch of the arch of the aorta with the coronary arteries.

† In this cut the aorta is opened at its origin, and the semi-lunar valves exhibited. The openings of the coronary arteries are seen above the margins of the valves.

artery, but into the aorta, and had proceeded to inspect, not the heart, but all the viscera of the body, they would have found their injections exuding from every surface; of the pleura and lungs; of the peritonæum and intestines; of the brain and dura mater; of the mouth and tongue; and universally through the cellular membrane of the whole body; but if any coarse injection, as tallow or wax, be used, following this natural course, it keeps within the arteries and veins, and if thin and well prepared, finds its way back to the auricle of the heart; but this injection also is extravasated, and is found in the cavities of the heart.

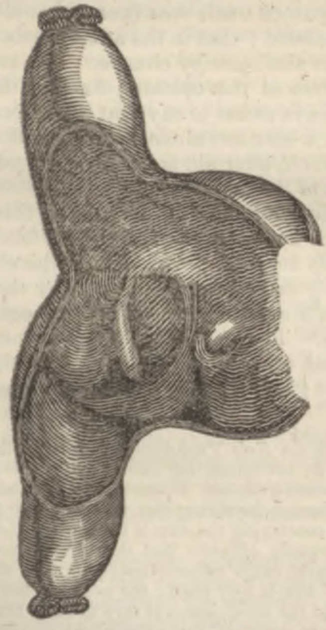
Du Verney was so far engaged in this question, that having an opportunity of dissecting the heart of an elephant, he tied up the coronary arteries and veins, washed and cleaned very thoroughly the cavities of the heart; and then tried, by squeezing, and all kinds of methods, to make that blood which was tied up in the coronary arteries and veins exude upon the inner surface of the heart, but with no effect.

On the present occasion, a theoretical answer happens to be as satisfactory as the most correct experiments: and it is this. If there really were to be formed (by disease, for example,) those numerous openings which Thebesius and Vieussens describe, then the blood flowing all by these shorter and easier passages, none could come to the great coronary vein; its office would be annihilated; and itself, contracting gradually, would soon cease to exist.

OF THE EUSTACHIAN VALVE.

There remains to be explained in the mechanism of the heart one point; and which I have separated from the others; not because it is the least important, but because it is the most difficult, and, if I may be allowed to say so, not yet thoroughly understood: I mean the anatomy of the EUSTACHIAN VALVE; which, if it had been easily described, should have been first described; for it is a valve which lies in the mouth of the lower cava, just where that vein enters the right auricle of the heart. How imperfect a valve this is, how difficult to dissect or to explain, may easily be known from this, that Winslow was first incited to look for the valve by some hints in Sylvius: he was soon after fairly directed to it by finding it in the tables of Eustachius, which were then first found and published by Lancisi, after the author had been dead 150 years; and yet with all this assistance Winslow sought for it continually in vain, till at last he reflected, that by cutting the heart in its fore part, he must have always in his dissections destroyed any such valve. By opening the back part of the cava he at last saw the valve, and demonstrated it to the Academy of Sciences in France; and having just received from Lancisi his edition of the Eustachian Table, so long hidden, and since so outrageously praised, he called it VALVULA EUSTACHIANA, a name which it has retained to this day, and he added RETICULARIS, to express its lace-like netted appearance at its upper edge. From Winslow's time to this present day, that is, for eighty years, there has been no good drawing, nor even any perfect description of the valve; and in the confusion of opinions upon the subject, what its use may be no one knows.

The Eustachian valve lies in the mouth of the ascending cava, just where that great vein is joined to the auricle of the heart. It looks as if formed merely by the vein entering at an acute angle, and by the inner edge of the vein, or that which is joined to the auricle, rising high, so as to do the office of a valve. The very first appearance of the valve, and its place just over the mouth of the cava, seem to point out that use which Lancisi has assigned it, viz. to support the blood of the upper cava, and prevent that column of blood which descends from the cava gravitating upon the opposite column which comes from the liver and lower parts of the body; and yet this, most likely, is not its use. The valve somewhat resembles a crescent, or the membrane called hymen. It occupies just that half of the cava which is nearest the auricle. Its deepest part hangs over the mouth of the cava, and is nearly half an inch in breadth, seldom more, often less, sometimes a mere line. Its two horns extend up along the sides of the auricle; the posterior horn arises from the left of the isthmus, as it is called, or edge of the oval hole; its anterior horn arises from the vena cava, where it joins the auricle. Behind the valve the remains of the foramen ovale may be seen, now shut by its thin membrane, but still very easily distinguished; for its arch-like edges are so thick, strong, and muscular, that they look like two pillars, and thence are called the COLUMNÆ FORAMINIS OVALIS.* These two pillars were called ISTHMUS VIEUSSENII, and by Haller are named ANNULUS FOSSÆ OVALIS; while the remains of the hole itself is so deep that it is



* This wood-cut represents the right auricle, opened to show the Eustachian valve, foramen ovale, and the mouth of the coronary vein.

named the FOSSA OVALIS. Before the Eustachian valve lies the great opening into the ventricle; but betwixt that and the valve there is a fossa or hollow, in which lies the opening of the great coronary vein; and the valve which covers the coronary vein is a neat small slip of white and very delicate membrane, sometimes reticular, the one end of which connects itself with the fore part of the Eustachian valve; so that both valves are moved and made tense at once.

The Eustachian valve is in general thin and transparent; it is sometimes reticulated or net-like even in the fœtus, but by no means so often as to vindicate Winslow, in adding reticularis to the name; it grows reticulated chiefly in the adult. The only beautiful drawing that we have of a reticular Eustachian valve is in Cowper; and that was from a man of eighty years of age. Perhaps in eight or ten hearts you will not find one that is reticulated in the least degree; in old men it is reticulated, just as all the other valves of the heart are, not by any thing peculiar to the constitution of this valve,—not by the pressure of the blood and continual force of the vessels, as Haller represents,—but by the gradual absorption which goes on in old age, and which spares not the very bones, for even they grow thin, and in many places transparent.

This is the simple description of a valve, which has been the occasion of more controversy than the circulation of the fœtus and the use of the oval hole. Winslow first began about eighty years ago to observe the connections and uses of this valve: he laid it down as an absolute fact, that this valve was almost peculiar to the fœtus; that it was perfect only while the foramen ovale was open; that it vanished gradually as the foramen ovale closed; that in the adult it was seldom seen, unless the foramen ovale was also open by chance. It is incredible what numbers of anatomists followed this opinion; for the difficulty of dissecting the valve made it always easier to say that it was only in the fœtus that it could be found: it is also incredible what absurd consequences arose from this doctrine, which, after all, is but a dream; for in fact the valve is more easily shown in the adult heart.*

The foundation being now laid for connecting this valve with the peculiar circulation of the fœtus, they conceived the following theory, which has come down to this very day; viz. that in the child the great object of nature, in arranging its vessels, was to convey the blood which came fresh from the mother's system directly into the carotids, and so plump into the head at once. The pure blood from the mother comes through the liver by the ductus venosus; it is deposited in the lower cava at the right side of the heart; and these anatomists supposed that this current

* One author, I find in the Acta Vindobonensia, is exceedingly angry indeed with all the great anatomists, for not connecting more strictly with each other the anatomy and accidents of the foramen ovale and Eustachian valve; with Morgagni, Albinus, and Wietbrecht, he is offended for saying that they had seen the foramen ovale open, without saying one word concerning the state of this valve; and with Lieutaud, Portal, and others again, he is equally offended that they should have had opportunities of seeing the Eustachian valve entire without enquiring into the condition of the oval hole. The reason of all this is very plain; the oval hole had not been open, neither in the one situation nor in the other, else it is very unlikely that such correct and anxious anatomists should have described that valve which arises from one of the borders of the oval hole, without observing it open, if it was so; especially as the oval hole being open is by no means an usual occurrence.

of fresh blood was directed by the Eustachian valve into the oval hole, through that into the left auricle and ventricle, and from these directly into the aorta and carotids; while the foul blood of the upper cava went down into the right auricle and ventricle, and from that into the ductus arteriosus, and so away down to the lower and less noble parts of the body, and to the umbilical arteries, and so out of the system; for the ductus arteriosus, which comes from the right ventricle in the fœtus, joins the aorta only as it goes down the back, and none of its blood can pass upwards into the head.

This is the theory which, modified in various ways, has amused the French Academy, or, rather, been the cause of a perpetual civil war in it, for a hundred years. This doctrine began with Winslow; it is still acknowledged by Sabatier; and Haller, after announcing a theory not at all differing from this, challenges it as his own theory; "hanc meam conjecturam etiam a Nichols video proponi." Of the truth of this theory Haller was so entirely satisfied, that he not only published it as peculiarly his own, but reclaimed it when he thought it in danger of being thus appropriated by another. Sabatier is the last in this train of authors; and in order that there might remain no ambiguity in what they had said or meant, he pronounces plainly that the Eustachian valve is useful only in the fœtus, and that there are two opposite currents in the right auricle of the heart; that the one goes from the lower cava upwards to the foramen ovale, while the other from the upper cava descends right into the opening of the ventricle. What shall we say to anatomists who in the narrow circle of the auricle conceive two currents to cross each other directly, and to keep as clear of each other as the arrows by which such currents are usually represented? This error in reasoning is below all criticism; it carries us backwards a hundred years in anatomy and in physics; and yet this is all that Winslow, Haller, Sabatier, and may others, have been able to say in proof of the connection of the Eustachian valve with the circulation of the fœtus.

Lancisi, again, believed that it was chiefly useful by supporting the blood of the lower cava, defending it from the weight of that column of blood which is continually descending from above; and Winslow and others approved of this, as being, perhaps, one use of the valve. But they have all of them forgotten a little circumstance, which must affect the office of the valve, and which should have been regarded, especially by those who said it was useful chiefly before birth; they have forgotten a little circumstance, which John Hunter also forgot, when theorising about the gubernaculum testis, viz. that the child lies with its head downmost for nine months in the mother's womb.*

Nothing is more certain than that the Eustachian valve is not peculiar to the fœtus; that it has no connection with the oval hole; that the valve is often particularly large after the foramen ovale is closed; that the valve is often obliterated where yet the foramen ovale remains open;

* I have left these opinions as originally expressed by Mr. John Bell, because I think it right that the reader should have the opinions fairly before him. In what follows he gives his own opinion of the function of this membrane. Notwithstanding all that is here delivered, I believe that the principal use of this membrane is to direct the blood during the fœtal circulation, and that it remains as a mere ligamentous bond, strengthening the auricle in the adult. C. B.

that in adults it is more easily demonstrated than in children; that in old age it is often reticulated as the other valves are. Its use relates neither to the foramen ovale, nor to the ascending cava; it relates to the auricle itself, and, therefore, it is found in all the stages of life, smaller or larger, according to the size or form of the heart.

The auricle on the side towards the venæ cavæ is imperfect; the anterior part of the auricle chiefly is muscular, and when it contracts, the laxity of the cavæ and the great width of the SINUS VENOSUS, *i. e.* of almost the whole auricle, would take away from its contraction all effect; but to prevent this, and to make the auricle perfect, the vena cava and auricle meet so obliquely, that the side of the cava makes a sort of wall for the auricle on that side. This wall has entirely and distinctly the recticulated structure of the auricle itself, with fleshy bands of muscular fibres in it. This wall falls loosely backwards when the auricle is quite relaxed, as, for example, when we lay it open; and thus it has got the appearance and name without the uses of a valve; but when the heart is entire, tense, and filled with blood, this valve represents truly a part of the side of the auricle: and that this part of the wall of the auricle should be occasionally a little higher or lower, looser or tenser, we need not be surprised. This further may be observed, that wherever, as in a child, this valve is very thin and delicate, the anterior part of the fossa ovalis goes round that side of the auricle particularly deep and strong. Let it also be remembered, that in certain animals this valve is particularly large and strong; now, in a creature which goes chiefly in a horizontal posture, it may strengthen and make up the walls of the auricle (the chief use which I have assigned for it in man); but surely it cannot protect the blood of the lower cava from the weight of blood coming from above, since the body of an animal lies horizontally, and there is no such weight. The Parisian academicians describe the heart of the Castor in the following terms: "Under the vena coronaria we find the valve called nobilis (viz. the Eustachian valve,) which fills the whole trunk of the vena cava, and which is so disposed that the blood may be easily carried from the liver to the heart by the vena cava, but which is hindered from descending from the heart towards the liver through the same vein."

OF THE IRRITABILITY AND ACTION OF THE HEART.

But even this curious mechanism of the heart is not more wonderful than its incessant action, which is supported by the continual influx of stimulant blood, and by its high irritability and muscular power; for though we cannot directly trace the various courses of its muscular fibres, there is not in the human body any part in which the muscular substance is so dense and strong. In the heart there can be no direct or straight fibres; for let them go off from the basis of the heart in what direction they may, still, as they belong to the one or the other ventricle, they must, by following the course and shape of that ventricle, form an oblique line. Vesalius has, indeed, not represented them so: he has drawn straight fibres only; because in the latter end of his great work he was without human subjects, and betook himself to drawing from beasts.

The fibres of the heart are all oblique, or spiral, some lying almost transverse; they all arise from a sort of tendinous line which unites the auricle to the ventricle; they wind spirally down the surface till the fibres of the opposite ventricles meet in the septum and in the apex of the heart. The fibres of each ventricle pass over the convex or upper surface of the heart, then over the apex, and then ascend along the flat side of the heart, which lies upon the diaphragm, till they again reach the basis of the heart. The second layer or stratum of fibres is also oblique; yet many of the fibres run almost transversely, uniting the oblique fibres; but when we go down into the thick substance of the heart, we find its fibres all mixed, crossed, and reticulated in a most surprising manner; so that we at once perceive, both that it is the strongest muscle in the body, and that the attempt to extricate its fibres is quite absurd.* Their desire of giving more correct and regular descriptions has been the cause why those who have particularly studied this point have been fatigued and disappointed: the most sensible of them have acknowledged, with Vesalius, Albinus, and Haller, that the thing could not be done; while those, again, who pretended to particular accuracy, and who have drawn the fibres of the heart, have represented to us such extravagant, gross, and preposterous things, as have satisfied us more than their most ingenuous acknowledgments could have done, that they also could accomplish nothing.

There is no question that irritability is variously bestowed in various creatures; that it is variously appointed in various parts of the body; that this property rises and falls in disease and health: without hesitation we also may pronounce that the heart is in all creatures the most irritable part; it is the part first to live and the last to die: "Pulsus et vita pari ambulant passu." When we see the punctum saliens in the chick, we know that there is life; and when we open the body of an animal soon after death, still the heart is irritable and contracts.

In the very first days in which the heart appears in the chick, while yet its parts are not distinguished, and the punctum saliens is the only name we can give it, the heart, even in this state, feels the slightest change of heat or cold: it is roused by heat; it languishes when cold; it is excited when heated again. It is stimulated by sharp points or acids; it works under such stimuli with a violent and perturbed motion. In all creatures it survives for a long while the death of the body; for when the creature has died, and the breathing and pulse have long ceased, and the body is cold, when the other muscles of the body are rigid, when the stomach has ceased to feel, when the bowels, which preserve their contractile power the longest, have ceased to roll, and they also feel stimuli no more, still the heart preserves its irritability; it preserves it when torn from the body and laid out upon the table; heat, caustics, sharp points, excite it to move again.

We know also another thing very peculiar concerning the irritability of this organ, viz. that it is more irritable on its internal than on its external surface; for if instead of cutting out the heart we leave it connected with the body, seek out (as the old anatomists were wont to do)

* Thickening the walls of the heart by vinegar, strong acids, alum, or boiling the heart, have assisted us in unravelling its structure but very little.

the thoracic duct, or pierce any great vein, and blow a bubble of air into the heart, it pursues it from auricle to ventricle, and from ventricle to auricle again, till, wearied and exhausted with this alternate action, it ceases at least, but still new stimuli will renew its force.

Thus it is long after apparent drowning or other suffocation before the principle of life is gone, and long after the death of the body before the heart be dead; and just as in this peculiar part of the system irritability is in high proportion, there are in the scale of existence certain animals endowed in a wonderful degree with this principle of life. They are chiefly the amphibious creatures, as they are called, needing little air, which have this power of retaining life; no stimuli seem to exhaust them; there seems especially to be no end to the action of their heart. A Newt's or a Toad's heart beats for days after the creature dies. A Frog, while used in experiments, is often neglected and forgotten, its limbs mangled, and its head gone, perhaps its spinal marrow cut across, and yet for a whole night and a day its heart does not cease beating, and continues obedient to stimuli for a still longer time. It seems as if nothing but the loss of organization could make this irritable muscle cease to act; or rather it seems as if even some degree of deranged organization could be restored: breathe upon a heart which has ceased to act, and even that gentle degree of heat and moisture will restore its action. Dr. Gardiner having left a turtle's heart neglected in a handkerchief, he found it quite dry and shrivelled, but by soaking it in tepid water its plumpness and contractility were restored.

Although the ancients knew how irritable the heart was,—although they often opened living creatures, and saw the heart struggling to relieve itself, because it was oppressed with blood,—yet they continued entirely ignorant of the cause; and why the heart should alternately contract and relax without stop or interruption seemed to them the most inexplicable thing in nature. Hippocrates ascribed it to the innate fire that is in the heart; Sylvius said, that the old and alkaline blood in the heart mixing with the new and acid chyle, and with the pancreatic lymph, produced a ferment there; Swammerdam, Pitcairn, and Friend, thought that the heart, and every muscle which had no antagonist muscle, was moved by a less proportion of the vital spirit than other muscles required. Others believed that each contraction of a muscle compressed the nerves of that muscle, and each relaxation relieved it; and that this alternate compression and relief of the nerve was the cause of the alternate movements of the heart. Another physician of our own country, a great mechanic, and a profound scholar in mathematics, and all those parts of science which have nothing to do with the philosophy of the human body, refined upon this theory most elegantly; for observing that the nerves of the heart turned round the aorta, and passed down betwixt it and the pulmonic artery, he explained the matter thus: "These great arteries, every time they are full, will compress the nerves of the heart, and so stop this nervous fluid, and every time they are emptied (a thing which he chose to take for granted, for in truth they never are emptied,) they must leave the nerves free, and let the nervous fluid pass down to move the heart."

Descartes, who studied every thing like a right philosopher of the old breed, viz. by conjecture alone, supposed that a small quantity of blood remained in the ventricle after each stroke of the heart; which drop of blood fermented, became a sort of leaven, and operated upon the next blood that came into the heart, "like vitriol upon tartar;" so that every successive drop of blood which fell into the ventricle swelled and puffed up so suddenly as to distend the heart, and then burst out by the aorta. Philosophers have been so bewitched with the desire of explaining the phenomena of the human body, but without diligence enough to study its structure, that from Aristotle to Buffon it is all the same, great ignorance and great presumption. But on this subject of the pulse of the heart, physicians almost surpassed the philosophers in the absurdity of their theories, till at last they were reduced to the sad dilemma of either giving up speaking upon this favourite subject, or of contenting themselves with saying, "that the heart beat by its facultas pulsifica, its pulsative faculty."

The ancients, I have said, often opened living creatures, and saw the heart struggling to relieve itself because it was oppressed with blood: this blood is itself the stimulus which moves the whole; for important as this function is, it is equally simple with all the others: and as urine is the stimulus to the bladder, food an excitement to the intestines, and the full grown fœtus a stimulus to the womb;—so is blood the true stimulus to the heart. When the blood rushes into the heart, the heart is excited and acts; when it has expelled that blood, it lies quiescent for a time; when blood rushes in anew, it is roused again: so natural is both the incessant action and regular alternation of contraction and relaxation in the heart.

It is when we are so cruel as to open a living creature that we see best both the operation of the blood as a stimulus, and the manner in which the heart reacts upon it. When we tie the two venæ cavæ so as to prevent the blood from arriving at the heart, the heart stops; when we slacken our ligatures and let in the blood, it moves again; when we tie the aorta, the left ventricle being full of blood will continue struggling, bending, turning up its apex, and contracting incessantly and strongly, and will continue this struggle long after the other parts have lost their powers. One author, whether from his awkwardness, or the delicacy of the subject, or really from the strength of the ventricle, assures us, that often while he has held the aorta of a frog close with pincers, it has burst by the mere force of the heart. If, after violent struggles of this kind, you cut the aorta, even of so small a creature as an eel, it will throw its blood to the distance of three or four inches.

Thus we not only know that we can excite the heart by accumulating blood in it, but that by confining the blood in it we can carry that excitement to a very high degree. But to understand what authors have greatly puzzled themselves about, we must remember that the blood performs a double office. It is, as arterial blood in the coronary circulation, the source of the heart's irritability; whilst, as dilating the cavities, it is the excitement to that irritability.

There is another circumstance of some moment in comprehending this. The irritability of the heart is not like that in a common voluntary muscle; every muscle has its law of action; and although the heart appears to be, and indeed is, regulated in the velocity of its action by the rapidity of its supply with blood, yet if torn out of the body it will continue pulsating, and the alternate action of auricle and ventricle may be seen although there may be no blood to propel. This points out the admirable manner in which the vital property is accommodated to the particular function,—how the mechanical and vital provisions are made to correspond.

With all this we can readily understand that the dilatation by the blood is the proper stimulus to the heart's action, and that distention is a more powerful cause of action than pricking it. Stimuli applied outwardly make it contract partially; it trembles in particular fibres: but it is only letting in the blood, or blowing it up with air, that can bring it into full action again. When we look with cruel deliberation upon the strokes of the heart in any living creature, we observe that at first, during the full and rapid action of the heart, there is hardly any perceptible interval among the several parts; but towards the end of each experiment, when the pulse flags, and the creature falls low, the swelling of the great veins, and the successive strokes of auricle and ventricle, are distinctly told. The dilatation and contraction of each part is what we cannot observe, they are so quick; but these things we distinctly observe—the auricle contracts and dilates the ventricle; the ventricle contracts, subsides, and fills the aorta; the aorta turns and twists with the force of the blood driven into it, and by its re-action; and the ventricle, every time that it contracts, assumes a form slightly curved, the point turning up like a tongue towards the basis, and the basis in some degree bending towards the point. The basis, indeed, is in some degree fixed to the diaphragm and spine, but the heart in its contraction always moves upon its basis as upon a centre; its ventricles, and especially its apex, are free; the point rises and curves so as to strike against the ribs; and the dilatation of the heart is such (together with the posture and relation of its several parts), that during the dilatation the heart turns upon its axis one way; the contraction of the heart reverses this, and makes it turn the other way, so that it seems to work perpetually with the turning motions of a screw. All this is most striking, while we are looking upon the motion of the heart in a living creature.*

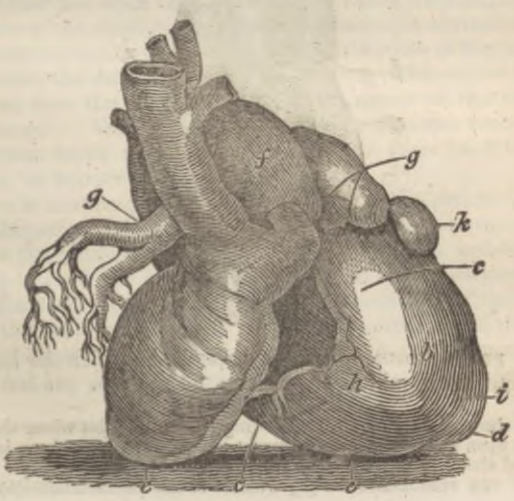
The posture of the human heart is very singular, and will illustrate this turning motion extremely well; for in the human heart the posture is so distorted, that no one part has that relation to another which we should beforehand expect. In the general system, the human heart is placed nearly in the centre, but not for those reasons which Dionis has

* We find this explanation of the beating of the heart against the ribs by Dr. William Hunter. "The systole and diastole of the heart, simply, could not produce such an effect; nor could it have been produced, if it had thrown the blood into a straight tube, in the direction of the axis of the left ventricle, as is the case with fish and some other classes of animals; but by throwing the blood into a curved tube, viz. the aorta, that artery, at its curve, endeavours to throw itself into a straight line, to increase its capacity; but the aorta being the fixed point against the back, and the heart in some degree loose and pendulous, the influence of its own action is thrown upon itself, and it is tilted forwards against the inside of the chest."—See note to John Hunter's Treatise on the Blood, p. 146.

It must be remembered, that the right ventricle throws its blood into the pulmonary artery at the same instant that the left propels its blood into the aorta, and the tendency to tilt up the apex of the heart must, therefore, belong to both arteries. The blood is also accumulating in both the auricles at the moment the arteries are thus filled, which is an additional cause of the point of the heart rising.

assigned; it is not in order that by being in the centre it may feel less the difficulty of driving the blood to any particular limb or part of the body; it is the place of the lungs that regulates the posture of the heart; and wherever they are, it is. Except the Oyster, I hardly know of any creature in which the heart lies expressly in the centre of the body. In Frogs, Toads, Newts, and Snakes, the lungs are not moved by any diaphragm: they are filled only by the working of the bag attached to the lower jaw, the lungs in them being under the jaws, and the heart is lodged at the root of the jaws, leaving, as in a Newt or Cameleon, Crocodile, Adder, Serpent, &c. the whole length of their trailing body behind. In a fish, the gills serve the creature for lungs: the gills are lodged under the jaws, and the heart is placed betwixt them. In insects, as in the common Caterpillar, (the aurelia of our common Butterfly,) the air enters by many pores on its sides; and accordingly its heart is not a small round bag, but may be easily seen running all down its back, working like a long aorta, but having regular pulsations, denoting it to be the heart: and this you easily see through the insect's skin, for it is more transparent along the back where the heart is.

The breast in man is divided into two cavities by a membrane named the MEDIASTINUM. This membrane passes directly across the breast from the sternum before till it fixes itself into the spine behind. It is on the left side of this membrane, in the left cavity of the breast, that the heart is placed, lying out flat upon the diaphragm, as upon a floor, by which it is supported: and that surface (*a*), which lies thus upon the diaphragm, is perfectly flat, while the upper surface (*c*), or what we usually call the fore part of the heart, is remarkably round. The whole heart lies out flat upon the diaphragm; its basis, where the auricles are, is turned towards the spine and towards the right side; the apex (*d*), or acute point, is turned forwards and a little obliquely towards the left side, where it strikes the ribs; the vena cava (*e*) enters in such a manner through a tendinous ring of the diaphragm that it ties down



the right auricle to that floor (as I may term it) of the thorax.* The aorta (*f*) does not rise in that towering fashion in which it is seen when we take a dried-up heart, which naturally we hold by its apex, instead of laying it out flat upon the palm of our hand; nor in that perpendicular direction in which hitherto, for the sake of distinctness, I have represented it in these plans; but the aorta goes out from its ventricle towards the right side of the thorax; it then turns in form of an arch, not directly upwards, but rather backwards, towards the spine; then it makes a third twist to turn downwards; where it turns downwards it hooks round the pulmonic artery (*g*), just as we hook the fore fingers of our two hands within one another; and from the bifurcation of the pulmonic artery there goes off a ligament to the aorta, which is the remains of the ductus arteriosus, to be afterwards described. The right heart (*h*) stands so before the other, that we see chiefly the right auricle and ventricle before, so that it might be named the anterior heart; the pulmonic artery (*g*) covers the root of the aorta; the left ventricle (*i*), from which the aorta rises, shows little more than its point at the apex of the heart; the left auricle (*k*) is seen only in its very tip or extremity, where it lies just behind the pulmonic artery; and the aorta (*f*) arises from the very centre of the heart. From this view any man may understand these vessels by other marks than the mere colours of an injection; and he will also easily understand why the heart twists so in its actions, and how it comes to pass that its posture is difficult for us to conceive, no one part having that relation to any other part which we should beforehand suppose.

OF THE PERICARDIUM.†

But the PERICARDIUM, purse, or capsule, in which the heart is contained, affects and regulates its posture, and makes the last important

* Let it be observed, that (*c*) in this drawing marks the point where the lower cava was tied close upon the diaphragm, to prevent the injection going down into the veins of the liver and abdominal cavæ.

† PLAN OF THE PERICARDIUM.—(*a*) Outside of the pericardium—(*b*) part where

point concerning the anatomy of the heart. It is a bag of considerable size and great strength, which seems to us to go very loosely round the heart, because when we open the pericardium the heart is quite empty and relaxed; but I believe it to surround the heart so closely as to support it in its palpitations, and more violent and irregular actions; for when we inject the heart, its pericardium remaining entire, that bag is filled so full that we can hardly lay it open with a probe and lancet without wounding the heart; and still further, when we open the pericardium before we inject the heart, the heart receives much more injection, swells to an unnatural bulk for the thorax that it is contained in, and loses its right shape. The pericardium is formed, like the pleura and mediastinum, of the cellular substance; it is rough and irregular without, and fleecy, with the threads of cellular substance, by which it is connected with all the surrounding parts; within it is smooth, white, tendinous, and glistening, and exceedingly strong. As the heart lies upon the floor of the diaphragm, the pericardium, which lies under the heart, is connected with the diaphragm a little to the left of its tendinous centre, and so very strongly that they are absolutely inseparable. The pericardium surrounds the whole heart, but it is loose everywhere except at the base of the heart, where it is connected with the great vessels: for the pericardium is not fixed into the heart itself, but rises a considerable way upon the great vessels, and gives to the roots of the vessels, which are seen on opening the pericardium, an outward coat, and surrounds each vessel with a sort of ring. For, 1st, It surrounds the pulmonic veins where they are entering the heart; there the pericardium is short: 2dly, It mounts higher upon the vena cava than upon any other vessel: the cava of course is longer within the pericardium, and it also is surrounded with a sort of ring: 3dly, It then passes round the aorta and pulmonic artery, surrounding these in one greater loop: 4thly, The cava inferior is the vessel which is the shortest within the pericardium; for the heart inclines towards the horizontal direction; it lies in a manner flat upon the upper surface of the diaphragm, while the lower surface of the diaphragm adheres to the upper surface of the liver. Thus it happens that the liver and the right auricle of the heart are almost in contact, the diaphragm only intervening; thence the lower cava which passes from the liver into the right auricle of the heart cannot have any length. While the pericardium thus passes round the great vessels, it must leave tucks and corners; and these have been named the CORNUA, or horns of the pericardium.

But there is another peculiarity in the form of the pericardium, which I have explained in this second plan*; viz. that the pericardium constitutes also the immediate coat of the heart; for the pericardium having gone up beyond the basis of the heart so as to surround the great vessels, it descends again along the same vessels, and from the vessels goes over the heart itself. I have marked the manner of this more delicate inflection of the pericardium at (*aa*), where the pericardium is loose; at (*bb*), the angle where it is reflected; and at (*cc*), where it

the membrane is reflected on the heart—(*c*) the same membrane covering the substance of the ventricle. N. B.—The membrane, which is extremely thin, is represented thick and coarse, for the sake of illustration.

* See page 404.

forms the proper coat of the heart, and where it is intimately united to its substance. The pericardium, where it forms this coat, becomes extremely thin and delicate, almost cuticular, but strong; under this coat the coronary arteries pass along in the cellular substance; under it the fat is gathered sometimes in a wonderful degree, so as to leave very little to be seen of the dark or muscular colour of the heart.

The pericardium, then, is a dense and very strong membrane, which I would compare with the capsule of any great joint, both in office and in form; for it is rough and cellular without, shining and tendinous within; bedewed with a sort of halitus like the great joints: its uses are to keep the heart easy and lubricated by that exhalation which proceeds from its exhalent arteries (and which can be imitated so easily by injecting tepid water into its arteries); to suspend the heart in some degree by its connections with other parts, especially by its connections with the mediastinum and diaphragm. The pericardium limits the distention of the heart, and checks its too violent actions; just as we see it prevent too much of our injections from entering the heart. How strong the pericardium is, and how capable of supporting the action of the heart, even after the most terrible accidents, we know from this, that the heart or coronary arteries have actually burst, but with a hole so small as not to occasion immediate loss of life; then the pericardium, receiving the blood which came from the rupture, has dilated in such a manner as to receive a large quantity of blood, but has yielded so slowly as to support the heart in some kind of action, and so preserved life for two or three days. But while, according to authors, we have been following the inflection of the pericardium, we should not omit noticing that the membrane is double, and that, while the finer layer of the membrane is reflected over the heart, a stronger texture of fibres is sent off into the sheaths of the great vessels which ascend from the heart.

If I have not mentioned any fluid under the direct name of AQUA PERICARDII, or the water of the pericardium, it is because I consider the accident of water being found as belonging not to the healthy structure, but to disease. Yet this same water occupied the attention of the older authors in a most ludicrous degree. Hippocrates believed that this water of the pericardium came chiefly from the drink we swallow, which found some way or other (as it passed by the pericardium) to insinuate itself into this bag. Some after him said, it was the fat of the heart melted down by incessant motion and the heat of the heart; some said it was from humours exuding through the heart itself, and retained by the density of the pericardium, that this water came; and it is but a few years since this clear and distinct account of it was given, viz. "that it proceeds from the aqueous excrementitious humour of the third concoction." The same men, "viri graves et docti*," declare to us that the uses of the aqua pericardii are to cool the heart, for it is the very hottest thing in the body; or by its acrimony to irritate the heart, and support its motions; or to make the heart by swimming in it seem lighter. By this it is pretty obvious what absurd notions they had of the quantity of water that may be found in the pericardium. But of all the outrages

* They are thus denominated in all the charters of the College of Physicians from the time of Henry VIII. downwards.

against common sense and common decorum, the most singular was the dispute maintained among them, whether it was or was not the water of the pericardium which rushed out when our Saviour's side was pierced with a spear? The celebrated Bardius, in a learned letter to Bartholine, shows how it was the water of the pericardium that flowed out; but Bartholine, in his replication thereunto, demonstrates, that it must have been the water of the pleura alone. This abominable and ludicrous question, I say, they bandied about like boys rather than men: Bartholinus, Arius, Montanus, Bertinus Nicelius, Fardovius, Laurenbergius, Chiprianus, with numberless other Doctors and Saints, were all busy in the dispute; for which they must have been burnt every soul of them, at the stake, had they done this in ridicule; but they proceeded in this matter with the most serious intentions in the world, and with the utmost gravity. The whole truth concerning water in the pericardium is, that you find water there whenever at any time you find it in any of the other cavities of the body. If a person have laboured under a continued weakness, or have been long diseased; if a person have lain long on his death-bed, then you find water in the pericardium. But if you open any living animal, as a dog, or if you open the body of a suicide, not a drop of water will be found in the pericardium. When such fluid is to be found, it is of the same nature with the dropsical fluids of other cavities: in the child, and in young people, it is reddish, especially if the pericardium be inflamed; in older people, it is pellucid, or of a light straw colour; in old age, and in the larger animals, it is thicker, and more directly resembles the liquor of a joint.

Thus does the pericardium contribute in some degree to settle the posture of the heart; but still the heart is to a certain degree loose and free. It is fixed by nothing but its great vessels as they run up towards the neck, or are connected with the spine; but how slight this hold is, how much the heart must be moved, and these vessels endangered, by shocks and falls, it is awful to think. The pericardium is no doubt some restraint; its connections with the diaphragm and with the mediastinum make it a provision, in some degree, against any violent shock; its internal lubricity is, at the same time, a means of making the heart's motion more free: yet the heart rolls about in the thorax; we turn to our left side in bed, and it beats there; we turn over to our right side, and the heart falls back into the chest, so that its pulse is no where to be perceived; we incline to our left side again, and it beats quick and strong. The heart is raised by a full stomach, and is pushed upwards in dropsy: and during pregnancy its posture is remarkably changed; it is suddenly depressed again when the child is delivered, or the waters of a dropsy drawn off. It is shaken by coughing, laughing, sneezing, and every violent effort of the thorax. By matter collected within the thorax it may be displaced to any degree. Dr. Farquharson cured a fine boy, about eight years old, of a great collection of matter in the chest, whose heart was so displaced by a vast quantity (no less than four pounds) of pus, that it beat strongly on the right side of the breast while his disease continued, and as soon as the pus was evacuated, the beating of the heart returned naturally to the left side. Who could have believed that, without material injury, the heart could be so long and so violently displaced? Felix Platerus tells us a thing not so easily believed, that a young boy, the son of a printer, having practised too much that trick which boys have of going upon their hands with their head to the ground, began to feel terrible palpitations in the left breast; these gradually increased till he fell into a dropsy from weakness, and died; and upon dissecting his body, the situation of his heart was found to have been remarkably changed by this irregular posture. Now, we are not to argue that such change of posture of the heart could not happen merely from this cause, because professed tumblers have not these diseases of the heart; it were as silly to argue thus against the authority of Platerus, as to say that every post-boy has not aneurisms of the ham, or that every chimney-sweeper has not a cancer of the scrotum.

We may now close this account of the mechanism of the heart; in which all the parts have been successively explained. We know how the heart is suspended by the mediastinum, and by its great vessels; how it is lubricated, supported, and regulated in its motions, by the pericardium: its nerves, which remain to be explained at a fitter time, are extremely small; while its vis insita, or irritability, is great beyond that of all the other parts. We can easily follow the circle of the blood, which, as it arrives from all the extremities, irritates the auricle, is driven down into the ventricle, is forced thence into the pulmonic artery, pervades the lungs, and then comes round to the left side of the heart, or to that heart which supplies the body; and there begins a new circulation, called the greater circulation, viz. of the body, as the other is called the lesser circulation of the lungs. Thus we recognise distinctly the functions of the double heart, with all its mechanism; the stronger heart to serve the body, the weaker heart to serve the lungs; and we see in the plainest manner two distinct functions performed by one compound heart: the right heart circulates the blood in the lungs, where it is purified and renewed; the left delivers out a quantity of blood, not such as to fill all the vessels, nor such as to move onwards by this single stroke of the heart to the very extremities of the body, but such merely as to give a sense of fulness and tension to the vessels: the force is merely such as to excite and support that action which the arteries everywhere perform in the various organs of the body, each artery for its appropriated purposes, and each in its peculiar degree.

By understanding thus the true mechanism and uses of the heart, we can conceive how the ancients were led into strange mistakes by very simple and natural appearances. We understand why Galen called the right auricle the "ultimum moriens," or the part which died last; for, upon opening the body soon after death, he found the right auricle filled with blood, and still palpitating with the remains of life, when all the other parts seemed absolutely dead; and if the blood always accumulates on the right side of the heart before death, it is plain that the stimulus of that blood will preserve the remains of life in the right side, after all appearance of life on the left side is gone. But the cause of this accumulation of blood in the right side is very ill explained by Haller, though it seems to have employed his thoughts during half his life. He says, that in our last moments we breathe with difficulty; the lungs at last collapse, and cease to act; and when they are collapsed, no blood can pass through them, but must accumulate in the right side of the heart. That there is really no such collapse of the lungs, I propose hereafter to show; but, in the meanwhile, this is the true reason, viz. that when the ventricles of the heart cease to act, and the beating of the heart subsides, the two auricles lie equally quiet, but in very different conditions; the right auricle has behind it all the blood of the body pouring in from all parts during the last struggles; but the left auricle has behind it nothing but the empty veins of the lungs; nothing can fill it but what fills the vessels of the lungs; or in other terms, nothing can fill the left auricle but the stroke of the heart itself: but instead of acting the heart falls into a quiescent state; the left auricle remains empty, while the blood oozes into the right auricle from all the extremities of the body till it fills it up.

Nothing is more agreeable than to find such phenomena described faithfully long before the reason of them is understood. In the Parisian Dissections I find the following description: "When the breast of a living Dog is opened by taking away the sternum, with the cartilaginous appendices of the ribs, the lungs are observed suddenly to sink, and afterwards the circulation of the blood and the motion of the heart to cease. In a little time after the right ventricle of the heart and the vena cava are swelled, as if they were ready to burst."* This was what deceived the ancients, and was the cause of all their mistakes. When they found the right ventricle thus full of blood, they conceived that it alone conveyed the blood; they found the left ventricle empty, and believed that it contained nothing but vital spirits and air; and so far were they from having any notions of a circulation, that they thought the air and vital spirits went continually forwards in the arteries; that the gross blood which was prepared in the liver came up to the heart to be perfected, and went continually forwards in the veins; or, if they provided any way of return for these two fluids, it was by supposing that the blood and spirits moved forwards during the day-time, and backwards in the same vessels during the night.

These things next explain to us why they called the right ventricle VENTRICULUS SANGUINEUS; they found it full of blood, and thought its walls were thinner, because it had only to contain the very grossest parts of the blood: and why they called the left ventricle VENTRICULUS SPIRITUOSUS and NOBILIS, because they saw it empty, and concluded that it contained the animal spirits and aërial parts of the blood, and its walls were thicker, they said, to contain these subtile spirits. They explain to us their names of ARTERIA VENOSA; and VENA ARTERIOSA; for they would have veins only on the right side of the heart, and arteries only on the left; and although they saw plainly that the pulmonic artery was an artery, they called it Arteria Venosa: and although, on the left side again, they saw plainly that the pulmonic vein was merely a vein, they would still cheat themselves with a name, and call it Vena Arteriosa: the veins, they said, were quiet, because they contained nothing but mere blood; the arteries leaped, they said, because they were full of the animal spirits and vital air.

The very name and distinction of arteries which we now use, arise

* Page 211.

from this foolish doctrine about air and animal spirits. To the oldest physicians there was no vessel known by the name of artery, except the ASPERA ARTERIA; and it was named Artery because it contained air; so that Hippocrates, when he speaks of the carotids, never names them arteries, but calls them the Leaping Veins of the neck. But when Eristratus had established his doctrine about the vessels which go out from the heart, carrying vital spirits and air, the name of artery was transferred to them; and then it was that the ancients began to call the vessels going out from the left side of the heart arteries, naming the aorta the ARTERIA MAGNA, and the pulmonic vein the ARTERIA VENOSA.

When a vein was cut, they saw nothing but gross blood, and of a darker colour; but when an artery was cut, they observed that the blood was red; that it was full of air bubbles; that it spurted out, and was full of animal spirits; and thus it became easy for them to show how safe it was to open a vein where nothing was lost but gross blood, how terribly dangerous it was to open an artery, which was beating with the spirit of life; and this they considered as such an awful difference, that when arteriotomy in the temple was first proposed, they pronounced it murderous, and on this reasoning it was absolutely forsaken for many ages.

But the oldest of our modern physicians soon found a necessity of mixing this blood and animal spirits together, and for a long while could hit on no convenient way by which this mixture might be effected: as a last shift, they made the blood exude through the septum of the heart: and then the currrent doctrine was, that of the blood which came from the liver, one half went into the pulmonic artery to nourish the lungs; the other half exuded through the septum of the heart, to mix with the animal spirits. Riolanus was the bitter enemy of Harvey and of his noble doctrine; and this is the miserable and confused notion, not to call it a doctrine, which he trumpeted through Europe in letters and pamphlets. To make good this miserable hypothesis, Riolanus, Gassendus, and many others, saw the necessity of having side passages through the septum of the heart. I really believe, from their mean equivocating manner of talking about these passages, that they had never believed them themselves.* "The chyle," says Bartholine, "and the thinner blood, pass through the septum of the heart, when the heart is in systole and the pores and passages are enlarged." Thus did the celebrated Bartholine believe the septum perforated. Wallæus, and Marchetti, and Mollinettus and Monichen, believed it, and Mr. Broadbecquius of Tubingen proved it.† But I believe most potently with Haller, that whenever they wanted to show those perforations, they managed their probes so as to make passages as wide and as frequent as the occasion required: "Solebant foramina parare adigendo stylos argenteos in resistens septum," says Haller; and this is a full and true account of all the authors who have described side passages through the septum of the heart; they needed them, and they made them.

Amidst all this ignorance, we cannot wonder that a thousand childish

* That I may not seem to speak too harshly of this knot of conspirators against Harvey, I will quote what Boerhaave says of Riolanus, who was at the head of them: "Non ipse callidus cavillationum artifex Riolanus," &c.

† Experimento perforatum ostendit Broadbecquius Tubingæ.

imaginations prevailed, nor that the qualities of the mind were deduced from the physical properties of the heart. We have heard the vulgar, for example, speak of the bone of the heart. And from whom did this arise? From Aristotle! who explains to us, that there is at the root of the heart a bone which serves for its basis; and not a physician has written upon the heart since his time, who has not spoken more or less mysteriously about this bone; while in truth the whole story means nothing more than this, that where the basis of the arteries are fixed into the hard ring or basis of the heart, the place is extremely firm, almost cartilaginous, especially in old age, when often the roots of the arteries are ossified or converted into what anatomists have chosen to call bone.

Often, also, we have heard the vulgar talk, not figuratively, but in the plain sense of the words, of a little or big heart, as synonymous with a timorous or courageous heart. But whenever we hear mistakes of this kind among the vulgar, we may be assured they have some time or other come from high authority. Bartholine was so much convinced that a small heart begot courage, and a great one irresolution and fear, that he is thoroughly surprised when he finds the contrary: "Cor vastus fuit homo, tamen audax fuerat, ut cicatrices in capite frequentes et rimæ in cranio testabantur." But if Bartholine be right, Kirkringius is quite wrong, and has mistaken the doctrine; for he says, "An magnanima fuerit hæc magni cordis fœmina, nescio," &c. "I do not know whether this woman's courage was as big as her heart; but this I do know, that she was a famous toper. Whether this drinking dilates the heart, and makes your staunch drinkers such famous fighters, I cannot pretend to decide." We have heard the vulgar talk also of a hairy heart, as familiarly as of a hairy man, being the mark of high courage and strength: but what shall we think of it, when we find that this report is to be deduced fairly from Pliny, through the most celebrated names among our old physicians? He it was who began with telling how the Messenians, that unhappy people, who lived for so many ages the slaves or helots of Greece, lost their great general, Aristomenes. But how great he was, never, according to Pliny, came to be known till after his death; for the Lacedemonians having catched him three times, resolved at last to open his breast; and there, as a proof of his most invincible courage and daring, they found his heart filled with hair. This from Pliny was nothing, if such dissections had not been made since then a hundred times. "There was a robber, (says Benivinius,) one Jacobus, who having been taken down from the gibbet apparently dead, but really having in him the remains of life, was laid out carefully, recovered, was perfectly restored, betook himself to his old ways again; and so in the natural course of things came round to his old mark, the gallows, and was this time very thoroughly hanged. Wondering (says Benivinius) at the perfect wickedness of this man, I longed very anxiously to dissect the body; and I actually found the heart, not covered, but (refertum pilis) crammed with hair."

But there is, in fact, no end of wonders and wonderful dissections among these robbers of his. His next subject was not a bold robber, but a poor sneaking thief (de corde furis cujusdam); there was no hair to be expected in his heart: but as he was a thief only, it was consistent with this doctrine that he should be first very heartless; secondly, have very little brain; thirdly, that he should have very inordinate appetites and desires. Now, there was first a great two-legged vein carrying the atrabilis, the source, no doubt, of all his inordinate cravings, directly into the stomach; secondly, there was a great abscess full of pus wasting the left side of his heart; and, thirdly and lastly, the back part of the head (which all the anatomists of that time knew very well was the seat of memory) was in him so small that it could hardly contain a spoonful of that kind of brain: and this want was the reason (having so little memory) that he was so persevering a thief; for let you whip him, banish him, clap him in the stocks, he forgot it straightway, and was back at his old tricks again, like a dog to his vomit.

But these are now almost forgotten, though, perhaps, the history of the absurdities of the human genius should no more be neglected than that of its beauties. Is it not delightful to feel, that after floating in this ocean of conjecture, after all these disorderly and wild dreams, we are come to have an idea of the heart, simple and beautiful; of a heart containing within itself two functions; first, the office of renewing the blood; secondly, the office of animating the arteries, and by them preserving in life and action the whole system of the body? These are the two offices which I shall now proceed to explain.

OF THE RESPIRATION OF ANIMALS.

ITS EFFECTS ON THE BLOOD.

The effects of oxydation then are, to redden the blood, to renew its stimulant power, and to communicate heat, not so much to the blood, as to the whole body through the medium of the blood, and to assist in the secretions and chemical changes which are incessantly going on in all parts of the system. This is accomplished by the perpetual and rapid motion of the blood through the lungs; and there it is exposed to our atmosphere, which is a mixed fluid very different from what we at first conceive, or what our ignorant wishes might desire to have it; not consisting merely of air fit to be breathed, but for the greatest part formed of an air which is most fatal to animal life, whence it has the name of Azotic Gas. Of an hundred measures of atmospheric air, we find twenty-one only to consist of vital or pure air, that is oxygen; seventy-nine consist of azotic air, or nitrogen, as it is called, fatal to animal life; and one thousandth part only is fixed air, or carbonic acid, which is also an unrespirable air. But of these twenty-one parts of pure air, seventeen parts only are affected by respiration; so that in respiration we use much less than a fifth part, even of the small quantity of air which we take in at each breath.*

* Dr. Bostock, after having examined the various opinions of the best chemists who treat of the effects produced by respiration upon the air, concludes thus—"1. Air which has been respired loses a part of its oxygen: the quantity varies considerably, not only in the different kinds of animals, but in different animals of the same species,

Within these few years, the following opinions prevailed on this subject. The air in respiration is diminished by the abstraction of a part of the oxygen; there is formed a quantity of carbonic acid gas by the union of the carbon of the blood with the oxygen respired; and there is discharged along with these a quantity of watery halitus. Therefore atmospheric air, after it has been breathed, is found to have suffered these changes: First, It contains now a considerable proportion of carbonic acid, which is easily discovered and even weighed, because, when a caustic alkali is exposed to it, the alkali absorbs the fixed air and becomes mild. Secondly, It has less of the vital air, as is easily ascertained by the eudiometer, which measures the purity of the whole: And, thirdly, All that remains is merely azotic air, unfit for animal life, or for supporting flame. The oxygen, then, in part unites itself with the blood; in part it forms fixed air by combining with the carbon of the lungs; in part it forms water by combining with the hydrogen of the blood. Respiration frees the blood of two noxious principles, the hydrogen and carbon; and it insinuates a new principle, viz. the oxygen, into the blood.*

and even in the same animal at different times, according to the operation of certain external agents, and of certain states of the constitution and functions. Upon an average we may assume, that a man, under ordinary circumstances, consumes about 4,500 cubic inches, or nearly 15,500 grains of oxygen in 24 hours. 2. A quantity of carbonic acid is produced, the amount of which varies very much, according to circumstances, both external and internal: its quantity depends, to a certain extent, upon the quantity of oxygen consumed; but the two are not in exact proportion to each other: in a great majority of cases, the quantity of carbonic acid produced will be found to be less than that of the oxygen consumed; so that there will be a surplus quantity of oxygen more than is necessary for the production of the carbonic acid. In consequence of the variations which take place in the amount of the carbonic acid produced, it appears almost impossible to fix upon any number which may indicate the average quantity; but it may be stated to be somewhere about 40,000 cubic inches in 24 hours. This will weigh 18,600 grains, or nearly three pounds, and will contain 5,208 grains of charcoal, and 13,392 grains of oxygen, which will be 2,100 less than the quantity of oxygen consumed. 3. The volume of the air is diminished by respiration; but this, like the changes mentioned above, varies so much at different times, that it is almost impossible to form any statement of the quantity: perhaps we may assume, that air which has been once respired is diminished by about $\frac{1}{50}$ of its bulk. 4. It appears probable, that nitrogen is both absorbed by the lungs and exhaled from them: but the two processes of absorption and exhalation differ very much, both in their absolute quantity and in the relation which they bear to each other; so that the proportion of nitrogen in the air is sometimes diminished by respiration—is occasionally increased, and frequently remains without alteration. 5. A quantity of aqueous vapour is discharged from the lungs, mixed with or diffused through the air of expiration; but we have not sufficient data from which to decide upon its amount; and it is probable, that the quantity varies considerably in the different conditions of the system, and the different situations in which the body is placed." *Bostock's Element. System of Phys.* vol. ii. p. 110.

* "Two theories have been proposed, in order to account for the phenomena of respiration. According to one theory, the carbonic acid found in respired air is actually generated in the lungs themselves; while, according to the other, this gas is thought to exist ready formed in the blood, and to be merely thrown off from that liquid during its distribution through the lungs.

"The former theory, which appears to have originated with Priestly, has received several modifications. Priestly imagined, that the phenomena of respiration are owing to the disengagement of phlogiston from the blood, and its combination with the air. Dr. Crawford modified this doctrine in the following manner (Crawford on Animal Heat): He was of opinion, that venous blood contains a peculiar compound of carbon and hydrogen, termed hydrocarbon, the elements of which unite in the lungs with the

Such has been the opinion of chemists up almost to the present day; but the rapid changes of opinion, and, indeed, of whole systems, and the confusion into which the discoveries of the day throw the result of all preceding labours, would almost provoke an anatomist to put out of his system the chemical discussion altogether, until the masters of that science have arrived at acknowledged principles. More careful experiments have proved that the volume of air expired is very nearly the same with that inspired,—the respired air differing only in the variable proportion of carbonic acid gas, and aqueous vapour; that all the oxygen taken from the atmosphere by respiration is consumed in the formation of the carbonic acid gas found in the respired air; and that the heat evolved by respiration is not the heat of the body, but the heat of the air respired, latent before, and now become sensible, owing to a change of capacity in the blood.

The change produced in the blood during the circulation in the lungs, is simply to free it of the superabundance of carbon with which it is loaded by circulation through the body.*

oxygen of the air, forming water with the one, and carbonic acid with the other; and that the blood, thus purified, regains its florid hue, and becomes fit for the purposes of the animal economy.

"The hypothesis of Crawford, however, is not merely liable to the objection that the supposed hydrocarbon, as respects the blood, is quite imaginary, but was found at variance with the leading facts established by Messrs. Allen and Pepys. By the elaborate researches of these chemists, it was established, that carbonic acid gas contains its own volume of oxygen; and they also concluded, that air, inhaled into the lungs, returns charged with a quantity of carbonic acid, almost exactly equal in bulk to the oxygen which disappears; an inference which, as applied to man and some of the lower animals, seems very near the truth.

"A review of these circumstances induced them to adopt the opinion, that the oxygen of the air combines in the lungs exclusively with carbon; and that the watery vapour, which is always contained in the breath, is an exhalation from minute pulmonary vessels. They conceived that the fine animal membrane interposed between the blood and the air does not prevent chemical action from taking place between them.

"According to the second theory, which was supported by La Grange and Hassenfratz, and has lately been adopted by Dr. Edwards, carbonic acid, generated during the course of the circulation, is given off from the venous blood in the lungs, and oxygen gas is absorbed.

"In the experiments of Dr. Edwards, on confining frogs and snails for some time in an atmosphere of hydrogen, the residual air was found to contain a quantity of carbonic acid, which was in some instances even greater than the bulk of the animal; and a similar result was obtained with young kittens." *Turner's Elements of Chemistry*, p. 753.

* "In studying the subject of respiration, the first object is to determine the precise change produced in the constitution of the air which is inhaled. Dr. Black was the first to notice that the air exhaled from the lungs contains a considerable quantity of carbonic acid, which may be detected by transmission through lime water.

"Priestly, some years afterwards, observed, that air is rendered unfit for supporting flame or animal life by the process of respiration, from which it was probable that oxygen is consumed; and Lavoisier subsequently established the fact, that during respiration oxygen gas disappears, and carbonic acid is disengaged. The chief experimentalists who have since cultivated this department of chemical physiology are Priestly, Scheele, Lavoisier, Seguin, Crawford, Goodwyn, Davy, Ellis, Allen and Pepys, Edwards and Despretz; of these, the results obtained by Messrs. Allen and Pepys, and Dr. Edwards, are the most conclusive and satisfactory, their researches having been conducted with great care, and aided by all the resources of modern chemistry.

"One of the chief objects of Messrs. Allen and Pepys, in their experiments, was to ascertain if any uniform relation exists between the oxygen consumed and the carbonic acid evolved. They found, in general, that the quantity of the former exceeds

OF ANIMAL HEAT.

The next effect of respiration is the communicating of HEAT to the body. There are some who pretend to say, that when they draw in vital air, they feel a genial warmth in the breast, diffusing itself over all the body; but it is easy to feel in this way, or any way, when a favourite doctrine is at stake, while those who know nothing about doctrines breathe the vital air without any peculiar feeling which they can explain.

To suppose, but for a moment, that all the heat which warms the whole body emanates from the lungs, were a gross error in philosophy: it were to suppose an accumulation of heat in the lungs equal to the vast effect of heating the whole body. But, were it so, we should feel a burning heat in the centre, a mortal coldness at the extremities, and marked differences in the heat of each part, in proportion to its distance from the lungs. In fevers we should feel only the intense heat of the centre: we should be distressed, not with the heat in the soles of the feet or palms of the hands, or in the mouth and tongue, we should feel only the heat of the lungs. When the limbs alone were cold, would the lungs warm them? How could they warm them up to the right temperature without overheating the whole body? When a part was inflamed, how could the heat go from the lungs, particularly to that point, and rest there?

It is a law of nature, to which, as far as we know, no exception is found, that a body, while it passes from an aërial to a fluid form, or from a fluid to a solid form, gives out heat. So, it might be said, what is the whole business of the living system but a continual assimilation of new parts, making them continually pass from fluid into a solid form? But this would be an erroneous view of the matter.

It were easy to say, that the gases were consumed in breathing, and the fluids in circulation became solids, and therefore heat was generated in the animal body. But, unfortunately for this hypothesis, these solids are again melted into fluids, and the fluids are giving out gases; and then as much heat as we might suppose was generated in building up the fabric of the body would be lost in its decomposition.

This is a subject of much difficulty, as may be readily conceived, when we consider, that for its elucidation we require to measure the air, and estimate, not the temperature of that air, but the degree of heat it is capable of producing: we are consequently engaged with chemical processes of great delicacy. The received opinion is this; bodies and even fluids and gases have different capacities for heat, and the heat may make a part of their compound, without being in a state to raise

that of the latter; but as the difference was very trifling, they inferred, that the carbonic acid of the expired air is exactly equal to the oxygen which disappears. The experiments of Dr. Edwards were attended with a remarkable result, which accounts very happily for some of the discordant statements of preceding inquirers. He found the ratio between the gases to vary with the animal. In some animals it might be regarded as nearly equal; while in others, the loss of oxygen considerably exceeded the gain of carbonic acid, so that the respired air suffered a material diminution in volume. With respect to the human subject, the statement of Allen and Pepys seems very near the truth." *Turner's Elements of Chemistry*, p. 750.

their actual temperature: this property of latent heat was the great discovery of Black. Now it is said that the blood, when going out from the heart to the lungs, differs in its capacity of absorbing and retaining the heat from the same blood on its return; that the arterial blood, returning in the veins, contains more absolute heat, though it be not of a higher temperature than the blood of the veins. By the process of respiration, when the purple-coloured venous blood is exposed to the air, it throws out its superabundant carbon: and when this carbon unites with the oxygen of the air respired, carbonic acid gas is formed and heat is evolved. The arterial blood, it is supposed, takes up this heat, which is not sensible heat, but latent. It is further alleged, that when the arterial blood is conveyed along the tubes and vessels to the body, and generally diffused, it is not heating the body, because the latent heat is not disengaged, and is not in a state to raise the temperature. But when that arterial blood is converted into venous blood, a process which takes place in the extremities of the arteries and veins of the body, then the latent heat is disengaged, because the venous blood has not the same capacity for retaining it as the arterial blood had: and thus heat is uniformily diffused in proportion to the activity of the circulation—in proportion to the conversion of arterial into venous blood.

This highly ingenious hypothesis of Dr. Crawford has been objected to by Dr. Davy, Edwards, and others, who assert that there is no difference of capacity in the arterial and venous blood. And the phenomena are explained in this manner: it is said that oxygen is absorbed by the blood returning from the lungs to the left side of the heart: that this oxygen, carried by the arteries over the body, unites with the carbon in the circulation through the body; and that it is during the assumption of this carbon, and the formation of carbonic acid, that heat is evolved. This appears to me to be a defective hypothesis, inasmuch as there are only two ways of explaining a change of temperature, — either by a difference of capacity of retaining what was formerly called *latent* heat, or by a difference in the aggregation or condition of the substances. They have rejected the hypothesis of the different capacities of heat. As to the other, they have not explained to us how the carbon, constituting a part of the solid texture of the frame, should give out heat when entering into the liquid blood, we may say when changing from the solid to the liquid state. We require a new genius to look over this subject, and to arrange the discordant materials. In the meantime, by rejecting the hypothesis of Crawford we are thrown into more confusion: but the truth is, that in every subject, where the experiments and reasoning of the chemist are brought to explain a vital phenomenon, he fails in being perfectly satisfactory.

It is by possessing this property of animal heat that we are enabled to resist the changes of external temperature, and maintain a genial warmth independently of the surrounding atmosphere. Thus man can inhabit all parts of the globe, however various are the degrees of heat in the different climates; and his temperature is always the same, being 97° or 98°. As to the means by which the uniformity of the animal temperature is thus preserved, the investigations of chemists have not yet conducted us to very satisfactory conclusions. It is supposed that the quantity of carbonic acid gas evolved from the lungs and the halitus may vary according to the altered state of the surrounding temperature; and it is also thought that the degree of perspiration of the skin, and the consequent evaporation, may vary in a similar manner, so as to correspond with the warmth or coldness of the atmosphere — but of these the proofs by actual experiment are yet very deficient.*

OF THE MEMBRANES OF CAVITIES, AND PARTICULARLY OF THE MEMBRANES OF THE THORAX.

Every part of an animal body, with the exception of the fluids, the matter of the nerves, of the muscles, and of the bones, is resolvable into membrane by maceration, and the contrivances of the anatomist. The fine web which supports the retina in the eye, and the strong cord on which the gastrocnemius acts, are formed of the same kind of tissue, the same cellular texture. Another remarkable circumstance is, that this cellular texture no where terminates, and that the membranes of the body are every where in continuity. If, for example, we begin our investigation with the tendon of a muscle, we shall find that it is resolvable into a twisted membrane, we may trace this membrane into the muscle, and we shall find it enveloping the muscular fibres, and extending through the muscle, and uniting again to form the tendinous insertion of the muscle into the bone. From the tendon the continuation is direct to the periosteum; the periosteum is continued into the ligaments and capsule of the joint; from this again we may trace the fasciæ, and intermuscular septa. These firmer structures we shall find loosening into the common cellular texture, and that texture, as has been already explained, may be traced over the whole animal frame.

But we have now particularly to consider the structure and connections of the membranes of the great cavities of the body; and, in the first place, the membranes of the thorax.

A membrane is an expansion or web of animal matter, having extension with a scarcely measurable thickness; it has one surface, free or disunited, and smooth, and lubricated with a secreted fluid. It has

* It was conceived, from the experiments made by Boerhaave, that persons could not live when exposed to a heat greater than that which is natural to the body. This was first disproved by Tillet, who gave the account of some young women, the servants of a baker at Rochefoucault, who were in the habit of going into the heated ovens at the temperature of 278°; and they could remain in them for about 12 minutes. Subsequent experiments have been made by Dr. Fordyce, Blagden, Dobson, and others; and it has been found, that although the temperature of the surrounding air be raised to 260°, the heat of the body suffered scarcely any change from its usual standard: it varied in their experiments between 98° and 100°. When many persons were together in the heated chamber, the temperature of the room was changed — it became much less. It was then supposed by Dr. Blagden, that independently of the cooling effects of the perspiration, their bodies had a property of abstracting and removing some of the heat. When they breathed upon the thermometer, the mercury fell — they cooled the tips of their fingers by blowing upon them. The pulse, during these experiments, rose, in some instances, to 130°. Their breathing was not affected.

Captain Lyon, while in Winter Isle, which is situated N. lat. 66° 11′, and while the temperature varied between 33° and 3°, made observations with the thermometer on recently killed foxes, and he found that the degree of heat of their bodies was always between 106¾° and 98°.

Dr. Davy states, that the standard heat of the inhabitants of Ceylon is two degrees above the usual standard.

the other surface rough and attached, being more like the common cellular texture, of which, in fact, the whole membrane is a composition.

The membranes of the viscera are arranged in two grand divisions, viz. the Mucous membranes, and the Serous membranes; all of which are remarkable for their extent of surface, but especially the former. The difference of the two great classes of membranes is referable to the nature of their secretions. The object of the secretions is to prevent adhesion of contiguous surfaces, which is most effectually done by the mucous secretion. But as the mucous secretion is not readily soluble, nor prepared for absorption; as when secreted it must be thrown off from the surface, and urged out of the body altogether; it is obvious that this is a secretion calculated solely for the membranes which are open, and from which it may be discharged.

The serous fluid is finer, more watery, and very readily absorbed; so that it is supplied to moisten the surfaces of shut sacs, and membranes which are continuous and have no outlet, such as those lining the great cavities. But if there be any tendency to inflammation on these surfaces, they are more prone to adhesion than the mucous membranes, because the inflammatory action will more quickly convert serum to coagulable lymph (which is the medium of adhesion) than it will the mucous secretion.

The mucous membrane is the continuation of the skin; it is every where continuous, but it admits of a natural division, viz. 1. The mucous lining of the lungs; 2. The mucous lining of the alimentary canal, and the ducts which open into it; and, 3. The mucous lining of the urinary organs.

We may trace the first from the nostrils up into the cavities of the nose, and from that into the lining membrane of the cells of the face. We may then trace it backwards into the throat, into the larynx, the trachea, the bronchia, and finally, into the bronchial cells, an extent perhaps equal to the whole surface of the body.

To trace these continuous surfaces is not an idle minuteness; for we require to know, that inflammation will creep along the surface by a prevailing action, which has got the name of continuous sympathy. Thus we are sensible in catarrh of a sense of pain and weight in the forehead, commencing with a dryness of the cavities of the nose; then we have increase of secretion, and tickling in the larynx; this is followed by pain and a sense of rawness in the throat; lastly, we have pain in the chest, or an uneasy tickling sensation in the very margin of the lungs, and thus the inflammatory action terminates only with the extremity of this long line of connection.

The second division of the mucous membrane is the lining membrane of the mouth, which we trace into the œsophagus, into the stomach, into the intestines; and, after a course of full seven times the length of the body, it appears on the verge of the anus, terminating, as it began, in the skin; and along the whole of this mucous lining we may sometimes trace the course of inflammatory action. An erythematous blush, visible in the throat, will sometimes take its course in a very dangerous manner, over the whole extent of the canal, even to the anus.

The third division of this membrane is where the fore-skin is reflected over the extremity of the penis into the urethra: here the mucous secretion commences, and it characterizes the whole extent of the canal, tracing it through the bladder to the pelves of the kidnies.

Thus we shall find, that the mucous membranes form the internal surface of all the hollow viscera, and now we shall also perceive that the serous membranes form the outward surface of the same viscera, investing both the solid and membraneous viscera with a common covering. The course of the serous membranes is, however, by no means so simple nor so easily comprehended by the student, as that of the mucous membrane: at the same time that they are reflected from one viscus to another, they form a shut pouch or sac. I shall at present confine myself to the anatomy of the membranes of the thorax or chest.

OF THE PLEURA.

The thorax is the superior cavity of the trunk, and contains the heart and great blood vessels, the lungs, and the thymus gland: it transmits into the abdomen the œsophagus and nerves; and these parts are involved and supported by the processes of the pleura.

By this it will be understood that there are two pleuræ: that which lines the central cavity has another name. Taking the membrane of one side we may thus describe it. The pleura is the fine serous membrane forming a bag which lines the cavities of the chest, and is reflected upon the lungs. We shall consider the pleura first as it lines the ribs (and where it is called PLEURA COSTALIS); secondly, where it is reflected on the diaphragm; thirdly, as it forms the septum dividing the chest; fourthly, as it is reflected to cover the lungs (where it is the PLEURA PULMONALIS).

The PLEURA COSTALIS is the lining of the lateral walls of the chest. These walls consist of the ribs, their cartilages, and the sternum, their interstices being filled up with the intercostal muscles. The lining membrane of course is attached in part to the inside of the ribs, in part to the muscular texture which intervenes. It is a simple membrane; for so we call it, although, like every other membrane, it may be divided into layers of cellular membrane. On its outer surface it is more loose and cellular in its texture; on the surface towards the cavity it is smooth and bedewed with secretion, and is unattached or free. The pleura lining the ribs is very thin, and is immediately attached to the periosteum.

As the ribs and sternum form the walls of the chest on the lateral and fore parts, the diaphragm forms the floor of division betwixt the cavity of the chest and the lower cavity, or abdomen. From the ribs, the membrane is reflected upon the diaphragm, to which it adheres; and from the diaphragm and lateral parts of the chest, it is reflected to form the partition of the chest which is called mediastinum; which completes the circle of connections, as far as relates to the lateral cavity of the chest.

To understand whether or not we should speak of one or more membranes under the name of pleura, we must understand what is meant by cavity, and how many cavities there are.

We speak continually of the cavities, when correctly there are none in the animal body; for there is no empty space: the heart and lungs, with their membranes, lie in close contact. But when the anatomist exposes these viscera, the air rushes in, and there are then cavities. Or if, in the living body, air should escape from the lungs, or blood or secretion should be deposited betwixt the membranes, then, correctly speaking, such fluid lies in the *cavity*. It would, therefore, be affectation to use any other term, and with this explanation no false conception can be formed.

Of such cavities there are three in the thorax, the cavity for the heart, nearly in the centre, and the two lateral cavities for the lungs. For although the lungs form one organ, yet being extended in two grand divisions laterally, and these divisions contained in different cavities, and embraced by distinct membranes, we speak of them as double, and call them the lungs.

The 1st *Plan* shows the two cavities of the thorax formed by the pleura costalis, and the septum or mediastinum formed by the meeting of the membranes.

The 2d *Plan* shows, by the continuation of the dotted line, how the *pleura costalis* is continued into the *pleura pulmonalis*.

In the first plan here, the dotted line represents the course of the pleura, in a supposed section of the chest. Two lateral cavities are seen with a partition; that partition or septum is the mediastinum, and passes from the spine to the sternum, dividing the chest into two lateral cavities. The second plan shows the manner in which the pleura is reflected to cover the lungs and form the pleura pulmonalis: a dotted line still marks the course of the membrane; and here we may observe, that when the pleura has formed the septum, called mediastinum, it is there again reflected over the vessels going to the lungs, and, covering the vessels, protects them, and forms what is called the ligament of the lungs. Tracing the membrane in its course, we do not find that it terminates any where; we find that it is every where continuous, and that the pleura pulmonalis and pleura costalis are the same continued surface of membrane. So that were it possible to dissect it all out, without a hole in it, it might be blown up like a bladder. It is unnecessary to say that such a dissection will not be attempted.

But in these plans a liberty is taken to represent the lungs shrunk, and leaving the sides of the chest, a thing which never takes place in nature. This is done that my reader may follow the line distinctly; properly the surface of the lungs (that is, the pleura pulmonalis,) and the inner surface of the ribs (the pleura costalis) should have been in contact; for although we continually speak of the cavity of the chest, yet there is no cavity but in disease, or when by wounds the air is permitted to escape from the lungs, and then, indeed, the circumstances are as represented in this plan: for the lungs leaving the side of the chest, there is a cavity which is then filled with air.

When we trace the membrane of the ribs over the lungs, we comprehend how the smooth and proper surface of the one is internal and the other external, and yet that these surfaces are continuous and the same. We understand too how the surface of the pleura pulmonalis and costalis are in close contact, and yet do not adhere, and that consequently freedom is given to the motion of the lungs. At least, if in respiration the lungs do not move from the sides of the chest, they are not prevented by the adhesion of the pleura, when in a healthy and natural state, but by a circumstance already in part explained. The lungs cannot recede from the pleura covering the ribs, because no air can be admitted to fill the space which would be then necessarily formed betwixt the lungs and ribs.

The LIGAMENTS of the lungs are understood when my reader comprehends the manner in which the pleura is reflected from the ribs over the spine, and from the spine over the great vessels and over the lungs. Where this reflection of the pleura takes place, embracing the tubes and vessels going to the substance of the lungs, it forms ligamentous roots, the only natural connection of the lungs to the chest.

The MEDIASTINUM is a partition dividing the great cavity of the chest into two lateral parts: it is stretched from the spine to the sternum. This is a common and it may be a true description of the mediastinum, as far as it goes, yet it is a most imperfect one. This partition of the thorax is esteemed a provision for our safety worthy of all admiration; and so, indeed, it is. But when it is said, that this partition provides that a man, being diseased in the lungs of one side, or wounded betwixt the ribs of one side, may still breathe with the other, I would venture to say, that it is a wrong reading in that volume which it ought to be our pride to preserve pure. Every motion of the natural system has its proper check; every delicate part has its guard against the violent motions of the natural system, and is constituted with a due provision against the injuries we are liable to in a state of nature. But nature had it not in contemplation that we should be exposed to the gun and bayonet; nor can I think, with a celebrated anatomist, that she has provided for sustaining the prolonged existence of him who is slowly wasted by pulmonary consumption. I cannot believe that there is either in the foramina of the heart, or the mechanism of the chest, a provision against the effects of disease. I have therefore to show that the mediastinum has a reference to the support of the heart and great vessels, against the unequal pressure to which, without this guard, they would be exposed in the necessary and natural changes to which the body is subject in health. But I have said that the description of the mediastinum is imperfect; and really, though seemingly simple, it is difficult to represent by words the connection of the membranes of the thorax.

The two distinct sacs of the pleura, each forming a lining membrane to the two sides of the thorax, approach towards the centre of the cavity, and would absolutely unite but for the intervention of the heart and its appendages. And so, indeed, it is, that anterior to the heart and posterior to it these membranes nearly touch. Where the sacs of the pleura approach each other anterior to the heart, they form the ANTERIOR MEDIASTINUM; and in the same manner, behind the heart and near the spine, they form the POSTERIOR MEDIASTINUM.

The anterior or pectoral mediastinum has, in the embrace of the membranes, much cellular membrane; and when in dissection we raise the sternum, this loose cellular membrane allows the pleura to be drawn separate so as to form a cavity, which cavity did not previously exist. The anterior mediastinum contains the thymus gland, some absorbent glands, and a considerable trunk of the lymphatic system, which has been called the DUCTUS THORACICUS ANTERIOR.

The posterior mediastinum, called sometimes DORSALE, contains the extremity of the trachea and part of its branches called bronchia, and part of the pulmonic artery and veins; the œsophagus, for the greater extent of its course; the descending aorta, and the great trunk of the absorbents; the thoracic duct; the eighth pair of nerves; the vena azygos, and the dorsal lymphatic glands.

Both the mediastina are a little towards the left side, and the posterior one is much the longest.

I now leave authority, and proceed to describe the more important connections of the membranes of the chest with the heart and great vessels. The pleura, which is a very thin and weak membrane where it invests the lungs, or adheres to the inside of the ribs, is particularly strong where it is reflected from the diaphragm; and from the diaphragm to the upper and more contracted part of the chest, all along the tract of the cava, it is of a ligamentous firmness, and is more like a fascia or tendon than those layers of cellular tissue which have of late got that name in connection with the subject of hernia. Towards the upper part of the chest, the pleura, or rather the mediastinum, covers and embraces the branches of the cava, and posteriorly it covers and protects the aorta and thoracic duct; in short, were it not for the fear of confounding the ideas of the younger student, I would say, that this structure of membranes excludes all but the lungs from the cavity of the chest, and consequently from the effect of the chest's motion in respiration. How the respiration does not affect the veins and cavities of the heart will now, I trust, be easily conceived, and consequently the use of the mediastinum be understood.

But before I proceed further, I must here observe, that the pleura where it is reflected to form the mediastinum is double; that is, the cellular texture acquires a different structure, has a ligamentous firmness, and performs the office of a fascia around the vessels, an office which could not have been done by the mere reflection of the lining membrane of the chest.

The enlarged capacity of the thorax in every direction, the raising of the ribs, the thrusting out of the sternum, is attended with the contraction and sinking of the arch of the diaphragm. But this motion, which expands the cavities of the chest, and consequently the cells of the lungs, and draws the air into them, would disorder the heart's motion, would cause a lodgment of the blood and distension of the great veins and sinuses, were they under the influence of the motion of respiration, as the lungs are. But the diaphragm moves chiefly on its lateral parts; it is checked and interrupted at the middle part by the connections of the mediastinum. In proportion as the lateral cavities of the chest, and the lungs consequently, suffer the influence of this expansion of the chest, and have the pressure taken from them, the parts contained in the mediastinum, on the contrary, suffer pressure by the action of the diaphragm and rising of the sternum. If the veins near the heart were exposed to the same influence to which the lungs are, they would be subject to the same change of quantity of what they contain; that is, the blood would be accumulated in inspiration, and forced out from them in expiration, as the air is in the lungs, and the regular action of the heart would be thus interrupted or disturbed.

There is a further use in these connections of the membranes surrounding the great vessels with the diaphragm, viz. to support or produce an equal pressure upon the great vessels of the trunk during the violent actions of the body. Thus in leaping, pulling, or straining, there is a sudden and great pressure on the viscera and veins of the abdomen, and at the same time there is a powerful acceleration of the blood from every remote part towards the great veins and right sinus of the heart. The vessels would be overpowered and burst but for the protection of the mediastinum. It is then that we perceive the happy influence of the diaphragm, in drawing down the mediastinum, and consequently restraining and supporting the heart and great vessels.

OF THE PERICARDIUM.

The pericardium, or heart-purse, is the third cavity of the thorax; but here again I must caution my readers on the use of the term cavity. The pericardium closely embraces the heart, retains the lubricating fluid, and restrains and limits the heart's motion. But this being already explained, I have only to add a circumstance slightly noticed under the former head. The pericardium is a double membrane: the inner layer of membrane belongs to the class of serous membranes; the outer is quite of a different character, being a tissue of strong fibres which form a web as strong as a fascia. It is this external layer of the pericardium which is continued upon the great vessels as they arise from the heart, and which forms their supporting sheath; and what the closer texture of sheath does to restrain and support the arteries and veins, is done by this outward layer of the pericardium of the heart.

The next point left unexplained is the manner in which the heart and pericardium are embraced by the pleura.

In this plan* we see how the heart, surrounded by the pericardium, is further embraced by the mediastinum, by which it is not only supported, but the great vessels are surrounded and led securely out of the thorax, until they reach their proper sheaths in ascending upon the neck, or passing out into the axilla.

OF THE THYMUS GLAND.

The thymus is a gland of a pale colour and soft consistence, having many divisions or lobuli. It lies immersed in the cellular membrane of the anterior mediastinum, but stretches upwards on the neck, and its extremities are betwixt the trachea and carotid arteries, but it lies principally on the pericardium. It has two superior cornua, and two inferior, the right of which is the longest. On puncturing this gland a white fluid may be expressed, and when we blow into this puncture the air pervades the whole gland, giving the appearance of a cellular texture: but no ducts have been discovered. The thymus occupies a very considerable space in the chest of the fœtus, while it diminishes rapidly during childhood; therefore it is presumed, that it has a function adapted to some peculiarity of the fœtal circulation: but not even a probable conjecture has been offered further. It has been supposed a kind of diverticulum chyli; it has been supposed to secrete a fluid to attenuate the blood; it has been supposed to separate a peculiar fluid which was again thrown into the blood through the small veins; it has been supposed useful to fill up the thorax during the contracted state of the lungs in the fœtus; forgetting altogether that it is large in the fœtus, and diminishes after birth; it has been supposed to protect the lungs from the pressure of the sternum; all which are suppositions merely, that have not the most distant proof to support them, and yet possess not sufficient absurdity to make them worthy to be recollected on that account.

OF THE LUNGS.

The lungs are the soft compressible bodies which fill the two lateral cavities of the chest; and their use is to convey the atmospheric air into contact with the circulating blood. They consist principally of a cellular texture, and air tubes communicating with the atmosphere through the trachea. The degree of fleshy consistence and solidity which they have, is owing to the many vessels which carry blood through them, and the firm texture of membrane necessary to support them. Their function is respiration. It is through the larynx, trachea, and lungs, that we respire; and respiration is a complicated as well as an important function. It carries away the superfluous carbon of the blood; bestows heat, and stimulates the system; endows us with the power of speech; affords us the sense of smelling, or greatly contributes to the

* (See page 423.) A, The heart. B, the pericardium. CC, the pleura of the right and of the left side, embracing the pericardium betwixt them.

perfection of the sense; while the lungs bestow due buoyancy to the bodies of man and animals.

In form the lungs correspond to the cavity which contains them. When taken from their place and extended, they are wide below, forming a base, and rise conically upward; they are concave where they lie on the arch of the diaphragm, obtuse above, convex forward, and more slightly so on the sides; their borders behind are obtuse, while they are pointed, and thin before. The lungs have a deep sulcus behind, left for the spine, and within the projecting lobes there is a place of lodgment for the pericardium and heart.

Attending to this general form, we see why the lungs are spoken of as double, for, unless by the connection of their common wind-pipe, there are two great lateral portions, each of which belongs to a distinct cavity. And when we look to the lungs of the two sides, we discover that they are not perfectly alike. On each lung a fissure begins a little above the apex, and runs obliquely forward and downward to the base. This fissure on the left side divides the lung into two lobes. On the right side there is a lesser fissure, which consequently forms a less intermediate third lobe.

OF THE TRACHEA, OR ASPERA ARTERIA.

The TRACHEA is that extent of the wind-pipe which is betwixt the LARYNX (already described) and the forking or division of this tube where it is about to enter the lungs. It is seated on the fore part of the neck, and anterior to the œsophagus or gullet. Anteriorly it is covered by the thyroid gland and the flat muscles, which go from the sternum to the os hyoides and thyroid cartilage, and all around it has a very loose and elastic cellular membrane to permit it to move in breathing, swallowing, &c.

The trachea is not a perfect cylinder, it is quite flat on the back part and membraneous; it is rigid to admit of the easy passage of the air through it, and this rigidity is derived from the cartilaginous hoops of which it is principally formed. These hoops are not perfect circles. They are deficient on the back part, and this deficiency is not only calculated to permit the tube to be flat on the back part, and to give place to the œsophagus, but to allow a more perfect elasticity; for the extremities of the cartilaginous hoops being free, their elasticity is thereby increased. The hoops of cartilage are not perfectly regular: above they are most so, and are broader; but they are more irregular, and have weaker cornua, the nearer the bifurcation: the cornua have transverse fibres uniting them, which appear to be muscular.

The membrane lining the trachea, and continued from the larynx into the cells of the lungs, is, as we have already said, a mucous membrane; it is soft, elastic, and vascular; but it has many pores or foramina opening upon it, especially about the larynx and epiglottis. These are the openings of the ducts of the bronchial glands, and on the outside of the membrane round and oval glands are visible. These glands are often diseased, inflamed, and ulcerated.* The moisture which bedews the

* *Glandulæ bronchiales conglobatæ*, mentioned by different authors, are no more

trachea is a limpid, bland mucus, which subsides in water, unless air-bubbles be in it. The thinner part of this secretion is carried off by the air which passes through the trachea, and the thick matter is expectorated.

This secretion, which in the healthy state is of the consistence of thin jelly, transparent and of a bluish colour, becomes from inflammation of the catarrhal kind, thinner and more transparent, and is copiously expectorated. In more chronic inflammation the matter becomes thick, opaque, and of the colour of straw. And in a still later stage it may become purulent, without implying lesion of surface. The firmer nodules of viscid secretion which are brought up are probably from the sacculi laryngis.

From its exposed situation, its sensibility and vascularity, the membrane of the trachea is very subject to disease. I have now before me examples of general inflammation, of inflammatory crust, of suppuration, and deep ulcer in the inside of the trachea. Often lesser degrees of inflammation change the nature of the bland secretion, making it more saline, acrid, and stimulating. Sometimes the inflammatory action will mix a portion of coagulable lymph with the mucus secreted, and which, by this addition, will take a tubular form, as in the croup. But let it be remembered, that coagulable lymph in the form of tubes or vessels may be coughed up from the lungs, a consequence of blood poured into the bronchia, without the presence of inflammation.

OF THE THYROID GLAND.

The thyroid gland is composed of two distinct glandular portions, of an oblong shape, which occupy the sides of the larynx, and which are united at their lower part by a narrow isthmus or band extending across the trachea below the cricoid cartilage. It varies considerably in its shape and size. But each lobe is generally thickest at its lowest end, and as it ascends gets more peaked. At its lower part it comes more forward, and partially embraces the two uppermost rings of the trachea; but higher up, it recedes backwards so that the uppermost point lies more upon the inferior constrictor pharyngis than upon the thyroid cartilage. The sterno-thyroidei, sternohyoidei, and omo-hyoidei muscles all cover the gland. It clings around the larynx, and follows it in all its motions. Each lobe lodges upon the sides of the first rings of the trachea, and part of the cricoid and thyroid cartilages. The muscles upon which it lies are the crico-thyroidei, thyro-hyoidei, and inferior constrictor of the pharynx. Sometimes there is a slip of muscular fibres descending from the os hyoides, and which expands upon its surface: this has been called the levator glandulæ thyroidæ—but it is not always present. Sometimes muscular fibres are seen extending over the gland, appearing to be a part of the crico-thyroideus muscle. On cutting into the gland its texture is seen to be very vascular, and a watery or viscid secretion can be squeezed from the cut surface. It is subdivided into distinct lobules, but these are not so obvious as in the salivary glands.

than the conglobate lymphatic glands, seated around the bronchia at the root of the lungs and in the mediastinum, and which belong to the lymphatics of the lungs.

Anatomists have failed in discovering an excretory duct for this gland; yet some have mistaken a vessel for it. It is observed to be in general larger in the female than in man—it is also observed to be proportionally larger in the fœtus than in the adult. Whatever other function may be discovered to be the office of this gland, I conceive it to be, in an essential degree, part of the organ of the voice: that the muscles which are over it compress it against the cartilages of the larynx, and influence their vibrations.

OF THE BRONCHIAL TUBES.

On entering the thorax the trachea inclines backward, and passes into the posterior mediastinum, and behind the arch of the aorta, and before the œsophagus; opposite to the third vertebra of the back it divides into two branches, passing to the right and left; these and their subdivisions are the bronchia.

When we follow one of these tubes, we find it entering the substance of the lungs, accompanied by blood vessels, branches of the pulmonary artery, with their corresponding veins; and lesser arterial branches enter here, which are derived from the aorta, and are called the bronchial arteries.

The bronchia divide and subdivide in regular order, branching like a tree through all the substance of the lungs, until their tender extremities terminate in the air-cells; for the cartilages of the bronchia, which near the trachea resemble those of the trunk, become annular and weaker, more oblique, irregular, and further removed from each other, until the extremities are little more than membraneous tubes.

OF THE BRONCHIAL CELLS.

The BRONCHIAL CELLS, into which the air is admitted in respiration, have been represented as very regular sphericles attached to the branches of the bronchia, and having no communication with each other, but held together by a minute cellular texture. Malpighi described them as round vesicles, as if the branches of the bronchia were dilated into clusters of distinct bags. Willis described them like myrtle-berries on the stalk. Hales estimated that those cells were in diameter the hundredth part of an inch, and the extended surfaces of them 1035 square inches. Keil estimates their whole number to be 1,744,186,015.*

Various attempts have been made to ascertain how much air the lungs are capable of containing when distended, and of emitting when the chest is compressed: but we cannot depend on their results being very precise. It is pretty generally agreed that, on an average, 40 cubic inches are alternately taken in and expelled at each ordinary act of respiration. It is supposed that about 170 cubic inches more may be forcibly expelled after a common expiration, as by coughing, straining, &c.; and that after this the lungs shall contain within them 120 cubic

* Hales, Keil, and Leiberkuhn, differ greatly in estimating the conjoint extent of the vesicular surface.

inches. Proceeding upon this estimate, after an usual expiration there remain 290 cubic inches of air in the lungs; and upon inspiration there are 330, which is the measure of the capacity of the lungs in their distended state. Since 40 is about the $\frac{1}{8}$th of 330, it follows that it is only this small proportion, the $\frac{1}{8}$th part of the whole air in the lungs, which undergoes a change during each successive act of respiration. And we possess the power of expelling, by a forcible expiration, fully two thirds of the entire quantity.*

So far back as 1788, Dr. Goodwyn, to whom physiology is much indebted, proved that during the different states of expiration and inspiration the lungs are sufficiently capacious to permit the circulation to proceed uninterruptedly from the right to the left side of the heart. Before his experiments a confused notion prevailed that the actions of respiration, the alternate dilatation and compression of the lungs, was for the purpose of aiding the circulation of the blood from the right to the left side of the heart. What has thrown obscurity over this subject is the interrupted flow of the blood from the head into the chest during expiration. Physiologists have attributed to the condition of the lungs that which is more properly referrable to the condition of the heart, during the changes to which it is exposed by the action of the diaphragm on the mediastinum in respiration.†

On the bronchial cells the ultimate branches of the pulmonary arteries and veins ramify and inosculate, and the thin membrane of the cell and the coats of these minute vessels do not prevent the influence of the air upon the circulating blood. My reader must well distinguish betwixt this regular cellular structure, for the admission of air which is drawn through the trachea and bronchia, and that cellular texture of the lungs which is common to them and every part of the body; this tissue which supports the air-cells, the bronchia, and the three several kinds of blood vessels, and the lymphatics which collectively constitute the substance of the lungs. This common cellular substance supports the air cells, and unites the lobules, and conveys the vessels to their destination.

Some have contended that there was a muscular tissue around the bronchial cells; but it is impossible to demonstrate this, and I must presume physicians have allowed themselves to be misled by symptoms during life.

Sometimes the air escapes from the proper bronchial cells into the cellular texture; then there is emphysema of the lungs; then the lungs are distended with air; but that air does not minister to the oxygenation of the blood, on the contrary the patient dies suffocated. And still more frequently it happens that the lungs being over exerted, as by long-continued difficult respiration, a watery or mucous effusion takes place into the common cellular texture of the lungs, which effectually compresses the proper air-cells, and after much oppression suffocates.

OF THE ORGANS OF THE VOICE.

The organs of speech are very complicated. We shall first consider how simple sounds are produced, and then how these sounds become ar-

* See Bostock, *Elem. Syst. of Physiol.* vol. ii. p. 25.

† See p. 469.—See also "The Connection of Life with Respiration," by Dr. Goodwyn.

ticulated and expressive of thought. It has been disputed what is the proper seat of the voice; and the difficulty of determining this has arisen from not distinguishing what is essential to the vibration which produces sound, and what aids that primitive organ in giving the voice strength and variety of tone. For the voice commences in the larynx, but reverberates downwards into the trachea, and even into the chest, whilst it may be directed with different effects into the cavities of the head and mouth and throat.

The organ of the voice is neither strictly speaking a stringed instrument, nor a drum, nor a pipe, nor a horn, but it is all these together; and we will not be surprised at this complication if we consider that the human voice is capable of every possible sound—that it can imitate the voice of every beast and bird—that it is more perfect than any musical instrument hitherto invented, and, in addition to every variety of musical note, it is capable of all combinations in articulate language to be heard in the different nations of the earth. The essential and primary part of the organ is these cords, with which the reader is already acquainted, the thyro-arytænoid ligaments, or cordæ vocales. The membrane lining the larynx is reflected over these ligaments, so as to be drawn by them in their motions, and this is what is meant when it is said the organ is like a drum; for these membranes must vibrate in the air. The muscles of the arytænoid cartilages draw tight the cordæ vocales and their attached membranes, and thus giving them a certain tension, and the air being expelled forcibly from the chest at the same time, they cause a vibration of these ligaments and membranes. This vibration is communicated to the stream of air, and sound is produced. This sound, as we have said, may reverberate along all the passages from the lungs to the nostrils; but unless there be a certain vibration in these cords of the larynx, there is no vocalization of the breath. For example, a man, in whispering, articulates the sounds of the mere breath, without that breath being vocalized and made audible by the vibrations in the larynx.

In singing, the vocalized breath is given out uninterruptedly through the passages, the rising notes in the gamut being produced first by the narrowing of the glottis, and secondly, by the rising of the larynx towards the base of the skull. Physiologists, and among the rest Richerand and Majendie, make a comparison between the wind-pipe and a flute or flageolet. The lower notes of the instrument are sounded when the fingers cover all the ventiges, and the sound goes down through the whole tube; but as the fingers are raised in succession from below, the effect is as if portions of the tube were cut off, and the shorter the tube the higher the note. We understand then that the sounding tube of the human voice being lengthened will give out grave sounds, and these will be higher or more acute as the tube is shortened. But those physiologists have fallen into the mistake of believing that the trachea is this tube: now unfortunately the trachea is elongated in proportion as the higher note of the gamut is sounded by the human voice. The comparison should have been instituted between that portion of the air-tube which is above the chink of the glottis, and then the resemblance is just. In the graver notes, the larynx is drawn down, and the lips protruded; and in the higher notes the larynx is elevated to the utmost, and the lips retracted.

The vowels, as every body knows, are those uninterrupted sounds which, commencing in the vibration of the larynx, are modified, in ascending, by the epiglottis, velum pendulum palati, uvula, tongue and lips, as a. e. i. o. u. The liquid consonants are those sounds which are partially interrupted by the motion of the tongue, as in l, whilst a sort of continued sound or drone is permitted. The proper consonants are shorter sounds, when the open sound or vowel is suddenly interrupted by the articulating motion in the tongue and lips, as f. Those are called explosive, when the mouth opens to give the sound sudden passage, as t. The nasal consonants are those where, although the sound be interrupted in the mouth, it is made to circulate or vibrate in the cavities of the head: of this you may become sensible by putting your hand upon your forehead in sounding the letters m and n.

Thus the voice may be divided in the sound which you make in whispering; when the breath is modulated and articulated in the mouth, but not vocalized. 2dly, You have it vocalized by the primary vibrations of the cordæ vocales: and these sounds, though not articulated, may vary to every note of the gamut, and receive an almost infinite variety of intonations, by reverberation on the different parts of the prolonged and varied surfaces of the trachea, larynx, pharynx, mouth, and cavities of the nose. Lastly, the vocalized breath may be articulated, that is, variously interrupted by the tongue, teeth, and lips, and become expressive of conventional language. The uninterrupted sounds are the natural language, being expressive of the same emotions in the whole family of mankind; but the articulate language is a system of arbitrary signs confined to countries or divisions of the earth. Imperfect as this last appears to be, it is capable of high perfection, and aids in a remarkable manner the developement of the intellectual powers.

The author has a paper in preparation for the Royal Society, in which some of these subjects are treated of; but it is principally to show that there has been a singular omission in the accounts hitherto given of the organs of the voice, more especially of articulate sounds.

OTHER TUBES OR VESSELS WHICH ENTER INTO THE TEXTURE OF THE LUNGS.

Although the blood-vessels which enter into the composition of the lungs are described elsewhere, yet, as they really constitute the more solid substance of the lungs, we may shortly review them here.

The blood-vessels which cling to the bronchia are called the VASA BRONCHIALIA. There are two, sometimes three, arteries of that name. There are one or two branches from the anterior part of the descending thoracic aorta; sometimes a branch from the superior intercostal artery; sometimes one from the subclavian artery. These, taking a serpentine course, cling to the air-tubes within the lungs. They at the same time send branches to the mediastinum, bronchial glands, œsophagus, and pericardium.

These are arteries to supply and nourish the membranes, glands, bronchia, and the other blood-vessels themselves.

The BRONCHIAL VEINS which correspond with the arteries. These are two, distinguished as right and left. The first commonly joins the vena azygos. The latter goes into the superior intercostal vein.

The next is the PULMONARY ARTERY, that which arises from the right side of the heart to carry the dark blood into the lungs: the other great artery of the system, as distinguished from the aorta. This artery, bending towards the lungs, divides and sends its grand right division behind the aorta and the superior cava, and before the right bronchia. The left branch is shorter and straighter, and diverges to its destination. Both of these dive into the substance of the lungs, and can be traced to great minuteness. These arteries terminate, like the branches of the aortic system, in veins. This was the first part of the great circulation discovered; and it was an ancient experiment to push coloured fluids from the artery into the veins of the lungs. On the vesicular lungs of the cold-blooded animals, by the assistance of the microscope, the blood can be seen moving directly from the arteries into the veins. The pulmonic veins receiving this blood, and gathering together their branches from the whole substance of the lungs, form trunks, and terminate in the left auricle.

The lymphatics of the lungs form yet another set of vessels, constituting the substance of the lungs. They come out superficially in great profusion, and run their course along the ligaments of the lungs to the thoracic duct. Most of them run into the conglobate or lymphatic glands in the posterior mediastinum, called glandulæ Vesalii. The nerves of the lungs are the branches of the par vagum, and of the great sympathetic nerve.

These parts combined constitute the soft spongy substance of the lungs, which the ancients, without much enquiry, called the parenchymatous substance.

COURSE OF THE BLOOD IN THE LUNGS.

Coloured water, or size, or oil of turpentine, being injected into the pulmonary artery, comes back by the pulmonic veins, running in what is called the lesser circulation. The same fluids being injected into the vein, return by the artery.* The fluid being more forcibly propelled into the pulmonary artery, flows by the trachea; and the exudation of the fluid is facilitated, if the action of respiration be imitated by blowing into the trachea at the time of the injection. These coarse experiments in the dead body prove little; but the course of the blood from the extreme pulmonic arteries into the veins, having been seen in the membranous lungs of the lacertæ, the chymical phenomena exhibited by respiration leave little for us to wish further in explanation of the functions of the lungs.†

There are some reflections which naturally occur in taking leave of

* In an experiment which was made by a pupil of mine, the mercury, which was thrown into the crural vein of a live ass, was found at the end of a month to be lodged in the cells of the lungs: it had not been forced into the pulmonary veins.

† For the consent or sympathy of the lungs with other parts, see the observations under the head of *Par vagum*, in the description of the nerves.

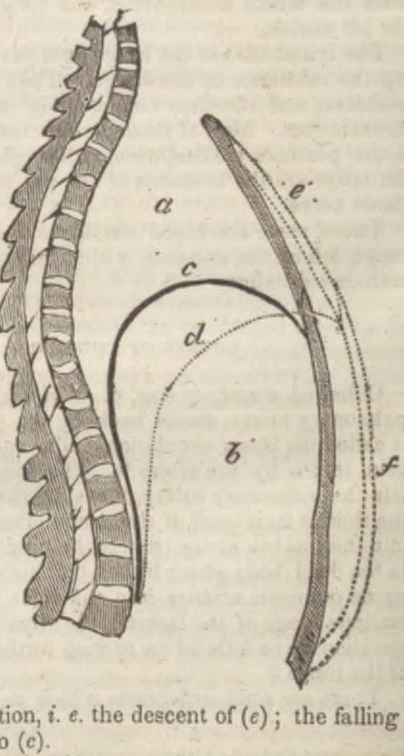
this subject of respiration, which may have the further effect of confirming in my reader the accurate knowledge of the anatomy.

OF THE MOTIONS OF THE THORAX AND OF RESPIRATION IN MAN.

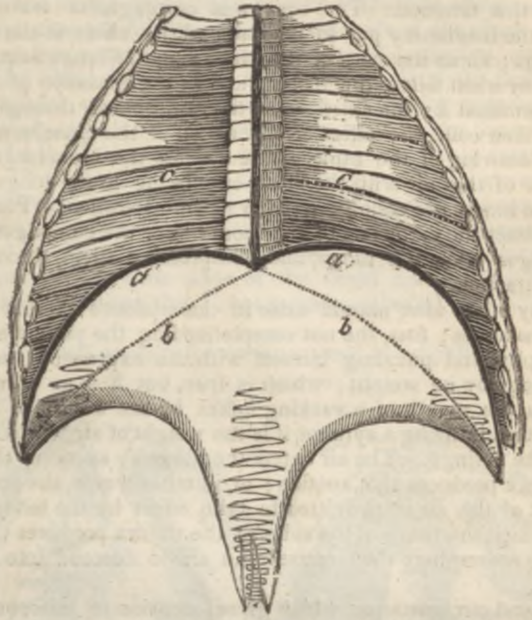
We have understood, by our studies of the skeleton and of the muscular system, how admirably adapted the thorax is to dilatation and contraction; and how the muscles act upon the bony and cartilaginous apparatus for this purpose. We have seen also that the cartilages are added to the ribs and sternum, to give them elasticity, and consequently strength, or at least a principle of resistance. This elasticity of the texture of the thorax serves another purpose: it preserves the chest in a middle condition between its utmost state of contraction and of dilatation, and tends to preserve life.

Let us now understand what takes place in the drawing of the breath.

This figure represents a section of the body—(*a*) the thorax—(*b*) the abdomen. These two cavities are divided by the diaphragm, which is represented by the arched line (*c*); for the diaphragm assumes this arched form especially in expiration. When the effort is made to inspire, the diaphragm descends, and then its state may be represented by the dotted line (*d*). As the diaphragm descends, it of course compresses the viscera in the abdomen (*b*), and this pushes out the abdominal muscles in the form of the dotted line (*f*); at the same time that the diaphragm and the abdominal muscles have changed their condition, the ribs are expanding, and the breast-bone (*e*) is rising, so that the thorax is enlarging in all its diameters. This being the act of inspiration, we easily understand expiration to be the return of these parts to their original condition, *i. e.* the descent of (*e*); the falling in of (*f*); and the rising of (*d*) to (*c*).



Let us now take a front view of the thorax, so that we may have our notions of the action confirmed and corrected. We have the cavities of the thorax divided by a dotted line; and the floor of these cavities formed by the arch of the diaphragm (*aa*). When the diaphragm contracts and descends, it cannot uniformly descend as represented in the lateral plan; for we have understood that it is tied up by the mediastinum. The perpendicular dark line represents the mediastinum. Thus the arch (*aa*), instead of descending in a single arch, acts on its lateral parts principally, and assumes the form (*bb*). As it was formerly explained, it acts on the lungs more than on the heart and vessels.



The student who has attended to the anatomy and relations of the lungs, must perceive that the rising and falling of the chest, and the propulsion upwards of the diaphragm (by the abdominal muscles), and its descent, must influence the lungs, alternately drawing the atmospheric air into them and expelling it; and thus the act of respiration is performed, the lungs being passive. He must perceive that by this mechanism, in which the whole muscles of the neck, chest, and abdomen, and back, are concerned, there is a continual exercise and an incessant motion or agitation of all the viscera. No doubt this is conducive to their proper function and to health. He will no doubt also observe that this extensive apparatus of bones, cartilages, and muscles, serve other purposes than of mere breathing: that they assist the circulation of the blood: that they are agitated in speaking, coughing, laughing, crying, smelling, vomiting, the expulsion of fæces, &c. He must perceive this importance in the œconomy, and must surely be desirous of knowing how they are combined and animated; for which see the Nervous System. The action of the diaphragm on the circulating vessels is a subject which for the present I must reserve.

Although the lungs are very often found adhering to the inside of the chest, and although this union occurs where we cannot discover that the person during life was subject to any inflammation of the chest, yet it is a preternatural appearance. The lungs (covered with the pleura) lie in contact with the sides of the chest, and consequently with the pleura costalis, but without adhesion. They are passive in the motion of respiration. The muscles of respiration clothing the thorax are the agents in this function. The bony and cartilaginous texture of the thorax is the machinery put in motion, and the effect is the dilatation of the lungs; for as the sides of the chest rise, the lungs being in close contact, they must follow this rising; and as the dilatation of the lungs is freely permitted by the entrance of the atmosphere through the trachea into their cells, the effect of the action of the muscles of inspiration is the drawing of the atmospheric air into the bronchial cells, and the contact of that air with the blood circulating in the lungs. In expiration the lungs are equally passive as in inspiration. The muscles which contract the diameters of the thorax force the compages of bones and cartilages upon the lungs, and, compressing them, throw out the air by the trachea.

That any other idea should arise in the student's mind is owing to two circumstances; first, the not comprehending the principles of natural philosophy, and puzzling himself with the expression that the air fills the lungs by its weight; which is true, but it is as true that the milk enters the mouth of a sucking infant by the weight of the atmosphere, or that in using a syringe, it is the weight of air which forces the fluid into the syringe. The air enters the lungs by suction; the motion of the thorax produces that suction; or, in other words, the operation of the weight of the air is permitted to take effect by the tendency to a vacuum which the rising of the sides of the thorax produces; the pressure of the atmosphere then causes the air to descend into the bronchial cells.

The second circumstance which gives occasion to misconception, is the lungs seeming to have a motion independent of the chest.

Thus, when a man is wounded betwixt the ribs, the lungs protrude, and this rising of the lungs appears to be owing to a power inherent in them: but attention to the true circumstance will explain the occasion of this. When the wound is received the air enters the chest, and the lungs fall collapsed; the cavity is therefore full of air, and the lobes of the lungs hang loose. The air plays freely out and in through the hole in the chest. But when by change of posture the flapping edge of the lungs falls against the hole in the side, the air which is in the chest can no longer make its exit, without forcing the lungs through the wound. Accordingly, in the act of expiration, the same compression which forces the air out in breathing pushes out the lungs from the side. We may have the proof from anatomy that the lungs lie in close contact with the pleura costalis.

When the intercostal muscles are dissected off, and the pleura costalis exposed, the surface of the lungs is seen in contact with that transparent membrane; and when the pleura is punctured with the lancet, the air rushes in, and visibly the lungs retire in proportion as the air is admitted. This proximity of the lungs to the ribs explains the effect of fracture of these bones in producing the tumour called emphysema, for thus it happens: the broken end of the rib, piercing the pleura costalis, tears also the pleura pulmonalis, and breaks the surface of the lungs, and opens the bronchial cells. Now when the chest is expanded, a little air is drawn through the rugged opening, and lodges in the cavity of the chest (now truly a cavity, the air occupying the space betwixt the lungs and chest). By little and little the small portion of air which is drawn into the cavity of the chest at each inspiration accumulates until a distressing quantity fills the whole of that side of the chest.

The chest being now full of air, the action of expiration, compressing the air in the chest, it insinuates itself by the side of the fractured ribs into the cellular texture, consequently a crepitating tumour of air is formed over the part hurt, and this quickly extends over the whole body, until the skin is blown up like a sack, and the man is in danger of suffocation. The suffocation is not a consequence of this distension of the cellular substance of the body, but of the fulness of the cavity of the chest on that side wounded. For at length, the chest being kept distended, and the diaphragm pushed down, and the mediastinum pressed to the opposite side, both sides of the chest are oppressed, and the breathing is so checked, that if not quickly relieved, the patient would die.

These plans will explain the common case of emphysema:

The emphysema of the body may take place in a different way.* The lungs may be diseased; air may be drawn through the abscess,

* The first plan exhibits a section of the thorax, with the rib broken A, and entering the lungs D. Air has already begun to accumulate in the cavity of the chest B. The air insinuating itself by the side of the broken rib, forms the tumour on the side C. The second plan exhibits the extent of the evil. The lungs D are compressed. The cavity of the chest left by the retraction of the lungs is full of air. The emphysematous tumour C is extended over the body. The right side of the diaphragm E is pushed down, and the heart and mediastinum F are forced towards the opposite side, encroaching on the lungs of the left side.

and collect in the cavity of the chest; or the bronchial and true air-cells may be hurt by exertion, so that the air gets access into the common cellular texture of the lungs; and from the lungs it may find its way betwixt the ligaments of the lungs into the cellular texture of the mediastinum, and hence up into the neck and over the body. These last instances are rare compared with that proceeding from fractured rib.

INTRODUCTION

TO

THE STUDY OF THE CIRCULATORY SYSTEM.

The discovery of the circulation of the blood has been always regarded as one of the most important, and has been ranked rather with the great doctrines of philosophy, than with the discoveries in our peculiar science: it has been boasted of by our countrymen, and much coveted, and often claimed, by strangers; it is indeed a discovery the most ingenious and beautiful.

How the well-proved doctrines of Harvey were perverted; what new, strange, monstrous, and impossible circles his antagonists contrived for the blood, it were tedious to relate: but it is most natural to mention why his doctrines were opposed. It was the universal opinion in those days, that the blood was formed in the liver, and sent out from it by all the veins to nourish the body, proceeding outwards during the day, and returning by night. The old physicians had thus entered into a train of thinking which it was not easy to change: these notions about the blood were become great and important doctrines, and had descended to them from their oldest teachers, with many weighty dependencies, conclusions, and rules of practice issuing from them: they were as articles of faith which it was a heresy to forsake; and it was easy to foresee, that should the Harveian doctrine prevail; should it be once completely proved that the blood moved outwards along the arteries, and returned by the veins; then all the reasonings of the physicians would be confounded; their theories embracing the whole body of physic disturbed; their system of practice entirely overthrown; and all they had written themselves, and all the ancient books which they had read with so much diligence (for they were really learned); all that they had ever been proud of, was to be wiped out from the thoughts of that and all succeeding ages!

But the doctrine of Harvey did at last prevail, dispelled those idle dreams of humours and temperaments, and spirits, and blood!—of the blood concocted in the liver, and moving outwards along the veins to nourish the body; of the blood moving outwards during all the day, and returning by night; of the arteries carrying air only or vital spirits, to animate the system by mixing with the blood, while the veins alone conveyed the proper blood. Yet this theory of the illustrious Harvey introduced general doctrines more mischievous in all their consequences than those which had just vanished; as, that the blood was composed of particular globules, the larger globules of smaller ones, and these again of globules of a third series; and that the arteries were so proportioned to the diameters of those globules, and descended by steps so regular and uniform, that each kind of artery had its peculiar globule which it received with ease, while others were rejected; or, if unhappily driven by a too violent action into vessels which they did not suit, were arrested in their progress, and produced either some local inflammation or some universal disease. These are the once famous doctrines of Malpighi, Boerhaave, and all the great men of their day; and which they dilated into various forms, and adorned with the fine words of lentor, remora, error loci.

To these succeeded the mechanical physicians, who, by unintelligible problems of mathematics and algebra, (reasonings which were ill-founded in their principles, even had the calculations been correct,) pretended to estimate the force of the heart, the velocity of the blood, the power of the arteries, the strength of the veins, and the shape and size of each secreting orifice, according to the secretion which it had to perform. These were the doctrines, these the discoveries, which rendered famous the names of Bellini, Pitcairn, Keil, Hales, and other mechanical physicians, whose books are no longer of authority, and are consulted only for the history of opinions.

The chemists next soon turned their thoughts, from the vain search after the universal solvent, and the philosopher's stone, to pharmacy and the useful arts. By the abilities and industry of Newman, this branch began to assume the more respectable appearance of a useful art: it began to be allied to science, and its connection with medicine was found to be of the most direct and important nature.

Having analysed the materials of the druggist, the chemist proceeded to analyse the parts of the human body to which those medicines were to be applied: but from this rational commencement followed one of the most trivial of all the miserable doctrines with which our science has been disgraced; for as the chemists had already explained the properties of the salts, metals, earths, and of all active substances, by the angles, cubes, or other forms which they saw their particles assume, they soon persuaded themselves that such forms as cubes, wedges, spiculæ, &c. existed in the blood; and acid and alkaline humours, sharp, corrosive, irritating, and pointed particles, were the terms in which they expressed their most admired theories; and acids, alkalis, and metals, and medicines for rounding the pointed particles, or obtunding (as they termed it) or sheathing, or covering the acrimonious humours, were their chief preventatives and cures.

Until the present day this fault has pervaded all the great theories, that in describing our vessels physicians have continued to use the language of hydraulics and hydrostatics; of a philosophy applicable only to rigid tubes: in short, in describing the living system, they have forgotten that it was endowed with life.

We also may have erred in our turn: but with whatever degree of contempt we may view the doctrines of these older authors; or however succeeding generations may be amused with ours—still this is plain, that the most important facts in all anatomy, and the chief doctrines of the human body, must always accompany the explanation of those two great functions of the heart and lungs. Of course, the constitution of the blood; the chemistry of airs; our dependance, so incessant and immediate, upon the atmosphere in which we live; the various and singular ways by which the fœtuses of different creatures, or the creatures themselves, according to their peculiar modes of life, draw their existence from the atmosphere; the various kinds of circulation by which this air is distributed through the system of each; the effects of air particularly upon our body; and the effects also of accidents, deformities, and diseases, in those prime organs—all this wide circle of physiology belongs, in the strictest and clearest sense, to the anatomy of the heart. For one chief purpose in studying the anatomy of the human body is to understand its functions, and to compare them with those of other creatures, till we arrive at last at some distinct conception of the whole; of the various structures of animals and vegetables; and of the various functions which in each of these classes support life and action, and through it the principle of life.

There is no occasion on which this desire of knowledge, this willing admiration of the wonders of nature, is so strong as on first studying the functions of the lungs and heart; for upon the conjoined offices of the heart and lungs all perfect life seems to depend. And how universal these two functions are; how necessary to the support of the greater animals; how essential also to the constitution of the meanest insect—it shall be my business to explain.

The knowledge of the arteries again bears along with it the whole anatomy of the human body. The nerves accompany the arteries; the lymphatics and veins twine round them; the glands and various organs are composed of them. The intimate structure of parts is known only by understanding the forms of their vessels; and as each individual part is nourished by arteries, he who has studied the arteries thoroughly knows the whole.

But to the surgeon the knowledge of the arterial system is valuable beyond all calculation or belief. He performs no operation in which arteries are not engaged; he cures no great wound in which arteries are not first to be tied; he enters into no consultation in which the arteries are not first spoken of. Without a knowledge of the arteries, he can neither think sensibly nor act safely.

Most unhappily all this comes to be known at that period of life when the deepest conviction can produce only fear and perplexity, sorrow and regret. Yet, strange to tell, there is no such conviction; no regret, no irresolution, no perplexity is ever seen.

If the negligence with which anatomy is studied may stand excused on any account, it is on this only, that anatomists have been accustomed to write, not for the public, in plain and simple language, but for each other, in an unknown tongue. By this I mean not a foreign or a dead language, but a peculiar style and phrase which no one can understand unless he be initiated; unless he have studied the science itself so intensely, that he has also learned the jargon in which it is conveyed: in short, no one but a thorough anatomist can understand the language of anatomy, nor can even he understand it without some labour. Anatomists have buried their science under the rubbish of names; there is not a difficult or hard-sounding word upon which they have any claim that they have not retained: they have choked their subject with useless minutiæ; they have polluted their language, by transferring to it from Latin many words which, by their continual inflections, in that language were beautiful; while their unvaried, uncouth termination in ours, is barbarous in the utterance, while it tends but to interrupt and puzzle the sense.

An anatomist, for example, will describe an artery as "going to the radial edge of the second metacarpal bone: then supplying the abductor and flexor muscles; then going along the bone of the first phalanx, seated upon this second metacarpal bone;" with many other distortions, ambiguities, and little contrivances, to conceal (as one would believe) that he is describing so simple a matter as the artery of the fore-finger: which the reader at last finds out either by some lucky chance, or by reflecting how many metacarpal bones there are; and then reckoning them first forwards and then backwards, that he may be sure which it is that the author means; for his author may count from the little finger towards the thumb, or from the thumb towards the little finger; or he may have a fancy of leaving out the thumb, and reckoning only four. What must be the surprise of any well-educated young man when he reads in those books which he must study, of the regions of the elbow or thumb, or fore-finger; and if an anatomist understands such things with difficulty, how distressing must they be to the student!

This is the scholastic jargon which has so long been the pride of anatomists and the disgrace of their science; which has given young men a dislike for the most useful of all their studies; and which it is now full time to banish from our schools. These are the authors who avoid plainness as if it were meanness; who are studious of hard words as if they constituted the perfection of science: "it is their trade, it is their mystery, to write obscurely;" and full sorely does the student feel it.

Want of arrangement, again, has still worse effects. Confusion is a monster in science.

If I should tell my reader that there are very nearly one thousand arteries in the body, going promiscuously to bones, ligaments, bowels and glands, muscles and nerves, to a thousand unconnected difficult parts, all of which he must know by name, how would he be affected! But when I observe, that these go to the neck, the head, the arm, the leg, he begins to see this confusion of muscles, and glands, and bowels, vanish, and to perceive that all these arteries may be usefully and very simply arranged. When he is next taught to know the course of each greater artery, and the parts in which each division and branch of it lies, he perceives clearly that the parts through which it runs, as the arm-pit, neck, or groin, must limit and regulate the number of its branches, and give to each twig even an appropriate place and name: when, next, the whole arterial system is marked and chalked out for him in different portions; when there are points of peculiar importance set apart which he is charged to learn with particular care—he sees a good end in all this toil; he begins with courage, and gets forward easily; it becomes an interesting, and of course a pleasing task; but still it is a task: and I entreat the young student, as he values his own honour, or the safety of his friends, not to bate himself one iota of the whole. Let him not take an indolent advantage of those arrangements which are meant to promote his industry, not to prevent it. Let him not read only concerning the greater arteries, neglecting the smaller ones, but go through the whole piece of anatomy honestly and fairly. He will no doubt forget in time the smaller arteries; but by having studied even them with diligence, he must remember the great and important arteries with a clearness of comprehension and arrangement, which those who have not gone thus honestly through the whole study can never attain. Let him also remember that studies like these, well performed during his early years, do, like past dangers, or the remembrance of good deeds, give an ease and pleasure to his after-life.

The arteries, I will now venture to say, should be with the surgeon as familiar as his name; and there is no argument which proves it more strongly than this, that a man of real learning, of sterling good sense, of a clear head and steady hand, a man accomplished in all other respects, and fitted by nature and genius for performing the most difficult operations, if yet he want this part of knowledge, may, in one unhappy moment, do things which he must think of with horror during all his life. I know well how such little accidents are thought of, when at last the evil day comes. A surgeon hardly believes this strict knowledge of the arteries to be so great a point. In the midst of an operation, or in a common wound, it gives him no concern to see arteries bleed which he did not look for; nor has he great reluctance to drive his needle among parts which he does not know. An artery bleeds, and he looks for it; he calls out at last to screw the tourniquet, and it stops; the tourniquet is loosened again, and again it bleeds; again the screw is tightened on account of the loss of blood; he expects to strike the artery; he is accustomed to strike it, not by knowing where it lies, but by seeing it bleed: at last some lucky dab of the needle succeeds, or perhaps from faintness of the patient the bleeding ceases: the surgeon is relieved from his present anxiety; but in a few hours he is called back to this scene of confusion and dismay; yet at last the bleeding is somehow or other mastered; and thus he gets on through all his difficulties, accident after accident, operation after operation, till at last he almost forgets that anatomy was a branch of his education, or the knowledge of blood-vessels necessary in operations or wounds.

I will not say that a man cannot suppress a bleeding from a wound in the arm, because he is not acquainted with the anatomy of the arm; but this surely I may be allowed to say, that it is a piece of knowledge which at all times, but especially in those circumstances, can do no harm; and that if you leave a patient to choose betwixt two surgeons, one skilled in the knowledge of arteries, another knowing them only by seeing them spout out blood, it is easy to foretell where his choice will fall.

Perhaps some will be so hardened as to say, "and yet we seldom hear that patients die of bleeding." Is it then a merit that your patient is not plainly killed; that he does not expire under your hands? Is it nothing to lose blood from day to day? Is it nothing that your patient is reduced to extreme weakness, suffering every thing but actual death? Is it nothing that he lies with tourniquets round the limbs in fear and anxiety, attended by young surgeons appointed to watch that bleeding, which may burst out while the patient turns in bed, and destroy him in one moment? Is it nothing to have fresh incisions and new searchings for the artery to endure? These are real difficulties and dangers, and they should be provided for; our honour as well as our duty requires it. Bleeding from a great artery is to the patient the greatest danger; the very report of an ill accident is to the surgeon (though God knows he may be blameless) the greatest disgrace; and, lastly, though it should not be so, his taking up a bleeding artery dexterously and quickly, when others have failed, is a great honour.

When we think of all the important consequences of being thoroughly versed in this part of anatomy, they crowd upon our imagination more in number than can be even named. The surgeon may, indeed, provide for the arteries to be cut in a regular operation, by consulting books; but when he is called to a patient bleeding and faint, perhaps expiring, that person must live or die by his immediate skill! By his skill he will obtain the good opinion, not of ignorant attendants only, but of the profession: and by a bold and sensible conduct in any difficult situation he may give a lesson of real use. Let us but for a moment think of the chances of those wounded in war; the alarming unthought-of accidents which overtake us daily in private life; the wounds and hurts which workmen receive; let us reflect on all the kinds of aneurism both in the heart and arteries, from wounds, from blows, from inward diseases; let us think of all the various operations in which arteries are concerned—and then declare whether, of all his studies, the young man should not value that most which makes him so immediately and eminently useful.

OF THE HEART,

AND OF THE

ARTERIES, VEINS, AND LYMPHATICS.

RESPIRATION continued.

RESPIRATION, OR THE MANNER IN WHICH THE OXYDATION OF THE BLOOD IS ACCOMPLISHED IN VARIOUS ANIMALS.

Those who are the best acquainted with the comparative anatomy will best know how natural it is for me to illustrate this function, by comparing various animals with man: how pleasant, how useful, it is to know these analogies, every student must feel; and it is now full time to correct many mistakes into which modern as well as ancient authors have wandered, from want of general principles, and from want of anatomical knowledge. I shall endeavour to make this chapter interesting and short.*

At one time all authors believed that the lungs were moved, not by any external agent, but by some internal power residing in the lungs.

When in their first essays to investigate this subject they opened the thorax, or rather the body, of amphibious animals, they observed that the creature lay out upon the table with expanded lungs; that the lungs continued for hours to appear like inflated bladders; the lungs expanded, the heart playing, the creature quite alive. When they emptied their lungs for them by thrusting tubes down the trachea, or pressing the lungs, the lungs entirely subsided; but in a little while the lungs, at the creature's will, rose again into complete inflation; again they appeared

* In the warm-blooded animals there is a standard degree of animal heat, which is uninfluenced by the changes of the external temperature. This class includes all the mammalia, with few exceptions, and birds. In the cold-blooded animals there is no fixed standard of heat, but the temperature of their bodies seems to be derived from the medium in which they live. It is, however, always a few degrees above or below that of the surrounding bodies, and cannot be brought to a perfect equality without depriving the animal of life. Among this last class are included the oviparous mammalia, fishes, and the invertebrated animals. The standard of heat in the warm-blooded animals varies: thus in birds it is 108°; in most quadrupeds 100°: that of man is the lowest, being 97° or 98°.

like two tense bladders. Surely, said they, there resides some expansile power in the lungs themselves; but when a few of them began to pursue this mistake with serious experiments, they committed absurdities which should be noticed, for they serve to illustrate the true doctrine concerning the expansion of the lungs.

Mr. Houston, in our philosophical transactions, undertook to prove the following thing, which, to use the words of a learned author, "are so improbable as to be incredible:" first, that the breathing of a dog is nothing affected by any wound of the thorax, if only the lungs themselves be not hurt: secondly, that the lungs never collapse, though the thorax be laid open; thirdly, that when the breast is entirely laid open, the lungs continue to move, and the thorax also continues to move, but that the motion of the thorax never keeps time with the motions of the lungs. But, to do Houston justice, he endeavoured to explain away the inconsistencies of his own experiments; and the world would never have been troubled any more with them, had it not been for a Mr. Bremond, a great academician, philosopher, and experiment-maker, who published the following suite of experiments in the academy of Paris.

His first mistake is this. "I found (says he) that having stabbed a Dog in one side only, it could run about the house and howl." This is what nobody will doubt. "But also (says he) the air which the Dog took in by the wound when it expired, was pressed out again by the wound when it inspired." This is one cunning stroke of Mr. Bremond; for had the air entered the chest during inspiration, that must have proceeded from the rising of the thorax, which is not the kind of respiration which he wanted to prove: but as the air entered the chest during expiration, it proceeds clearly, according to his principles, that the lungs in squeezing out their air have a contractile power; that they contract by their own motion, and leave the ribs, and so make room for the air.

"Next (says Mr. Bremond) I opened the thorax of a living Dog, and there I saw, that when the lungs contracted the thorax dilated, and when the thorax contracted the lungs dilated."—But in fact, it means no more than this, that often in these agonies produced by such cruel experiments upon animals, or by actual wounds in the human body, the diaphragm, chest, every thing which contributes to breathing, is so closely contracted, and the pressure is so great, that the lungs are actually compressed and protruded: so that his seeing, as he says, the lungs dilated, that is, squeezed out, when the thorax contracted, is like the ignorance of a child looking from a carriage-window, who believes and wonders at the trees and houses running backwards. But as no experiment-maker ever allows his experiments to remain incomplete, Mr. Bremond finishes his by the following daring assertion, "that always when he made his incision no more than three inches long, the lungs dilated themselves with so much violence that they drove out the air before them, protruded themselves through the opening, and made the blood jerk out at all points." In short, he repeats this mistake in every possible form, viz. that the motions of the lungs and thorax are directly opposite to each other; that the lungs are contracting while the thorax dilates, and the thorax contracting again when the lungs dilate. When I open a Frog, it fills its lungs with perfect ease after both its breast and belly have been entirely cut away. "If admitting air into the thorax could really make the lungs collapse, why do not those of the Frog collapse?" This is such gross ignorance as should not have been endured in one reading papers before the Royal Academy of France. He is farther back in physiology than Oligerius, Jacobæus, or Malpighi.—The Frog has a respiration peculiar to itself, or at least to its kind.

FIRST SPECIES OF RESPIRATION, VIZ. BY A DIAPHRAGM.

Under this title I shall explain the respiration of Man, and of animals like Man; which have heavy lungs, of a strong fleshy texture, a prodigious number of blood-vessels passing through them, their lungs lodged entirely in the chest, and their respiration performed by a diaphragm.—I mean to arrange respiration according to the mechanism of those organs by which it is performed; and place in the first order that of Man, and animals which in this point resemble Man; and I say respiration by a diaphragm, for this is indeed the only use of a diaphragm. The support of the great blood-vessels, the compression of the viscera, the expulsion of the urine and fæces, the ridding the womb of its burden; all could have been performed by the pressure of the abdominal muscles alone; the diaphragm is added merely for breathing.

Forsaking, for a moment, authority and minute anatomy, let us explain it in the shortest and most intelligible way.—The diaphragm divides the thorax from the abdomen; it is strong, muscular, and acts with great power, enlarging the thorax; it is convex towards the breast, and concave towards the belly; when it acts the belly is protruded, the diaphragm becomes flat, the thorax is enlarged, and a vacuum would be formed, but that instantly the lungs follow it and prevent a vacuum; for the lungs are free in the thorax, the air has free access to go down into the vesicles of the lungs; and so when the diaphragm retires, the lungs follow it, being dilated by the pressure of the air which enters by the trachea.

But this protrusion of the belly excites the abdominal muscles to react; their pressure restores the diaphragm to its natural form; when pressed back again by the abdominal viscera, it rises in the thorax, becomes again convex towards the lungs, the thorax is reduced in size, the lungs are compressed, and that air is driven out again which they have just received. The thorax also moves in concert with the diaphragm: and this motion is most curiously arranged; for, first, the intercostal muscles lift the thorax for respiration, in the very moment in which the diaphragm is pressing down, and consequently at the instant when the abdominal muscles, which are attached to the lower borders of the thorax, are relaxed, so that they suffer it to rise. Next, the thorax is to be compressed and pulled down by the abdominal muscles: and this happens at the very instant in which the abdominal muscles react against the diaphragm; so that the abdominal muscles, while they thrust back the diaphragm, pull the lower edges of the thorax down with great power.

Thus in Man, and almost all animals, the respiration is performed by a diaphragm.

SECOND SPECIES OF RESPIRATION, viz. THAT OF BIRDS.

This figure represents the apparatus of respiration in a bird. *a* is the solid lungs, which are not moveable; *b*, *c*, the bones of the body, the breast-bone *c* extending the whole length of the body; 1, 2, 3, 4, 5, 6, the air-cells occupying the thorax and abdomen, which are here one cavity, or rather series of cavities. These are dilated when the chest rises to the line *h*.

Birds are supposed to breathe like Man, but have in fact no diaphragm to divide their body; they have vesicles or air bags extending through the whole body, and connected with the true lungs; their sternum and ribs expand over the whole and by their motion move the air vesicles, which blow the air through the true lungs; while the true lungs, far from having any thing to do with a diaphragm, never move.

Every one skilled either in anatomy or physiology must know, that one of the greatest physiologists of our times has written a paper about the respiration of birds, little understood, and in proportion much admired; of which function he is so thoroughly ignorant, as to explain how they breathe with a diaphragm; and until I set this point right, my arrangement is good for nothing.

"The diaphragm of fowls (says Mr. Hunter) is thin, transparent, and membraneous, and runs across the abdomen." But if thin, membraneous, and transparent, it can perform none of the functions of a diaphragm, and must be merely such a membraneous interseptum as some Amphibia and Reptiles have, supporting the viscera, or confining them in their place. But he thinks to make good his point by acknowledging the imperfection of this diaphragm; and adding, that it is moved by certain small muscles, which arise from the inner surface of the ribs, and pull the diaphragm and lungs down. He still persists in calling it a diaphragm, in the very sentence in which he informs us that "it is perforated in many places with holes of a considerable size." Since Mr. Hunter is so bold as to say of other authors, that they have too limited notions of a diaphragm, we may be allowed to say, that his notions of it are as much too liberal as theirs are too confined. But descriptions and arguments of this kind, where the author is entirely wrong, should not be tediously refuted, nor answered in any other way than by a simple statement of the case.*

* For the respiration of birds, *i. e.* for raising and depressing the thorax, I see many

The anatomy of a fowl's respiratory organs is plainly this:—The trachea having descended into the thorax, divides into two branches; of which one goes in a simple and ordinary manner into each side of the lungs. The heart, which lies immediately upon this division of the trachea, sends into the lungs two great pulmonic arteries, and receives in return two veins. The lungs themselves are very small, dense, and bloody; they are somewhat of the shape of the human lungs; they are seated in the very uppermost part of the chest, are closely braced down to the back, and are indeed in part niched in among the ribs, which in birds have their edges very deep. These are the true lungs for oxydating the blood; they never move; the air passes through them in the following way.

These lungs cannot move, because they are braced down by a membrane very thin, and cobweb-like, yet very strong. This membrane is a peritonæum, lining at once the whole thorax and abdomen, (which still are not parted from each other,) and it is a covering to the lungs, liver, and other viscera; but also the same cobweb-like membrane forms cells, which fill the whole cavity from the neck down to the anus, and from the breast-bone to the back; and which are so attached to all the surfaces, being, as I have said, the lining membrane, that as the breast moves these cells must move.

These cells appear at first sight quite irregular; but I hold it as a principle, that although we may not see it, yet all is orderly in the animal body; in fact, the order of these cells is extremely regular. First, there is a membrane which comes down from the breast-bone in a perpendicular direction till it touches the viscera; it runs the whole length of this common cavity of breast and abdomen; it enters into the great cleft of the liver, and so divides the liver into two lobes, serving as a ligament for the liver, as a mediastinum to divide the great cavity into two, and also as a sort of root or basis for the cells of either side; though beautifully transparent, it is very strong. At the upper end this mediastinum touches the heart, and there expands into a very large bag exquisitely transparent, which is at once an air-cell and a large pericardium. Next, at its lower end, it touches the gizzard or stomach, and forms a large cell surrounding it. Behind the liver which fills all the upper part of this great cavity, and the gizzard which fills all the lower part, lie all the intestines, which are also surrounded with many cells; at the sides the cavity is occupied by three or four large cells extending from the middle membrane to the flanks of the bird. And, lastly, when we look into those greater cells which are nearest the lungs, we see clearly many openings, very large, oblique, running flat under that part of the mem-

muscles having a very strong analogy with those of Man. The pectoral muscles are amazingly strong, and their scapulæ absolutely fixed, so that these could raise the breast with great power; but I suspect that no such power is needed, that the elasticity merely of the sternum and ribs raises them. There lies under these, upon the back, a very strong muscle like our serratus posticus. There lies on the inside of the ribs a set of three beautiful muscles like large intercostals: they are quite insulated from all other parts, are seen instantly upon opening the belly: these are what Mr. Hunter calls Muscles of the Diaphragm; but in truth the breast of a bird is pulled down strongly by its short, yet strong abdominal muscles, and rises again by its own elasticity with little help; and these are merely intercostal muscles.

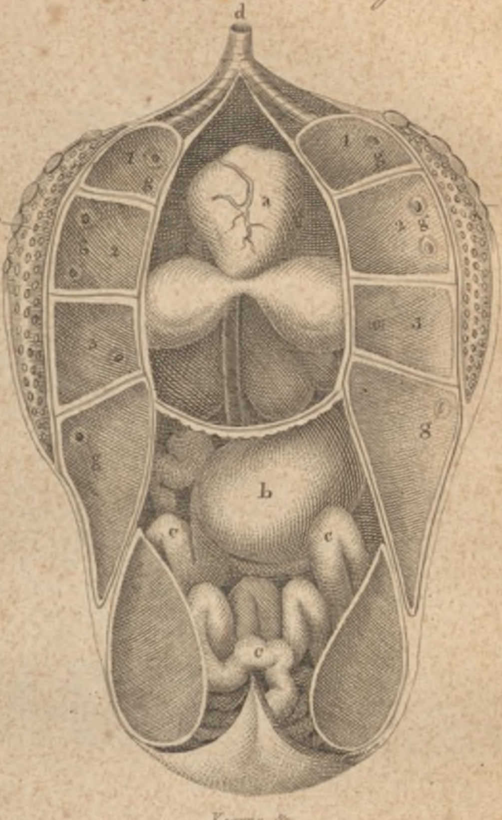
brane which braces down the lungs, so as to communicate the air from the lungs to all the cells very freely.

Now let me add, in one word, that the essential parts of respiration are these: First, There is no diaphragm, no division of breast and belly, the stomach lying upon the rectum in the pelvis; a true and muscular diaphragm could not exist in birds, having nothing to do in their scheme of respiration. Secondly, The true lungs are small, high in the back, quite immoveable, so that no diaphragm nor no power of vacuum could unfold them; and these lungs are perforated at every point, so that they could not expand by air. Thirdly, What has been confounded with the true lungs is the vast congeries of abdominal cells, which are of use only in lightening the creature that it may fly, and in forcing the air through the true lungs. Fourthly, There is in the place of a divided abdomen and thorax, with long abdominal muscles, no proper abdomen, a long thorax, a high sternum, and very elastic ribs, extending along the whole body till they almost meet the pelvis, making the abdominal muscles very short; and the air cells all along adhere to the inner surface of these bones.

With these points clearly before us, we cannot mistake the mode of respiration in birds. The thorax does the whole; the thorax is raised, and immediately the cells are expanded, by which two functions are performed; for the air which comes into the cells, passing through the lungs, oxydates the blood, and the cells become full at the same time so as to make the body specifically lighter. The thorax is depressed again, and the air, which passes now a second time through the lungs, may a second time oxydate the blood, for it is not thoroughly spoiled; and what is spoiled is diluted with the air of many cells, which respiration cannot empty at one stroke.

The final cause also is plain; had the lungs in a fowl been solid and fleshy, (as they are in fowls, or even in any other creature,) and at the same time sufficiently large to perform, without the help of those air bags, all the functions of lungs, they must have been large and heavy in proportion to the body of the fowl; they must have occupied much room, and added much to the weight. But the lungs of a fowl are very dense, very small in proportion to its system, very full of blood, quite fixed, and undilatable; the rapid course of the air through them backwards and forwards enabling them in their business of oxygenation to do much with little. In short, there are two functions to be performed in birds: first, the oxydation of the blood, which is performed by the small, fleshy, contracted lungs, which lie immoveable in the upper part of the thorax, and through which the air blows continually as through a furnace, while they are quite passive; and, secondly, the lightening of their bodies for flying, which is performed by the abdominal cells. It was also necessary that the sternum and bony compages should be large, in order to afford space for the origin and lodgement of the muscles of the wings, and enable them to raise the whole weight of the body in flying. The describing of a diaphragm, and the confounding of the abdominal cells with the true lungs, where none can be, was like to have put us all wrong.

The Ostrich's Lungs
drawn by the Parisian dissectors



Kearny, Sc.

a The Heart lodged in one great Air Cell b the Stomach and c the Intestines surrounded by other great Cells. d the trachea branching towards the lungs. e e the true lungs firm fleshy very small & fixed down to the backbone. 1 2 3 other great Air Cells in immediate contact with the Lungs & communicating with all the other Cells. the holes g g g &c. are the openings by wh. the Cells communicate with the Lungs & with one another.

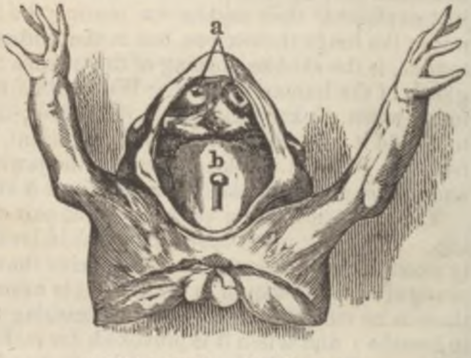
THIRD SPECIES OF RESPIRATION, VIZ. THAT OF AMPHIBIA.

This species of respiration differs from the two first in these respects; it differs from the respiration of Man, because there is no diaphragm; it differs from that of birds, for there is no chest covering the lungs. There is a short sternum, no chest, no ribs by which the lungs may be moved, there is no vacuum formed in their respiration; they fill the lungs by the working of their pharynx, that is to say, instead of the air being drawn in by the action of the thorax, it is forced down by the action of the muscles under the jaw. By the swallowing of the air, as it were, the membraneous air-cells are inflated; and when inflated, they are emptied by the contractions of the abdominal muscles.

The Frog, the Newt, the Cameleon, the Tortoise, and many other creatures, breathe in this way; and as one of the most curious mechanisms for respiration, I shall represent that of the Frog. As I have just explained, their organs for moving the lungs are not in the chest, nor in the lungs themselves, but in the throat. Behind the root of the tongue, is the slit-like opening of the trachea; this is what is called the glottis in the human subject. We see this rima opening and gasping for air when we keep the mouth distended; it has no epiglottis or valve to defend it; its own contraction is sufficient, for when closed you cannot even guess at its place; besides, the jaws force down the air into it, and the long tongue carries the food over it into the gullet.

The small nostril is a very important part of the apparatus of breathing. The Frog never opens its mouth in breathing. Looking carelessly upon this creature, we do not perceive that it ever breathes, for it lies plunged over the mouth in water. It is never seen to open its mouth; there is no motion in its sides like breathing; in short, it does not seem to breathe; and when it is provoked, (or rather through fear,) though it still keeps its mouth closely shut, its sides and back rise, and it blows itself up apparently by some internal power. But when we observe the creature more narrowly, we perceive that there is a frequent motion of its jaws, or rather of that skinny and bag-like part of its mouth which is under the lower jaw. We are apt now to fall into a worse mistake, for this bag under the jaw is alternately dilated and contracted; the mouth is never opened to take in new air; the creature seems to live all the while upon one mouthful of air, and seems to be playing it backwards and forwards betwixt its mouth and its lungs.

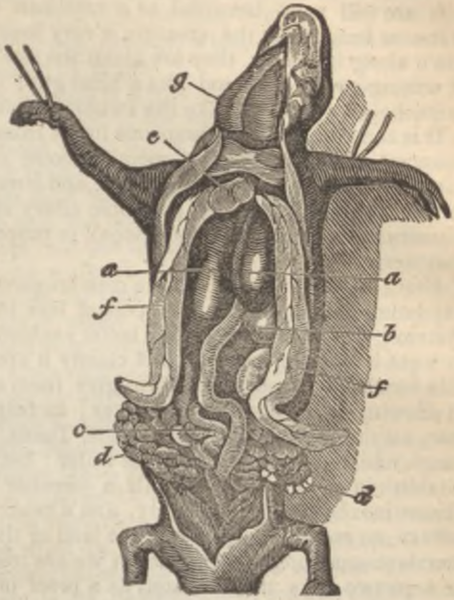
But, lastly, when we observe its nostrils, we find that there is in the nostrils, a twirling motion for each movement of the jaws, which makes the whole process perfectly simple to our comprehension; for a Frog breathes by the nostril alone, it cannot breathe by the mouth; it never raises its mouth above water, nor opens it but to catch flies or other food. If you keep its mouth open, you see it presently struggling for breath; for its respiration goes on in the following way: its broad jaws are continually shut; they lock into each other by grooves; the mouth is completely close, and forms a sort of bellows, of which the nostrils are the air-holes, and the muscles of the jaws which come from the os hyoides draw the draught by their alternate contraction and relaxation; and the nostrils lie so obliquely over the hole in the skull, that the least motion of them enables them to perform the office of a valve. First, there is a twirl of the nostril which lets in the air; then a dilatation of the bag under the jaws, by which the mouth is greatly enlarged and filled with air; then a second motion of that bag, by which the mouth is emptied and the lungs filled; then there is a slight motion of the sides of the creature, by which the muscles of the abdomen expel the air again; and then the twirl of the nostril and the motion of the jaw succeeds again; so that with these creatures inspiration is the swallowing of the air (but not into the stomach) by their broad expanded jaws, with their coverings driving it down into the lungs; and expiration is the contraction of the abdominal muscles driving it out again: and these two motions, when we observe a Frog attentively, are as perfectly regular as respiration in a Man. Their muscles of respiration are not the muscles of the belly, but the muscles of the jaws; and this causes the uncouch broadness of the jaws in Frogs, Newts, Lizards, Serpents, Turtles.



(*a*) The nostrils—(*b*) The tongue.

Now we shall no longer wonder why the Frog never opens its mouth; why it never seems to breathe; why, after opening its belly, the lungs still project; why, after emptying its lungs, it can fill them again at will, not by any peculiar power in the lungs, but by blowing them up with its jaws. If you gag the the Frog and keep its mouth open, it cannot fill them, because it cannot breathe; if you plug its nostrils, it suffocates, though not soon; if you keep its mouth open by force, you soon find it struggling for breath; and looking into its throat, you see the glottis opening from time to time.

The Newt (or as it is called in Scotland, the Ask) breathes with the jaws and nostril like the Frog; it has, like the Frog, a constant motion by short strokes of the bag under the jaw, (which bag is formed by the membranes of the mouth, covered and moved by the genio-hyoidei and mylo-hyoidei muscles,) but we observe that every minute, or less, it stops as if intending some particular motion; then gradually the bag swells out under the lower jaw to a great size; then the air contained in it is puffed down into the lungs with a sudden flap of the bag; and in proportion as the jaws are emptied, the long sides of the creature are heaved up.



(*a a*) The liver of the Newt—(*b*) the stomach—(*c*) the intestines—(*d*) the ovaria—(*e*) the heart—(*f f*) the vesicular lungs, which are long like intestines, and transparent like the swimming bladders of a fish—(*g*) the bag of the jaws by which the lungs are blown up.

The Toad, the Cameleon, the Green Lizard, breathe exactly in the same way. The Cameleon has the flat broad jaws of the Frog; they lock into each other, and it does not open its mouth in respiration; it swallows its air in mouthfuls, drives it downwards into its lungs; its lungs are of a vast extent, stretching from the jaws all along the abdomen: it is the vast size of its lungs, almost concealing the abdominal viscera, that makes Gesner say, "that of the entrails of a Cameleon the lungs only are visible." The air it swallows in greater or smaller quantity as its needs or fears prompt it. When you alarm this timorous animal, it fills its sides just as a Frog swells out its back; and either in this greater respiration, or in its ordinary breathing, we see it pressing the air onwards from cell to cell; and we see the motion proceeding from its jaws to its breast, and all along its sides, till its lank form is quite puffed up almost to bursting.

All these creatures have in addition to their peculiar respiration, a peculiar kind of lungs, thin, membraneous, and extremely delicate: the lungs even of so great an animal as the Crocodile are, when inflated, very delicate and transparent, of a rose colour or slight red, consisting of delicate vesicles, and exactly like the Frog's lungs. The lungs of the Frog are in shape like a fir-cone, with the stalk of the cone on each side fixed to the side of the heart. But these conical lungs of each side are delicate, silvery, perfectly transparent, divided within into innumerable cells like a honeycomb; and these also are so extremely delicate, that though the outside membrane is as transparent as a soap-bubble, the divisions can hardly be seen, except by inflating and drying the lungs, and then cutting them. The lungs of the

Ask are still more beautiful, as a specimen of what are called membraneous lungs ; for the creature is very long in the body, its lungs run down along its sides ; they are about the size of a common earth-worm or writing-quill ; they end like a blind gut ; they are of a bluish white, exquisitely transparent, like the swimming bladder of a fish.

It is the nature of membraneous lungs to oxygenate but a very small quantity of blood ; they are membraneous, only because there is not that vast profusion of arteries, veins, and strong vesicles, which there is in the human lungs. The pulmonic artery and vein are always, in the membraneous lungs, extremely small in proportion to the system which they serve.

From these peculiarities of the membraneous lungs, it is plain that the oxydation of the blood is a process of less immediate necessity in their system ; and thus they are the better enabled to go into the water, and to want breath for a time. But chiefly it appears, that the meaning of this peculiarity is not so much to give them the privilege of Amphibia, in allowing them to go into the water ; for many creatures, as the Cameleon, all the tribe of Lizards, Newts, Toads, Serpents, &c. have these lungs, and yet never approach the water : but that the chief use of it is to establish in this class of animals a peculiar constitution, a permanent, almost inexhaustible, irritability, and a tenaciousness of life ; which, I believe, no creature, whether of the land or the water, wants, which has membraneous lungs. And when we are told that these creatures can be kept two days under water, as a proof of their being Amphibia, I cannot but consider it as a very childish proof ; for, in the first place, we see them breathing with wonderful regularity when out of the water ; when plunged into the water, we see them very soon struggling for breath, and if they can live for two days without air, it is only because they could bear any other kind of injury with equal ease, and could live two days without their heart or their head. Circulation is necessary, respiration is necessary to their life, but the irritability and properties of the living parts are sustained longer without new supply than in the warm blooded animals.

FOURTH SPECIES OF RESPIRATION, VIZ. THAT OF FISHES.

In this species of respiration the creature breathes neither water nor air, but water mixed with air, and this office is performed by gills in place of lungs.

The reason why I have called this a species of respiration, needs to be very fully explained ; for, though little observed, it is a certain fact, that a creature, without any apparent change upon its system, can do well, having its blood oxygenated at one time by gills, at another time by lungs. The Frog, for example, lives long in the water ; while it does so, it may be considered as a fœtus which cannot breathe : the young Frog which has not yet acquired its proper and natural respiration, breathes like a fish. For the first fourteen days after hatching from the egg, and while the Tadpole is very small, it has gills, which are two long, projecting, fimbriated appendages like fins ; by the thirty-sixth day these appendages are taken into the jaws, and form four rows of gills on each side, regular, and like those of a fish ; but at the same time, this fœtus has its lungs within the body, not to be used till it come out into the air, when the lungs assume their function and the gills shrink. The same system in this instance, which was at first served by gills, is in the end oxygenated by lungs.

The motion of the gills in fishes is a true and perfect respiration: for, in the first place, if there be no air in the water, or not enough of air, they cannot breathe; distilled water is to a fish what the vacuum of an air-pump is to a breathing creature: if you exhaust water with an air-pump, if you boil it, if you distil it, if in any way you deprive it of its air, fishes cannot breathe in it, but come up to the surface and gasp for air. If you take a fish out into the air, it is the same with plunging any breathing creature into water, it gasps and dies. Fishes cannot breathe in air wanting water, for that element is not accommodated to their species of lungs; nor in water wanting air, for then there is no oxygen; and we find, upon extracting the air from water which fishes have breathed, that it is contaminated, exactly in the same way with air which had been breathed by any breathing animal, and that it differs very little from that in which a candle has burnt out. This is the reason that when many small fishes are inclosed in a narrow glass, they all struggle for the uppermost place, and that when in winter a fish-pond is entirely frozen over, you must break holes for the fishes, not that they may come and feed, but that they may come and breathe; without this, if the pond be small, they must die. Fishes according to their kind require water differently impregnated with air. The shallow water that runs over a pebbly bottom is by its agitation more thoroughly mixed with the atmosphere, and there the trout and salmon breed.

In the respiration of fishes, there are two curious points to be considered: first, the manner in which their respiration is performed; and, secondly, the manner in which their blood, when thus oxydated, is distributed over the body.

In the osseous fishes the apparatus of respiration is more like the texture of the ribs than would seem at first view. The operculum, or large flap which covers the gills, consists of arched bones, over which a membrane is stretched, and they have a very beautiful and somewhat complex system of muscles operating upon them. The margin of the operculum has a soft pliant fringe, which, in the motion of respiration, accurately shuts the slit or opening. When the creature breathes, it is by the operation of the muscles upon this covering: it is rendered convex, and the cavity under it is dilated without the margin rising; the consequence of which is, that the water is drawn from the mouth through the branchiæ, and is for a moment lodged behind them. At length the elevation of the operculum is so great that the fringed margin is raised, and then the water rushes out and is discharged backward. By this we understand why the fish keeps the head continually up the stream, and why it is the art of the fly-fisher to keep his head down the stream, or to suspend him in such a manner as to keep his mouth out of the water; for the fish cannot breathe if the water is rushing into the gills from behind, and he cannot make use of air as he does of water, but is exhausted and suffocated.

Having explained this first point, viz. the mechanism of the gills, I proceed next to explain the circulation of their blood, how their blood is oxydated, and how it is distributed over the body.

A fish and an amphibious animal have both of them the simple heart, consisting of one auricle and ventricle, but with this singular variety, that the Frog, for example, wants the heart belonging to the lungs, a small artery only from the common system performing the office; while the fish again wants the heart which should circulate the blood through the body, and has that heart only which belongs to the lungs. The whole blood of the fish passes through this single heart, and therefore the whole mass circulates, parcel by parcel, through the gills, for every time that it circulates through the body. We shall begin its circulation, then, at the heart. First, The whole blood of the body is returned into the heart of a Skate, by two great veins. These two great veins deliver it into a vast auricle, or reservoir rather, which lies over the heart. The auricle delivers it into a strong ventricle, whose action is further strengthened by the action of its aorta, which, from the heart up to where the valves are, is very muscular and powerful, and constitutes, in a manner, a part of the heart. But this great vessel must in this species of circulation change its name, for it really is not an aorta, has nothing to do with the body; both the heart of a fish, and this its only vessel, belong entirely to the lungs or gills, and as these are called branchiæ, this is the branchial artery. The gills of this fish are five in number on each side, and on each side the branchial artery gives out two branches which serve the five gills; the lower branch is large, and serves the three lower gills; the higher branch, which goes off like one of the arms of a cross, serves the two upper gills.

Secondly, these arteries being distributed along the gills, divide into exquisitely small branches, producing that feathery appearance which is so beautiful. Those minute subdivisions of the branchial vessels expose the blood to the air. This may explain to us how in the human lungs the exposing of the blood, even with the interposition of membranes and of the arterial coats, may be sufficient for the oxydation of the blood. All the blood thus oxygenated is returned by veins, corresponding exactly in number and arrangement with their arteries: and the heart being turned aside, and all the other viscera taken out, the veins are seen accompanying their arteries and emerging from the gills to form the aorta.

Thirdly, The aorta is formed by the veins of the gills, and the veins of the gills lie close upon the skull of the fish, and the aorta upon the back-bone; and this vessel is in one sense a vein, since it is a continuation of those veins which return the blood of the gills; but both in office and form it is a true aorta; in office, because it distributes blood to the whole body; and in form, because it no sooner swells out into the shape of an aorta than its coats grow hard, strong, muscular, fit for its office, while those of the veins from which it is formed are pellucid, delicate, and very tender. The aorta is full of the oxydated blood of the gills; and although, by the delicate circulation of the gills, it has lost all communication with the heart, it circulates this oxydated blood through the body to all the muscles, glands, viscera, &c. without the intervention of a new heart.

The veins which return the blood of this aorta are the ordinary veins;

they arrive in two great branches at the heart, and need not be further explained.

I will not be at the trouble to repeat the tedious calculations of authors concerning the immense surface which the gills expose: let the student look to the gills, and he will presently, with the help of this short sketch, understand how the whole function goes on.

FIFTH SPECIES OF RESPIRATION, VIZ. THAT OF INSECTS.

There is in this kind of respiration no breathing organ like the lungs, but tracheæ or air tubes by which air enters into all parts of their body.

What is most perplexing in this species of respiration is the prodigious quantity of air which these creatures receive; the little connection betwixt the air tubes and the heart; the impossibility of tracing blood vessels from the heart to the various parts to nourish them; and the clearness with which we see their air tubes branching over all parts of their body. The stomach, bowels, and other viscera, the legs and wings, even the very scales of insects, have branches of the air tubes dividing over their surfaces like the delicate vessels of leaves and flowers. In short, the magnitude of these air tubes is quite surprising; and their branchings are so minute, delicate, universal over all the body, that it looks almost as if the air tube had exchanged functions with the heart and arteries.

It is plain by these expressions of admiration that I do not mean to attempt so difficult a subject as this at present: I only mention difficulties which it is surprising that others have not declared and investigated, for nothing can be more interesting. The little that we do know shall be simply and plainly told.

The forms of insects are often very strange, their lives very irregular, sometimes in water, sometimes in air; many of them begin in Worms, and end their lives as Flies and Moths; and according to these varieties of their form, or life, or generation, their air tubes are various.

Sometimes, as in the common Bee, they have nearly the form of lungs: they begin like two bags, resembling those of the Alga Marina, or sea-weed, in shape; and these bags distribute pulmonary tubes, with occasional bag-like dilatations in the course of the tubes, through all the body. More commonly the air tubes of insects are direct tubes, mere tracheæ, of a very singular construction; they have rings like the tracheæ of animals; they have a delicate membrane covering these rings, and forming them into a tube: the tube continues always rigid like a flexible catheter, or other tube of twisted wire not liable to collapse: they begin by many open mouths opening along the sides of the insect, and they terminate in myriads of vessels, which, in their forms and progress over the various parts of the body, resemble blood vessels more than it is easy to conceive. These air tubes being thus rigid, are always full of air, and by their refractions through the transparent parts of the insect's body, they give it in the microscope a great degree of brilliancy; as, for example, in the Louse, whose air tubes make the brilliant lines and points which are contrasted like a silvery colour with the dark and opaque parts; or in the Mite, which is as beautiful in the microscope as the Louse; and when the larger insects are prepared by drying and varnishing, and preserved in turpentine, the air tubes are beautiful. Of these curious particulars, the openings of the air tubes are best seen in the Worm, from which the common Butterfly is produced; we count these holes down the sides, we name them puncta respiratoria, spiracula, or most commonly stigmata. That particular form in which they resemble more the lungs of animals is seen in the pulmonic bags and the tracheæ or air tubes of the common Bee. Their exquisite branchings through the various parts are well seen in the air tubes which run along the wings of a Bee, or those which twist and ramify round the intestines and stomach of a Worm; and it is not to be forgotten, that though the beginnings of these tubes in their great tracheæ and near the puncta respiratoria or stigmata are quite transparent, their extreme branches are beautifully white like vessels filled with chyle, or rather one might be apt to mistake them for nerves.

Of the way in which this function is performed, there must be more varieties than we can know or comprehend: this we may safely conclude from the little that we do know, finding the variety so very great.

Almost all insects, with the exception of dipterous larvæ, have their puncta like those of the Caterpillar, ranged along the side, and inosculating from branch to branch: often the puncta open along the sides; but in place of inosculating from branch to branch, all round one side, they inosculate across the belly, the one side communicating with the other. This is best observed in the small larva from which the Bee proceeds. And here it must be observed, that, as in insects, with the exception of dipterous, always the stigmata or breathing points correspond neatly with the folds or rings while it continues a larva, and with the segments or divisions of the body when it becomes a Fly; in the Bee-worm also the inosculations answer to the joint of the body.

Sometimes when an insect lives in water, it has only two puncta respiratoria: these puncta begin either in the snout or in the tail; they are the openings of two great air tubes which run down each side of the insect like two aortas, and the insect has means of rising to the surface, takes down a bubble of air along with it, and discharges a bubble of air before it rises again: of this nature are the air tubes of that Worm from which the Ephemeris proceeds. The two great air tubes are seen like two aortas running all along the body, and their minuter branches are seen ramifying beautifully upon the abdominal muscles and other parts. Many insects are aquatic when first they are hatched from the egg. They have little gills which serve them while they continue in the water, as, for example, the larva of the Ephemeris Fly. These little gills are fringed with microscopic mamillæ, which communicate with the great tracheal branches; so that along with the gills they have the ordinary structure of air-tubes, and the day on which they emerge from the water, the gills shrink, and the air-tubes begin their function; and these changes succeed each other very rapidly in all insects, but most especially in the Ephemeris, which is destined to live but one day.

It is most of all singular, that in some insects the number of respiratory points, or puncta, changes according to the various conditions or stages of their existence. For example, a larva which crawls among the dust, since it must breathe less easily, has more puncta than when it has changed its state to that of a Fly, and has its puncta very freely exposed to the air: in the Rhinoceros Beetle the larva has more puncta respiratoria, and closer, because it crawls on the ground amidst mud or dust; they are less numerous in the Fly, as its air-holes are always more freely exposed; and when the Beetle is actually flying, those puncta, which were closed by the cases of the wings are fully opened; so that the insect breathes more freely, and perhaps its body is lightened, so that it flies more easily: it is also particular that in the full-grown Beetle, though the puncta be less in number, the lungs are enlarged, they both change their form and become more capacious; for the tubes are mere tracheæ or straight lines, with direct branches in the larva, but in the Beetle they are dilated from point to point into air-bags.

Insects in general are bred in eggs, transformed into larvæ, and of these the greater number assume the form of aureliæ; an aurelia is a Fly, small but full formed, with its legs drawn up, its wings plaited and folded, ready at all points to burst from the covering which surrounds it; for both in posture and in the membranes which surround it, it resembles a fœtus. In these three stages it still is supplied with air by air-tubes: they open by puncta respiratoria while it remains a larva; the same puncta still serve it while it is wrapped up an aurelia or concealed Fly; when the Fly bursts out, the same puncta, the same tubes, which have served in its former stages, serve it still; only this is most curious, that when from a larva it proceeds to be a Fly, the skin which it rids itself of (by crawling out of it and pushing with its feet) carries off along with it many of the internal parts; the mouth, the anus, and especially all the respiratory tubes, lose an internal skin at the same time that the old skin or slough is pushed off from the outward surface of the body; and when the puncta are thus changed, they are left more open than before, and often their number is changed.

These are the various ways by which insects are supplied with air; and nothing can be more interesting than to observe the vast proportion of air which they draw in, which is certainly a provision for their living in places where oxygen cannot be plentifully supplied. And the fact is well known, that insects can live on air much less pure than what is necessary to breathing creatures, and that they exhaust the oxygen of the atmosphere much more completely than any other living creature. The variety in the manner of conducting the air to the system of insects, is changed, and suited, as I have observed, to their various ways of life, and to the various conditions and stages of their life; while they are Worms, when they are involved fœtuses, and when they have burst their shell, and are full grown. In short, Worms, Aureliæ, Flies, Beetles, Bees, and all forms of insects, have all of them their tracheæ by which they breathe a wonderfully large proportion of air.

There can be no mistake concerning the function of their air-tubes and of their circulation; it is ignorance or inattention only that can cause confusion; the heart of a Caterpillar, of a Snail, of the larvæ from which various Flies are produced, is seen distinctly through their transparent body, running down their back in form of a tube, sometimes slightly oval, sometimes having frequent dilatations, and throbbing, though with less equable and distinct pulses than in the more perfect animals: or, perhaps, we should say rather exhibiting oscillations.

Nor can there be any mistake that it is air they breathe; for before we dissect an insect, we must kill it; the contortions of a live Caterpillar prevent all deliberate dissection, or even a view of the parts; we may poison the insect, as with turpentine or spirits: we commonly drown it; this is done by immersing it in a little tepid water. Nay, we find a thing which is at first inconceivable to be really true, that notwithstanding the inosculations of the air tubes with each other, which seem to provide against all such effects, when we close up the stigmata of an insect one by one, the parts become in the same proportion paralytic; if we varnish over the stigmata of one side, that side becomes paralytic; if we varnish over the stigmata of both sides up to the last holes, the insect lives, but in a very languid condition, it survives in a kind of lethargic state for two days, without any pulsation in its heart; if we also stop the two highest holes, it dies.

Of all the examples of respiration, that which is reported by Spallanzani is what I most wonder at, and cannot but doubt. In acescent liquors, or the juices of animal bodies, animalcules are seen plainly with simple glasses, moving sometimes rapidly, sometimes slowly; but never hitherto has any author pretended to see their lungs or heart. Mr. Spallanzani says, "that these animalcules are elliptic bodies; that in the centre of each ellipsis he sees two stars, which are in constant alternate and regular motion, whether the creature rests or moves. Each star-like body has in its centre a small globe, and every three or four seconds the globules are blown up slowly to three or four times their natural size, and as slowly compressed again; and every time that the radii are inflated the central globule subsides. On one side of these star-like bodies there is an oval part, which is continually agitated with a trembling motion; he calls the star-like bodies, lungs, and the oval body he thinks is the heart." Spallanzani sure has forgotten that he is speaking of lungs in an aquatic insect; if these star-like bodies have any such use they must be gills.

These are the animalcules which Buffon called organic germs, and from which, as materials and pieces, he built up the animal body. But if all this be true, then the day is come which he little expected, when the organic particles, on the faith of which he built all his system of generation, are proved to be living and moving animalcules, voracious of food, devouring each other, breathing air, and having a visible pulsating heart; animalcules deposited from the atmosphere, and generating like other insects of the kind.

Thus we are convinced of the importance of respiration, and the absorption of air in all living creatures from Man even to the meanest reptile; and not least needful in the last and lower order, which receive in proportion a fuller supply of air than fishes, amphibia, or Man.

OF THE PECULIARITIES IN THE CIRCULATION OF THE FŒTUS.

The peculiarities of the fœtus relate principally to the circulation of the blood, and are such chiefly as fulfil the circulation without any need of its passing through the lungs, enabling the fœtus to live without that function in its mother's womb.

The system of the fœtus is attached to the maternal system, through the placenta, as we shall afterwards find. The placenta is a sort of cake, consisting of numerous convoluted vessels, belonging in part to the fœtus, in part to the mother, and fixed to the interior surface of the uterus. The umbilical cord, or funis, consists of one large vein and two arteries: and these vessels go out from the umbilicus of the fœtus to the placenta, and circulate the blood in that body, by which, of consequence, the blood of the fœtus is exposed in vessels of indescribable minuteness, to the corresponding vessels of the maternal system.

We are assured that the blood which comes to the fœtus through the umbilical vein is pure, or of greater value than that which the fœtus returns to the mother's system. Either this blood is restored to all its properties merely by passing through the mother's system, and what is thus drained off from the extremities of the mother's system is more than sufficient for the life of the child, or, without such direct communication, the placenta performs to the fœtus a function equivalent to that of the lungs.

The blood returning from the placenta to the fœtus, by the great vein, is of the arterial colour, as we have said, and fit for the uses of the fœtal body, and capable of nourishing it. The umbilical vein entering the body of the fœtus, by the umbilicus, runs, directed by the broad ligament of the liver, under that viscus. Here, within the liver, it forms a large and direct inosculation with the vena portæ. To comprehend this subject at all, we must so far anticipate, as to say, that the vena portæ is a vein which collects the blood of the stomach, spleen, and intestines, and carries it into the liver.

The blood thus, as it were, conveyed by the umbilical vein into the system, does not circulate there, but finds a direct passage into the heart. This passage is called DUCTUS VENOSUS: it runs direct from the extremity of the umbilical vein into the CAVA ASCENDENS, and consequently it conveys its blood into the right auricle of the heart.

This blood does not pass through the circulation of the lungs; perhaps it ought not to pass; for there being no respiration, no air admitted to the lungs, the blood might rather be contaminated; perhaps it cannot pass, the lungs never having been expanded with air: but, however that be, there is a side passage for conveying it from the right to the left side of the heart clear of the lungs. For this use is the FORAMEN OVALE, which is an opening of no inconsiderable size betwixt the right and left auricle of the heart; its area is as large as that of the vena cava; and it is sufficient to convey the blood freely from right to left.

The DUCTUS ARTERIOSUS serves quite another purpose; for though the circulation of the aorta is well maintained in the adult body by the force of one ventricle only, yet in the fœtus one ventricle will not suffice. In the fœtus the heart must push its blood, not only through that system of vessels which is within the body, but also it must push it onwards through a second circle of vessels, viz. those of the placenta; for we might be tempted to say that the iliac arteries do not descend into the thigh and pelvis of the fœtus, but the iliac artery itself, with little diminution, (very small branches only being given downwards into the pelvis and thigh,) turns upwards along the side of the bladder; and these two arteries, going out from the navel, form with the great vein the umbilical cord; and the heart of the fœtus has to give life and action, not only to the internal system of the body of the fœtus, but to these two arteries, which run out to the distance nearly of three feet along the umbilical cord, and which make wonderful convolutions in the placenta, and terminate with extreme minuteness, as we have said, in the extremities of the umbilical vein. It is this which occasions the necessity of the ductus arteriosus, which is merely a union or inosculation of the pulmonic artery with the aorta. This union is formed by a great branch of the pulmonic artery in the fœtus, joining the aorta below its curve. This great branch (for it is greater than the two branches which go to the lungs) is named the DUCTUS ARTERIOSUS, and may be defined an inosculation betwixt the pulmonic artery and the aorta, so very large, that it gives the aorta of the fœtus twice its natural size and proportion, and enables the blood of that artery to receive the full force of both ventricles.

The contaminated or venous blood of the fœtus must be returned to the mother, or at least to the placenta; for which purpose the two iliac arteries are reflected along the side of the bladder, as I have just explained. I say the iliac arteries, without reserve, because the hypogastric and femoral arteries, that is, the arteries of the pelvis and thigh, though they are the largest branches of all the body in the adult, are in the fœtus extremely small; and thence that smallness of the lower extremities compared with the largeness of the head, which characterizes the child, and which it takes years to redress.

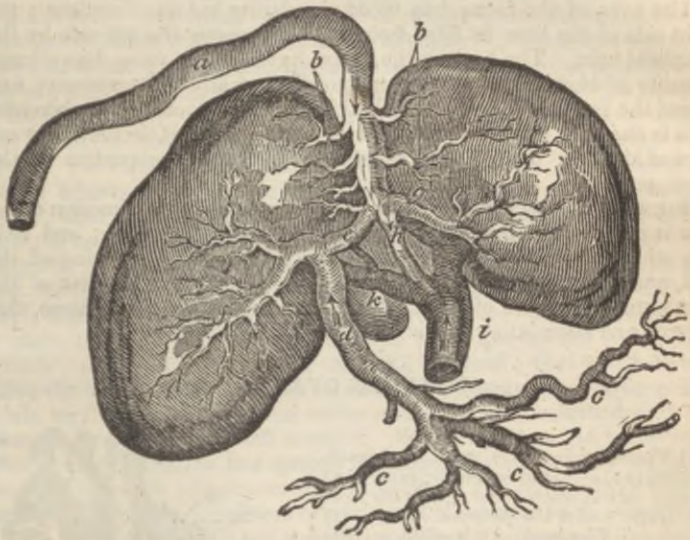
Thus have I defined these parts and their uses, in order that their strict anatomy may be the more easily explained; and the part first mentioned, viz. the ductus venosus, is the part most difficult to be understood, and never without the help of a plan. In the plan I have endeavoured to elucidate these points.

First, The mere anatomy, connections, and inosculations of the vessels; showing how the umbilical vein brings in the blood of the mother; how that vein spreads in the liver, and feeds all its left side with blood; and how the ductus venosus carries part of that blood away from the circulation of the liver, conducting it directly onwards to the right side of the heart.

Secondly, I have endeavoured to explain what parts of the liver each branch supplies, and how these vessels lie in the liver of a new-born child.

The blood from the maternal system, transmitted through the placenta, and oxydated, or having undergone some change equivalent to what takes place in the lungs of the adult, comes down along the umbilical vein; the vein enters by the navel, adheres to the inner surface of the abdomen, enters into the liver at the top of that great transverse cleft which divides the liver into two lobes, and, after entering the liver, it begins, as if it were the regular and peculiar vessel of the liver, to distribute branches through its substance from right to left.

In the Plan—(*a*) shows the umbilical vein, (*b*) branches given to the substance of the liver, (*c c c*) three great veins from the spleen, stomach, and intestines, which run together, and form (*d*) the VENA PORTÆ ;—(*e*) the cylinder of the portæ, being its great right branch where it lies in the transverse fissure ;—(*f*) the great right branch of the vena portæ in the



liver. Next comes (*h*) the ductus venosus, whose office is important, but the size of which is not quite what we should suppose. It comes off direct from the umbilical vein (*a*) ; its course is short, and a little curved ; it joins at (*i*) the largest of the hepatic veins, *i. e.* of those great veins which return the blood from the liver, and along with it goes directly into the right auricle of the heart ; (*i*) the cava abdominalis ; (*k k*) the cavæ hepaticæ. This, perhaps, might suffice as a description of the ductus venosus ; but it is convenient, and will make a clear subject, to finish that circulation of which this ductus venosus is one of the chief difficulties.

The ductus venosus (*h*) I consider as the end of the umbilical vein (*a*), for here its circulation ends ; or, if it sends blood into the right branch of the vena portæ (*k*), its proportion is but small. But the VENA PORTÆ, (which is just the collection of all the abdominal veins (*c c c*) into one trunk,—of the splenic vein, of the mesenteric vein, of the hemorrhoidal vein, *i. e.* the vein from the pelvis)—the vena portæ (*d*), I say, composed of all these veins, is the true vein of the liver.

The branches of the vena portæ are gathered into a trunk ; that trunk enters the liver ; it divides into two great transverse branches, the one serving the right side of the liver and the other the left ; but in the fœtus this left branch is not known as the limb or left branch of the vena portæ, but looks rather like the right branch of the umbilical vein; indeed it is named so by Mr. Bertin.

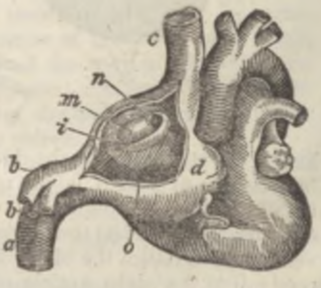
Those peculiar veins which we find in the fœtus are accommodations for its circulation, are ranked among the peculiarities of the fœtus, and are, when the child is born, obliterated by a new circulation; and what is very curious, by a circulation which goes through the same vessels in a retrograde course.

The liver of the fœtus has blood circulating in two directions; the right side of the liver is filled from the vena portæ, the left side by the umbilical vein. The liver of the fœtus, having two veins, has a large quantity of blood, a growth larger than that of any of the viscera; and indeed the liver alone seems to fill all the upper region of the abdomen. This is changed when the child is born; the umbilical circulation is cut off, and the liver of the child ceases to grow but in proportion to the other parts.

But what is most extraordinary is this, that the proper function of the liver is not performed while the fœtal circulation continues; and it is only when the blood of the umbilical vein is cut off by the tying of the cord, and when the venous blood comes slowly up from the vein of the membraneous viscera of the abdomen, to fill this extensive system, that the true and stimulating bile is formed in the liver.

FORAMEN OVALE.

(a) The ascending cava, with its hepatic branches (b b),—(c) the descending cava,—(d) the right auricle, where it lies against the roots of the aorta and of the pulmonic artery,—(i) the isthmus Vieussenii, as it is called, or circle which surrounds the oval hole,—(m) the valve of the foramen ovale,—(n) a small opening, which we always find towards its upper part,—(o) the opening towards the ventricle. This plan is intended chiefly for showing the true place of the foramen ovale.



The foramen ovale, which we have mentioned as one of the chief peculiarities of the fœtus, is a hole of no inconsiderable size, transmitting the blood freely from the right to the left side of the heart. Its use is obvious, even from a general view of the system; and when we look more closely into its mechanism, its uses are completely explained. Its valve being placed on the side of the left auricle, perfectly settles (and that by the only authentic proof) the course of its blood; and, satisfied with the description which I am now to give, I decline all disputes about the nature of this opening, or its valve. This is a subject which disputes may perplex, but cannot explain. Another reason which I have for declining such controversies is this: It is an easy matter to impose upon a whole academy, easier by far than upon one ingenious man; and thus it came to pass that in the French Academy each theorist brought dissections of the heart, and foramen ovale, suited to his own doctrines; each, when convenient, changed his ground a little, and brought new dissections; and thus valves and auricles, fœtal and adult hearts, double cats and human monsters, made their annual exhibitions in the halls of the French Academy; the Society never sickened nor tired, and the raree-show lasted exactly one hundred years.

What kind of doctrines were current at such a time it is almost superfluous to explain; yet I think it not amiss to remark two examples, of obduracy on the one hand, and of ingenuity on the other, in two of the greatest men. Mr. Mery had conceived notions about the circulation of blood in the fœtus which can hardly be explained*; but it was one point essential to his doctrine, that the blood in the fœtus moved directly from the left auricle to the right. He was forced to deny that the foramen ovale had a valve; and this doctrine he continued, with many quirks and tricks, to maintain to his dying day. Mr. Winslow agreed with Mery. He said, that the foramen ovale had no valve; that though it had a membrane, that membrane performed nothing of the office of a valve; that the blood passed freely from right to left, or from left to right, as occasion required; that thus the two auricles were as one. He forgot for a time that there is but little circulation in the fœtal lungs; that the right auricle is filled with all the blood of the body, while the left is filled very sparingly by the pulmonic veins. From these data it is plain, that the balance must always be in the favour of the right auricle; that it always must be more full of blood; that without some valve the blood must rush with a continual pressure from right to left; while again, the place of the valve is itself a demonstration that the blood cannot pass from left to right. Winslow, when he some years after perceived that he had spoken idly upon this subject, left Mr. Mery among his foolish arguments and dissections, and retracted all that he had written, with a manliness of spirit which deserves to be recorded.

The foramen ovale is not strictly oval, but is rather round. In the plan it appears oval, because there I have endeavoured to represent the condition of the vessels when the heart is dilated and the vessels full; but when we lay it out for demonstration or for drawing, it appears, as in the drawing, of a rounded shape.

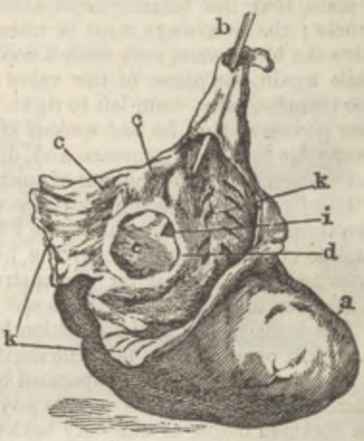
The ovale hole is in the partition betwixt the two auricles at its very backmost point; for, in fact, the auricles touch each other only behind: at their fore-part they are separated by the roots of the aorta and pulmonic artery, as may be seen in any of the plans. We look, then, for the foramen ovale at the very backmost part of the right auricle; or rather it is placed so high in the auricle as to seem to belong rather to the root of the cava descendens. A ring rises round the borders of the hole, very prominent. This was named ISTHMUS VIEUSSENII; but this conceited name of isthmus, Vieussens gave it, is quite unintelligible, and it must be changed for that of the CIRCULUS FORAMINIS OVALIS, the ring or circle of the oval hole. This circle is thick at its edges; very strongly muscular, like the musculi pectinati of the auricle; insomuch that

* All that can be done towards the explaining it in one word is this: He "fancied that the right cavity of the heart was so large and the left so small, that always the left side was obliged to disgorge again upon the right side; and this was the meaning of the blood rushing through the foramen ovale from the left side to the right."

authors of some character have thought this a sphincter for the oval hole. There is no doubt a kind of decussation of the fibres at each end of the ovale hole; so that these fibres, forming a sort of pillar on each side or edge of the foramen, the name of Pillars of the Ring, or COLUMNÆ FORAMINIS OVALIS, is less exceptionable; though these pillars, or any thing deserving such a name, will not be easily found by one beginning anatomy.

The valve of the oval hole lies entirely on the left side, as the round edges of the right side many demonstrate. By taking the blunt probe, we find we can lift it towards the left side; but being pushed towards the right side, it rises into a sort of bag, and opposes the probe. The valve is perfectly transparent; it seems delicate, like all the other membraneous valves, but is really strong. There is often left, after the closing of the valve, a small opening at its upper part. The valve closes soon after birth. The hole is so large, that this membrane forms a very large share of the partition betwixt the auricles; its transparency is such, compared with the rest of the walls, that it is as distinct in a body, or in an adult, as in a fœtus.

This is the anatomy of the oval hole, and of its valve; and this proves, and any one who examines it will entirely be convinced, that the blood of the fœtus passes through it from right to left.



This heart of a fœtus had all its parts cut away, except the ventricles (*a*)—the vena cava, with a blow-pipe in it (*b*)—and the wall or partition betwixt the auricles (*c c*), which is here unfolded to show the foramen ovale. The musculi pectinati, or muscular fibres of the auricle, are seen at (*k k*),—(*d*) is the annulus foraminis ovalis,—(*e*) is the valve itself,—(*i*) is the small opening in the upper part of the valve, where the valve falls slack, and ready to open.

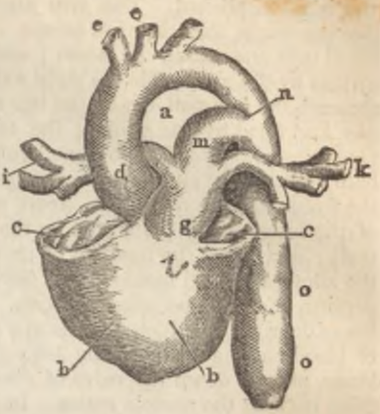
DUCTUS ARTERIOSUS.

The ductus arteriosus I have defined a great inosculation betwixt the pulmonic artery and the aorta; not for the purpose of conveying away that blood which should pass through the lungs, but for giving to the blood of the aorta the propelling power of both ventricles; and how well it is able to perform this office will be easily seen from the drawing on the margin.

The pulmonic artery of the adult divides, as has been marked in all my former plans, into two great arteries, one going to the right side another to the left; but in the fœtus there arises a middle branch be-

This sketch is taken from a little preparation made on purpose, where a quill was thrust in so strongly betwixt the ductus arteriosus and aorta, as to separate them unnaturally, and leave a space (*a*) betwixt them. (*b b*) Marks the two ventricles—(*c c*) the place from which the two auricles were cut away to make every thing clear,—(*d*) the root of the aorta, known by (*e e*) its branches,—(*g*) is the root of the pulmonic artery, (*i*) the right and (*k*) the left pulmonic arteries, —(*m*) the ductus arteriosus, or middle branch, running into the aorta,—(*n*) the place where they join,—(*o o*) the aorta increased in size by this addition.

N. B. This heart is but a very little under the natural size in a new-born child.



twixt these two. It is larger than both put together; it is in the middle, and so comes most directly from the heart; it goes in a straight line towards the aorta, and joins with it immediately below the arch. This is the ductus arteriosus, the centre branch of the three branches into which the pulmonic artery of the fœtus is divided. It is bigger than the aorta in the fœtus; it gives the full force of the right ventricle to the blood of the aorta, in addition to that of the left. In the adult it is so thoroughly obliterated, that by the most careful dissection we can show no other vestige of it than a cord-like adhesion of the aorta and pulmonic artery.*

These, then, are the chief peculiarities of the circulation in the fœtus†: but the conclusions which have been drawn from this mechanism are, as I suspect, very far wrong. But this I can in no shape prove, till I shall have first represented the real condition of the fœtal heart. First, then, let it be observed, that every drop of blood which comes into the system is, either by the powers of the placenta, or by communion with the mother's system, oxydated blood.—One part of this blood, indeed, passes through the circulation of the liver before it reaches the heart, while another passes more directly through the ductus venosus; but both are mixed, and the blood is all of one quality when it arrives at the auricle, in order to fill the heart, and to begin its course round the body. Now, since the blood is all of one quality, Nature could have no cause for dividing such blood into two portions; one to pass through the lungs, the other to pass over the body. She could have no motive for employing, as in the adult, two hearts. The design of Nature plainly is, to prepare a double heart, and keep it in reserve for the circulation of the adult, but to use it as a single heart in the fœtus. And see how simply

* For the other peculiarities of the fœtus, see the description of the intestines, of the kidney, of the thymus, and of the membrana pupilaris of the eye.

† The umbilical arteries must be explained in another place.

this is accomplished. The two auricles communicate so freely by the foramen ovale, that they are as one: the two ventricles both deliver their blood into one vessel, the aorta; and they are also as one. The blood arrives by the cavæ, fills the right auricle, and in the same moment fills, through the foramen ovale, the left auricle; so that the auricles are as one, and filled by one stroke; the two auricles act at once, and so the ventricles also are filled by one stroke; the aorta receives the blood of both ventricles at one stroke. So that, in the strictest sense of the word, the fœtus has but one single heart, the heart of the body (the function of the lungs being performed by the placenta, far from its proper system); and when the function of its own lungs begins, then Nature, by the simplest of all mechanisms, divides the two hearts, that they may perform each its peculiar function. First, the flow of blood into the lungs deprives the ductus arteriosus of blood; and, secondly, this flow of blood coming round to the left auricle of the heart, restores the balance, presses down the valve of the foramen ovale, and makes the partition betwixt the auricle entire. In short, while the oval hole and ductus arteriosus are open, it is a single heart; and when they close, as they do the moment the child is born, it becomes the double or perfect heart.

Now the mistake which all physiologists have fallen into is this:—They have not observed that no creature can live with a single heart, which has the oxydation of its blood performed by lungs. A fish lives by a single heart, because its blood is oxydated by gills, not by lungs: insects live with a single heart, as their lungs, or the branches of their lungs, are distributed like arteries over all their body: the fœtus can live with a single heart, because its blood is oxydated by the placenta. And that this idea may make a more determined impression, it will be good to prove, that the function of the placenta actually is equivalent to the function of the lungs; and that it is the placenta itself that produces this change upon the blood, I am the rather inclined to believe, because we see the veins and arteries of the chick spreading over the membranes of the egg, and we can observe the artery sending dark-coloured blood into these membranes, while the vein brings back florid or oxydated blood.

If, during child-labour, the umbilical cord falls down before the head of the child, at first it is not pressed but beats strongly, and the fœtus is felt struggling in the womb; but when, after a few pains, the head descends into the pelvis, the cord is pressed betwixt the head and pelvis, the pulse falters, ceases; the child ceases to stir in the womb; and if not born in a few minutes is irrecoverably dead, and is black in the face like one strangled or drowned. When a child comes with its feet or other parts of the body first, the head being last delivered, is difficultly delivered; the accoucheur struggles long in bringing out the head; the umbilical cord is compressed all the while, betwixt the child's head and the brim of the pelvis, and the child dies. Neither the ductus arteriosus nor the oval hole can save the child, for it dies because it is deprived of the function of the placenta, which is the fœtal lungs; and this is the cause why it appears, when born, like one suffocated or drowned.

When the child is born, the nurse lays it on her knee. The cord being uncut, you will observe that the one function declines exactly as the other strengthens; that if the child do not breathe freely, the cord will continue to beat steadily, the placenta still attached to the uterus continuing to perform the function of the lungs; that when the child begins to cry freely the pulse of the cord and the function of the placenta cease at once. If the child breathe freely, but yet do not cry, and you tie the cord, it is instantly forced to cry for a fuller breath; and if a rash person tie the cord prematurely, when the child neither cries nor breathes, he cuts off the function of the placenta before the function of the lungs is established, and often the child is lost: this, in the hurry and officiousness of ignorant women, happens every day. If even after two days the child's breathing be much interrupted by coughing, crying, or any spasmodic affection of the lungs, Nature seeks again the function of the placenta, and the pulse returns into the cord so as to raise it from the belly of the child. These things prove what the best physiologists have sometimes forgotten, that the fœtus has, in the function of the placenta, something equivalent to the function of the lungs.

One great mistake then runs through the whole of physiology. It has been universally believed that the free and easy transmission of the blood was the chief use of the lungs, as if they had acted like fanners to flap on the blood from the right to the left side of the heart. They affirmed, that either continued distension or continued collapse hindered the progress of the blood; and they also believed universally, that if but the ductus arteriosus or foramen ovale, or any thing, in short, were left open to let the blood pass, that person may live in spite of hanging, drowning, or suffocation of any kind.

This will be found to be the most perfect of all absurdities; and to allege such a thing against authors requires some kind of proof: it will suffice, if I prove it against a few of the most eminent. So much were the older authors wedded to this misapprehension of the dilatation of the lungs being useful only by driving forwards the blood, that, in the Parisian dissections, we find the following experiment made on purpose to prove the fact. "We have also made another experiment (say the Parisian dissectors) to know more distinctly the necessity of the motion of the lungs for the entire circulation of the blood. An injection being made by the right ventricle of the heart into the artery of the lungs of a dead dog, it happens, that if one continue to make the lungs rise and sink alternately by means of bellows put into his trachea, the liquor pushed into the artery does easily pass and go through the vein into the left auricle; but when one ceases to blow, it passes not but with a great deal of difficulty," (page 262.)—Which doctrine is dilated into its full absurdity in the next paragraph. "Having viewed the difference of structure in a tortoise and in a dog, it is easy to give some probable reason of the phenomena of these experiments; and the reason is, that it is necessary that these vessels shall be dilated for the receiving of the blood of the right ventricle of the heart, and that they may be afterwards compressed in expiration to press out the blood, and make it pass into the left ventricle." Swammerdam indeed says, concerning the Frog's lungs, that an artery goes over them, which has no other purpose but to nourish the lungs; and that it is of the nature of those called branchial arteries in Man. But the College of Dissectors have plunged still deeper into this remarkable blunder; for they say, (page 261), in speaking of the lungs of Newts, Frogs, and other creatures, which I have represented as having a pulmonic artery extremely small in proportion to their system, "that in such creatures the lungs have merely that quantity of blood passing through their substance which is necessary for their own particular nourishment;" which is saying, in the plainest terms, that they have lungs (only, I suppose, that they may be like other creatures), but their lungs are of no manner of use, except to nourish themselves.

One should have thought that the folly of this opinion would have appeared more striking in proportion to the earnestness of these arguments, and that no subsequent author would have deigned to honour such an opinion so far even as to notice it: but the celebrated Haller not only adopts this notion very fully, but enriches it with further explanations, saying, "that the vessels are all, during the contraction of the lungs, forced into numerous angles and joint-like folds; that the angles are made even, and the passages of the blood more direct upon the expansion of the lungs." As if the lungs folded and closed upon each other like the wings of a Butterfly or Beetle.* Santorini also represents the vessels of the lungs as thus collapsed, plaited, and folded a thousand various ways, "assaissé et replié de mille manieres differentes," &c. "One effect of expiration (says Haller) is so to compress all the arteries of the lungs, that they cannot receive the blood from the ventricle of the heart so freely as they are wont to do."†

"It must seem very strange for me, after saying that inflating the lungs restores an animal after apparent death, and recovers the drowned, to affirm that long continued respiration is fatal‡: and yet we need not look long for the cause of this; for during this long continued respiration much blood must be gathered in the lungs, but none can get out."§ Nothing is attributed, in his explanation, to the want of air, but all is attributed to the obstruction of the blood: yet if this were all, Amphibia would need no lungs, fishes would need no gills, insects could need no air-tubes; for none of these assist the motions of the heart. Monro, who puts Haller to rights in every thing else, follows him in this. "In all amphibious animals, therefore," says Monro, "every part of the body may receive a considerable portion of blood, although the respiration and free passage of the blood through their lungs be interrupted," (p. 21.) &c.

* "Præterea, in vivo animali, cujus cor contrahitur, et in arterias pulmonales sanguinem data vi emittit, omnino nunc sanguis in eas arterias facilius, atque adeo celerius irrumpit, postquam deletus retardatricibus plicis, recta nunc sunt."

† "Verum alter effectus expirationis est utique pulmonis arterias ita comprimere, ut ne pari facilitate sanguinem a suo cordis ventriculo recipiant."

‡ "Paradoxum videri possit, ab inspiratione sanguinis in pulmonem commeatum expediri: inflato etiam aëre, quod genus est magnæ inspirationis, animalia moribunda reviviscere, et sanguinis per pulmones iter revocari: et tamen hanc eandem, adeo faventem sanguinis per pulmonem motui inspirationem, sola paulo diuturniori continuatione, anxietatem primo incredibilem facere, deinde, si vel voluntatis violento imperio tamen aer in pulmone retineatur, vel ab alia causa intra pulmonem copiosior servetur, denique sanissimum et fortissimum hominem subito interire."

§ "Hujus nunc anxietatis et suffocationis, et denique mortis causam non est arduum invenire. Adparet enim, ab inspiratione diutius continuata, sanguinem in pulmonem quidem advenire, et congeri, exitum vero ex pulmone non invenire."

And the celebrated Blumenbach, the man most admired on the continent for his Physiology, says, at p. 80. "Post extremam respirationem redeunti per venas cavas sanguini vias ueta in pulmones nunc collapsos præcludatur."*

Thus it has been the opinion down to the present day, that the collapse or over distension of the lungs are both equally opposite to the easy passage of the blood: but instead of going round about the matter, as some lesser authors have done, I like rather the manner of the Reverend Dr. Hales, who says, plumply, "that suffocation consists in the falling flat of the lungs." (p. 271.)

Now, the condition of the human lungs is quite opposite to all this; and also (in respect of distension) is less different from the lungs of reptiles than it is easy for any one bred up in the old doctrines to conceive.

In expiration the lungs do not collapse in any sensible degree. Let us take for our data the common calculations concerning the quantity of air in the lungs, and let us see what they will do towards proving this opinion.† The lungs are supposed to contain at the time of their utmost fulness about 330 cubic inches of air. When we continue breathing in a natural and easy way, we draw in and expel alternately about 40 cubic inches of air; but when we choose to force respiration, we find that we can expel without danger or harm 170 inches more; we can expel 210 inches of air, leaving only 120 inches remaining in the lungs. Now, let us for a moment observe how little danger or distress it occasions when a forced respiration is made—such as is used in coughing, laughing, speaking, crying, expelling the child, urine, or fæces, bracing up the body for the lifting of heavy weights, or other violent occasions, for which such forced respirations are by nature reserved. Let us notice how much forced respiration exceeds the ordinary respiration, and how small a proportion the quantity of an ordinary breathing, viz. 40, bears to 330, the whole quantity of air within the lungs. Reflecting thus what large inspirations of air we may take, and how very little we do take, we begin to perceive how gentle the motion of the lungs must be.

There remains always within the lungs a great mass of air, which I will call the permanent dilatation of the lungs, which, from the first movements of the child, from the hour of birth till death, and even after death, must remain in the lungs. This mass, equal to 330, cannot be entirely breathed out; even the utmost force of respiration expels but the half: this is never done but on extraordinary and most urgent occasions, which do indeed disturb the circulation; as coughing, laughing, crying, or running do. And here we may stop an instant to admire one happy effect of this provision; if in ordinary breathing we had emptied the lungs, we should have been continually subject to suffocation; whereas when any thing irritates to cause coughing, we can by extraordinary effort expel an additional quantity of air, and, by cough-

* Mr. Keate, one of the latest writers on the recovery of drowned persons, has the same notion. "We inflate and empty the lungs (says he), in order by their expansion and contraction to FORCE the blood across from the right to the left side of the heart."—And he expresses himself as perfectly indifferent what kind of air be used, foul or pure is all one.

† See a pamphlet on the Connection of Life with Respiration, by Dr. Goodwyn, published in 1788; and Menzies on Respiration.

ing or sneezing, remove the cause of irritation. If there had not been at all times of ordinary breathing a large portion of air in the lungs, we must have inspired, and have drawn in the irritating body instead of expelling it. But this great mass of air in the lungs is seldom so moved; it is regularly and gently agitated by the change of 40 parts of the 330, which we expire and draw in again at each breath; we do not empty and fill the lungs at each breath: there is, on the contrary, a permanent expansion of the lungs, and a mass of air always in them; there is along with this a gentle and regular agitation; and there is changed at each respiration a small proportion of this mass of air. Our lungs are little different (in respect of distension) from those of Amphibia: for their lungs also, a I have described in the Frog, are permanently expanded, and at each resp tion a little dilated and contracted; the air a little changed, a little moved, a little renewed; the change is in both cases placid and gentle, and hardly to be perceived.

With these opinions concerning the state of our lungs, nothing can appear to me more coarse than the notion of their being entirely filled and emptied at each breath; nothing more ignorant than the supposing them to fall flat, as Hales expresses it, so as to hinder the motion of the blood: and the grossness of this opinion appears in its true light when I put down this last proof, viz. that for each act of respiration there are four pulses of the artery, or four strokes of the heart. Is it not plain, then, to the meanest apprehension, that if the blood moves twice through the lungs in expiration, and twice during inspiration, or, in other words, if there be four strokes of the artery for each respiration, and if each of the four pulses be equally strong, that the blood passes through the lungs in all states and conditions with equal ease?*

It is also universally believed, and it is indeed a most legitimate conclusion, from this doctrine of the collapse of the lungs hindering the passage of the blood, that if but the foramen ovale or any passage be left open to let through the blood, that person will live without breathing.

It has been affirmed, that the Seal, the Beaver, the Otter, have the foramen ovale open. In the Seal, the Parisian dissectors found the oval hole open as in a child; but when they came to the foramen ovale of the Beaver and Otter, they found them, and sore against their will, quite close. In their disappointment they could have said any thing; but all that they thought prudent to say was, that the Beaver had not been in the water for a long while, not even to refresh himself†, and the Otter had been close penned up in his hut at Versailles; and so the foramen ovale had closed in these poor beasts quite close; and behold they were no longer Otters and Beavers, but little better than dogs.‡ Although

* Their old and favourite experiment, so often repeated by Hooke, Croone, and others, before our Royal Society, viz. of blowing up the lungs of a dog, and then compressing them, is good for nothing: for there the thorax is cut clean away; the permanent distension of the lungs is entirely lost; and then, no doubt, there is such a collapse of the lungs, as may, or rather must, hinder respiration; for the lungs are alternately distended to the greatest degree, and then emptied as completely.

† The Beaver sits in his hut just up to the hips in the water, and builds his hut so that he may sit just up to the hips.

‡ "Cette ouverture, qu'on appelle le trou ovalaire dans le fœtus, fait l'anastomose par le moyen de laquelle le sang va de la veine cave dans l'aorte sans passer au travers

Haller* declares that he had found the foramen ovale open in a man who was hanged; though Rœderer, Cheselden, and many creditable witnesses, have testified the same; still there has gone along with these confused doctrines about the foramen ovale a kind of dream, (like that concerning the transfusion of the blood,) that if but the foramen ovale could be preserved open, Man might even be made an amphibious creature. At first this notion began to peep through the mists of this doctrine; and you might find an author, when he had dissected a person with the foramen ovale open, insinuating by oblique notions, what a vast pity it was that the man had not known, during his life, how kind nature had been to him, and what a perfect diver he was! while another says plainly, on a like occasion, "What a pity it was that this child did not live!" we should have seen almost an amphibious human animal, at least a most notable diver.† On this slender ground they told the most wonderful tales, among which Pechlinus's story of the Tronningholm gardener is one of the prettiest. "The ice having broken, the gardener, in trying to help out some others, as frequently happens, slipt in himself into a place full eighteen yards deep. There he no sooner touched the bottom, than he felt as if you had clapt a plaster over his mouth; his feet stuck fast, his body became rigid, and he stood there as stiff as a stake, with no one of his senses about him, except only that he thought he heard all the while the Stockholm bells ringing most pleasantly; and there he stood for sixteen hours, the folks seeking him up and down, and wondering where he could be: at last having found him, they hooked him out with a pole; and after much warming, and rubbing, and working, and giving him hot drinks, they got his blood to circulate, and brought him to life again. He had sense enough, however, he said, to feel their hook; and, indeed, they had angled so ill, that his head was all bruised, and he had terrible headachs: but, however, the Queen-Mother gave him a good pension, and he was sixty-five years of age when Pechlinus wrote." This is one of the many stories of men preserved by the foramen ovale not having been shut. At first, I say, this opinion began to peep out in hints and reflections; then it strengthened into wonderful tales of people being recovered who had been under the water six days; till at last a great genius undertook to make water-whelps upon a new principle, viz. with the foramen ovale open. This great genius was the Count de Buffon. And a very celebrated author of our own country, Dr. Beddoes, forgetting, perhaps, how successful Buffon is, tells us, (page 41.) that "by frequent immersion in water the association betwixt the heart and lungs might perhaps be dissolved, and an animal be inured to live commodiously under water for any time."

Let us move just a step backwards in this new trade of making am-

du poumon; et c'est apparemment pour une même usage que ce passage se trouve dans le veau marin que dans le fœtus, à cause du besoin que l'un et l'autre ont de se passer de la respiration, sçavoir le veau marin pendant qu'il est plongé dans l'eau, et le fœtus pendant qu'il est dans le ventre de sa mère, où il est certain que les anastamoses servent à décharger le poumon de l'abondance du sang qui le suffoqueroit."—Vid. *Acad. des Sciences*, anno 1699, page 149.

* Vol. ii. part ii. p. 11.

† Mr. Chemineau says, "On auroit vue avec étonnement un Homme presque amphibie comme la Tortuë." Page 38.

phibious animals, and observe how the celebrated Buffon succeeded. "I procured a pregnant bitch (says Buffon) of the large greyhound kind: and when just about to litter, I fixed her so in a bucket full of warm water that her hinder parts were entirely covered. In this situation she brought forth three puppies; which, after being disengaged from their membranes, were immersed in a fluid nearly of an equal temperature with that of the amnios. After assisting the mother, and washing the puppies in this water, I suddenly removed them into a pail of warm milk, without allowing them time to respire. I put them into the milk in preference to the water, that they might have an opportunity of taking some food, if they found a desire for it. I kept them immersed in the milk for more than half an hour; and when taken out of it, all the three were alive. They began to breathe, and they discharged a quantity of fluid matter by the mouth. I allowed them to respire about half an hour, and again immersed them in the warm milk, where they remained another half hour. I then took them out; two of them were still vigorous, but the third seemed to languish: I therefore ordered it to be carried to the mother; which, besides the three brought forth in the water, had littered other six in the natural manner. The puppy which was born in the water and had continued one half hour in warm milk before it was allowed to breathe, and another half hour after it had respired, seemed to be very little incommoded; for it soon recovered, and was as active and lively as those which had received no injury. Of the six that were brought forth in the air, I threw away four: so that there remained only two with the mother, beside the one that had been littered in the water. I continued my experiments upon the other two which had been twice immersed in the milk: after allowing them to breathe about half an hour, I plunged them a third time into the milk, where they remained another half hour. Whether they swallowed any of the milk I could not determine; but when removed, they appeared to be nearly as vigorous as before their immersion."—"I pushed these trials no farther: but I learned enough to convince me, that respiration is not so indispensably necessary to the existence of a new-born animal as to an adult; and that by employing certain precautions, it is, perhaps, possible to keep the foramen ovale open, and by this means produce excellent divers, or a species of amphibious animals, which would be able to live equally in air or in water."

I cannot pay Mr. Buffon the compliment of thinking that he was deceived in so simple an affair as this; it was not the foramen ovale that he was to keep open, if he wanted to make Amphibia; but, since the function of the placenta was just cut off in these whelps, and since he did not allow them the office of the lungs, he was to seek for some other third function, which could stand in place of the functions of the placenta and lungs; and since no such function has yet been observed, I judge from all the principles which I have laid down, that Mr. Buffon was conscious that he had succeeded in no degree; and that he could no more have converted them into amphibious animals, than he could have made them what they were, viz. plain whelps. "Sed quis fallat omnisciam, ut sic loquar, naturam? Illa non colludit nostris erroribus, et quod ignorantia celaverat suo detegit tempore." Yet there is a peculiarity in the system of young animals, which, if it does not make them less dependent on the exercise of the lungs, does, at least in children, make them bear with defects of structure which prove destructive to more advanced life. By the function of the lungs, as we have stated, the heat of the body is preserved. Now the child in utero suffers no expenditure of heat; and this is one reason why the placenta and the provisions of the circulation of the fœtus do not furnish so perfect an apparatus of oxygenation as the lungs and adult heart; and so we shall find that when the child after birth suffers from some malformation by which it is imperfectly suited to its new condition, laying it in tepid water, as it were restoring it to its former condition, is the most powerful means of diminishing the intensity of the paroxysm.—This will be illustrated under the following head.

OF MALCONFORMATIONS OF THE HEART, AND OTHER CAUSES, PREVENTING THE DUE OXYDATION OF THE BLOOD.

We are at no period of life, from the cradle to the grave, exempted from those diseases which prevent the due oxydation of the blood. They often are born with us; they often overtake us when advanced in life; they cause an anxiety and misery, which exceeds all other distress; pain and suffering of every other kind humanity can bear, but the feeling of instant dissolution is what the noblest mind sinks under. We know by the pale and subsiding countenance how awful the inward feelings are, and woe be to him who has not feeling enough to sympathise with this distress, and an anxious desire to understand the cause, and to alleviate the misery of inward diseases which he cannot cure!

These are seducing motives, and might of themselves have drawn me on to give this slight sketch of the malconformations and diseases of the heart: but I feel also the stronger motives of duty and necessity; for truly, without some knowledge of the ill organized, irregular, and diseased heart, the structure and functions of the heart in its sounder state would be but poorly understood. This sketch, then, is the last part of this anatomy of the heart.

While the following history serves to correct our notions of the mechanism of the heart, we must also observe how it explains and illustrates up to a much higher point the combined functions of the heart and lungs, viz. the oxydation of the blood. Perhaps nothing can better explain the effects of a full and healthy oxydation, than a sparing oxydation of the blood, such as produces disease.

The fœtus alone can live with its single heart; it lives in the womb by its having a heart different from that of an adult. A fœtus, then, being born, cannot live with that heart which served it in the womb; and Nature, as I have explained already, divides the single heart, that is to say, closes the communication betwixt the right and the left side, and there is then a heart for the lungs and a heart for the body. But if any fault in the organization prevent this separation of the heart; if the foramen ovale be preserved open; or if there should be any hole in the septum betwixt the ventricles of the heart; if the pulmonic artery do not admit the blood, now that the child is born, and should breathe the air; if the aorta arise from the right ventricle, so as to carry off all the blood from the lungs; or if the aorta be so displaced, that its mouth stands in part over both ventricles, so as to receive the blood of both—then the organization, movements, and functions of the heart are all wrong; no blood passes into the lungs, the child cannot live; it either dies immediately in convulsive struggles, or lives in misery but a few years.

It is not in this rapid enumeration that these varieties of malconformation can be understood, nor yet do they deserve to be minutely detailed. I shall keep the middle path; and those of my readers will easily follow me who have studied the mechanism of the heart: concerning which this subject will recal to their memory all the important facts.

The most usual of all these disorders of the heart is some fault in the pulmonic artery, or some defect in the state of the great vessels in their origin from the cavities of the heart; and that disorder again is fruitful of others; for if the pulmonic artery cannot receive its blood, the foramen ovale cannot close: then the blood cannot circulate nor pass into the lungs when they first expand; then the office of the right heart is taken away, it has no power but to drive the blood with struggles through the foramen ovale into the left heart; the left heart then drives this blood, unoxydated as it is, into the aorta: the heart is now a single heart; it is the left heart alone that receives or circulates the blood: either it labours but for a few pulses, and then the child, after a convulsive struggle, expires; or there is some degree of opening in the pulmonic artery, a little blood passes through it into the lungs; the child is by that enabled to struggle with its convulsive pangs for eight or ten days, and then expires.

Such a scene the celebrated Dr. Hunter once witnessed; and there was, I perceive, in that heart a peculiarity very much to be admired. The chief fault was in the pulmonic artery, which was contracted into a solid substance or cord absolutely and completely impervious, so that the lungs had never received one drop of blood by the pulmonic artery. And here I must stop to notice one thing which I have always suspected, and which this dissection proves, viz. that though it is natural to believe, and the best physiologists suppose it, that some blood, as much at least as to support the form of the pulmonic vessels, passes through the fœtal lungs; yet here is direct proof that a well-nourished child may be born capable of breathing, and in which the pulmonic vessels are all free except at the heart, in which not one drop of blood ever passed into the pulmonic circulation. But chiefly it is to be observed, that this child, with its pulmonic artery, quite impervious, could not have struggled a single day, far less ten days, without some proportion of oxydated blood! and accordingly we find that it had a small portion, just such as supported life for a few days; which small proportion it obtained thus: The blood went to be oxydated, not from the right ventricle into the pulmonic artery, but from the left ventricle into the aorta; from thence into the ductus arteriosus; and then, by a retrograde course, backwards through the lungs; and then by the pulmonic veins it was returned oxydated into the left side of the heart, from whence it came. This child accordingly lived a few days, and could not live longer; because this difficult circulation was continually accumulating a quantity of black blood in the right side of the heart.

This child, then, had a heart resembling that of the Newt or Frog; for the pulmonic artery was closed, and the right heart of no value; the left heart pushed its blood into the aorta, and the aorta, as we may express it, sent a side branch into the lungs. In this first instance, then of malconformation, the child could not live, because it wanted the pulmonary artery, and of course the office of the right ventricle; it had but a single heart.

Next to this disorder of the pulmonic artery, viz. being obliterated or being closed, is this: That the aorta, in place of arising distinctly either from the right or from the left ventricle, is so placed, that its root stands directly over the septum ventriculorum, or partition of the ventricles; that the partition is perforated with a large hole, opening a very free passage from side to side; and that the heart being cut up, we find, upon thrusting down the finger into the aorta, that it passes with equal ease into the right or into the left side of the heart.*

In this conformation of the heart, the single heart appears again in a new form, and the office of the right or pulmonic side of the heart is well nigh annihilated. First, The pulmonic artery is small, sometimes almost close: Secondly, The aorta, arising as well from the right as from the left ventricle, carries off one half of that blood which should be circulated through the lungs: And, lastly, That blood, small as it is in quantity, which has passed through the lungs, is brought round to the left side of the heart; but the left side is not as it should be, close, to keep this purer blood for the circulation of the body, but it is mixed with the blood of the right side, through the perforated septum; so that its virtues, as oxydated blood, are diluted or almost lost.

If the pulmonic artery were unaffected, and the aorta placed equally over both ventricles, then the one half exactly of that blood which should be oxydated would undergo the change. But in all these malconformations, the root of the pulmonic artery also is in fault; it is narrow; it is so small, that at first opening such a body it alone attracts the eye; its mouth is sometimes so beset with a sort of fleshy granulous papillæ, that there is hardly left opening enough to pass a silver probe. The degree of contraction in the pulmonic artery is the true measure of all the oxydated blood which that system can receive; but in such a system the quantity is still farther reduced by various accidents of the organization. Thus, for example, — The pulmonic artery, is, we shall suppose, but one third of its natural size, and the original quantity of oxydated blood is proportionably small;—next, the foramen ovale, being open, carries off much blood towards the left auricle; the aorta, planted over the right ventricle, carries off also much blood. But let us suppose, that still as much remains as to fill the pulmonic artery to its full: when the pure blood comes round to the left side, it is mixed through the foramen ovale, and through the breach of the septum, with a quantity of black blood, which is continually accumulating upon it; and the small quantity of oxydated blood is, if I may use the expression, drowned in the general mass.

That I may explain the point of its accumulating a little farther, let me repeat, that even in a child which has died on the tenth day of such

* This is by far the most common defect or malformation of the heart.

a disorder, the heart is crammed with dark-coloured blood: that in those children which have lived two or three years under such a distress, the heart has been greatly enlarged: that in a boy dissected by Sandifort, who died at fifteen, the thing that was first seen upon opening the body was, not the lungs covering the heart and lapping over it, but a large mass, lying betwixt the lungs, oppressing them and pushing them aside in every direction. This was the pericardium covering a heart of enormous size, filling the thorax, and reaching almost to the first rib: very little of the right lobe of the lungs, and none almost of the left, was to be seen; the veins in the upper part of the thorax, viz. the subclavian and jugulars, were choked by the pressure, and much distended; the heart itself was full of blood, and the coronary veins so turgid, that it resembled a most minute and beautiful injection of the heart.

But it is most of all singular, that this heart was so enlarged, that the great veins, (which are indeed as reservoirs for the right side of the heart,) and especially the upper cava, dilated along with it in such a degree that there was felt distinctly a pulsation in the neck by a sort of back stroke every time the heart beat.

Still a child, even with a heart so ill organized, may struggle through all the weakness and all the diseases of childhood* for a few years, but they are years of complete misery; and still, as is proved by much sad experience, the boy cannot live, but must die.

Another conformation, the strangest of all, is that in which new parts are added to the circulating system, as if with design to make it resemble the heart of an amphibious creature; for it happens, sometimes, that there is as it were a third heart interposed. For example, the two venæ cavæ end in the right auricle, the pulmonic veins enter into the left auricle, and the right and left ventricles receive their blood from their auricles in the usual way; yet the right ventricle sends out no pulmonary artery, the left ventricle sends out no aorta: but both of them pour their blood into a middle ventricle, and the arteries go out from it: and here, as the blood is fairly delivered by both ventricles into this third ventricle, and as the pulmonic artery and aorta both arise from it, there is, of course, a fair division of the blood: and of the quantity which should be oxydated, exactly one-half undergoes that change. This is somewhat like the heart of the Turtle: it is plainly the structure of an amphibious heart, a single heart; for though there be three cavities, yet are they single in their function: it is a single heart with half oxydated blood. Such a heart is sufficient for Amphibia, or for the fœtus; but not for a child, which must breathe and have a double heart.

These are a few of the varieties of the imperfect heart; but the sufferings of children who are born with these imperfections, the marks of imperfect oxydation, and the manner of their life and death, was a chief motive for entering on this subject.

When the heart is so imperfect that the child lives but a few days, its sufferings are slight, and not lingering, so that we cannot mark them: they are not explained to us by any account of its inward feelings:

* Sandifort attended a puer cœruleus, who, in addition to his chief disease, passed through the small-pox and measles safely, and attained the age of fifteen.

They are all accumulated into one terrible struggle, in which we see the worst marks of ill oxydated blood.

The child is born well and healthy, it cries and draws its breath, it is removed from the mother; the function of the placenta ceases, but there is no other to succeed it; the child turns black in the face, struggles for breath, and is convulsed; and without any apparent cause it seems in the agonies of death: but yet it lives, it becomes black all over the body; the blackness never goes off except when it changes sometimes into a deadly ash colour. The child continues for a few days labouring under almost unceasing convulsions, which growing gradually weaker, it at last expires; and while it lives, the heart palpitates; sometimes it throbs so, that it can be distinguished at a distance by the eye. Dr. Hunter, in the child which I have already mentioned, laid his hand upon the breast, and the throbbing which he felt there was terrible to him.

When the child has the heart so formed as to admit into the lungs even a very small proportion of blood, it struggles through the first years of life, and its protracted sufferings can be more easily observed. Then no mark of ill oxydated blood is wanting; every thing is the reverse of health, or the natural appearance flushed and florid of a growing child; its colour is always dark, its motions languid and powerless; it is cold, so that the parents must keep it carefully wrapped in flannels and furs to preserve any thing of vital heat; its breathing is difficult and distressed; fits come upon it at times; and if the child has begun to walk, the least hurry, or fear, or quick step, even walking across the room, brings a return of the fit: in which the extremities are deadly cold, the face black, the breathing one continued struggle, and the end of the fit is the obtaining of a degree of relief, which happens in a most singular way.

The coldness, the livor, the languor, the fainting, the struggle for free breathing, are all marks of ill oxydated blood. The convulsive paroxysm is a sure consequence of the want of stimulus and force, and of blood accumulating on the right side of the heart. If, then, the child fall down in this paroxysm, it is the very surest proof that ordinary respiration will not save him from the struggle: if during the fit he breathe so that he recovers, and that presently his strength, colour, sprits, every thing, is in a degree restored; then it is plain that the respiration during the fit, imperfect as it appears to us, is really more effectual than ordinary respiration.

When we observe which is the most natural way of obtaining relief, and notice the very peculiar manner in which these children breathe, we shall understand why they are breathing best when we believe they are hardly getting breath, and how they are recovering slowly when we think them labouring in the greatest danger. The child, feeling the growing oppression at its breast, if it be young, signifies a desire to be turned upon its face; if not indulged, it contrives to turn itself that way before its hard struggle begins. When the child begins to breathe hard, it drives out the air with a sudden exertion, and apparent pain; he remains longer without respiration than an adult could do; his expirations are attended with a sort of scream. What can this way of breathing mean?

To my apprehension it implies that kind of breathing which I have called forced respiration, and no other plainly can serve.

The ordinary respiration, by which we draw in 40 cubic inches of air, has failed; the fit is approaching, because that quantity of air will not suffice. However rapidly the child breathes, however rapidly the heart palpitates, it will not do, because there are but 40 inches of pure air mixed with the whole of that great mass which remains always in the lungs. Then the child, driven by instinct, provides for the fullest respiration: it turns upon its face, that the weight may help to compress the thorax; it forces with all its power, and seems to cease from breathing, and refrains a long while in that state, because it is emptying and compressing the lungs. Then its purpose is accomplished; the lungs are more emptied than in ordinary respiration; it draws in the largest draught of air, utters a sort of scream, seems quiet again: and again, by pressing its breast, and by contortions (convulsive like) of its body, it empties its lungs at a distant interval, and receives again the fullest draught of air. It is this forced respiration that brings into the lungs 170 cubic inches of air (if we were speaking of the adult) more than the usual respiration does. This, then, is four times more effectual than ordinary breathing. And when a boy grown up to those years in which he knows the warnings of his disorder, and has found out this relief,—when such a boy, by pressing upon the corner of a table, or by throwing himself upon the ground, prevents or alleviates his paroxysms,—in what way can it be but by practising for a time this deeper respiration, pressing the chest, forcing and compressing the lungs beyond their usual degree of collapse, and so obtaining a fuller draught, a draught of 170 inches of air, to be mixed with the 120 inches which must always remain in the lungs?

After half an hour of a kind of breathing most awful to behold, but much more effectual than common breathing, the child recovers slowly. The boy, when advanced a few years, knows how to prevent the fit; but the child of two or three years old knows only how to struggle with it: yet this struggle being a more effectual breathing, the child is relieved at once from an anxiety, and oppression, and throbbing, which precedes the fit for many days; the languor goes off, the heat in some degree returns, and the lips acquire a vermilion colour, and the skin a higher tint, which last for many hours after the fit is gone.

In those children, again, which have the heart so formed that they may live, not two or three years only, but to the age of 15 years, it naturally happens that the symptoms follow each other in their course very slowly; and the ill oxydation of the blood in this its slower progress it is very curious to observe.

There is one thing in the economy of the fœtus very singular—the child, the chick, the fœtus of every kind, need less of this principle of oxygen: the fœtus lives (if this be so) like an amphibious creature; perhaps it has little oxydated blood; yet being totally deprived of that little, it soon dies. Perhaps the fœtus, living the life of an amphibious creature, is not without some of that peculiar tenacity of life which characterises that class; for the struggles and sufferings which a weakly infant endures, before it parts with life, are matter of observation even among the vulgar. Another circumstance is obvious from our preceding account of respiration. The office of the heart, lungs, and circulation, has among other functions to produce heat. But the fœtus still in the mother's womb cannot expend heat, and therefore cannot require its generation. Independent of other offices requiring a more perfect circulation (and when I say circulation, I include respiration, which is in a manner a part of it), the child visiting the light, and living in an atmosphere colder than its body, requires to generate heat. Here is one cause of the violence of these paroxysms, when the apparatus of circulation and respiration are imperfect. And this is the reason that immersing the child in warm water is one of the most effectual ways of relieving the fit.

But to return to our first position, it would appear that children have a greater degree of tenacity of life, or are capable of struggling against the defects of respiration. For this reason, I believe, it is that children, having a heart so ill arranged that absolutely they cannot live beyond years of puberty, yet during the first year feel no complaint, and seem thriving and healthy; the vegetating life of a sucking child saves it from all dangers of hurried respiration and rapid pulse.—But when it leaves the breast; when it begins to stir and move; when its blood moving languidly, begins slowly to accumulate at its heart; when the properties of its living fibres change so as to require a fuller supply of oxygen from the blood—then the unhealthy colour, languor, palpitations, slighter fits, and all the marks of its disease, begin; and often its colour gradually changes, and it becomes the puer cœruleus, or livid child, before we can perceive by any other marks how dangerous a condition it is in.

In one child* the first year had elapsed before the very slightest of those complaints came on, which ended in death at a very distant period of fifteen years. At first, its finger-nails were observed to be livid, yet not continually; the colour varied, but still the nails were unnaturally livid, so as to alarm and surprise the parents: but there was as yet no reason to desire advice. The child seemed healthy, began to use its legs, and in the second year it walked alone.—Next, it happened that one day, after being forced to take a medicine, not without some resistance, his face was on the following day freckled with red spots, which soon changed to a livid hue. Now the lassitude and chillness came on; motion or exercise was more and more oppressive to the boy; till at last, when he fatigued or hurried himself, the hands and feet became livid, the mouth and tongue became almost black, and last of all, those fits came on in which the whole body becomes livid or black.

This is the progress of this darker colour of the body; but his other complaints also advanced with a very slow and regular pace. He increased in stature; his appetite was good; he complained of great lassitude; of head-ach, with a sort of gravitating pain; of anxieties, especially during the winter months; and of such extreme coldness, that neither fire in winter nor summer's sun could warm him: he never felt heat except when just wrapt up and newly laid in bed.

Now the blood began to accumulate; the struggles of the heart began; and so terrible were the throbbings of his heart at times, that they might be seen, or even heard. Actual faintings succeeded; the poor

* Vide Sandifort.

boy, now eleven years of age, knew that he was to die; he said, that "no one could know or cure his illness, and that no one could imagine what feelings he had here at his heart."

Motion was now quite impossible; upon the slightest effort saliva flowed from his mouth, a fainting fit ensued, and he continued for a little while blind. All that he was wont to delight in was now indifferent to him; he could not move; his face was turgid, his eyes prominent, his feet were swelled with an œdema, his eyes dead and heavy, expressive of some inward distress; when he was put to bed his anxieties were very great, and thus he died a slow and miserable death. A case nearly similar to this occurred very lately, and the preparation was added to the collection now in the possession of the College of Surgeons of Edinburgh. The whole sufferings of the child had been attributed to the effects arising from the sudden death of its grandmother, while the child was asleep in the same bed; yet the condition of the heart showed evidently that the cause was of a permanent nature, and must have been from birth. And here we have another instance, that as the constitution advances, it is more influenced by the privation arising from malformations.

Sometimes a child wants spirit or strength to strive against the lassitude of this disease. A girl under Vasalva's care lived to her fifteenth year; but from her infancy, from her very birth, she had lain in bed, partly on account of sickness, but chiefly on account of extreme weakness. She had a short and difficult breathing, and her skin was tinged all over with a livid colour; her quiet state saved her from the suffocating paroxysms; but her heart was just like all the others, the foramen ovale open, and the pulmonic artery closed.

These, then, are the marks of imperfectly oxydated blood: a livid colour, coldness which nothing can remove, oppression and anxiety of the breast, palpitations and difficult breathing; and when the blood is by passion or motion hurried too fast towards the right side of the heart, then come fits, which last a longer or shorter time in proportion as they have been long delayed, and which end in death. And, last of all, I would rank among these consequences an imperfect nourishment; for all the boys have been small, most of them particularly slender; and one boy especially, of fifteen years of age, is mentioned by Dr. Hunter, who, in respect of tallness, was just what you should expect at his years, but slender to a wonderful degree; not as if wasted by consumption, but as if by natural habit. His form was quite surprising, so that Hunter could give no idea of his shape, otherwise than by comparing his body with that of a Greyhound; and his legs, he says, put him in mind of those of a Crane, or some tall water-fowl.

When we see the effect of this insufficient supply of that for which the lungs are provided, we cannot but reflect on the idea of Mr. Cline, that in animals the capacity of the chest is the measure of their strength, and their power of receiving nourishment. A fact illustrated by the opinion of the grazier or the horse jockey.

SIMILAR CONSEQUENCES FROM MALCONFORMATION OF THE LUNGS, AND FROM THEIR DISEASED CONDITION.

The consequences must be alike, whether it be that the heart sends no blood towards the lungs, or that the lungs cannot receive that blood; and the malconformations of the heart are hardly more frequent than those of the lungs; and both, we may be well assured, are infinitely more frequent than we suppose; especially when we observe how many children die suddenly, discoloured, and in convulsions; and how many of those advanced in years have lived very miserable with complaints in the breast.

A young man of twenty-four years of age, by birth a Pole, and at the time of his death a soldier in the German service, had been continually oppressed from his cradle upwards with difficult breathing and anxieties at his breast. He had been three or four times relieved from slighter complaints of the breast; but at last the bleedings and demulcent medicines failed: he lay ill in the military hospital two months, where of course his complaints were correctly known. He had none but the slighter degrees of difficult breathing; when one day sitting up in bed he suddenly expired. Being opened, the right side of the lungs was found to be totally wanting; not destroyed by disease, as we have often seen, not oppressed by water, nor eroded by pus, but entirely wanting; a peculiarity which he had from his mother's womb, for it was attended with a peculiar arrangement of the vessels. On the right side there was no vestige of the lungs, not even the smallest button to mark where they might have been; there was no branch of the trachea for the right lobe intended by Nature, but both the legs of the trachea plunged into the left lung, which was large: there was no forking of the pulmonary artery to give a branch to the right side, but the whole trunk of the pulmonic artery plunged into the left lung.

But if one should suspect that there might have been once a right branch, the lungs destroyed, and the mouths curiously united by that coagulable lymph which the membranes of the viscera, and the pleura especially, throw out when inflamed, there are still other cases which must remove all our doubts, especially that of a young man*, who died in a very lingering way, and in whom, before his death, there was plainly perceived, along with his slight anxieties, a pulsation in the right side of the breast. Upon opening his body, there was found in the left side neither lungs nor heart; nor, upon the most careful examination (seeking for the wasted lung), could there be found the smallest remains of lungs, bronchia, pulmonic arteries, or the slightest evidence that any such parts had ever been. But the surest proof of this remains behind, for the heart stood in the right side of the chest; it stood perpendicularly, quite upright like a dog's; it gave out a right pulmonic artery, but there was not even the smallest vestige of any artery having been appointed for the left lobe. We must not say, but that his chest may have been full enough of lungs and heart, and he may have had a well oxydated blood; in which case, it was no very dangerous derange-

* Under the care of Dr. Heberden.

ment that his lungs were all on the right side, more than if his liver had been on the left. But let us notice that the aorta was extremely small; the diameter of the aorta is the true measure of the blood which is received from the lungs. Where the aorta is small, surely the lungs are not good, nor the system fully supplied with oxydated blood.

We also know, that though the vessels of the lungs themselves may be natural and well arranged, the lungs may still be amiss; they may want the proper structure of cells in which the blood should be exposed; they may be encumbered with tumours arising out of their substance, by which they will be prevented from dilating. One is pleased to find in old authors good descriptions of diseases which have remained for ages unknown; and among these I reckon that of the celebrated Spindler; whose description I admire as much as that of any succeeding author.

The child of a certain prince having died after a few days of great suffering, Spindler opened the body, and found all sound and right, except that there was seated upon the two lungs two tubercles of a variegated red colour, as were the lungs themselves; which tumours, no doubt, hindered the passage of the blood, which he expresses with a correctness in respect of physiology quite unknown in those times. "Quæ vomicæ procul dubio hujus asphyxiæ causæ extitere denegata circulatione ex dextro in sinistrum cordis ventriculum." His description of the disease so long before it was properly understood is curious: "During the eight days in which the child lived, it had never cried strongly nor clearly, had never sucked, had never been regular in its bowels, breathed as if its sides had been blown up; it was suddenly seized with a fit, which seemed epileptic, soon went off, but soon returned; the whole face and body became first red, then of a copper colour; the breathing was interrupted, the eyes immoveable, the feet and hands lay almost lifeless; it suffered at least a hundred of these fits before it expired."

To enumerate those cases where a defect of the lungs was the consequence, not of malconformation, but of disease, were a business quite inconsistent with my design; yet I wish to record these two,—First, It has been long observed, that by long continued suppuration, the lungs are so often wasted that not a bud or particle of them remains: sometimes these patients survive, dragging on a languid and miserable existence, enjoying no freedom, life, nor spirits; and the cause of their frequent ailments is discovered at their death. The lungs also may be thus compressed, even by the mere pressure of water within the chest, which has caused such a subsiding, or rather absorption, of the lungs, without any ulcer of their surface, that one lung has been oppressed till it became no more than three lines in thickness; and indeed it was not easily found: so Haller says in his Commentary upon Boerhaave. But of all the strange things which Haller, or any man has ever related, what he tells in the following words is the most incredible; at least it is so improbable as to be incredible: "A man having died of a lingering disease occasioned by a fall, the left lobe of the lungs was not to be found; that side of the chest was full of a coagulable serum; but the aspera arteria and large arteries and veins (a thing which I never could have believed, had I not seen it myself,) opened with gaping orifices into the cavity of the thorax, as if they had been cut across; so that it was very hard to conceive what had prevented the blood from pouring out." Haller, p. 34.

The truth is, that the vessels appear open when they are not; for within their gaping mouths there is a secretion of coagulable lymph, and the formation of a clot of blood which stops them.

Secondly, in the peripneumonia notha there is not merely an inflammation of the pleura, as the name expresses, but of the lungs themselves; and it is not from inflammation, pain, fever, or acute suffering, that the patients die; but because the lungs are entirely crammed with blood, the heart can no longer move; they are not sensible of their dangerous state, but are suffocated in a moment, and die without a groan. It seems more frequent in other countries than in this, though no country is exempted. When this disease comes upon a place, it comes with all the frequency and destruction of an epidemic disease; and the sudden unexpected deaths are terrible. Valsalva found an old gentleman going abroad in the morning, and prevented him, questioning him about his complaints, which he himself thought very slight: but Valsalva gave notice privately to the servants to expect nothing better than their master's death; and notwithstanding all assistance, he was that very evening dead.

The pulse is weak, the cough slight, the difficulty of breathing more anxious than painful; the face sunk in the features, and flushed, or rather of a lurid colour, except when it is cadaverous, pale, and sallow; the suffocation is sudden; the lungs have, as Morgagni expresses it, a liver-like, solid consistence; they have no longer the cellular appearance of lungs, for their bronchia are crammed with blood; their common cellular texture is also full of exuded blood: they are dense, solid, very heavy, and black, and they sink in water like the lungs of a fœtus. The heart is so curbed in its actions, that it gives but a small, feeble, and trembling pulse; and even in a few days (as in the fœtus having an imperfect organization) the heart is wonderfully dilated and enlarged, and filled with fluid and grumous blood. Haller laments the death of friends by this terrible disease, and especially of his own son, "whose body he gave to be opened by those skilled in dissections." A long continued difficulty of breathing, proceeding from disorder of the larynx, will much in the same manner deprive the lungs of their power of oxygenating the blood. Effusion takes place into the texture of the lungs, so as to compress the air-cells; and sometimes the natural mucous secretion of the bronchia is so increased as to impede the entrance of the air; by which the cells are choked, and the lungs become incapable of oxygenating the blood.

I have here confined the disquisition to the illustration of the natural functions of the heart and lungs: and therefore I have struck out of the present edition some observations, very curious in themselves, on the diseases of the heart, which however, were I to admit them, and were I to follow them up by the introduction of other divisions of the pathology, would lead us too far.

OF THE ARTERIES.

THEIR STRUCTURE.

The membranes which form the coats of the arteries may be separated into many plies or layers; but properly there are three coats, distinguishable by structure and use. Besides these proper coats, the arteries, and indeed all vessels, have a surrounding sheath of condensed cellular texture. I shall begin my description with this exterior covering.

OF THE SHEATH OF THE ARTERY.

The sheath of the artery is a coat of loose cellular texture, which surrounds it. It may be traced from the exterior layer of the pericardium, along the aorta and all its branches, till it escapes the eye, from the delicacy and minuteness of the ramifications which it surrounds. It has connection with the common cellular membrane in the interstices of the muscles, and with the fascia; so that it forms the bond of union betwixt the vessels and the surrounding substance of the limb: as in general an artery is accompanied with its veins (the venæ comites), and with a nerve, and generally with lymphatics, the cellular texture forming the sheath is common to all these, envelopes them, and binds them together. But, again, it is important to the surgeon to observe, that the artery has appropriated to it a division of this sheath. For the sheath of the artery is strengthened by ligamentous filaments, so as to form a sort of vagina in which the artery lies, and to which it is attached by very loose and elastic filaments of cellular texture.

External coat.—The exterior proper coat of an artery, sometimes called the tendinous coat of the artery, is dense, strong, tough and elastic.* The power of resisting the force of the heart, that is, of resisting over distension, is very principally seated in this coat. When a ligature is tied about an artery, it is this coat which, by its toughness, withstands the operation of the cord, when the internal coats are cut and give way. It may be dissected into several layers, especially in an old subject.

Muscular coat.—The middle or muscular coat of an artery is of a very distinct structure; for although some (trusting to chemical tests, and neglecting the finest suite of experiments by Mr. Hunter, which go to prove the muscularity of the arteries,) have denied that this coat consists of muscular fibres; yet there is not the slightest doubt that it is fibrous, that these fibres contract, and that they lose their contractile power on death. This coat consists of fine muscular fibres, which run in a course around the artery: none go in the length of the artery, nor run obliquely in the human subject. It is a mistake to suppose that these are not visible in the greater arteries, although it be in the smaller branches that they bear the largest proportion to the other coats.

* Tunica *cellulosa propria.* Haller. *Cartilaginea.* Vesalius. *Tendinea.* Heister.

Indeed, it is well known that the arteries possess two distinct properties: 1. Elasticity; 2. Muscularity. The former quality is possessed, in the greatest degree, by the arteries near the heart: the latter quality is possessed, in a larger proportion, by the arteries more remote from the heart. The elastic property is well calculated to resist the shock of the heart's action; but in the extremities this is not necessary, for there the violence of the heart's motion is subdued or diminished, and then, consequently, there is a necessity for a second power, similar to that of the heart, viz. the muscular power of the arterial coats.

INTERNAL COAT.—The inner coat of an artery, sometimes, but very improperly, called cuticular coat, is very thin and smooth, and very easily torn, especially in its transverse direction. The density and fineness of its texture is for the purpose of retaining the blood, and its smoothness for permitting the blood to flow with the least possible interruption. But there is another property more difficult to comprehend fully: an endowment of life, and a mutual influence, which exists betwixt this coat and the contained fluid, without which, as it appears to me, the circulation could not proceed at all.

The VASA VASORUM are those small arteries and veins which enter into the coats of the artery, to nourish them, and to support their living properties. For the blood within the cavity of the artery, though it be arterial, is not capable of giving a supply, neither of nourishment nor of power of any kind to the coats; by which we see that it is not the contact of arterial blood that suffices to the supply of living parts, the blood must be sent through the small arteries, and must suffer the agency of these small arteries.

The vasa vasorum pass to the proper coats of the arteries, by perforating the sheath, and are carried through, as it were, by the support and connection of the cellular membrane. It is this circumstance which makes the surrounding cellular substance of the artery a matter of vast importance in operations on the arteries, for if it be destroyed, so also are the nourishing vessels, and then the artery is a dead tube, and sloughs under the ligature.

CELLULAR COATS.—There is a cellular coat betwixt the sheath and the outer tendinous coat; another layer of cellular membrane intervenes betwixt the outer and muscular coat; and, again, a third layer of cellular substance, (which, however, is very fine,) is interposed betwixt the muscular and inner coat of the artery.

OF THE MOTION OF THE BLOOD THROUGH THE ARTERIES.

There is no subject of physiology more important than the consideration of the causes which accelerate or retard the blood in the arteries, and none on which it appears to me that more extraordinary mistakes have been entertained.

The increasing muscularity of an artery, as it extends from the heart, is a provision for giving increase of arterial power in proportion to the diminution of the power of the heart. By the due distribution of these two powers the blood is made to circulate with an equal velocity in parts near and in parts remote from the heart; yet the length of an artery has been considered as a means of subduing the velocity of the blood, and the tortuous form of an artery has been considered as the most effectual check to the force of circulation. Exactly the reverse of this is the case. A few examples will prove it. The blood mounts against the power of gravity to the head; an increasing tortuosity distinguishes the arteries of the head. And so the arteries of the temple and the occiput increase in their tortuosity as they advance upwards. The arteries of the mamma go in a straight course while the woman is not suckling, but if she should die while nursing, then the tortuous form of the arteries may be demonstrated by injections, and is very remarkable. If a tumour grows upon any part of the body requiring or exciting a greater flow of blood to the part, then we find that the vessels of the part, which in their natural state are nearly straight, assume a tortuous form at the same time that they are enlarged. The surgeon knows well that if he cuts a tortuous vessel in an operation, the blood flows from it with a force much greater than from a vessel in its natural state. If the muscles of animals require much and long exertion, they require also more blood to preserve an increased irritability or power of action, and therefore they require tortuous arteries. Thus the muscles of the jaws of the lion, the muscles of such animals as cling and hang to branches of trees, possess tortuous arteries to carry on the circulation with more than common power during their long and powerful contractions. More numerous proofs might be given to show that the tortuous artery, being an artery with an increased muscularity, is ever a more powerful artery. Another circumstance may be demonstrated, and that is, that a tortuous artery is one which impedes the blood while it is passive, and has an unusual power of accelerating the blood when its muscular coat is excited.

It appears to me, that the nature of the forces circulating the blood have been much overrated by experimenters, from the neglect of a principle which more than any other should raise our admiration, and is important in the practice of surgery. They have calculated the power of the heart by the difficulties to be overcome in the circulation.* They have made a fluid of the exact degree of viscidity of the circulating blood; they have put this into a glass tube, the extremity of which was drawn into a capillary vessel; they have raised the fluid in the tube until it flowed through the capillary extremity, and by the height of the column they have calculated the force necessary to push the fluid onward. But the operations of nature in a *living body* cannot thus be calculated, for there must come a living property into the estimate. The Creator has not contrived means of overcoming an obstruction, but through the influence of life has removed that obstruction altogether, which exists in dead parts. These experimenters are contriving means to measure the cohesion which takes place between the fluid and the solid parts, but it would have been well to have enquired whether in the living frame such attraction takes place as exists between the particles of dead matter, or whether or not that attraction was modified by the

* Borelli, estimating the power of muscles according to their weight, calculated that the force of the heart equalled 180,000 lbs.

Kiell, by a complicated process, came to the conclusion that its force was equal only to five ounces and a half.

Hales calculated that its force was equal to 50 lbs.

influence of life. In fact, in the living body, the cohesion or attraction betwixt the fluids and the vessels is destroyed; there is no such cause of retardation as we witness in dead tubes in inert matter. A weak impetus propels the blood, because it has not the force of attraction to overcome; but if by injury, inflammation, or any other derangement, the peculiar influence existing betwixt the vessels and their fluids is deranged, attraction takes place, then the blood adheres to the sides of the vessels, coagulates and stops, which is the occasion of the spontaneous stopping of the blood in cut vessels; and, I must add, that this is a principle most strangely overlooked in many ingenious books, which offer an explanation of this circumstance.

When we have persuaded ourselves that we have arrived at some just notions of the power circulating our blood, and have in imagination placed the frame of the human body before us, and contemplated the various results from the circulation of a living fluid, our conception of these wonders is imperfect, until we see the body in activity, and witness the effects upon the blood, of the change from repose to exertion.

The instant that a man becomes animated, or starts into exertion, the motion of the blood is thrown into disorder. There is no longer the measured activity of the heart, and the gentle and equable motion of the lungs. The whole vital organs suffer the nature of a revolution. Is this an error or an imperfection in the frame-work? Far otherwise; out of this agitation, and seeming irregular violence, come additional means for sustaining the activity of the body. It is like those changes in nature, storms and tempests, and extremes of heat and cold, which seem the forerunners of misfortune, but which remove whatever is stagnant and noxious; preserving all nature in healthful activity.

The valves of the veins are provided for the exercise of the body; through them the pressure of the muscular frame-work, when employed in walking, running, leaping, or any sort of exertion, becomes a power additional to that of the heart and arteries in circulating the blood. While the veins are tubes, conveying back the blood which was sent out by the arteries from the heart, they are, from their capacity and their numbers, also reservoirs of the blood which moves through them languidly. The veins are compressible by the muscles: this compressibility is so far from being an imperfection in the apparatus of the circulation (an opinion too hastily received), that it is attended with the most happy result; since through this effect solely there is ever preserved an equality betwixt the force and rapidity of circulation and the muscular exertions.

Without the valves of the veins, which hinder the blood from moving retrograde, the pressure of the muscles would not effect this purpose of throwing the blood in increased quantity upon the heart; the blood would be forced by exertion to the extremities, instead of towards the centre of the circulation. The observations of those who preceded Harvey went thus far; and Fabricius distinctly says, that the valves of the veins were to prevent the blood from being forced outwards upon the extremities during exertion. They can bestow no additional activity; they only direct the impulse received from the muscles of the extremities towards the heart.

The heart assumes an activity proportioned to the blood which it receives; and the lungs, always in sympathy with the heart, partake of this activity, and the respiration is increased. The office of the lungs is to render the blood capable of supporting the life of the body, and in an especial manner the irritability of the muscles; now the motions of respiration are in proportion to the quantity of blood which has been compressed from the veins, and placed under the more active operations of the heart and arteries. It is thus that an activity is given to the circulation, and consequently the means of supporting the irritability of the muscles, in the proportion to its expenditure in exertions.

The circle of operations is in this succession; the muscles compress the veins; the heart is distended with blood; the lungs are excited by the state of the heart; the activity of the circulation and the respiration is thus promoted: and the effect is, that the circulation in the muscles is increased, and their irritability thereby supported.*

The action of the muscles has not only an influence in sending back the blood to the heart, but also in accelerating the flow of blood outwardly through the arteries. In performing an operation on an infant, or trying to suppress an hæmorrhage from a drunken man, I have witnessed, with surprise, the additional force given to the jet of blood from an artery during the moment of exertion.

It is fortunate that we can have recourse to the account of experiments made by a man of veracity, instead of repeating hateful experiments on dying animals. When Hales was attempting to estimate the power of the heart by attaching glass tubes to the arteries of a horse, and admitting the blood to rise into the tube, he observed that an occasional variation took place in the length of the column of blood; and this not attributable to the force of the heart, but to the exertions of the creature. He saw, even in the moment of its expiring, that the blood rose remarkably in the tube; and that on stopping the nostrils of the animal, the blood rose five inches; that it rose considerably and suddenly on the animal drawing a deep inspiration.

Hales observed accurately, but he drew a wrong conclusion. He thought this additional rise in the column of blood was owing to the dilatation of the lungs, and the greater freedom with which the blood passed from the right to the left side of the heart. On the contrary, we know that, during a struggle, there is a greater difficulty in the circulation through the lungs. The true explanation of this effect must be derived from the observation of the manner in which the heart and great vessels are guarded, by the tension of the membranes which are around them; and which tension is increased in a remarkable manner during the violence of corporeal action; without which, indeed, the heart would be overpowered by the blood sent in upon it; and by which the additional force of the abdominal muscle and diaphragm is still employed in accelerating the blood in the course in which it ought to flow.

In this review of the forces circulating the blood, by giving to the vessels, and to the membranes surrounding the heart, their due importance, I have somewhat diminished the value of the heart's action, and

* A very interesting memoir on the influence of the atmosphere on the circulation of the blood was presented to the French Institute in 1826, by Dr. Barry. The reader may refer with great advantage to the report of Messrs. Cuvier and Dumeril, published in the Philadelphia Medical and Physical Journal, for July, 1826.—J. D. G.

reduced it to the regulation of the general current of the fluids, and the action of the lungs in connection with the circulating system. When we reflect that the blood of some creatures circulates without a heart, and see acephali born without a heart, yet fully nourished,—and when we see the aortic system of fishes removed almost out of the influence of the heart,—and when we see that the heart of all animals is placed in juxtaposition, and in accurate sympathy with the lungs,—it is impossible to refuse assent to the proposition, that the arteries possess the chief power in circulating the blood through the corporeal system; and that the heart is rather the regulator than the prime and efficient cause of the circulation. And by this it is not only meant that its state of excitement and activity commands and draws after it the motion of the blood generally, but that it regulates the actions of the lungs, in exact accordance with the state of the blood and the necessities of the system.

I have shown that the irregularity in the demand of remote parts for blood cannot be answered by the acceleration or diminution of the heart's action; that the principal organs of the system have a provision for that partial increase of activity in their vessels which does not disturb the general economy, nor call for the action of the heart. I think I have shown that the object could not be effected by the increase or diminution of the heart's activity; and that if the endowment and vital properties of the organs were entirely dependent upon the general force of circulation, and not on the capacity of their own system of vessels, to increase or diminish the force of the blood, life would be held by a still more precarious tenure than it is: the vital action would interrupt the general system, and the agency of passion, and mental, and even corporeal activity, would disturb the economy of the organs essential to life.

For entering on this subject I have offered the apology, that I felt myself obliged to do so by the nature of my daily occupations. But surely there is another and better reason in the nature of the subject itself. To ascertain the difference between fluids moving in pipes, and according to the laws of extended nature, and the circulation of fluids in the vessels of living beings, must be an important part of science.

It is interesting to him who loves to take an extensive survey of nature, and very important to the student who is about to devote himself to the survey of animated nature, to perceive, by these proofs, that there are new principles and new laws to be studied. By the novelty of this enquiry, to some it may prove the occasion of opening those sensibilities to the works of nature which, by habit of inattention, have been lost to things seen in the more familiar path of existence. To contemplate with the microscope the circulation of the blood in minute vessels, makes the head giddy, so surprising is the rapidity of the globules of blood; and on raising the head, and calmly considering the matter, the surprise does not cease; we have surveyed a new world, where the velocity and seeming impetus have no sufficient cause, and to which the laws of things hitherto familiar do not extend.

GENERAL PLAN OF THE ARTERIES.

AORTA.

The arteries of all the body (excepting only those of the lungs employed merely in oxygenating the blood) arise from one trunk, the aorta; which we must describe as of great size, since we compare it with other arteries, but which is wonderfully small, considering that it is of its branches only that the whole arterial system is composed.

Those will have the truest notion of the distorted form of the aorta who have studied the anatomy of the heart. Its root is deep buried in the flesh of the heart. In the Tortoise we see the flesh of the heart rising round the root of the aorta, and endowing it with the power of a second ventricle: in the Frog we find its internal surface beset with a triple row of valves, and its coats are like those of a ventricle, they are so exceedingly strong: in Man we find it plainly muscular, surrounded in circles with great fibres, and having much muscular power.

The beginning of the aorta, then, lies deep in the flesh of the heart; it is there that it gives off its coronary arteries: it bulges at its root into three great knobs, which mark the place of its three valves, and are called the lesser sinuses of the aorta; it is large at the root, it grows smaller as it rises, it mounts upwards and backwards from the heart, till it begins to form its arch or curvature; its direction is first towards the right side of the thorax; looking backwards, it turns in a very distorted manner, where it forms the arch; it strides over the root of the lungs, going now to the left side and backwards, till it touches the spine; its arch lies so upon the forking of the trachea, that its aneurisms often burst into the lungs: it then applies itself close to the spine, so that in aneurisms the pressure of the aorta often destroys the vertebræ; and now lying along the left side of the spine, and with the œsophagus running close by it, it passes down through the thorax, and from that to the belly under the crura of the diaphragm.

This, then, may serve as a short description of the aorta, which is the root of all those arteries which we proceed now to explain. It is the trunk from which the general tree of the arteries is to be traced.

From the arch of the aorta go off three great arteries, which rise to the head, or bend sidewise towards the arms, and so nourish all the upper parts of the body. Of these three arteries, the first is a great one, named Arteria Innominata, which contains, if I may so express it, the RIGHT CAROTID and the RIGHT SUBCLAVIAN, and divides so as to form those two arteries, about one inch after it arises from the arch; the next is the left carotid artery, going to the head; the third is the LEFT SUBCLAVIAN, going to the left arm. The roots of these three branches occupy a great part of the arch of the aorta.

ARTERIA INNOMINATA.

The right carotid and right subclavian arteries arise from the innominata. The right subclavian goes off in a more direct course than the left; it is thought to receive the blood more fully; perhaps, also, it is rather larger than the left subclavian : but, at all events, there is something peculiar in the mechanism of the right arm ; most probably it is the peculiar form or direction of this artery that gives to the right arm a superior dexterity and strength. When Horses are to be broken, we find the chief difficulty to consist in teaching them to move equally with both feet, for they prefer the right ; when a Dog trots, or when he digs the ground, he goes with his right side foremost, and digs chiefly with his right foot ; and in these creatures we find the same arrangement of these arteries as in ourselves. But in Birds, where an equal balance of strength is required for the wings, both subclavian arteries are distinct branches of the aorta. When we lose our arm, the left hand acquires by use all the strength and dexterity of the right. Since, then, either arm can acquire this dexterity, and since the right leg is stronger by its dependence upon the motions of the right hand, we have every reason to believe, that the preference given to the right hand has some physical cause, and that it is the peculiar form of this artery, viz. going off more directly on the right side, and that those who are ambidexter must have the right as well as the left subclavian going off as one independent branch.

There is another peculiarity which has occurred. This arch sometimes gives out four branches, and the left subclavian, arising first from the arch, has passed behind the trachea, betwixt the trachea and the œsophagus. In a subject dying of difficult deglutition, which had subsisted from childhood, it was attributed to the pressure of this preternatural artery, an effect which I cannot easily believe ; and it has been proposed to rank it as a new and certainly incurable species of disease, under the title of dysphagia lusoria, as arising from a lusus naturæ of this artery.

LEFT CAROTID.

The next branch of the arch is the LEFT CAROTID. The two carotids mount along the sides of the neck, are felt beating strongly, and seem much exposed. They retire for protection behind the prominence of the thyroid cartilage. They divide into external and internal carotids under the angle of the jaw. The EXTERNAL CAROTID supplies the neck, the face, the inside of the throat ; and the reader will have chiefly to observe its course all along the neck, its branching at the angle of the jaw, and the operations and wounds about the throat, neck, face, and especially about the root of the ear.

LEFT SUBCLAVIAN.

The left subclavian is the third branch of the aorta. Each subclavian artery varies its name according to the parts through which it goes. This great artery of the arm is named SUBCLAVIAN under the clavicle, where it gives branches to the neck ; AXILLARY in the arm-pit, where it gives branches on the one hand to the scapula, on the other to the breast. It is named BRACHIAL where it runs down the arm, and where there are few important branches ; and, finally, its branches, into which it divides at the bend of the arm, are named RADIAL, ULNAR, and INTEROSSEOUS, because they respectively run along these parts, the radius, the ulna, and the interosseous membrane.*

THORACIC AND ABDOMINAL AORTA.

The aorta, after completing its arch, passes through the thorax, giving but few branches, and those very slender. But the ABDOMINAL AORTA, as soon as it has emerged from under the crura of the diaphragm, gives three great abdominal arteries: first, the CÆLIAC, going in three branches to the liver, the stomach, and the spleen; secondly, the SUPERIOR MESENTERIC, which furnishes all the small intestines; and thirdly, the LOWER MESENTERIC, which supplies most of the great intestines down to the rectum. The arteries of the kidneys and of the testicles follow these, and then the aorta divides into two great branches for the pelvis and legs.

The ILIAC ARTERIES are the two great branches into which the aorta divides within the abdomen, and these again are each subdivided into

* The arch of the aorta, like all parts of the system belonging to the organic life, is subject to irregularities; among which the most common departure from the usual distribution, is the origin of the left vertebral artery immediately from the arch, between the left carotid and left subclavian; the latter vessel being at the same time situated very near to the posterior part of the arch.

The following are the most remarkable deviations from the general rule that we have yet met with, and we cannot believe them to be very uncommon, although not very frequently observed. In the aorta of an adult male subject, an anomalous branch was given off from the arch immediately between the root of the innominata and right carotid. This branch ascended almost perpendicularly to the inferior edge of the sternal end of the clavicle, and then inclined towards the centre of the body. It terminated in two branches of considerable size, which ramified on the inferior part of the thyroid gland, in this subject so enlarged and elongated on both sides, as to descend very nearly to the edge of the sternum. The regular thyroid arteries, from the external carotid and subclavian, were distributed as usual in this gland. The left lobe was as much elongated as the right, but was without any additional artery, which precludes the possibility of attributing the state of enlargement to the distribution of this vessel immediately from the aortic arch. The origin of the left subclavian was very peculiar and uncommon; it arose from the most posterior part of the superior surface of the arch, full two inches distant from the left carotid.

In the second case, we have the aorta of a female, we find a branch similar to the irregularity above described, taking origin from the innominata, a short distance from the aorta. This branch was distributed upon the inferior part of the right lobe of the thyroid gland, exactly as in the first observed subject; but the gland was in no other respect extraordinary.

This branch from the innominata has not been noted by any one, except ALLAN BURNS, who, in his surgical anatomy of the head and neck, makes the following remarks:—

"The thyroid gland generally receives its supply of blood from four vessels, but we sometimes find a fifth, sent to it by the arteria innominata. Where this anomalous vessel exists, it will usually be found entering the cross slip of the gland, just on the fore-part of the trachea. This artery sometimes supplies the place of one of the regular thyroid branches. In extirpating the thyroid gland, these facts must be recollected." p. 256.

In both instances observed by us, the irregular artery was distributed on the inferior part of the right lobe. As far as we know at present, no one has hitherto recorded an instance of the origin of this anomalous thyroid branch, *directly from the aorta*.—See *The Philadelphia Journal of the Med. and Phys. Sciences*, Vol. xiv. p. 118. [For an account of the irregular muscle, frequently to be found arising from the os hyoides and inserted into the left side of the thyroid gland, see *Soemmering* de corporis humani fabrica, Vol. i. p. 117. *Caldani* tab. anat. xii.]—J. D. G.

two great arteries; the INTERNAL ILIACS to supply the pelvis, the EXTERNAL ILIACS to go to the thigh.

INTERNAL ILIACS.

The INTERNAL ILIAC supplies the bladder, the rectum, the womb, with lesser arteries; but its great arteries go out by the openings of the pelvis to supply the very large muscles of the hip and thigh. Thus the GLUTÆAL, a very great artery, turns round the bone, goes out by the sciatic notch, and goes to the glutæal muscles. The SCIATIC, almost equally large, turns down along the hip opposite to the glutæal, which turns up. The PUDIC, of great size, also turns out of the pelvis, turns inwards again towards the root of the penis, and belongs entirely to the private parts, as its name implies.

EXTERNAL ILIACS.

The EXTERNAL ILIAC, when it passes out of the abdomen, takes the name of FEMORAL ARTERY: it divides into two large arteries a little below the ligament of the thigh: the one goes deep, belongs to the muscles, and is called PROFUNDA; it furnishes all the thigh, and it might with the strictest propriety be named the femoral artery. The FEMORAL ARTERY, as we call it, is the other great branch, which continues superficial, runs obliquely down the fore part of the thigh, gives few and but trivial branches to the thigh, and is really destined for the leg. When the artery turns inwards towards the ham, it is named POPLITEAL ARTERY; and, like the artery at the bend of the arm, this one at the bending of the knee divides into three great branches, which, like those of the arm, take their names from the bones along which they run; the ANTERIOR TIBIAL ARTERY lies on the fore part of the tibia; the POSTERIOR TIBIAL ARTERY runs along the back part of the tibia; the FIBULAR ARTERY runs along the fibula; and these great arteries terminate by making arches with each other in the sole of the foot, in the same manner that the RADIAL and ULNAR ARTERIES join in great arches in the palm of the hand.

This slight plan I have chosen to throw out before my reader, that the succeeding parts may seem more methodical, and that he may have at a slight glance the chief parts of his task before him; and knowing all his duty, he cannot be inattentive to that on which the lives of his fellow-creatures must so often depend.

OF THE ARTERIES OF THE HEAD.

OF THE CAROTID ARTERIES IN GENERAL.

THE carotid arteries are also named the Arteriæ Cerebri, as if they were the sole arteries of the brain; and the ancients, either ignorant or forgetful of there being any other arteries for the brain, or not observing that the vertebral arteries might convey blood enough for the functions of the brain, did actually name the carotids the Arteriæ Soporiferæ; believing that, if they were tied, the person must fall asleep.* How a person might die from having the great arteries of the head tied, I can most readily conceive; but how he should rather fall asleep, and not die, is quite beyond my comprehension: and yet many of the best anatomists, in the best age of anatomy, have abused their time repeating these experiments.†

Galen has explained it well, saying, "that physicians and philosophers, tying the carotid arteries, tie in along with them the recurrent nerves which serve for the voice; and if they will have silence to be

* The name which we use, viz. that of carotids, is synonymous in Greek with Arteriæ Soporales.

† Valsalva, Van Swieten, Pechlinus, Lower, and especially Drelincurtius in his Experimenta Canicidia, and many others, spent days and weeks in tying up the carotids of Dogs. What does all this imply? Surely a strong belief in tales which would disgrace the Arabian Nights; tales concerning a manner of tying a cord round the neck of a She-goat, or even of a young Man, so that, without hurting them, they should be made to sleep or wake, according to the bidding of the spectators.

Costæus first tells this tale: "Circumforaneous mountebanks (says he*) often perform this miracle. They tie a ligature round the jugular veins of a She-goat; and they tighten it and relax it from time to time, so that at their pleasure the animal falls down motionless and stupid, and at their bidding leaps up again with great vigour." The most incredible tales soon followed, and soon crept into otherwise good and useful books. Even Hoffman seems not unwilling to believe that the Assyrians had been in use of tying up the jugular veins in their young men before circumcision, that they might feel less pain. A serious operation God-wot! for so slight a cause. Even Morgagni talks more seriously of the She-goat, and of this snibbing of the young men of Assyria, than one could wish in respect to the character of one so truly great as Morgagni.† But the person the most celebrated in this affair was Realdus Columbus; and the wildest and most barefaced tale that ever was told, is that delivered by his pupil Valverda, in his Anatomy of the Human Body.

"The carotid arteries (says Valverda) being tied up, or any how obstructed, the person grows stupid, and falls presently into a profound sleep. This experiment I saw at Pisa in the year 1554. It was performed upon a young man by the celebrated Columbus in the presence of a great many gentlemen and strangers, with no less misery to them than amusement to us (the pupils), who, though we knew the cause, ascribed it altogether to the black art." But if any one word of this were true, Valverda would have told us, and been proud to tell us, by what particular operation, ligature, or pressure, this strange thing was performed; and Columbus himself, the author of this new amusement, would surely have dropped some hints about it in some place or other of his works. But from the modest silence of the master, and the secrecy of the pupil, we have reason to believe it is untrue; and if Columbus did ever venture to exhibit such a mean piece of legerdemain, he put himself quite upon the level with the quack and his She-goat. The quack, indeed, was much beyond him in point of merit, since it must have been far easier to teach a clever young man to fall down or start up than to teach all this to a She-goat.

* Disquisitiones Pathologicæ, lib. 6. cap. 6.

† The celebrated Cant not only believes this most powerfully, but reasons upon it in the following manner: "Ruffus Ephesius, lib. 1. cap. 34. hanc soporem adferre negat, hinc aliud nomen permitteret; sed Realdus Columbus publice in theatro demonstravit hunc effectum præstari hac arteria: itaque nomen retinebimus UTI-OTE rei CONGRUENS. Sic enim quotidie experimur post prandium somnolentiam, quam facile deducere possumus ab effectu hujus arteriæ; nam ventriculo extenso premitur aorta descendens, quo sanguis copia majori ruit in carotides; quæ hinc extensæ comprimunt cerebrum quodammodo, quo motus animales non ita expedite absolvuntur, verum vitales augentur motus, quæ ambo fiunt in somno."—*Tab. Cant impetus faciens*, p. 6.

sleep, no doubt the creature is mute after their awkward operation; but no other function is hurt neither then nor afterwards."

This is probably the whole truth; for if but one Dog lives after both carotids are tied, nothing can be more certain than that those which die must have suffered by some awkwardness or disease. Is it wonderful that, after such a cruel tedious operation as this is, the Dog should be exhausted, should be weakened by loss of blood, should feel sore, and hang his head and droop, and let the slaver fall from his jaws? that he should skulk in corners, look side-long, be jealous, and not easily moved from his hole? These are what they have thought fit to call drowsiness and signs of sleep; but it is such drowsiness and such sleep as would have followed such a cutting up of the creature's neck, whether the experiment-maker had touched the carotids or not. The creature lolls its tongue, hangs its head, closes its watery and heavy eyes, is drowsy, or, in other words, feverish for many days: it eats with all the voracity of a Dog, but with difficulty, and slowly, owing to the swelling of its throat; and if it dies, it dies from the same cause. Nothing is more certain than that these are the only particular effects, and that the carotids of a Dog may be tied without any other danger than that of the wound.

There is nothing new under the sun. We are continually tantalized with old tales in new forms. Who would expect to find at this very day a practical application of the She-goat and the Assyrian young Men? One author has published to the world, "that a young Lady, of a nervous and delicate constitution, subject to nervous distresses in a wonderful variety of forms, but more especially in the head, sometimes afflicted with head-aches, sometimes with delirium, sometimes with convulsions, was relieved by compressing the carotid arteries." Often by compressing the carotid arteries, this gentleman prevented the delirium; "for all these complaints proceeded from a violent palpitation of the heart, with the stream of blood rushing violently towards the head." He has seen this compression bring on a stupor; he has seen it bring on a profound sleep. Is it not a pity that he had not attended more to the history of this business, and joined to these facts the story of the She-goat and the young Men of Assyria?

If what Dr. Parry says be true, that in lean people, in women at least, we can, by reclining the head backwards, compress the carotids entirely against the fore part of the neck, with the finger and thumb; why, then, we need have no fear of hæmorrhages of the nose, wounds about the jaw, cutting the parotid gland, or operations about the tonsils or tongue! But there is a dangerous mistake here; for there is (as I know by much experience) a wide difference betwixt preventing the pulse of an artery and suppressing the flow of blood through it. In the case of a Man fainting during any great operation, if you are holding in the blood with the point of your finger upon some great artery, you feel the pulse there, while the face is deadly pale, the extremities cold, and the pulse of the wrist, and of all but the largest arteries, gone. In fainting, even the heart itself is not felt to move; and yet it moves, and the blood circulates: how else could a person lie in an hysterical faint for hours, I had almost said days? I have tried, in great operations near the trunk of the body, to stop the blood with my hands; but though I could suppress the pulse of the femoral artery with my fore finger, I could not command its blood with the whole strength of my body, but have seen it with horror rush as freely as if my hand had not been there.* In short, I suspect Dr. Parry's belief of his stopping the carotids with his finger and thumb is as vain as Dr. Monro's expectation of compressing the abdominal aorta by pushing with his fist against the belly.

The CAROTID ARTERY, having emerged from the chest, runs up along the neck by the side of the trachea, a single undivided artery, without twig or branch, till it is opposite the jaw. The length of this artery gives us a fair opportunity of observing, of proving, if we choose, that arteries are cylinders, and not, as they once were supposed, of a conical form. But the cylindrical form of this artery should not occupy our attention so much, as that peculiarity of direction, which, though apparently exposed, keeps it safe; or those important connections and relations which are so necessary to know before tying it in the operation of aneurism, or when wounds have been received high in the neck and under the jaw.

The carotid artery, from the place where it emerges from the chest up to the angle of the jaw, is continually receding from the fore part of the throat, is getting deeper and deeper by the side of the trachea; at last the strong projection of the larynx or cartilaginous part of the tube defends it; and when it has got to the angle of the jaw, it lies there so deep under the ear, betwixt the ear and the jaw, in a sort of axilla, as we may call it, filled with fat and glands, that it is almost out of reach of danger.

The artery lies nearly parallel to the spine, though seeming to retreat from the projection of the throat. It lies deep, invested with its sheath. The omo-hyoideus crosses it. The sterno-cleido-mastoideus covers it.

The deeper situation of the carotid artery, as it ascends, and in reference to the larynx, saves it from the attempts of suicides: it is rarely cut, or when cut, it bleeds so that no ignorant person can command it, and the surgeon is too late. But although tumours and aneurisms are rare, and through unwillingness and a well-grounded fear such patients are usually left to take their fate; yet there may happen cases in which it may be necessary to do so bold a thing as to tie this artery.†

The connections of the carotid, as it rises along the neck, must determine our judgment, if ever any such case should occur. To stop the growth of an aneurism, to allow the extirpation of other tumours about the jaw, to save a patient from dreadful bleedings of the throat, or from the hæmorrhages of deep wounds, when, for example, a patient is stabbed in the neck, or a ball passes through the mouth and under the angle of the jaw; these may, in some unlucky moment, present themselves as motives for tying the trunk of this artery, when all its great branches

* This is true, and we have all seen this splashing of blood from the ineffectual compression of the femoral artery, and yet it is certain that it may be compressed.—C. B.

† I leave this as it was expressed by my brother in the first edition. The carotid artery has been often tied since this was written, and even by the author himself. It was with great pleasure that I lately witnessed the cure of a soldier by the tying of the carotid. He had received a desperate wound with a sword, which entering in the neck came out at his mouth.—C. B.

are torn. But always the observation of Galen is to be remembered, that the nerves accompanying these arteries are liable to be tied together with them.*

Let us recollect how the carotid artery, jugular vein, and eighth pair of nerves, come out from the skull, for it is almost at one single point. The internal carotid artery enters by a hole in the temporal bone; the jugular vein comes out by a larger hole, betwixt the same bone and the occipital bone, the foramen lacerum; immediately behind it the eighth pair of nerves, or the par vagum, goes out through a division of the same foramen lacerum, separated from the vein only by a little cross slip of the dura mater; and so the carotid artery, jugular vein, and eighth pair, touch each other at the basis of the skull. Through the whole length of the neck they continue the connection which is thus early begun, and are included in the same sheath. The par vagum being the great nerve of the viscera, at least of the heart, lungs, and stomach, strictures upon it or wounds are certainly fatal. It is therefore to be avoided with the utmost care in all operations performed in the neck, and especially in tying the carotid artery.—It lies in a division of the general sheath proper to it, rather under the artery, and betwixt the artery and vein.

When the common carotid has risen to the angle of the jaw, it divides into two great arteries, one going to the outside of the head, the other to the brain; the one of course named the EXTERNAL, the other the INTERNAL CAROTID. Some of the most eminent anatomists are incorrect when they say, that the carotid artery gives no branches till it arrives at the larynx. They say so because the first branch goes to the larynx; but, in fact, the carotid passes much beyond the place to which it is to give its first branch, for instead of branching at the larynx, it does not do so till it arrives at the corner of the jaw; there, as I have observed, it can, as in an axilla, lie deep and safe; and the laryngeal artery, which is the first branch† of the carotid, turns downwards again to touch the larynx.

The first division, then, of the carotid artery is into the external and

* The common carotid artery has been within a few years past taken up frequently and successfully both in America and Europe. The advantage obtained from having secured the common carotid artery a day previous to the removal of a huge morbid growth requiring the excision of nearly two-thirds of the lower jaw, led professor MOTT of New-York, to the establishment of the important rule of securing the great trunks of arteries leading to diseased parts, a short time previous to their extirpation. The value of this improvement is acknowledged by all practical surgeons to be great, and we hope that Dr. Mott will shortly favour the profession with a history of the operations about the lower jaw especially, in which he has derived much of his success from the practice referred to.—J. D. G.

† An American Surgeon, MOTT, has the honour of having first successfully applied the ligature upon the common iliac artery for the cure of aneurism. The artery was tied just below the bifurcation of the aorta, opposite the promontory of the sacrum. The peritoneum was not injured, and the patient speedily recovered, and is at present entirely well. For a detailed account of this operation, see the first number of the American Journal of the Medical Sciences, for Nov. 1827, the London Medical Repository, &c.

The *internal iliac artery* has recently been successfully taken for the cure of gluteal aneurism, by Dr. WHITE, of Hudson, N. Y. An account of this operation will be seen in the 2d No. of the American Journal of the Medical Sciences, a periodical which bids fair to contribute largely to the advancement of the American medical character.—J. D. G.

internal carotids; and the external carotid gives branches so interesting to the surgeon, yet so numerous, that it is at once very desirable and very difficult to get a knowledge of each: arrangement is here of more importance than in any order of arteries, though extremely useful in all.

ARRANGEMENT OF THE BRANCHES OF THE EXTERNAL CAROTID ARTERY.

The external carotid gives three sets of arteries; each of which, having a plain and distinct character, cannot be forgotten, nor their direction, nor their uses, nor their relative importance, misconceived; for if we consider but the parts along which the carotid artery passes, as 1. The thyroid gland; 2. The tongue; 3. The face; 4. The pharynx; 5. The occiput; 6. The ear; 7. The inside of the jaws; 8. The temple:—if we remember thus the order of these parts, we shall not forget the order in which the branches go off.

BRANCHES OF THE COMMON CAROTID ARTERY.

1. Arteria Thyroidea Superior.
2. Arteria Lingualis.
3. Arteria Facialis.
4. Arteria Pharyngea.
5. Arteria Occipitalis.
6. Arteria Auricularis Posterior.
7. Arteria Temporalis.
8. Arteria Maxillaris Interna.

1. The branches which go off from the carotid forwards are peculiarly important; one of them goes to the thyroid gland, another to the tongue, and a third to the face; parts which, to say no more, are peculiarly exposed; but they are, besides, the subject of many particular operations.

2. Those branches which go backwards and inwards, as the pharyngeal, the auricular, and the occipital arteries going to the ear, the pharynx and the occiput, are both extremely small, and also run so deep, that wounds of them are rare and of less importance, and fortunately those branches are the only ones which it is difficult to remember.

3. The great artery which passes behind the lower jaw, named maxillary artery, and the temporal artery which lies behind the jaw, imbedded in the parotid gland, must be studied with particular care; the difficulty of cutting out tumours here, the course of the temporal artery in which we bleed, and which, lying imbedded in the parotid gland, demonstrates the absurdity of talking about cutting out the parotid gland, since plainly it cannot be done, without first tying the carotid itself, and then probably the operation would be fruitless, since a disease which had pervaded parts so deep would certainly return; and, lastly, the terrible hæmorrhages which often happen from the throat, nose, tonsils, &c. give an importance to these two branches above almost any other: they should be very familiarly known to the surgeon.

1. ARTERIA THYROIDEA.

The THYROID ARTERY, often also named the upper laryngeal artery, comes off from the external carotid almost in the very moment in which it separates from the internal carotid. Its place is behind the angle of the jaw; it goes downwards and forwards in a very tortuous form, till it arrives at the thyroid gland, upon which it is almost entirely expended; but yet it gives some branches, or rather twigs, of which the following are the chief:

1. One superficial branch goes upwards to the os hyoides, and sends its twigs sometimes under, sometimes over the os hyoides: it belongs chiefly to that piece of membrane which joins the os hyoides with the thyroid cartilage, and to the muscle named musculus thyro-hyoideus. This branch is both long and beautiful; it meets its fellow of the opposite side with free inosculations; it supplies cutaneous twigs, and twigs to the platysma myoides.

2. A second superficial twig goes downwards to the lower part of the thyroid cartilage, where it meets the cricoid, and there gives little arteries to the mastoid muscle, jugular vein, and skin.

3. There is another branch, which proceeds frequently enough from this second one: it belongs entirely to the larynx, for which reason the thyroid is often named the superior laryngeal artery: it dives immediately betwixt the cartilages of the larynx; it enters betwixt the thyroid and cricoid cartilages, and carries in along with it a nerve from the eighth pair of nerves; it gives its twigs to the epiglottis, and to all the small muscles which lie under cover of the thyroid cartilage, and which move the little arytænoid cartilages; and then passes outward, emerging from the larynx, and appears again supplying the crico-thyroideus muscle.

The fourth branch of the thyroid is properly the main artery, or continuation of this branch into the substance of the thyroid gland; it applies itself to the side of the gland, and nourishes its substance by a great many small branches into which it is divided. These branches are all oblique, tending downwards and forwards. Their course is upon the side of the gland; because, indeed, the gland consists chiefly of two lateral lobes, and hardly any of the gland, or only a small portion, crosses the trachea; consequently this artery does not inosculate so much with its fellow of the opposite side as with the lower thyroid, which comes from the subclavian artery, and whose branches, mounting upon the lower part of the gland, have pretty nearly the same degree of obliquity with those of the upper thyroid.

5. A branch of this runs across, and inosculates with the artery of the other side.

RECAPITULATION OF THE BRANCHES OF THE

ARTERIA THYROIDEA.	1. Rami Musculares. 2. Arteria Laryngea. 3. Ramus Anastomoticus. 4. Arteria Thyroidea Propria.

2. ARTERIA LINGUALIS.

The LINGUAL ARTERY is one of which the four branches are nearly of an equal size, and which of course require all of them to be equally well remembered. It is next to the thyroid, comes off immediately above it, goes forward towards the os hyoides, runs directly above the extremity of the cornu of that bone, and towards the tongue; it lies flat upon the side of the tongue upon its flesh or muscles, and gives the following branches:

1. Upon passing the horn of the os hyoides, it gives first one twig of less note backwards to the constrictor pharyngis, at the place where that constrictor arises from the horn of the os hyoides (viz. the constrictor medius); and it gives another branch forwards round the basis of the os hyoides, where it meets its fellow, viz. ramus anastomoticus: and to those who are acquainted with the muscles which arise from the os hyoides, it is needless to say what muscles it supplies.* This, which is named the RAMUS HYOIDEUS, seems to be very necessary, as it is a very constant branch; and when it does not come from the lingual, it infallibly arises from some other, commonly from the facial artery.

2. DORSALIS LINGUÆ is a branch which goes off from the lingual at the insertion of the stylo-glossus muscle into the tongue: it turns first outwards a little, and then inwards over the root of the tongue, where the arteries of the opposite sides meet, and form a sort of net-work. Its chief branches are directed backwards towards the epiglottis and mouth of the pharynx, amygdalæ, &c.

About the middle of the tongue, or about half way to the chin, measuring along the jaw, the lingual artery forks into two branches; the one below the tongue, the sublingualis, belongs to the sublingual gland and surrounding parts; the other remaining at the root of the tongue, belongs to the tongue itself.

3. SUBLINGUALIS then arises next; it comes from the side of the artery next the tongue; it runs under the sublingual gland, covered like it by the genio-hyoideus muscle, and emerges only when it arrives at the chin, where it terminates in the skin. Its branches are chiefly to the sublingual gland, which lies over it, and to the genio-hyoidei and mylo-hyoidei muscles and skin, for these are the parts which immediately cover it.

4. The ARTERIA RANINA is the larger branch of these two; it runs along the root of the tongue quite to the tip of it. In this course it is accompanied by its vein, which appears on the inside of the mouth when we turn up the tip of the tongue. This is the vein which the older physicians were so fond of having opened in sore throats; the artery is that which we are so apt to cut in dividing the frenulum linguæ; an awkwardness from which a great many children have died.

RECAPITULATION OF THE BRANCHES OF THE

ARTERIA LINGUALIS.
- 1. Rami Pharyngei.
- 2. Ramus Hyoideus Anastomoticus.
- 3. Arteria Dorsalis Linguæ.
- 4. Arteria Sublingualis.
- 5. Arteria Ranina.
- 6. Rami Irregulares Musculares.

* Viz. the hyo-glossus, digastricus, mylo-hyoideus, the genio-hyoideus, the genio-hyo-glossus, sterno-hyoideus, and hyo-thyroideus.

3. ARTERIA LABIALIS, OR FACIALIS.

The labial artery is named occasionally the EXTERNAL MAXILLARY artery, to distinguish it from one which goes off at a higher point, and goes to the inside of the jaw; or ANGULARIS, because it goes to the corner of the mouth and there divides; or FACIALIS, implying, that it supplies the face, as indeed it does as far as the angle of the eye and forehead, where there are other small arteries. Haller adheres to this name of LABIALIS, and in compliment to him we adhere to it.

This artery is still carefully kept down in the deep angle; although it is to come out upon the jaw, yet it is not exposed till it actually makes its turn: it lies under the stylo-hyoideus and the tendon of the digastric muscle*: it is very tortuous, that it may move along with the jaw, and lies still so deep, even when it approaches the jaw-bone, that it is forced to make a very violent and sudden angle when turning over it. This sudden turn, which is sometimes almost a circle, is made, as it were, in the heart of the great sub-maxillary gland, the artery being buried under it. The labialis is a very large artery, very tortuous; sometimes one great trunk gives off two important arteries at once, the lingual and the facial; in which case they separate just at the angle of the jaw, where the artery, dividing the substance of the gland, is quite imbedded in fat. When we consider how deep this artery lies according to this general description, and the parts which it passes along, it becomes easy to foresee what branches it will give, and to trace them in imagination.

1. Where it lies the deepest upon the side of the pharynx, it sends a branch directly upwards, which goes straight to the arch of the palate, spreading its small twigs upon the arch of the palate, upon the velum palati, and upon the uvula: it usually has two small branches for supplying these parts, one superficial and one deep; and thus the labial gives a particular artery to the palate, named ARTERIA PALATINA INFERIOR.

2. It gives a particular artery to the tonsil, which arises at that point where the stylo-glossus begins to mix with the other muscles of the tongue. This little artery penetrates the walls of the pharynx upon which it lies, and spreads its many twigs upon the tonsil and tongue.

3. While passing through the sub-maxillary gland, dividing it, as it were, into two parts, the labial artery gives a great many small twigs into the substance of the gland itself; and after these it gives many twigs to the tongue, the skin, the muscles, &c. Of these, two chiefly are remarkable; one, which goes to the pterygoid muscle chiefly, though it also gives branches to the constrictors of the fauces and palate, and to the root of the tongue; and another artery, more constant and regular, which breaks off at the place where the labial artery curls and bends to turn upwards; it runs superficially, and goes straight forwards to the root of the chin, where it is named ARTERIA SUBMENTALIS: it turns upwards over the chin to the face at the middle of the chin, and often inosculates with some of the arteries of the face: it sometimes comes from the sublingual artery.

But the artery having emerged from betwixt the lobes of the submaxillary gland, (for this artery in a manner divides it into lobes,) and from among the fat with which it is surrounded, makes a sudden turn over the angle of the jaw at that point where we feel it beating strongly; and then mounting upon the face, begins to give a new set of arteries.

1. A branch to the masseter muscle; for the labial artery passes over the jaw, and up the face, just at the fore edge of the masseter muscle; and this branch inosculates with a twig descending over the surface of the masseter from the temporal artery.

2. The labial artery ascending in the hollowest part of the cheek, and lying flat upon the buccinator muscle, gives out small branches to it, which inosculate chiefly with the transversalis faciei, another branch, and a considerable one coming from the temporal artery across the face. Here also the main artery has still a very serpentine line, on account of the continual motions of the part.

3. Before the artery comes to that point where it is to give off the coronary artery of the lower lip, it gives a branch named labialis inferior; which artery belongs to the lower part of the lower lip: its branches go to the triangularis and quadratus muscles, which lie on the chin and on the side of the chin, and also to the lower part of the orbicularis oris. This branch inosculates particularly with a twig, which comes from within the lower jaw through the mental hole, and with its fellow, and of course with the coronary arteries which run immediately above it, viz. in the red part of the lip.

The artery now divides into two branches, one for each lip, named the CORONARY ARTERIES, because they always surround the lips entirely, though their manner of going off is not perfectly regular. The lower coronary artery is usually smaller, and is to be named the branch, while the upper one not only surrounds the lip, but mounts along the side of the nose; it is larger; and is therefore to be considered as the continued trunk. We frequently observe the upper coronary larger on one side of the face, and the lower coronary larger on the other.

4. The LOWER CORONARY comes off about an inch or more from the angle of the mouth, at that point where the triangularis oris and many other muscles meet. It goes directly forwards to the angle of the mouth, enters into the lower part of the lip, and runs along the red pulpy part of it, where with the finger and thumb it can be felt beating. It inosculates with all the arteries formerly mentioned; as the submental, the twig which comes through the hole near the chin, the inferior labial artery, and with its fellow. With all these it inosculates so freely, that it signifies little from which side your injection is driven: it goes freely all round the lips, and the arteries are every where equally filled.

5. The UPPER CORONARY ARTERY we are to consider as the continued trunk. The labial artery is still rising, and still tortuous, when it arrives at the angle of the mouth; runs into the border or fleshy part of the upper lip, and runs along it till at the middle of the lip it meets its fellow of the opposite side, with a very free inosculation: yet the two arteries do not terminate here, but usually two very delicate arteries ascend towards the point of the nose, along that little ridge from the nose to the lip which we call the filtrum; and almost always a considerable artery runs up from the superior labial artery by the side of the nose. From this is given off a branch to the nose, viz. the NASALIS LATERALIS,

and now the artery still ascending, (under the name of ANGULARIS,) gives off branches to the cheek and eyelids, and growing gradually smaller, it arrives at last near the angle of the eye, and inosculates pretty freely with the branch of the internal carotid artery, which is named ophthalmic, because it first nourishes the parts of the eye with many branches, and then comes out of the orbit at the corner of the eye, where, though small, it may be felt beating distinctly.

ARRANGEMENT OF THE BRANCHES OF THE

ARTERIA FACIALIS.
1. Palatina Ascendens. { Ramus Palatinus Superficialis. / Ramus Palatinus Profundus.
2. Ramus Muscularis.
3. Ramus Tonsillaris.
4. Ramus Pterygoideus.
5. Arteria Submentalis. { Ramus Superficialis. / Ramus Profundus.
6. Ramus Massetericus.
7. Arteria Coronaria Labii Inferioris.
8. Arteria Coronaria Labii Superioris.
9. Arteria Angularis,—from which Nasalis Lateralis.
10. Ramus Anastomoticus Cerebralis.
11. Ramus Frontalis.

The *second* set of arteries, which go backwards from the external carotid, comprehend the pharyngeal, the occipital, and the auricular.

4. PHARYNGEA INFERIOR.

The LOWER PHARYNGEAL* is a small slender artery, which gives no branches deserving to be numbered ; it stands alone, and should be described as one simple artery, whose small branches spread all about the throat in the following manner.

This artery is smaller than any other branch of the carotid yet enumerated. It arises opposite to the lingual artery ; and as it arises from the inner side, it comes out in a manner from the fork betwixt the external and internal carotid arteries ; it rises upwards very slender and delicate : it lies deep in the neck, upon the fore part of the flat vertebræ, or rather lies upon the flat face of the longus colli muscle.† After rising in one slender artery, single, without branches or connections, it begins all at once to give twigs.

First, It gives branches inwards to the throat ; for one twig surrounds the lower part of the pharynx about the root of the tongue, and sometimes goes forwards along with the glosso-pharyngeal nerve into the tongue. Another twig goes to the middle of the pharynx, and wanders towards the velum palati, giving branches to the amygdalæ. And still another goes higher towards the basis of the skull. It also gives twigs to the velum palati, to the back of the nostrils, to the upper part of the pharynx where the upper constrictor lies, (viz. that which comes from

* It is named lower pharyngeal, to distinguish it from one which comes downwards from the internal maxillary.

† When dissected, it must be taken out in a manner from behind the pharynx. The carotids must be raised outwards before it can be seen ; for it lies under them, betwixt them and the throat.

the basis of the skull,) and it gives small arteries to nourish the basis of the skull; as, to the os sphenoides, to the cuneiform process of the occiput, to the point of the temporal bone, and to the cartilage of the Eustachian tube.

Secondly, It sends branches outwards to the mastoid muscle, to the jugular vein, to the ganglion of the intercostal nerve, and to the eighth pair; and one particular branch, very small and delicate, goes along conducted by the great jugular vein, enters together with it into the skull, and makes one of the arteries of the dura mater, but it is a very delicate twig.

In general, one artery only of the dura mater is known or mentioned; but we shall see, besides the great artery of the dura mater, lesser arteries entering to it by all the perforations at the basis of the skull. The pharyngeal actually terminates in the dura mater, passing through the foramen lacerum posterius, and sending also a branch in together with the jugular vein. The occipital artery also sends one with the jugular vein, one by the foramen mastoideum, and one by a small hole in the occiput. The temporal often sends one through by the hole in the back part of the parietal bone.

5. ARTERIA OCCIPITALIS.

The OCCIPITAL ARTERY is also a simple artery, distributing its twigs about the ear, over the occiput, and down the back of the neck, and having no branches of sufficient importance to be particularly marked.

It arises next to the pharyngeal from the back part of the carotid; and lying particularly deep, it not only is covered at its root by the other branches of the carotid, but is covered in all its course by the thick muscles of the neck, except just where it is passing behind the mastoid process.

At first the occipital artery lies close in among the bones, passing over the transverse process of the atlas, crossing the root of the great jugular vein, and passing under the root of the mastoid process so as to lie at this place under the belly of the digastric muscle. Still, as it encircles the occiput, it passes along very deep under the bellies, first of the trachelo-mastoideus, and then of the splenius and complexus, and emerges only when it arrives at or near the middle ridge of the occiput; and, lastly, it rises with many beautiful branches over the back of the head, to meet the branches of the temporal artery.

In this course the occipital artery sends out the following branches:

1. Branches to the biventer, which lies over it, and to the stylo-hyoideus muscle; and there is one longer artery which attaches itself to the root of the mastoid muscle, and passes along that muscle to inosculate with the thyroid arteries, or with the lower cervical arteries which mount upwards as this descends.

2. Next it gives, like the pharyngeal, a small artery, which goes backwards along the jugular vein; and having entered by the foramen lacerum, attaches itself within the skull to that part of the dura mater which lies under the lobes of the cerebellum.

3. The occipital artery, as it passes under the ear, sends out to it a

small posterior artery, which goes to the little lobe of the ear, and creeps up along its posterior border.

4. At this point the occipital often gives another artery, which passes upwards behind the ear, and is named the POSTERIOR TEMPORAL ARTERY.

5. The occipital artery, as it passes under the trachelo-mastoideus and splenius, gives branches to these two muscles; and it sends out from betwixt the trachelo-mastoideus and complexus a long branch (the *cervicalis*), which descends along the neck a considerable way; and after having further supplied the splenius, complexus, and also the deeper muscles of the neck, it terminates by inosculating with a branch from the axillary artery, which as it crosses the neck is named transversalis colli. This descending branch of the occipital inosculates also with the vretebral arteries through the interstices of the vertebræ.

Having pierced the belly of the complexus, the artery now rises over the occiput in small and beautiful arteries; the chief of which belong to the occipital belly of the occipito-frontalis muscle and to the skin: it finally ends in inosculations with the backmost branches of the temporal artery. But of these extreme twigs of the occipital, two are remarkable, because they pass through the skull to the dura mater; one through a small hole in the occipital spine, and one through that small hole which is behind the mastoid process. Sometimes the hole is in the temporal bone, but more frequently in the suture which surrounds the back part of the temporal bone.*

RECAPITULATION OF THE BRANCHES

OF THE ARTERIA OCCIPITALIS.	1. To the Styloid Muscles and Jugular Glands.	
	2. Through the Foramen Lacerum to the Dura Mater.	
	3. Ramus Auricularis.	Ramus Temporalis posterior.
	4. Ramus Cervicalis	Ramus Superficialis. Ramus Profundus.
	5. Arteria Occipitalis	Propria Ascendens.

6. ARTERIA POSTERIOR AURIS.

The POSTERIOR ARTERY OF THE EAR is the smallest and least constant of all the arteries which go off from the carotid; for it is often wanting, or often comes from some branch, and not from the carotid itself; often from the occipital, sometimes from the pharyngeal artery; it can scarcely be reckoned as a regular branch of the carotid. This artery, also, like the pharyngeal and occipital, gives out no distinguished branches which we need to mark; it chiefly belongs to the ear; it gives branches to the cartilage of the external ear; it sends a larger branch through the stylo-mastoid hole to the internal ear, and the rest of its twigs go to the integuments, or to the bones.

The POSTERIOR AURIS arises much higher than any of those arteries which have been just described; it does not come off from the external

* Viz. the additamentum suturæ squamosæ.

carotid till it reaches the parotid gland; or rather it arises where the carotid is plunged into the substance of that gland; it passes directly across under the styloid process, and over the belly of the digastric muscle, and then goes up behind the ear: in this passage it gives branches to the parotid gland, and to the biventer muscle, the parts on which it lies; next it gives a twig, which furnishes the root of the cartilage of the ear, and perforates the lowest part of the cartilage, so as to spread itself upon the drum of the ear; this branch is named ARTERIA TYMPANI.

Its next branch, the ARTERIA STYLO-MASTOIDEA, is the most remarkable, for it is of considerable size, enters the mastoid hole, while the portio dura, or great nerve of the face, comes out: it is a chief artery of the internal ear; for it gives branches, 1. to the tympanum, one of which beautifully surrounds the bony circle, and then spreads upon the membrane itself; 2. to the muscle of the stapes, to the semicircular canals, to the cells of the mastoid process and its delicate vessels; which arteries, when well injected with size, paint the walls of the cavity of the tympanum, and of the semicircular canals.

The main artery having given off the arteria tympani and this stylo-mastoid artery, and having passed the stylo-mastoid hole, becomes properly the arteria posterior auris, rising behind the ear, and giving its branches to the skin and mastoid muscle, and to the muscle behind the ear, (posterior auris,) and to the bone and periosteum, chiefly about the mastoid process; then its small branches play round the back part of the concha or shell of the ear; and, lastly, the artery, still mounting behind the ear, ends in small twigs, which go to the fascia of the temporal muscle, and which, of course, inosculate above the ear with the temporal artery.

The *third* order of arteries includes the termination of the external carotid artery in the temporal and maxillary arteries, which is after the following manner:

EXTERNAL CAROTID ARTERY — *continued.*

The artery having entered into the parotid gland, lies there absolutely imbedded in its substance; and of the two arteries in which it terminates, one passes directly through the substance of the parotid gland, emerges before the ear, mounts upon the temple, and is named of course the TEMPORAL ARTERY; it performs here in the temple the same office which the occipital does behind, viz. it supplies the pericranium, muscles, and skin: all this is very simple. But the other branch, in which (since it is exceedingly large) one would say the carotid terminates, goes off from the temporal with a sudden bend, sinks very deep under the articulation of the lower jaw, terminates in a leash of branches at the back of the antrum Highmorianum, and there gives branches to the lower jaw, the upper jaw, the inside of the cheeks, to the temple, (deep arteries which lie under the temporal muscle,) to the upper part of the pharynx, to the nostrils, and to various other parts: it is this artery too which gives off the chief artery of the dura mater. The description of so great an artery, so widely distributed, becomes both difficult and important.

7. ARTERIA MAXILLARIS INTERNA.

The INTERNAL MAXILLARY ARTERY turns off from the temporal artery while imbedded in the substance of the parotid gland, and about the middle of the upright branch or process of the lower jaw-bone. It passes betwixt the lower jaw-bone and the outer pterygoid muscle; it then goes forwards till it touches the back part of the antrum maxillare, and terminates in a leash of vessels betwixt the back of the antrum and the pterygoid process; and, finally, it ends at the spheno-maxillary fissure, or, in other terms, at the bottom of the socket of the eye, where it gives the infra-orbitary artery, and a branch to the back of the nostrils.

In all this course the internal maxillary artery is extremely tortuous: first, it rises with a high and round turn at that point where it goes off from the temporal artery; then it bends suddenly downwards, where it passes betwixt the pterygoid muscle and the jaw-bone; then, as it approaches the back of the antrum, it rises with a third bending, and continues rising, with very great contortions, till it ends in small vessels at the back of the eye and nostrils.

Before this artery gives out its greater branches, which require to be marked with numbers, it very generally gives some small twigs, nameless, and of less note; as a small twig to the ear, and the glands around it, another which gets into the tympanum to the bones and cells, and a branch of it sometimes goes into the skull by that hole named foramen ovale, by which a division of the fifth pair of nerves comes out, and goes to that part of the dura mater which covers the sides of the sella turcica.

Of the larger branches which the internal maxillary gives out, the first is the ARTERIA MENINGEA, the great or MIDDLE ARTERY of the DURA MATER. It goes off from the maxillary just where it leaves the temporal artery. Sometimes before entering the skull it gives small branches to the pterygoid muscles, to the mouth of the Eustachian tube, to the os sphenoides, and sometimes through that bone to the dura mater; but the main artery passes through what is called the spinous hole, which is in the very extreme point or spine of the sphenoid bone: it is this artery of which the surgeon should be particularly aware, and which touches the parietal bone at its lowest corner in the temple, and spreads from that point all over the dura mater like the branches of a tree. But besides these, its chief branches, which spread thus upon the parietal bone, on its inner surface, it gives smaller ones, which go into the substance of the bone, or into the ear, and sometimes through the orbit into the eye. Thus first several smaller twigs go into the substance of the os petrosum to nourish it; the holes may be seen about the rough part, where the os squamosum and os petrosum are united; next two twigs enter into the aqueduct by the small hole on the fore part of the petrous bone, one keeping to the canal itself, the other going to the cavity of the tympanum, and to the chain of bones there; and, lastly, one or two small twigs pass through the outer end of the foramen lacerum into the orbit, and go to the lachrymal gland.*

* Sometimes the great and proper artery of the lachrymal gland, instead of arising

The LOWER MAXILLARY ARTERY is a slender and curious artery, which belongs chiefly to the teeth of the lower jaw, and which runs all along in a canal within the jaw-bone. The internal maxillary proceeds nearly an inch before it gives off this branch; and then, while lying under the pterygoid muscle, it gives off a long and slender artery, which enters the jaw-bone at that great hole which is betwixt the condyloid and coronary processes; then runs all along within the jaw-bone, surrounding each of the teeth with arteries at the bottom of each socket. About the middle of the jaw-bone it divides into two branches, which proceed together in the bony canal, till one of them emerges upon the chin at the mental hole, inosculating there with the arteries of the face, viz. the labial and submental arteries, while the other goes onwards to supply the roots of the fore teeth also, and to meet its fellow within the jaw-bone at the chin. The nerve for the lower jaw enters along with this artery; the vein of this artery accompanies it, but lies under it in a separate canal, though still in the same line. The artery itself, before it enters into the hole of the lower jaw, commonly gives twigs to the inner pterygoid muscle which covers the hole. Considering the size of this artery, we cannot wonder at profuse bleedings from the teeth, or rather from their sockets.

The PTERYGOID ARTERIES.—While the artery is thus crossing betwixt the jaw and the pterygoid muscle, it gives branches to the external pterygoid muscle, both into its substance and over its surfaces. The number of these pterygoid arteries is variable and unimportant.

Next, while the maxillary artery is passing in a contorted form under the zygoma, where the temporal muscle is lodged, it gives off two arteries, which are called the DEEP TEMPORAL ARTERIES, to distinguish them from the proper temporal artery, the only one which we feel outwardly, and which is superficial. Of these two deep temporal arteries, one runs more outwards, viz. towards the ear, the other runs more inwards, viz. closer upon the bone; whence the one is called the DEEP EXTERNAL, the other the DEEP INTERNAL TEMPORAL ARTERY.

The DEEP EXTERNAL TEMPORAL ARTERY arises where the maxillary is passing under or near the jugum; it is of course near the coronary process of the jaw-bone. This branch then passes along the tendon of the temporal muscle, and ends in that muscle, giving branches also to the external pterygoid muscle; it is a short artery, and not very important by its size.

The DEEP INTERNAL TEMPORAL ARTERY arises further forwards, viz. where the artery is close upon the back of the antrum; from which point, mounting directly upwards, it passes in the very deepest part of the temporal arch, viz. that which is formed by the cheek-bone. It is longer and more important than the outward branch, supplies the deepest and thickest part of the temporal muscle, mounts pretty high upon the temple betwixt the muscle and the bone, and often, where it lies behind the cheek-bone, it sends a branch through that bone into the orbit which supplies the fat and periosteum of the socket, and in some degree also the lachrymal gland.

from the ophthalmic or proper artery of the eye, arises thus from the artery of the dura mater.

The ARTERY OF THE CHEEK is a very regular artery, in so far as regards its destination, viz. for the cheek; but in its origin it is extremely irregular. It has not often the importance of coming off as a distinct branch from the maxillary; but comes off rather more frequently from some of its branches, as from the deep temporal artery just described, or from the alveolar, or infra-orbital arteries, which are presently to be described. This artery perforates the buccinator muscle, and is spent upon it, and upon the other muscles of the cheek, as the zygomaticus and levator labii; it ends, of course, by inosculations with the arteries of the face.

The ARTERY OF THE UPPER JAW serves much the same office with that of the lower jaw, viz. supplying chiefly the sockets of the teeth; whence it is named ARTERIA ALVEOLARIS. It is an artery fully as large as that of the lower jaw; it begins upon the back of the antrum Highmorianum, and runs round that tuberosity towards the face and cheek with very tortuous branches. Its branches are distributed first to the buccinator and fat, which fills up the great hollow under the cheek-bone, and also to the cheek-bone itself, where it is connected with the jaw-bone. Secondly, Other branches perforate into the antrum Highmorianum by small holes, which are easily seen upon its back part, and some of these branches go into the sockets of the backmost teeth. Thirdly, A more important branch than any of these, the branch indeed from which it has its name of alveolar artery, enters by a hole into the substance of the jaw-bone, and goes round in the canal of the teeth, just as the artery of the lower jaw does, giving branches to each socket. The curlings of this artery upon the back of the antrum are very curious; and while its deeper artery furnishes the teeth, some of the superficial branches go to the gums.

The INFRA-ORBITAL is so named from the hole or groove by which it passes all along under the eye from the back of the nostril till it emerges upon the face. The infra-orbital, and the branch last described, viz. the alveolar artery, generally come off from the maxillary by one common trunk; the alveolar goes forwards and downwards by the back of the antrum: the infra-orbital mounts upwards, and enters the spheno-maxillary hole, or rather it comes off just at the spheno-maxillary hole, which is the great slit at the bottom of the eye. As the artery enters its proper canal at the bottom of the eye, it gives some twigs to the periosteum and to the fat of the socket; as it passes along its canal in the bone one branch dives down into the antrum through the bone; for this plate of bone in which its groove runs is at once the floor of the eye and the roof of the antrum; within the socket it gives twigs also to the deprimens oculi, and to the lower oblique muscle, to the lachrymal sac, or even to the nostrils; when it emerges from the socket by the infra-orbitary hole, it terminates in the levator labii and levator anguli oris, and in inosculations with the arteria buccalis, labialis, and especially with the nasal branch of the ocular artery. This infra-orbitary artery is accompanied through the canal, and out upon the face, with a small nerve of the same name, viz. the infra-orbitary nerve.

After this, the maxillary, though nearly exhausted, still sends out three small arteries, in which it terminates irregularly, sometimes one, sometimes another twig being larger. Of these three, one goes to the palate, one to the pharynx, and one to the nostrils.

THE UPPER PALATINE ARTERY arises near the infra-orbital; and from that point, viz. the spheno-maxillary slit, it descends along the groove, which is formed betwixt the pterygoid process and the palate-bone; and when it has gone down to the palate, one lesser branch turns backwards through the posterior palatine hole, and expands upon the velum palati; the other larger branch is the great palatine artery, for it comes through the anterior or larger palatine hole; the artery itself is large; it runs all along the roof of the mouth betwixt the pulpy substance of the palate and the bone; in this progress it gives little arteries to the sockets of the teeth, and it frequently terminates, not merely in the palate itself, but in a small artery which runs up through the foramen incisivum, or hole under the fore teeth, into the cavity of the nose. This artery is also accompanied with a corresponding palatine nerve.

The UPPER PHARYNGEAL ARTERY is the highest of all the branches of the internal maxillary; it goes off at the back of the orbit, opposite the spheno-maxillary fissure; it ascends along the sphenoid bone to the place of the sphenoidal sinus, and along the upper part or arch of the pharynx, where that bag adheres to the basis of the skull; it also goes along the sides of the pharynx. Its twigs are of very diminutive size; some go into the substance of the sphenoid bone to nourish it by small holes both over the cells and in the alæ; a branch goes towards the pterygoidean or vidian hole*, where it inosculates usually with a branch from the internal carotid artery, sometimes with the lower pharyngeal, or with the meningeal arteries.

This artery ends in small branches which play round the mouth of the Eustachian tube.

The NASAL ARTERY is the last branch of the internal maxillary. It passes through the spheno-palatine hole†; by this opening it comes into the nostril at its upper and back part; the twigs go, one shorter to the backmost of the æthmoid cells, another to the cells of the sphenoid bone; one longer branch goes to the back part of the septum narium; and one branch, the longest of all, often passes both the upper and lower spongy bones, (along the lining membrane of the nose, giving twigs to the antrum as it passes,) till it inosculates with that twig of the palatine artery which rises through the foramen incisivum into the nose. This nasal artery often has two branches.

These branches are so numerous, and so small, that they require recapitulation.

MAXILLARIS INTERNA.

1. Ramus Auricularis.
2. Arteria Meningea Media.
3. Arteriæ Parvæ.
4. Arteria Maxillaris Inferior.
5. Arteriæ Pterygoideæ.
6. Arteriæ Temporales Profundæ.
7. Arteria Alveolaris.
8. Arteria Infra-Orbitalis.
9. Arteria Palatina Maxillaris.
10. Arteria Pharyngea.
11. Arteria Nasalis.

* This is the hole by which the recurrent of the 5th pair goes backwards from the nose into the skull.

† Observe, this is not the spheno-maxillary slit so often mentioned, which is a slit-like opening lying between the wing of the sphenoid bone and the upper jaw-bone; and,

8. ARTERIA TEMPORALIS.

The TEMPORAL ARTERY, if we consider its straight direction, may be regarded as the termination of the external carotid artery. When the maxillary artery bends away from it to go under the jaw, this goes directly forwards through the substance of the parotid gland, mounts before the ear, and as it passes alternately the parotid gland, the face, the ear, it gives its three chief branches to these parts, and ends in that temporal artery which runs along the side of the head under the skin, which we feel, and even see distinctly, beating, and which we open when bleeding in the temples is required.

The temporal artery is named SUPERFICIAL, because of its lying under the skin only, above the fascia of the temporal muscle, while the deep branches from the maxillary artery lie under the muscle.—The temporal artery passes just before the meatus auditorius, and behind the branch of the jaw-bone; it pushes its way through the substance of the parotid gland, and there it gives its first branches, commonly seven or eight in number, but quite irregular, into the substance of the gland itself; next it gives off to the face an artery of very considerable size, which arises from the same part of the artery with these parotideal branches, viz. under the zygoma and within the gland: like them it goes off almost at a right angle, and is like one of them, but larger, nearly of the size of a crow-quill; it pushes sideways through the substance of the parotid, emerges from it upon the face just below the cheek-bone, and runs across the cheek in the same direction with the parotid duct; it is named from this direction TRANSVERSALIS FACIEI. Its branches go to the joint of the jaw-bone, the masseter, buccinator, parotid gland, &c. and terminate in inosculations with all the arteries of the face.

Next the temporal artery, as it rises towards the zygoma, and of course approaches the angle of the jaw, gives an artery which is proper to the articulation of the jaw. This artery belonging to the joint of the jaw is often named ARTERIA ARTICULARIS. After having sent its two branches to the articulation of the jaw, it sends another artery to the ear, which divides into two twigs; one of them, going round the back part of the ear, assists the branch of the stylomastoid artery in forming the little circular artery of the tympanum; while another branch, penetrating through the slit which is in the articulation of the lower jaw, goes to the muscle of the malleus.

But before it reaches the zygoma, the temporal artery gives another branch, which is named the MIDDLE TEMPORAL ARTERY, to distinguish it from the deep temporal arteries which lie under the whole thickness of the temporal muscles, and the superficial temporal, which lies above the fascia; for this middle temporal artery lies under the fascia; but on the outside of the muscle it arises from the main artery just under the zygoma, rises over the zygoma, and then pierces its way under the fas-

as it is at the bottom of the socket, whatever parts enter it go to the eye. The spheno-palatine hole is betwixt the sphenoid and palate bones; it is at the back of the nostrils, and the branch which enters it belongs to the nostril.

cia of the temporal muscle, and under that covering gives branches to the temporal muscle, the artery itself still rising and passing obliquely forward towards the outer corner of the eye, where one of its twigs often goes to the orbicularis oculi, and inosculates with the ophthalmic artery.

About this point, or rather above the zygoma, the temporal gives off those small arteries, irregular in number, which are named ANTERIORES AURIS, the anterior arteries of the ear, and which play all round the fore part of the ear.

The temporal artery having now emerged from the parotid gland, and from the thick fascia which covers it, makes a sudden serpentine turn before the ear; and then rising about half an inch perpendicularly, it forks with a pretty wide angle into two arteries, which are named the anterior and posterior temporal arteries. These lie quite superficial under the skin, above the fascia, and are distributed in this manner: First, the ANTERIOR TEMPORAL ARTERY goes directly forwards to the naked part of the temple, and runs up the side of the forehead with a very serpentine course; it is here that in old men we see its contortions and pulsations very distinctly; it goes round arching forwards, and upwards from the temple towards the top of the head. It belongs chiefly to the skin and frontal muscle, and that tendinous kind of sheath which covers the cranium; it gives some branches to the orbicular and corrugator muscles; it forms often a superciliary arch with the proper frontal artery; it often sends off a branch very early towards the outer corner of the eye, which is entirely destined for the orbicularis oculi.

The POSTERIOR TEMPORAL ARTERY is the last branch of all. It arches backwards over the top of the ear; it turns thus backwards till it meets the branches of the occipital artery; it deals its branches from either side upwards and downwards, *i. e.* towards the ear, and towards the top of the head in great profusion, till it is quite exhausted. These branches belong to the skin chiefly and to the pericranium; and the smaller twigs pierce the outer tables of the skull, and go into the bone in great profusion for its nourishment.

RECAPITULATION OF THE BRANCHES OF THE

TEMPORALIS.
1. Ramus Massetericus.
2. Arteria Transversalis faciei. { Comes Ductûs Parotidei.
3. Arteria Temporalis Subfascialis.
4. Rami Auriculares.
5. Arteria Temporalis Anterior.
6. Temporalis Posterior.

CONCLUSION.

It would surely be wrong to conclude the description of a system of arteries so important as this, without attempting to interest my reader in this piece of anatomy, by observing a few anatomical and surgical facts.

It is natural to observe, as a thing which may prevent confusion in the student's mind, how irregular (after all our attempts at arrangement) the smaller arteries unavoidably must be; how natural it is that each particular part should draw its blood from all the arteries which are near or round it. The ear has its posterior artery peculiar to itself; but it has also an anterior artery from the temporal, where it lies under the parotid gland; and it has even a superior auris from that branch of the temporal artery which bends round towards the occiput, and arches over the ear. The dura mater has its great middle artery appropriated to itself, a peculiar branch, the first of the maxillary artery; but it has besides small assisting arteries, entering by almost every point at the basis of the skull; and especially it has arteries from the maxillary, by the mouth of the Eustachian tube, from the pharyngeal, running in by the hole for the great jugular vein; and from the occipital, both by the hole of the jugular vein in the basis of the skull, and also by the small occipital hole in the back part of the skull, close by the temporal bone. The throat also, though it has many peculiar arteries, derives its branches from a great many sources; as from the lingual artery by twigs, which cross the root of the tongue; from the labial artery by branches, which go to the tonsil, tongue, and palate; from the pharyngeal artery, many branches, not confining themselves to the pharynx, stretch forwards to the palate, tongue, and tonsils; and, lastly, the maxillary artery gives a profusion of branches to all parts of the throat. These may serve as hints by which the student, if he wishes to become a correct anatomist, may trace the inosculations; or for the surgeon, if he wishes to separate the study of this minute anatomy from that of the greater arteries.

But there is a circumstance which may guide the student in the study of the arteries. The confusion or intricacy of branches arises from our manner of counting them off from the trunks; now the manner of the branching varies, whilst there is no variety in the place of any artery, or the manner of its final distribution.

The thyroid artery, or the lingual artery, may come off separately, or together, but they never vary in their exact place; their relation to the thyroid cartilage, or to the cornu of the os hyoides, or to the muscle, or the nerve, is invariably the same. Some advantages might be had, by arranging the arteries according to their destination, instead of their departure in succession from the trunk: but the latter mode gives so great a facility to the learner, that we shall not depart from it.

The surgeon's interest in understanding these arteries is very strong. It were impossible to enumerate all the various occasions on which this piece of anatomy may be useful; but, surely, one may easily say enough on this subject to attach the young surgeon to the diligent study of these arteries.

Among the various motives for diligence, I would mention these: the terrible hæmorrhages which he is daily called to stop, when suicides, though they have not cut the carotids, have cut the great arteries of the thyroid gland: the necessity of thinking about the tumours of the gland itself; for I have had the unhappiness to see a person perish by suffocation, while consulting-physicians forbade any operation; and I had no other than the melancholy privilege of watching, for many hours, the last struggles of a person, who had the day before been walking through all the rooms in tolerable ease and health. Could nothing have been resolved on? Must we always submit to this? Might not an incision in the fore part (where few arteries are) have at least uncovered the trachea, given a temporary relief, and made the tumour suppurate more freely? The extirpation of the tongue, which is mentioned with horror, would be a less terrible operation to one acquainted with these arteries; the extirpation of all tumours under the jaws is dangerous; the cutting out completely the parotid gland is a thing quite impossible, since the greatest of all the arteries, viz. the temporal and the maxillary, lie absolutely imbedded in the gland. What shall we think, then, of those surgeons who talk in such familiar terms of cutting out the parotid gland? Bleedings from the nose have been so often fatal, that Petit is celebrated to this day for a discovery which he never made, viz. the way of plugging the nose so as to stop this bleeding. Have not the French Society been busy renewing inventions for securing even so small an artery as that of the dura mater? In the hare-lip operation, in cutting cancers, in dissecting tumours from all parts of the face, the surgeon commands the blood only by knowing these arteries. Cowper, the celebrated surgeon and anatomist, had his head so full of this project, that instead of waiting for hæmorrhage during his operation, he cut off two days before the chief source of the blood. He was going to cut out the parotid gland; and two days before he placed a small button of caustic on each side of the labial artery, where it lies upon the cheek, passed a ligature under it, tied it firm, and then proceeded to his operation next day. But this great anatomist made at one stroke two grievous blunders: he missed, for want of knowledge, the chief arteries of the parotid gland, for they come from the temporal artery; and, if I mistake not, he had tied the vein, for most assuredly it is the facial vein which he is describing in his twelfth table from Bidloo. How terrible the extirpation of tumours from the gums, throat, tonsils, &c. is, I need not say; where the surgeon always uses burning irons instead of needles, where not unfrequently the patient dies.

OF THE ARTERIES OF THE BRAIN, SPINAL MARROW, AND EYE.

OF THE ARTERIES OF THE BRAIN.

THE INTERNAL CAROTID ARTERIES are named the ARTERIÆ CEREBRI, as being the chief arteries of the brain; while, in truth, the brain is also supplied by two other arteries nearly equal in size, viz. the vertebral arteries, which though they do indeed arise from a different trunk, viz. the subclavian artery, yet are so entirely destined for the brain, give so few branches before they reach the skull, are so important when they arrive there, and above all make so large a communication with the carotid arteries, that without a description of the vertebral arteries, any description of the carotids must be defective. They unite so with the carotids as to form but one great system of vessels for supplying the brain.

The two greatest functions of the animal body, those of the womb and of the brain, the one for the life of the individual, the other for the continuation of the species, are the most liberally supplied with blood.

The womb has on each side two arteries; it has two spermatics, and two hypogastrics; and the inosculations of these vessels are very large and free. The brain has two great arteries on each side; it has two carotids, and two vertebral arteries; they are infinitely larger than those of the womb; their inosculations are so particular, that there are no others like them in all the body: the injection of any one artery easily fills the whole; the preservation of but one artery saves the life of the creature, when others are stopped.

These four arteries alone convey to the brain the fifth part of the whole mass of blood. This is the calculation made by Haller; and even those who would settle it at the lowest point still acknowledge, that the carotid and vertebral arteries receive at least the tenth part of all the blood of the body. The brain, then, which weighs not a fortieth part of the whole body, receives one tenth of all the blood; a proportion which must occasion surprise.

Besides the profusion of blood which thus rushes into the brain, the impetus with which it forces its way seems dangerous; and Nature also seems to have provided against the danger. We cannot be but sensible of this danger; for the slightest increase of velocity occasions strange feelings, if not absolute pain. We cannot run for any length of way, nor ascend a stair rapidly, nor suffer a paroxysm of fever, nor, in short, have the circulation quickened by violent exertions, by emotions of the mind, or by disease, without feeling an alarming beating within the head; we feel it particularly in the carotid canal where the artery passes through the bone. If it continue from disease, or if we persist in our exertions, giddiness, blindness, ringing of the ears, come on. Haller remembers, that while he was lying in a bad fever, he suffered so much from the pulsations of the carotid artery within the skull, that his head was lifted from his pillow at every stroke. I wish he had said, "seemed to be lifted from his pillow at every stroke;" for it was rather a sickly feeling than what could actually happen.

Did this vast column of blood rush directly into the brain, we do not know what might be its effects; but surely they could not be harmless, since Nature has provided against it in man, and in the lower animals which hang their heads, with a peculiar care. In Man, this blood is retarded chiefly by the tortuous course which the artery is obliged to follow*, and by that long bony canal which, by holding the carotid as in a sheath, must suppress its violent action, and at least prevent its being dilated by force of the blood, when, as often happens, the lower part of the artery is more full and tense. Perhaps also it may have some effect, that the carotid, as it lies by the side of the sella turcica, is not naked and free, but is inclosed in a venous sinus, which consists of cells like those of the male penis, and in the heart of which the carotid lies.

It is also peculiar in all the arteries of the brain, that they do not enter in trunks into its substance. This seems to be a violence which the soft texture of the brain could not bear; but all the arteries, having perforated the dura mater, attach themselves to the pia mater, a delicate membrane, which is the immediate covering of the brain; which follows

* Although this be true, still the subject is pursued further when speaking of the circulation of the blood through the arteries.—C. B.

all its divisions, lobes, and convolutions; which enters all its cavities, and lines its internal surfaces as it covers the external. To this membrane of the brain the arteries attach themselves: it conducts them every where along the surface of the brain, and into its cavities; and when the arteries are to enter into the substance of the brain, they have already branched so minutely upon the pia mater, that they enter into the pulpy substance in the most delicate twigs; so that having injected the brain, at whatever level you cut into it, you find its white surface dotted with red points regularly, and like the dots of a pin.

But in the lower animals, especially in the Calf, the Deer, the Sheep, which hang their heads in feeding, there is a provision of so singular a nature, that we can have no doubt that these contortions of the great trunks and minute divisions of the smaller arteries in Man have the same final cause; for in those creatures the carotid, before it enters the brain, first divides into innumerable smaller arteries. Not one of these is sent off for any particular function; they are immediately reunited again, and gathered together into one trunk; and then the force of the blood being thus broken, the artery divides a second time into branches of the ordinary form, which enter safely into the substance of the brain.

It is still further supposed, that the arteries of the brain have this peculiarity, distinct from all others in the body, that as they enter the skull they lay aside one of their coats, and that of course the arteries of the brain are peculiarly weak. That the arteries of the brain want that outward coat of cellular substance which all arteries passing through other cavities or along the limbs have, is no doubt true, and so far they are thinner: but how much they are weakened by this loss, it is not easy to say; for they want none of the coats which are essential to the constitution of an artery; and this cellular coat, though it constitutes much of the thickness of an artery, has, I believe, but little to do with its strength. Yet true it is, that the arteries of the brain, either from being weaker in themselves, being less supported, lying upon the soft and pulpy substance of the brain, are more frequently burst by falls, or even by the slightest accidents, than the arteries of any other part, even the limbs, however much exposed. Our injections burst them very often; the slightest blow or fall upon the head often produces an internal effusion of blood, which occasions death; but that the arteries of the brain are so delicate as to be burst by a false step, so as to produce a fatal aneurism within the brain, is a truth perhaps not commonly known.

A young woman, carrying in her arms her first child, about six months old, slipped her foot with a slight shock; but it was on plain and even ground, and she did not fall down. In the instant of this shock she was sensible of a sudden pain in the right side of her head: it was so peculiar, that she said she could cover the point with her finger; and though slighter at intervals, this pain never left her to the moment of her death. She walked home, went about her little family matters, suckled her child; but was seized that evening with sickness, not violent like that of any sudden disease, but rather like the easy vomiting of a pregnant woman.

She continued very sick, with slight head-ach; but still was out of bed all day long, went about her household affairs, and had no symptom which could lead one to suspect her very dangerous condition, or what a dreadful accident had happened. She got up during the night after this accident for some cool drink, felt herself extremely giddy, was obliged to support herself by a chest of drawers which stood by her bed-side, and went to bed again immediately. On the evening of the second day she got out of bed, made tea as usual, was out of bed during the evening, had no complaint, except the continual sickness, slight pain of the head, and giddiness still slighter. That night she expired. Her pulse all along had beat low and weak, and never more than 60 in a minute.

When I was brought to open the body, I heard nothing of the pain of her head, though it was fixed and constant, and without that nothing could be more puzzling than this combination of circumstances. First, the sudden slipping of her foot, and the incessant sickness which ensued, suggested the idea of hernia; but no such secret was known among her relations; and upon opening the abdomen, no hernia was found, neither open nor concealed, as in the thyroid hole.

Next we were informed of a palpitation, which had been usual with her. It appeared that she had complained chiefly about the period of her first menstruation, and some years before her marriage. It seemed to be hysterical merely; but upon opening the thorax, we found the heart wonderfully enlarged and crammed with a dark and grumous blood.

But next a new scene opened upon us; and this enlargement of the heart appeared to arise like that of the liver, which so often accompanies fractured skull, from the languid action of the heart and torpor of all the system in those who lie even for a few days comatose.

Now, for the first time, I was informed that the shock of slipping her foot had caused a sudden pain of the head; that it was pointed, confined to one single spot, incessant, accompanied with perpetual vomiting, or desire to vomit, and with giddiness during the night.

Upon opening the head, I found the dura mater of a most singular appearance; livid, or rather like the gizzard of a fowl, with green and changing colours. Having cut it open, the pia mater appeared like red currant jelly, with fresh coagulated blood so firmly attached to it, that it seemed as if driven into its very substance, and incorporated with it. Upon cutting and tearing open the pia mater, each convolution of the brain was surrounded and separated from that next it by coagulated blood. Upon cutting into the ventricles of the brain, that of the right side was found to contain four ounces of entire and coagulated blood; the cavity at first view was like opening a ventricle of the heart; the blood, very dark and firmly coagulated, was forced out by the pressure of the surrounding parts; the coagulum became gradually firmer and whiter, till it turned to a very firm stringy clot, which stuck in the mouth of the middle artery of the brain. Being carefully examined, it was found to be sticking firm in the mouth of the artery which had burst, as if by the separation of two of its rings. The blood, which thus filled the right ventricle, had also made its way down in prodigious quantity into the third and fourth ventricles, quite into the occipital hole; but the opposite ventricle it had not filled.*

* This case is preserved here as an example to the reader of the manner in which Mr. John Bell narrated his cases. Were the subject to be pursued, many other cases

The quantity of blood ascending to the head is exceedingly great; its free circulation in all the arteries is perfectly secured; and the plan of its distribution is extremely simple, for the carotid entering by the os petrosum gives three branches. First, a branch which unites the two carotids with the two vertebrals, and forms the fore part of the circle of Willis. Secondly, it gives an artery to the great middle lobe, whence it is named the great middle artery of the brain. Thirdly, an artery which is named anterior cerebri, as belonging to the fore part of the brain. But the vertebral, as it arises through the occipital hole, lies upon the cerebellum, and supplies all the cerebellum, and also the back part of the cerebrum. One branch goes to the back part of the cerebellum, another to the fore part of the cerebellum, a third branch goes to the back part of the brain; and thus there is formed betwixt the carotid and the vertebral, by means of the great inosculation of the circle of Willis, one great set of vessels; which should first of all be described free from all the interruptions of trivial arteries, which go off from point to point, but of which the destinations cannot be important, which are hardly known, which do not go in any two subjects the same way.

OF THE INTERNAL CAROTID ARTERY.

The internal carotid artery leaves the external carotid at the angle of the jaw: it is so inclined to contortions that at this point it bulges, and even seems the outermost of the two. In mounting along the neck, it is tied by cellular substance to the fore part of the rectus or straight muscle of the neck, and it is also connected with the par vagum and intercostal nerve: the ganglion of the intercostal, or sympathetic nerve, lies by its side; the nerve, before it forms this ganglion, comes down small and thread-like through the same canal by which the carotid passes into the skull.

The contortions of the carotid are great, both before and after its passage through the bony canal; but within the canal it is forced to particular and successive bendings, such as indicate plainly some design of Nature: for the canal for the artery is long and tortuous, while the nerves and veins pass through plain and simple holes. When the carotid first presents itself to enter the skull it is curved, and is a little behind its hole; it bends forwards and inwards a little, and so enters the canal; in entering the canal it rises almost perpendicularly upwards, but soon bends forwards again, lying, as it were, upon the floor of the canal; then it bends again upwards and forwards, to emerge from the canal; by which turn the portion of the artery which is engaged in the canal has the form of an Italic *ſ*. Even after it gets into the skull, it must still bend once more sideways and forwards, as if to meet its fellow, and to get to the side of the sella turcica; then it goes directly forwards till it touches the anterior clynoid process; and then doubling back, or returning upon itself, it rises perpendicularly; and so perpendicular is this last turn, that when cut across, the mouth of the artery

of rupture of these arteries might be given, not certainly tending to confirm the ideas inculcated here. I doubt very much if life can continue so long after the rupture of this artery, and I am rather inclined to believe that the artery was ruptured in the night of the young woman's death.

gapes perpendicularly upwards: here it begins to give its branches to the brain.

It is by the side of the sella turcica that the CAVERNOUS SINUS surrounds the artery. This sinus is formed by the two plates or lamellæ of the dura mater, parting from each other, and leaving an interstice full of cells, like those of the penis or of the placenta. It is filled with blood, by communication with several of the smaller sinuses or veins about the basis of the brain; the ophthalmic veins bring into it the blood from the eye; four or five small veins descending from the fossa Sylvii bring blood into it from the middle parts of the brain; the sinuses of the os petrosum (both on its upper and lower grooves) open into it, one high, another lower down, and that circular sinus or vein which surrounds the root of the optic nerves opens into it from either side. All this blood is poured into the cells; the internal carotid artery rises through these; and by the side of the carotid artery lies also that small nerve of the sixth pair which is connected with the great intercostal nerve.

Vieussens first discovered this curious structure; Ridley denied it, and Haller at last in his turn confirmed it. Vieussens believed that the sinus which deposited this blood conveyed it away again. Haller says that this is the peculiar office of that vein which accompanies the carotid artery, and which is named the vena sodalis arteriæ carotidis. It was once supposed that certain small arteries opened also into the sinus; but it has neither arteries nor pulsation.

Thus we trace the carotid through its canal, through the cavernous sinus, up to the side of the sella turcica, and about to enter the brain, to give off the arteries of the brain. But before we describe these, it will be easy to count shortly those little twigs which it gives off in the canal and in the sinus.

The carotid artery seldom gives out arteries before it enters the skull; it is a lusus naturæ, when it does happen that the occipital or pharyngeal arteries come off from it.

The first twig, which in any case it gives off, is sometimes a small artery, which returns downwards along with the upper maxillary nerve;* next, a small twig, accompanied by a branch from the meningeal artery, goes into the tympanum by way of the aquæductus Fallopii; and next, while the artery is within the sinus cavernosus, it gives out two little branches, the one forwards, the other backwards, named ARTERIES of the RECEPTACULUM.

1. The little artery which goes backwards from the sinus or receptaculum goes chiefly to that part of the dura mater which covers the posterior clynoid process, and which covers the cuneiform process of the occipital bone; it gives twigs to the 4th, 5th, and 6th pair of nerves, and to the pituitary gland; in short, to all the parts at the back of the sella turcica; it ends in inosculations with those twigs of the vertebral artery which come off from the vertebral before it enters the skull.

2. The little artery which comes out from the receptaculum to go forwards, arises where the carotid is crossed by the 6th pair, and has been confounded with a delicate nerve which joins the intercostal nerve to a branch of the 5th pair. The distribution of this little artery is nearly

* The second branch of the 5th pair.

the same with that of the first, for it belongs to the 3d, 4th, and 5th pair of nerves, and to the pituitary gland.

The carotid having risen to the anterior clynoid process, gives out there a small artery, less than a crow-quill, which enters directly into the orbitary hole, accompanies the optic nerve into the eye, furnishes the eye, the eye-lids, the muscles, and the lachrymal gland, and sends out branches upon the forehead, viz. the frontal arteries, in which it ends. This is a short history of the OPHTHALMIC ARTERY; which, as it furnishes all the arteries of the eye, must be described apart.

DIVISION OF THE INTERNAL CAROTID.

The carotid, now about to enter into the brain, divides at the sella turcica into three arteries; one to the fore lobe, another to the middle lobe, and a third to form the circle of Willis. These arteries are usually so numbered that the communicating branch is first described; next, the anterior artery of the brain; and, lastly, the middle artery of the brain. But of this arrangement no one who is accustomed to observe the course of this artery can entirely approve; for when the carotid rises from the side of the sella turcica, it divides into its three branches all at once, in a tripod-like form: the middle branch of the tripod is largest; the next, which goes forwards to the fore lobe of the brain, is smaller; the third, which is the communicating branch, going backwards to unite with the vertebral artery and form the circle of Willis, is the smallest of all. The middle artery of the brain then is, from its great size, to be regarded as the trunk.

1. ARTERIA MEDIA CEREBRI.

The middle lobe of the brain is separated from the anterior lobe by a very deep sulcus or furrow, which is named FISSURA SYLVII. This fissura Sylvii is formed by the transverse process of the sphenoid bone, or, in other words, by that very sharp line which runs out laterally from each of the anterior clynoid processes, and which parts the fore lobe, which lies in the shallow part of the skull upon the orbitary processes of the frontal bone, from the middle lobe, which lies in the deepest part of the skull behind the clynoid processes. The MIDDLE ARTERY OF THE BRAIN, having risen from the side of the sella turcica, runs straight along this fossa Sylvii, and is really the continued trunk of the carotid; it is larger than the artery at the wrist; it goes directly outwards, viz. towards the temple; it runs along the fossa Sylvii, and is lodged deep in that cleft; where it lies deep, it divides into two great branches, one deep and one superficial: it gives some branches to the anterior lobe, but it is chiefly limited to the middle lobe of the brain; its branches to the posterior lobe, or inosculations with any branches of the basilar artery, are comparatively few.

Thus the artety ends by passing into the substance of the brain. But nearer the sella turcica, and before it enters into the fossa Sylvii, it gives some small and delicate arteries; the consideration of which seems to be unimportant at first view, but which is really useful in explaining the anatomy of the brain. It gives small twigs to the pituitary gland, to the optic nerve, to the tentorium, and especially to the pia mater covering the basis of the brain. Among these small twigs certain sets of arteries make a very distinguished figure.

1. There is one small artery which runs up into the anterior horn of the lateral ventricle, and forms that great plexus which lies along the floor of the ventricle, named PLEXUS CHOROIDES. This, then, is the ARTERY of the CHOROID PLEXUS.

2. There is a set of arteries, of considerable number, but varying in respect of number, small as sewing threads, which inosculate repeatedly with each other, and which are scattered widely and beautifully over the crura cerebri and basis of the brain, forming in the pia mater a plexus or web of vessels. This part of the pia mater is named velum from its beauty and delicacy; and this is what Wepfer, among other older authors, considered as a species at least of the rete mirabile: but that name implies a peculiar office, as in beasts, which this delicate net-work of vessels cannot have.

2. ARTERIA ANTERIOR CEREBRI.

The FORE ARTERY of the BRAIN comes off from the middle artery at right angles nearly; for the great or middle artery runs directly outwards towards the temple, while this second artery runs directly forwards along the fore lobe of the brain. It is named sometimes the artery of the corpus callosum, because of two great branches into which it is divided one goes to that part of the brain. The corpus callosum (a most absurd name for any part of the brain) is the white and medullary substance where the two hemispheres of the brain are joined; and upon separating the two hemispheres with the fingers, the corpus callosum is seen like a large white arch, and the artery of the corpus callosum is seen also arching over its surface.

The anatomy of the arteria anterior cerebri may therefore be explained thus: first, it goes off at right angles from the middle artery of the brain, which is to be considered as the trunk, and there it often gives small twigs to the olfactory and optic nerves; next, the two anterior arteries of each side, while they go forwards as if towards the crista galli, bend a little towards each other; they almost meet, but do not absolutely touch; they form a communication with each other, which of course is exceedingly short, but pretty large. It is this short communication which completes the circle of Willis at its fore part. This cross communication betwixt the arteries of the opposite sides passes just before the sella turcica and pituitary gland, and exactly in the middle it sends off an artery, which goes down into the third ventricle, and gives branches to the fore part of the fornix and to the septum lucidum.

After this communication, both arteries rise, with a large sweep along the flat surface of that deep division which the falx makes betwixt the two hemispheres of the brain: there each divides into its two great branches; one attaches itself to the corpus callosum, or that arch which we see upon holding apart the two hemispheres; it arches along with the corpus callosum so as to describe a semicircle; it is the larger of the two branches; it is named ARTERIA CORPORIS CALLOSI: the other branch keeps upon the flat surface of the brain, where the one hemisphere lies flat upon the other, and it rises in a beautiful arch within the pia mater, dividing into beautiful and very minute ramifications before it enters actually into the substance of the brain.

These two great branches of the anterior artery are well distinguished by Wepfer by the names of arteria profunda and arteria sublimis, (the deep and superficial of the anterior artery,) as there is a deep and a superficial branch of the middle artery. The arch of the arteria anterior cerebri overhangs in a manner that of the artery of the corpus callosum, and both of them inosculate under the falx with the arteries of the opposite side.

3. ARTERIA COMMUNICANS.

The COMMUNICATING ARTERY goes as directly backwards from the middle artery as the anterior artery goes forwards. It is small, proceeds backwards, and a little inwards; it goes round the sides of the corpora mamillaria, and is about a quarter of an inch in length before it meets the branch of the vertebral artery; and though it does give off small twigs, as to the infundibulum, to the optic nerve, to the crura cerebri, and especially one of greater size, to the choroid plexus; yet all these are trivial arteries, such as every trunk at the basis of the brain gives off. It is not its twigs that are to be observed, but itself only that is important, as forming one of the largest and most important inosculations of the body. It unites the middle artery of the brain, which is the trunk of the carotid, with the posterior artery of the brain, which is the first and greatest branch of the vertebral artery.

This anastomosis is the circle of Willis, too remarkable not to have been very long observed; it was drawn by Veslingius and by Casserius; it is but ill represented by Bidloo and by Cowper; it is not a circle, but is right lined, and of course angular: it is of very unequal size; in one body it is large, in another smaller, often even in the same body it is irregular, the one side being large and the other small.

This inosculation brings us round to the first branch of the vertebral arteries, viz. the ARTERIA POSTERIOR CEREBRI; for the vertebral artery gives two arteries to the cerebellum, and one to the back part of the brain.

OF THE VERTEBRAL ARTERY.

The vertebral artery, though but the secondary artery of the head, is the principal one of the brain, and conveys a very great proportion of blood; and its turnings and windings before it enters the skull are almost as particular as those of the carotid itself. The vertebral is among the first branches of the subclavian artery, and comes off from it where it lies across the root of the neck. The two lower ganglions of the sympathetic nerve lie over it, and their threads surround its trunk, making curious net-works round it. The artery then enters into the canal prepared for it in the transverse processes of the vertebra, commonly getting in by the 6th vertebra: but in this it is irregular, sometimes entering into the 7th or lowest; and it has been seen entering into the uppermost hole but one. In this canal it ascends in a direct line from the bottom of the neck to the top; but, like the carotid, it makes great contortions before it enters the skull; for when it has reached the second vertebra, its transverse process being rather longer than those of the lower vertebræ, the artery is forced to incline outwards; and the transverse process of the atlas or first vertebra being still much longer, the artery in passing through it is carried still farther outwards; it is forced to make a very sudden turn, and is visible without cutting the bones. When the artery has passed through the transverse process of the atlas, it makes another very sudden turn, lies flat upon the circle of that vertebra, so as to make a large hollowness or groove upon the bone, and then it enters the foramen magnum by rising in a perpendicular direction; and then again it bends and inclines forwards, lying flat along the cuneiform process of the occipital bone, where it soon meets its fellow, and the two uniting form the basilar artery.

This basilar artery lies, with regard to the bone, upon the cuneiform process of the os occipitis, and runs along it from the foramen magnum to the sella turcica; with regard to the brain, it lies upon that great tubercle which is named the tuber annulare or pons Varolii; and as the artery goes along in one great trunk, it gives out from each side little arteries, which belong to this tuber annulare.

The brain has three arteries derived from the vertebral artery as it has from the internal carotid; two are given to the cerebellum and one to the cerebrum.

1. ARTERIA CEREBELLI POSTERIOR.

The POSTERIOR ARTERY, or LOWER ARTERY of the CEREBELLUM, is small and not regular. It comes off from the basilar artery either immediately after the union of the vertebrals, or from the vertebral artery immediately before the union. It is often smaller on one side than on the other, and sometimes it is wanting on one side. It moves downwards in a sort of retrograde course betwixt the accessory nerve of Willis and the group of fibres which form the eighth pair, and dives in betwixt the cerebellum and the medulla oblongata. Its larger branches spread out upon the pia mater, and then enter into the medullary substance. They belong to the cerebellum, to the spinal marrow, and some of them to the pons Varolii. But there are also smaller and particular twigs, as twigs to the eighth and ninth pair of nerves: one also, which enters into the fourth ventricle, to form a sort of velum or choroid plexus there; and as this posterior artery winds downwards under the cerebellum, it gives many branches about the vermis, and small twigs which run betwixt the lower point of the pons Varolii and the pyramidal bodies.

Next, the ARTERIA BASILARIS proceeds forwards along the pons Varolii in one great trunk: now the pons Varolii is just the tuberosity produced by the crura cerebri and cerebelli meeting and uniting to form the spinal marrow. The corpora olivaria and pyramidalia are just two bulgings at the root of the spinal marrow; and as every great artery, whatever its destination may be, gives twigs to those parts which it passes over, so does the basilar artery; giving twigs first to the corpora olivaria and pyramidalia, next to the crura cerebelli and to the crura cerebri: and as it runs along the pons Varolii it distributes little arteries to it from right to left. These little arteries also mark the sides of the pons with small furrows, which are seen when the arteries are dissected away. One of these transverse arteries, longer than the rest, looks like another posterior cerebri. It goes to the seventh pair, or auditory nerve, in the following way: The seventh pair of nerves proceeds from the back part of the pons Varolii; and as it goes forwards, the two nerves which it consists of, viz. the portio dura and the portio mollis, are separated from each other by a small and very beautiful artery which shoots in betwixt them, and enters along with them into the ear. The basilar artery also gives twigs to the fifth and sixth pair of nerves, which arise from the fore part of the pons, as the seventh pair arises from behind.

Arrived at the fore part of the pons Varolii, the basilar artery gives off almost at one point four great arteries, two to the right hand and two to the left. These are the anterior cerebelli and the posterior cerebri.

2. ANTERIOR CEREBELLI.

The ANTERIOR ARTERY of the CEREBELLUM, or the upper artery, as it is called, goes off at right angles from the basilar artery, and bends round the crura cerebri to get to the cerebellum. It gives its branches first to the crura cerebelli, to the cerebellum, and to the processus vermiformis. Secondly, there is a greater artery going over all the upper part of the cerebellum, (where it lies under the brain,) and also another which keeps closer to the brain than to the cerebellum, branches over that velum or delicate part of the pia mater which is interposed betwixt the cerebellum and brain; and going along it supplies the crura cerebri, and arrives at last at the place of the nates, testes, and pineal gland, and attaches itself to them. Some of the twigs go down into the fourth ventricle.

3. ARTERIA POSTERIOR CEREBRI.

The POSTERIOR ARTERY of the brain goes off immediately after this, is like it, runs parallel with it, is larger, goes to the posterior lobe of the brain, and receives near its root the communicating artery from the carotid, which forms the circle of Willis. Where this posterior cerebri and the anterior cerebelli run parallel with each other, the third pair of nerves rises betwixt them. The posterior cerebri first gives a small twig on either side to the bottom of the third ventricle, which runs so far forwards as to give branches to the thalami, infundibulum, and to the crura fornicis. Then the main artery, bending like that last described round the crura cerebri, and passing deep into the great division betwixt the cerebellum and brain, arches upwards towards the back lobes of the brain; but before it arrives there it gives first small twigs to the crura cerebri, and then another notable artery (though small) destined for the internal surfaces of the ventricles. This is a chief artery of the choroid plexus; it enters the lateral ventricle by the inferior horn; goes along with the cornu ammonis; helps to form the choroid plexus; inosculates, of course, with the choroid arteries from the carotid; and twigs also go from this artery to the nates, testes, and pineal gland, or in other words, to the velum which separates the cerebellum from the brain, which closes the ventricle behind, and which covers the pineal gland, and is a membrane or velum to it also; the pineal gland, nates, and testes, being situated neither in any of the ventricles, nor on the surface of the brain, but betwixt the surfaces of the cerebrum and cerebellum, where the one lies upon the other.

After this second branch to the internal surfaces, the great trunk of the posterior cerebri branches profusely like a tree all over the back part of the brain, inosculating forwards with the middle artery of the brain, and also with the artery of the corpus callosum.

Thus is the whole brain supplied with blood; and next in order come the arteries of the spinal marrow.

PLAN OR RECAPITULATION OF THE ARTERIES OF THE BRAIN.

CEREBRAL ARTERY. INTERNAL CAROTID.

1. Rami Pterygoidei.
2. Rami to the Origin of Nerves and the Cavernous Sinus.
3. ARTERIA OPHTHALMICA.
    1. Arteria Centralis Retinæ.
    2. Arteria Lachrymalis.
    3. Arteria Supra-orbitalis.
    4. Arteriæ Ciliares.
    5. Arteria Æthmoidalis.
    6. Arteria Nasalis.
    7. Arteria Frontalis.
    8. Arteria Anastomoica.
4. Rami to the Pituitary Gland, Nerves, Infundibulum, and Membranes.
5. ARTERIA CEREBRALIS ANTERIOR.
6. ARTERIA CEREBRALIS MEDIA.

VERTEBRAL ARTERY.

1. Rami Musculares, before entering the Canal.
2. Rami Spinales.
3. Rami Musculares, under the Occiput.
4. Meningeæ Posteriores.
5. ARTERIA CEREBELLI POSTERIOR.
6. Rami Spinales.
7. Union to form the ARTERIA BASILARIS.
    1. ARTERIA ANTERIOR CEREBELLI.
    2. ARTERIA CEREBRALIS POSTERIOR.
    3. ARTERIA COMMUNICANS.

OF THE ARTERIES OF THE SPINAL MARROW.

I have mentioned none of those smaller arteries which the vertebral gives off before entering the skull, because, being destined chiefly for the spinal marrow, they belong to this second class.

The vertebral artery, as it mounts along its canal towards the head, gives at each step, or as it passes each vertebra, a delicate twig; these little arteries pass through the intervertebral spaces, go to the deeper muscles of the neck, and inosculate with the thyroid and cervical arteries. In like manner, other small arteries go inwards to the spinal marrow at the place where each nerve comes out. They enter into the sheath of the spinal marrow, and inosculate with the chief arteries of the medulla spinalis.

As the vertebral passes through the atlas, both above and below that bone it gives out much larger arteries to the muscles, as to the recti, trachelo-mastoideus, and complexus, inosculating largely with the occipital artery: often there is at this point one large and particular artery going out to the back of the neck.

Again, as the vertebral passes through the occipital hole, it gives out a little artery, which accompanies the trunk itself up through the foramen magnum, and goes to that part of the dura mater which covers the cuneiform process, and there it inosculates with the twig of the carotid, which enters along with the jugular vein. This is the posterior artery of the dura mater.

Next come the arteries of the spinal marrow, the anterior of which comes out from the trunk of the vertebral artery; the posterior (though it also sometimes comes off from the vertebral before the basilar is formed) more commonly comes off from the posterior cerebelli.

1. ARTERIA ANTERIOR MEDULLÆ SPINALIS.

The ANTERIOR ARTERY of the spinal marrow is the larger of the two. It was discovered first by Willis; it had been looked upon, till the time of Vieussens, as a nerve accompanying the spinal marrow; because, when empty of blood and uninjected, it is white, and not unlike a nerve. This spinal artery begins within the skull by two branches, which unite as they proceed down the spine. These two branches arise one from each vertebral artery, at the very point where the vertebrals are about to unite to form the basilar trunk: each artery passes down its own side of the spinal marrow, betwixt the corpora olivaria and the corpora pyramidalia: each artery, before it leaves the skull, gives twigs to the tuber annulare, and to the pyramidal and oval bodies, for they are the beginnings of the spinal marrow; and soon after emerging from the skull*, the two spinal arteries join so as to form one anterior spinal artery. This joining is usually at the top of the neck, or rather within the skull, but sometimes so low as the last vertebra of the back. Almost always they join within the head or near it; and the anterior spinal artery which they form descends along the spinal marrow in a furrow which it forms for itself. The peculiar office of this artery is to supply the spinal marrow and its sheath, which it does by sending continual branches into the substance of the spinal marrow; while other branches go into the sheath itself, and pass out from the spinal canal along with those nerves which go out from the spinal marrow, accompanied by little processes of the sheath, which are named processus denticulati.

But this artery, being extremely small, would be soon exhausted, were it not reinforced with small arteries coming into the sheath: these pass through the vertebral interstices into the spinal canal, and are derived from every artery that passes near the spine. Thus in the neck, the spinal artery receives twigs from the vertebral arteries, and from the thyroid and cervical arteries; in the back it receives twigs very regularly from each of the intercostal arteries, and it receives its twigs from the lumbar arteries when it has got down as low as the loins.

But this spinal artery, which is continually diminishing, at last fails in the loins; and where the cauda equina is, that is, principally in the canal, the lumbar vertebræ, and of the os sacrum, the medulla is no longer supplied by a spinal artery, but by the small branches of the lumbar and sacral arteries, which enter by the holes of these bones.

* The artery which accompanies the ninth pair or lingual nerve, often comes from the anterior spinal artery.

Of those adventitious branches which reinforce the artery of the spinal marrow as it descends through the spine, each gives several other branches; they give twigs to the muscles of the spine, twigs to the substance of the vertebræ themselves, twigs to the sheath of the spinal marrow; and, finally, twigs which inosculate with the spinal artery, and which sink into the nervous substance to nourish it.

2. ARTERIA SPINALIS POSTERIOR.

The POSTERIOR SPINAL ARTERY differs in all essential points from the anterior: first, there are two posterior spinal arteries which arise, not from the basilar or vertebral arteries like the anterior, but usually from the arteria anterior cerebri; and they are smaller than the anterior spinal artery. Secondly, these two arteries give small twigs to the bottom of the fourth ventricle, and then go round from the fore to the back part of the medulla oblongata; but there, instead of uniting like the beginnings of the anterior artery, they continue separate, run down the spinal marrow as two distinct arteries, with very frequent inosculations betwixt them. This artery is also unlike the other in respect of its termination, for it disappears at the second vertebra of the loins. Its inosculations with the arteries from without are very free.

OF THE ARTERIES OF THE EYE.

The arteries of the eye, as we have seen in the plan, come from one branch only, the ophthalmic artery, the branch which the carotid, when it touches the anterior clynoid process, sends into the orbit along with the optic nerve. But small as this original artery is, (not so big as a crow-quill,) the system of arteries which arises from it is very great; whether we consider their number, the irregular parts which they supply, or the great inosculations which they form even with the outward arteries of the nose and face.

These are reasons for setting this order of arteries apart; and even with all possible care in the arrangement, it is not easy to deliver an orderly intelligible history of this artery. The ophthalmic artery supplies not only the eye itself, *i. e.* the globe, but it supplies also all the apparatus, if I may so call it, of the eye, *i. e.* the muscles, the lachrymal gland, the eye-lids, and even the forehead and nose.

1st, It sends a great branch, which leaves the ophthalmic artery, and takes its course outwards and upwards along the eye, to supply the lachrymal gland where it is exhausted. 2dly, The ophthalmic supplies the eye itself, both by that artery which enters into the centre of the optic nerve, called arteria centralis retinæ, and also by other arteries, which are named the ciliary arteries, because they go onwards to the fore part of the eye, where the ciliary circle is. 3dly, The muscles are supplied by an artery which comes from the same place nearly with those ciliary arteries. 4thly, There are two arteries which go down through holes in the socket into the bones and cavities of the nose; and these, as they perforate chiefly the æthmoid bone, are named æthmoid arteries. 5thly, and lastly, Those arteries which go out upon the forehead and nose are so directly from the trunk of the ophthalmic artery, that they must be regarded as the termination of it. This is the system of vessels which comes now to be described, and this is, perhaps, the best order for the description.

ARTERIA LACHRYMALIS.

The LACHRYMAL ARTERY is the first branch of the ophthalmic; but in order to know its place correctly, we must first observe how the ophthalmic artery enters the orbit. It comes off from the carotid, where that artery touches the clynoid process; and is so close upon the process, that the setting off of the ophthalmic is almost covered by that projection. It then dives under the optic nerve, and appears on the outer side of it; and as the artery goes along through the orbit, it makes a spiral turn till it completely surrounds the nerve.

The lachrymal artery goes off from the ophthalmic immediately after entering the orbit*, though sometimes it arises from the artery of the dura mater; and then it enters by the foramen lacerum, which is the next opening to the optic hole. It goes off from the ophthalmic about two or three lines after it has entered the socket. It goes all along the outer side of the orbit, because the lachrymal gland lies in the outer corner of the eye. When it reaches the gland, it is branched out and entirely expended upon it, except that it sends some small twigs forwards to the eye-lid. Of these vagrant branches, one twig goes to the periosteum of the orbit, perforates the cheek-bone, and so gets into the hollow of the temple, inosculating with the deep temporal artery; while another little branch goes to the tarsus of the upper eye-lid, and another to the tarsus of the lower eye-lid, and thus ends the lachrymal artery.

ARTERIA CENTRALIS RETINÆ.

This branch of the ophthalmic artery is so named because it perforates the optic nerve, runs up through its very centre or axis, enters into the cavity of the eye through the very centre of the optic nerve, and spreads its branches all over the retina. It usually arises from the ophthalmic artery, where it turns in the middle of the orbit over the upper part of the optic nerve†; it plunges into the nerve; and this artery, or rather the artery and vein, both (for the vein accompanies it) make so large a canal in the centre of the optic nerve, that their sheath stands quite open and gaping when the nerve is cut across; and was long known to the older anatomists by the name of porus opticus, before the meaning of this orifice or hole was understood.

When this artery arrives within the eye it branches out most beautifully upon the outer delicate membrane of the retina. The angles

* Sometimes it goes off one or two lines before the ophthalmic enters the optic hole, sometimes from the middle of the artery.

† It may be found arising from the ciliary arteries, or sometimes from the muscular.

and meshes which this artery makes give the name of retina or net-like to the whole; for the pulpy part of the optic nerve expands into a very thin and delicate web which resembles mucus. This web has its strength from these branches of the central artery. The branches of the artery, and the mucus-like expansion of the nerve, lie in two separate layers; and hence some anatomists reckon the retina a double membrane.

The arteria centralis having given off sideways these innumerable branches to the retina, still goes forwards, plunges through the substance of the vitreous humour, does not stop till it arrives at the back part of the lens, and is of course the ARTERIA CENTRALIS OCULI, the central artery of the eye itself. This central artery cannot be seen in the adult, and therefore there may be a question as to their existence at all; but by injecting the arteries of the eye of a fœtus of a slink Calf, or of any young animal, the arteria centralis oculi is found to distribute its branches in the following way: As it goes forwards through the centre of the eye-ball, it gives off its delicate arteries from side to side, which go along the partitions of the vitreous humour (for the vitreous humour is divided every where by membranes into small honey-comb-like cells). These cross arteries inosculate with those of the retina, and are plainly the arteries which secrete and support the vitreous humour.* The central artery stops when it comes to the back of the lens: it is scattered in a radiated form, as if by the resistance, into many great branches. These branches go round all the capsule of the lens, and meet again on its fore part; where, uniting into one or more small arteries, they pass onwards into the opening of the pupil, and help to form that membrane which in the fœtus passes from the margin of the iris, and shuts the pupil.

So the arteria centralis retinæ passes first through the centre of the optic nerve; next through the centre of the vitreous humour; next, after going round the capsule of the lens, it passes through the posterior chamber of the aqueous humour, and terminates in the centre of the pupil. But as these last arteries, viz. of the pupil, vanish soon after birth, we may consider the central artery as ending in inosculations with those arteries, which coming upwards along the sides of the eye along with the retina, form a strong circle of arteries at the root of the ciliary process.

ARTERIÆ CILIARES.

The ciliary circle is known, upon looking outwardly at the eye, by that white line which borders the iris, and separates the iris or coloured part of the eye from the white or colourless part. That circle marks the place where there is a great concourse of arteries. The corpus ciliare, or ciliary body, is the part within the eye which lies flat upon the fore part of the vitreous and crystalline humours, which is like a second iris behind the first, which is extremely vascular, and corresponds with the ciliary circle without. This corpus ciliare is radiated (that is a consequence of the peculiar order and arrangement of its vessels, which run in rays from the ciliary circle, *i. e.* from the circumference towards the centre). These radii coming from the ciliary circle are called the ciliary

* I have observed the artery branching in the midst of the vitreous humour, but these branches I have seen terminating on the back of the capsule of the lens.—C. B.

processes; so that the ciliary circle, corpus ciliare, and ciliary processes, are all parts of the same vascular organ. This is the part of the eye to which all those arteries go which are next to be described.

1. Two arteries of considerable size go off from the sides of the ophthalmic artery: these go along the sides of the optic nerve; they go towards the ball of the eye; and the one on the outer side of the eye is named EXTERNAL CILIARY ARTERY; that on the inner side of the optic nerve is named the INTERNAL CILIARY.

2. These two divide themselves again into two subordinate branches: one of them as soon as it touches the eye, that is, just beyond the implantation of the optic nerve, enters its substance, and is spread out on its choroid coat in a great number of branches, which are named CILIARES BREVES, the short ciliary arteries: the other goes further forward upon the eye before it enters, and even after it enters, it still goes forwards to the very fore part of the eye before it divides; hence named CILIARES LONGÆ.

3. The ANTERIOR CILIARY ARTERIES are some small and uncertain branches, which come sometimes from one source, sometimes from another, but most commonly from the muscular branches; and they go along with the muscles, and consequently enter the eye at its fore part just where the recti muscles are inserted. But, though small, these anterior ciliary arteries are of considerable number.

From the places at which these several arteries enter the ball, one might guess *à priori* how they will be distributed through its coats.

The ciliary arteries do not all of them arise from the ophthalmic artery; many arise from the muscular branches. As soon as they touch the eye-ball, they enter into it near the insertion of the optic nerve, pass through the sclerotic coat (leaving for its nourishment a few twigs); they divide so, that just after they have entered we can count twenty-five or thirty all round the root of the optic nerve, which go forwards in a radiated form, and are completely diffused upon the choroid coat; these are the POSTERIOR CILIARY ARTERIES. This coat of vessels lines the choroid all the way forward to the lens, goes still onwards to the fore part of the lens, and then turning down upon the lens at right angles, it meets with the anterior vessels, and forms the ciliary circle, and the ciliary processes or radii: a few twigs go still forward upon the uvea and iris, so as to make a very important connection of all the vascular parts of the eye.

Secondly, The LONGER CILIARY ARTERIES enter the sclerotic a little further forward, and penetrate at a greater distance from the optic nerve. They are two arteries thus distinguished; they pass forward betwixt the sclerotic and choroid coats, and on approaching the ciliary circle they each divide and make a circle of inosculation. Their branches meet each other, and are now joined both by the shorter ciliary arteries and by the anterior ciliary arteries; by which conjunction an anterior circle is formed, which corresponds with the outer circle of the uvea, and is called the OUTER CILIARY CIRCLE: this again sends radii of vessels, perhaps 30, inwards, which meeting, form a second circle, the INNER CILIARY CIRCLE.

Thirdly, The anterior ciliary arteries enter the eye at its fore part, and immediately unite with these, as has just been explained; they help to form the ciliary circle, which is the great conjunction of all the internal vessels of the eye.

The MUSCULAR ARTERIES are the least regular of all the branches of the ophthalmic artery. From one or other branch of the ophthalmic there generally arise two muscular arteries; the one for the upper, the other for the lower muscles.

ARTERIA MUSCULARIS SUPERIOR.

The UPPER MUSCULAR ARTERY consists of small twigs, which go chiefly to the levator palpebræ and rectus superior; and these, though they sometimes arise as two small twigs from the ophthalmic artery itself, yet in general come off rather from that artery which, as it goes out by the supra-orbitary hole, is named the supra-orbitary artery. These muscular branches of the supra-orbitary, then, supply the upper muscles of the eye, as the levator palpebræ, the obliquus major, the rectus superior, and the sclerotic or outer coat of the eye.

ARTERIA MUSCULARIS INFERIOR.

The LOWER MUSCULAR ARTERY is very generally an independent artery, and pretty large. It comes off from that part of the ophthalmic artery where it is giving off the ciliary arteries. This muscular branch is large enough to give off sometimes the arteria centralis retinæ, and often some of the short ciliary arteries arise from it; it is so long as even to reach the lower eye-lid. The muscles which it supplies are all those which lie on the lower part of the eye, as the deprimens oculi, abducens oculi, obliquus minor. It also gives variable twigs to the sclerotica, the optic nerve, the periosteum of the orbit, and sometimes to the adnata and lower eye-lid.

The set of arteries which stand next in order are those which go down into the nose through the æthmoidal bone, whence they are named æthmoidal arteries. The æthmoidal arteries are, like the other branches of the ophthalmic, pretty regular in their destination, but far from being regular in the manner in which they arise.

ARTERIA ÆTHMOIDALIS POSTERIOR.

The POSTERIOR ÆTHMOIDAL ARTERY is so named, because it passes through the posterior of two holes which are in the orbit at the joining of the æthmoidal with the frontal bone.* It is an artery by no means regular in its place, coming sometimes from the ophthalmic trunk, sometimes from the lachrymal artery, very rarely from the supra-orbitary artery. It is of no note: it is the smaller of the two æthmoidal arteries; it goes through its hole, and is scattered upon the bones and membranes of the nose. While it is circulating its twigs among the æthmoidal cells, it inosculates, of course, with the nasal arteries of the external carotid.

* In describing the skull, these are named the internal orbitary holes.

ARTERIA ÆTHMOIDALIS ANTERIOR.

The anterior æthmoidal artery is rather more regular and more important; it passes through a larger hole, and is itself larger; it comes off more regularly from the ophthalmic trunk, and it goes not down into the nose, but upwards into the skull.

The ophthalmic artery, much exhausted by giving off many branches, has risen over the optic nerve, has completed its spiral turn, and has just got to the inner corner of the eye, where the æthmoid hole is when the anterior æthmoid artery arises from it. It arises just behind the pulley of the upper oblique muscle, plunges immediately into its peculiar hole, and, passing along a canal within the æthmoid bone, it merely gives twigs to the frontal and æthmoidal sinuses, and passes up by one of the largest holes in the cribriform plate of the æthmoid bone. When within the skull, it is under the dura mater, betwixt it and the bone; it goes to the dura mater and to the root of the falx, and some of its delicate twigs turn downwards again into the nose, through the small holes of the cribriform plate accompanying the branches of the olfactory nerve.

The fifth order of arteries is very numerous, including all those which send their twigs outwards upon the face. They are the supra-orbitary artery, the artery of the upper eyelid, the artery of the lower eyelid, the artery of the forehead, and the artery of the nose.

ARTERIA SUPRA-ORBITALIS.

The supra-orbitary artery is so named from its emerging from the socket by that notch in the superciliary ridge which we call the supra-orbitary hole. It comes off from the ophthalmic artery at the place where it gives off the ciliary and lower muscular arteries: it so often gives off the arteries which go to the upper muscles of the eye, that some have named it the superior muscular artery. It passes onwards, giving twigs to the levators of the eye and of the eyelid, and to the upper oblique muscles, and to the periosteum: and before it arrives at the supra-orbitary hole, it divides into two twigs; of which one lies deep, and supplies the periosteum of the forehead, inosculating with the temporal artery; the other lies more superficial, but still is covered by the orbicularis and corrugator supercilii, on which muscles it bestows all its branches.

ARTERIÆ PALPEBRALES.

The two PALBEBRAL ARTERIES arise from the ophthalmic after it has passed the tendon of the obliquus superior, when it has in a manner emerged from the socket, and is lying at the inner angle of the eye; there it commonly gives off two small arteries, one to the upper and one to the lower eyelid: and often the two arise by one trunk.

ARTERIA PALPEBRALIS INFERIOR.—The ARTERY of the LOWER EYELID is the branch of the two which goes off the first; but it is the smaller and less regular of the two. Its twigs go, one to the union of the two tarsal cartilages, to the caruncula lachrymalis, and to the adjoining part of the adnata; another goes deeper, viz. to the lachrymal sac, and even into the æthmoid cells; and a third twig runs along the margin of the tarsus, named tarsal artery, supplying the Meibomean glands.

ARTERIA PALPEBRALIS SUPERIOR.—The ARTERY of the UPPER EYELID arises along with the lower palpebral, or near it; it gives few branches; one keeps to the angle of the eye, and supplies the orbicularis oculi, the caruncula, and the tunica conjunctiva; another, having pierced the fibres of the oblique muscle, runs along the borders of the tarsus, inosculating with a similar branch of the lachrymal artery, and forming an arch along the upper tarsus, as the other does below.

ARTERIA NASALIS.

The NASAL ARTERY goes off at the edge of the orbit, rises over the lachrymal sac, and over the ligament of the eyelids; it first gives a twig upwards to the root of the frontal muscle; then another goes down over the lachrymal sac, and after giving branches to the sac, goes to the orbicularis muscle, and inosculates with the infra-orbitary artery; and lastly, the most remarkable branch of this artery, from which indeed it has its name, runs down upon the side of the nose, making a beautiful net-work, and inosculating with the last branch of the labial artery, called angularis, which runs up to meet it.* This is quite a cutaneous artery; many of its twigs go to the skin; it is felt beating strongly; it was often opened when arteriotomy was more regarded than it is now.

ARTERIA FRONTALIS.

The FRONTAL ARTERY is now to be distinguished from the supra-orbital; for the supra-orbital rises deep in the socket, emerges by the supra-orbitary hole, passes along chiefly betwixt the bone and muscles, and makes no remarkable figure upon the face; while this frontal artery keeps chiefly upon the surface of the muscles, is quite subcutaneous, has nothing to do with the supra-orbitary hole, and rises beautifully upon the forehead. It is a delicate and slender artery, not so large as the nasal, and looks like one of its branches; it gives off first a branch to the eyelids, named superciliary artery, which supplies the root of the frontal and the upper part of the orbicularis muscles; it sends an ascending branch which dives under the frontal muscle, and belongs chiefly to the os frontis and pericranium. This is the little artery which often makes a perpendicular groove in the os frontis. The chief branch of the artery continues subcutaneous, is felt beating along the forehead, belongs chiefly to the skin of the forehead and to the hairy scalp, and mounts to the top of the head, to the place of the fontanelle, where it has free inosculations with the temporal artery.

This last branch is the end of the ocular or ophthalmic artery, of which the branches are so irregular in their origin, that the most diligent anatomists have declined that part of the description, and yet have arranged the branches upon that scheme, viz. the points from which the

* Some of its branches absolutely penetrate the cartilages of the nose, and so get access to the Schneiderian membrane, and supply it with blood.

several twigs arise: whereas I have thought it more prudent, since the branches are regular in respect of the parts which they supply, to arrange them according to those parts, viz. the lachrymal gland, the eye-ball, the muscles, the æthmoid cells, the face; an order which also very nearly corresponds with the order in which the arteries arise. The learning and remembering these arteries, it is right to acknowledge, is a task more difficult than useful; more suiting the severe anatomist, than the practical surgeon; yet who, if he do his duty, will learn all; and as he learns much, must expect to forget much.

OF THE ARTERIES OF THE ARM.

The subclavian arteries arise from the arch of the aorta. The left subclavian arises from the extremity of the arch, and just where the aorta is turning down towards the spine. It is longer within the thorax, runs more obliquely to pass out of the chest, receives in a less favourable direction the current of the blood. But the right subclavian arises from the aorta by that artery which is called the ARTERIA INNOMINATA; for it is an artery which can have no name, being neither the carotid nor the subclavian, but a trunk common to both. It is large, rises from the top of the aortic arch, receives the blood in the most direct manner; from which physiologists have deduced those consequences which have been already explained.*

1. The artery of the arm, as it proceeds, changes its name according to the parts through which it passes. It is named subclavian within the breast, axillary in the arm-pit, brachial as it goes down the arm, and when it divides at the bending of the arm its two branches are named the radial and ulnar arteries, after the radius and ulna, along which they run, until at last they join to form vascular arches in the palm of the hand.

Nature has thus arranged and divided the parts of this artery; and the study of its branches becomes easy to those who will first condescend to observe this simple arrangement, and the parts through which it goes. 1st. While the artery is within the breast, it lies transversely across the root of the neck; it supplies the neck, the breast, and the shoulder; it gives all its branches upwards into the neck, or downwards into the breast. Upwards, it gives the vertebral to the inside of the neck (if I may use an expression which cannot now be misunderstood); the cervical, which goes to the outside of the muscles of the neck; and the thyroid, which goes to the thyroid gland. While it gives off from its opposite side, downwards and into the chest, the mammary, which goes to the inner surface of the breast; and the upper intercostal artery, which serves the space betwixt the uppermost ribs. The mediastinum and pericardium, and even the diaphragm, though far distant, receive branches from this mammary artery.

2. When the artery, having turned over the sloping part of the chest,

* Douglas says the left is shorter, which I can by no means understand.

glides into the axilla, and lies deep there betwixt the scapula and the thorax, what parts can it supply, or what vessels can it give off, but scapular and thoracic arteries? Its branches accordingly are three or four slender arteries to the thorax on one hand, named the four thoracic arteries, which give twigs to the glands, the pectoral muscles, and the breast or mamma; and on the other hand it gives off first great articular arteries which surround the joint, and still great scapular arteries which surround the scapula, and nourish all that great mass of flesh which lies upon it.

3. But when this artery takes the name of the humeral artery, and passes along the arm, it must be simple, as the arm is simple; for it consists of a bone, of one mass of muscles before, and another behind: the artery of course runs along the bone undivided, except that it gives off one branch, which runs parallel with the main artery, and running deeper among the flesh, is named muscularis or profunda.

4. It divides at the bend of the arm, in order to pass into the fore-arm in three great branches. In wounds thus low, all danger of losing the arm from wounds of the artery, unless by the gross ignorance or fault of the surgeon, is over: we do not attend so much to the parts which it supplies, or, in other words, to its inosculations, as to the parts against which the great branches lie. We observe here, as on all occasions, the artery seeking protection, and running upon the firmest parts: its three branches now pass, one along the radius, another along the ulna, a third along the interosseous membrane.

5. In the palm of the hand we find the artery still following the order of the bones; and as the carpal bones are as a centre or nucleus, upon which the metacarpal and finger bones stand like radii, the palmar artery forms a complete arch, from which all the fingers are supplied by arteries, issuing in a radiated form.

Of all these subdivisions the subclavian artery is that which seems the least important to know; and yet, without a perfect knowledge of it, how shall we understand many important arteries of the neck or shoulder? How shall we understand the anatomy of the greatest of all the nerves, viz. the sympathetic nerve which twists round it? How shall we judge rightly of tumours near it, or of aneurisms, which so often mount along this artery from the arch of the aorta until they are felt here?—Of the second division of the artery, viz. where it lies in the axilla, the importance is most unequivocal; since every attempt to stop hæmorrhages, by compressing this artery, requires a knowledge of it; since every full bleeding wound near this place alarms us, and requires all our knowledge; since every tumour that is to be extirpated opens some of its branches; since we cannot cut off a cancerous breast, or the glands which should be taken along with it, without cutting the thoracic arteries.—Next the artery of the arm, simple as it is, interests us greatly. It is this simple artery which is hurt in aneurisms; it is its delicate, I had almost said capillary, branches, which are to establish a new circulation, and to save the limb. We have indeed no apprehensions of losing the limb for want of blood (the continual success of our operations having established this point); yet it is most interesting to observe the extreme smallness of these branches, as an assurance to us in other cases of danger; though I do indeed believe, that there cannot in any simple wound in any limb be the smallest danger from this much dreaded obstruction of the blood.

The arteries of the fore arm are more interesting still; for if we will be so selfish as to consider the difficulties of the surgeon merely, wounds of the arteries in the fore-arm are very distressing. These arteries lie deep among the muscles, drive their blood (when wounded) through the whole arm, and either occasion a difficult and most painful dissection, or cause a deep and gangrenous suppuration; so that whether the surgeon be so dexterous as to secure the arteries, or so timid as to leave the arm in this woeful condition, the patient is to undergo such sufferings by pain or by a long disease, as must interest us greatly.

The arteries even of the wrist and hand, though small, are important. The difficulty of managing wounds of these arteries stands but too often recorded in all kinds of books for us to doubt the fact. If many have died after frequent bleedings from these arteries, though under skilful hands, what ought we not to submit to in the way of study and labour to acquire and to retain a knowledge of these arteries; since by that alone every thing that is surgical in tumours, aneurisms, amputations, is well or ill performed, according to our degree of knowledge; and since, according to our degree of knowledge, we are disengaged in our minds, and have free possession of our judgment, to do any thing which may be required? In short, as we proceed along this artery, we shall perceive that each division of it rises in importance; or at least that if wounds about the axilla be more dangerous, they are proportionably rare; that if accidents about the wrist or hand be less dangerous, they are, however, more frequent, so as to deserve every degree of attention.

I. OF THE SUBCLAVIAN ARTERY.

This artery is so named from its passing under the clavicle, by which it is protected; and we include under this division all that part of the artery which lies betwixt the arch of the aorta and the outside of the clavicle, where the artery comes out upon the chest. Here the artery is of a very great size; it lies directly across at the top of the chest and root of the neck; and, like a cylinder or axis, it gives its branches directly upwards and directly downwards, to the throat, to the neck, and the parts within the chest. Upwards it sends the vertebral, the thyroid, the cervical, and all the humeral arteries; downwards it sends the upper intercostal artery, and also the internal mammary, which, besides its going along the inner surfaces of the chest, gives branches to the pericardium, mediastinum, thymus, and other parts.

1. ARTERIA MAMMARIA INTERNA.

The INTERNAL MAMMARY ARTERY is the first which the subclavian gives off; it is of the size of a crow-quill; long, slender; its ramifications very beautiful. On each side of the chest the mammary artery passes down along all the inner surface of the sternum, and ends at the cartilago ensiformis, in numerous inosculations with the epigastric artery; for the epigastric arises from the femoral at the groin, just as this does from the subclavian at the top of the chest, and runs upwards along the belly, as the mammary runs downwards along the breast, till they meet each other midway. This is an inosculation which fifty years ago was much noticed. Physiologists deduced the most important consequences from it, ascribing the connection of the breast and womb to the flux and reflux, to the alternate stoppage and acceleration of the blood in these vessels; although the sympathy of the breasts and womb is plainly a connection which Nature has established upon other laws, upon a kind of sympathy such as we see everywhere in the system, but can in no instance explain.

The course of the mammary artery, and the order of its branches, is this: It goes off from the lower and fore part of the subclavian artery; it lies on the outside of the membraneous bag of the pleura; and considering the pleura as ending in an obtuse and rising apex, the mammary artery lies at first a little behind the pleura; its first movement is to rise and turn with an arch over the top of the pleura or bag which incloses the cavity of the chest; there it descends again, and passes betwixt the ribs and pleura: the artery runs along the inside of the thorax under the middle of the cartilages. At the seventh or eighth rib the mammary itself emerges from the thorax, and becomes an external artery; it first sends a branch towards the ensiform cartilage, which plays round it, and then it goes to the upper part of the abdominal muscles by two distinct branches, the one of which is internal, the other external. The internal branch goes into the belly or substance of the rectus muscle, descends nearly as far as the navel, and inosculates with the epigastric artery. The external branch turns off to one side, goes rather to the lateral muscles of the abdomen, especially to the two oblique muscles, and inosculates more with the lumbar arteries; and so the mammary ends. But as it passes down along the chest, it gives the following branches:—

First, Where it is passing the clavicle, bending to go downwards, it gives a small retrograde branch which follows the course of the clavicle, and goes to the muscles and skin of the neck.*

Secondly, It gives an artery, or rather arteries, to the thymus, ARTERIÆ THYMICÆ. These are in the adult extremely small, because the gland itself is so; but in the child the gland is large, the upper part lies before the trachea, the lower part lies upon the heart, or rather upon the pericardium betwixt the two lobes of the lungs: the upper end then is supplied by the thyroid arteries; the middle part is often supplied by a distinct and particular branch, viz. by the ARTERIA THYMICA coming from the mammary, but this is far from being always so; the lowest part of the gland has twigs from those arteries which properly belong to the mediastinum, upon which it lies, or to the pericardium, or to the diaphragm.

Thirdly, The mammary gives also the upper artery of the diaphragm, its lower artery being the first branch of the aorta within the abdomen. This upper artery of the diaphragm is named ARTERIA NERVI PHRENICI, because it accompanies the phrenic nerve. The phrenic nerve is passing from the neck (where it arises) into the chest, by the side of the axillary artery, when it receives from the mammary this small artery

* Sabbatier is so confused, and copies Haller so ill, that he mistakes this for the transversalis humeri, which is really an important artery.

which goes along with it; and this artery (which is so extremely small that nothing but its regularity can give it any importance) goes down through the whole chest, accompanying the phrenic nerve over the pericardium till they arrive together on the upper surface of the diaphragm, and spread out there. This artery, small as it is, gives twigs as it passes along to almost all the parts within the chest.

Fourthly, the mammary gives an artery to the pericardium, which may be called the UPPER PERICARDIAC ARTERY; and which is of such importance, that generally when it does not come off from the mammary, it comes from the subclavian itself, or even from the aorta. It belongs to the upper and back part of the pericardium.

Fifthly, The pericardium has another artery from the mammary, which belongs to that part of it which is united to the diaphragm: it is thence named by some ARTERIA PHRENICO-PERICARDIACA.

Sixthly, The mammary gives many small arteries to the mediastinum; for the mammary is covered only by the sterno-costalis muscle, which is often hardly visible in Man, so that the artery may be said to lie upon the pleura, betwixt it and the ribs. The mediastinum is just that doubling of the pleuræ which descends from the sternum to the spine, and of course many small arteries go down from the lower surface of the sternum along the pleuræ into the mediastinum, and by that to the pericardium, or even to the membrane of the lungs.

The mammary, as it goes downwards, sends branches through the interstices of the ribs; two twigs pass through each insterstice, going to the intercostal muscles, and to the muscles which lie upon the thorax, as the pectoral muscles; also to the mamma, to the obliquus externus abdominis: they form loops of inosculations round the ribs with the proper intercostal and thoracic arteries. These twigs pass through the interstices of the six or seven upper ribs, but at the seventh the artery itself comes out. They are too numerous and too small to be either counted or named.

Seventh, The mammary, before it terminates in the two branches, of which one keeps the middle and goes to the rectus muscle, while the other goes outwards to the oblique muscle, as already described, gives about the place of the sixth rib a branch, which, in place of passing out of the thorax, keeps to its inner surface, goes downwards along the seventh, eighth, and ninth ribs, makes its inosculations there with the intercostal and other arteries, and ends in the side of the diaphragm, and in the transverse or innermost muscle of the abdomen, which indigitates, as we call it, with the diaphragm. From this destination it is sometimes named the RAMUS MUSCULO-PHRENICUS.

PLAN OR RECAPITULATION OF THE BRANCHES OF THE

MAMMARIA INTERNA.	1. Rami Mammariæ intercostales. 2. Arteria Thymica. 3. Arteria Comes Nervi Phrenici. 4. Arteria Pericardiaca. 5. Arteria Mediastini. 6. Arteriæ Diaphragmaticæ. 7. Arteria Epigastrica Communicans.

2. ARTERIA THYROIDEA INFERIOR.

The LOWER THYORID ARTERY, whose branches go to the neck, the shoulder, and the thyroid gland, arises from the fore part of the subclavian artery, close upon the origin of the internal mammary. It is there covered by the root of the mastoid muscle. It buds out from the root of the great axillary artery, in the form of a short thick stump, which immediately divides whip-like into four small and slender arteries.

1. The main branch of this artery is again named the *ramus thyroideus arteriæ thyroideæ.* This thyroid artery is the first great branch; it does not ascend directly, but moves a little inwards towards the trachea, from which the root is a good deal removed; it bends behind the carotid artery, is tortuous, and ascends by the side of the trachea till it touches the lower lobe of the thyroid gland; it spreads upon it like a hand, inosculates very freely with the upper thyroid artery, and nourishes the gland. This branch moreover gives some twigs to the lower constrictors of the pharynx and to the œsophagus; but its chief arteries, beside those which plunge into the gland, are its TRACHEAL ARTERIES. These tracheal arteries, two or three in number, are reflected along the trachea, turn down with it into the chest, and reach even to the bifurcation of the trachea, where, inosculating with the intercostal arteries, they form a most beautiful net-work.

2. The ascending thyroid artery, or *thyroidea ascendens*, is a small and delicate branch, which lies pretty deep, going off rather from the back part of the artery; it supplies all the deep parts of the neck, and even penetrates the vertebræ; it soon divides into an irregular number of branches; the artery keeps almost close to the naked vertebræ, lying under most of the muscles; its general tendency is upwards, surrounding the neck in a spiral form. Its chief twigs are, first, some which go towards the surface, *i. e.* to the muscles which lie over the artery, as to the scalenus, the mastoid muscle, the levator scapulæ, and the splenius: and twigs of this artery play over the rectus capitis and the anterior surface of the vertebræ, and attach themselves to the eighth pair of nerves, and to the ganglion of the sympathetic nerve. Its deeper arteries again go to the inner transversarii, and other muscles which lie closer upon the neck; and these are the branches which pass in through the intervertebral holes, and penetrating the sheath of the spinal marrow, and following its nerves, inosculate with the spinal arteries.

3. The transverse artery of the neck, or transversalis colli, is an artery of the same kind with the last, viz. chiefly destined for the muscles, but more superficial. It passes obliquely round the neck outwards and upwards, goes under the trapezius muscle, and covered by it sends branches as far as the occiput. Its twigs are distributed thus: First, to the mastoid muscle and to the skin; next, to the trapezius, levator scapulæ, and splenius; then, a long branch passing obliquely upwards over the splenius, and under cover of the trapezius, gives twigs to those muscles, and ends in inosculations with the lower branches of the occipital artery; and, lastly, another branch goes downwards towards the scapula and shoulder.

4. The last branch of this artery is the TRANSVERSALIS HUMERI; an

artery so important in its destination, and so irregular in its origin, and so frequently arising as a distinct and particular branch, and having so little relation to these trivial branches of the thyroid artery, that I shall describe it by itself.

3. ARTERIA VERTEBRALIS.

The vertebral artery arises next from the upper part of the subclavian artery; and running upwards and backwards but a little way, it plunges into the hole destined for it in the vertebræ; and it has been already described through all its course both within the bony canal and within the brain.

4. ARTERIA CERVICALIS PROFUNDA.

The deep cervical artery comes next in order; it is generally the least important of all the branches from the subclavian artery, and the least regular in its place. It often comes from some other branch, and often it is entirely wanting; its course resembles a good deal that of the transversalis colli, *i. e.* it goes to the deepest muscles of the neck, and to the vertebræ, and ends about the occiput; it usually arises from that part of the subclavian artery where it is just going to pass, or has already passed, betwixt the scaleni muscles. Its branches are few in number; it gives branches to all the scaleni muscles; others also which play over the anterior surface of the vertebræ and the deep muscles of the neck, as the spinalis colli, inter-transversarii, the root of the splenius and trachelo-mastoideus; the complexus also receives a branch, which usually inosculates with the occipital artery.

5. ARTERIA CERVICALIS SUPERFICIALIS.

The SUPERFICIAL CERVICAL ARTERY is still less regular, being very often supplied by the thyroid. Its course is directly the reverse of the last, running rather outwards and downwards, or, in other words, belonging rather to the shoulder than to the neck. The subclavian artery has got from under the muscles, and has passed the splenii a little way before it gives off this superficial cervical. This artery immediately attaches itself to the plexus of the brachial nerve, and is indeed hidden in the plexus: its first branch is given to the plexus, but its next and chief branch goes across to the top of the shoulder; it sends branches to the levator scapulæ, trapezius, and even to the skin; while a deeper branch goes to the splenius and complexus, where these muscles arise in the neck; and when this artery is large, it sends branches along the margin of the scapula, which go even to the serratus major, rhomboidei, latissimus dorsi, &c.

After enumerating these jarring names, I perceive the necessity of arranging once more those arteries which go to the neck. Let the student then observe, 1. That the vertebral artery goes to the brain; that the cervical arteries belong to the muscles of the neck. 2. That the thyroid gives two arteries to the neck, the thyroidea ascendens and the transversalis colli. 3. That when a second set of arteries for the neck begins to be enumerated the name is changed; that of colli is dropped, and that of cervicis adopted. 4. That as there are two branches of the thyroid going to the neck, viz. the ascending thyroid and the transversalis colli, there are also two entire arteries going to the neck, and which come off immediately after the thyroid, viz. the cervicalis profunda, more constant, and the cervicalis superficialis, which is less regular.

6. ARTERIA INTERCOSTALIS SUPERIOR.

The UPPER INTERCOSTAL is given to supply the intercostal space betwixt the two uppermost ribs, because the aorta, which gives out all the other intercostals, regularly one for each rib, does not begin to give them off till after it has made its turn downwards; of course it leaves the two upper ribs without arteries. To supply this, then, is the office of the superior intercostal artery, which is about the size of a crow-quill, and goes off from the subclavian generally next after the vertebral and thyroid arteries. It comes from the upper and back surface of the subclavian trunk; it turns downwards and backwards, and lodges itself by the side of the spine in the hollow where the spine and the first rib are joined, and where the first thoracic ganglion of the great intercostal nerve lies. Before it takes its place betwixt the ribs, as the intercostal of the two upper spaces, it sends a branch upwards upon the face of the lower vertebræ of the neck, which is given to the scaleni, to the longus colli muscle, and to the nerves: next it gives off the highest intercostal artery for the space betwixt the first and second ribs, which artery divides into two branches; one perforates the thorax, and goes out upon the back, and supplies the muscles which lie flat upon the back of the chest; while another branch, the proper intercostal branch, runs along betwixt the ribs. Next it gives off a second intercostal artery, which also has its external and internal branches, and of which a branch inosculates over the third rib with the uppermost intercostal of the aorta. Besides these, it gives also small branches to the œsophagus, which inosculate with the tracheal arteries; and it gives branches to the spinal marrow, which pass into the canal along the holes for the nerves; and which not only supply the sheath, but also inosculate with the arteries of the spinal marrow itself.

7. ARTERIA SUPRA-SCAPULARIS.

THE SUPRA-SCAPULAR ARTERY, or the superior scapular artery, is one of such magnitude, and is so different in size and destination from the cervical and other small arteries of the neck, that it ought to be described apart: though of great size and importance, it is yet so little known, that Sabbatier does not even describe nor name it.

The SUPRA-SCAPULAR ARTERY very often comes off from the THYROID artery; in which case it is the last in order of all the branches of the thyroid, that is to say, the nearest to the shoulder, and then it is named TRANSVERSALIS HUMERI, because of its going across the root of the neck of the shoulder. Sometimes it arises from the cervicalis superficialis; but then it is a small artery, and in such cases it reaches no further than the tip of the shoulder, and does not descend to the scapula. Often

I see it arising as a distinct artery, large, very long, and tortuous; running across the root of the neck, till at the top of the shoulder it dives under the acromion process; and then passing over the notch of the scapula, supplies all the flesh of its upper surface.

The reason of my naming it supra-scapular artery, is its passing thus over the scapula, while another, the largest branch of all those proceeding from the axillary artery, is named sub-scapularis, from passing under the scapula.

To repeat the origin then of this supra-scapular artery — it arises sometimes as an independent artery, and is so great, that we wonder that it does not always do so: often it arises from the thyroid, is its last branch, and is named TRANSVERSALIS HUMERI, authors not observing that it belongs absolutely to the scapula; it rarely arises from the cervicalis superficialis, and when it does so it is small: often in a strong man it arises apart; and when it does arise from the thyroid or cervical arteries, it is often so large as to annihilate as it were all the other branches of the artery from which it arises.

Where this artery passes out of the chest it is covered only by the root of the mastoid muscle; and it gives twigs to the mastoid, to the muscles which ascend to the throat, to the subclavian muscle, to the fat, jugular vein, and skin.

Next it gives a superficial branch to the skin, trapezius, and other superficial parts about the shoulder.

Next it turns over the acromion process, passes through the supra-scapular notch, with many windings and contortions; spreads itself over all the outer surface of the scapula, both above and below the spine, and is the sole supra-scapular artery. The manner of its spreading is this: having passed over the ligamentum proprium posterius scapulæ, (for it very seldom passes through the notch,) and near the supra-scapular nerve, it lies flat upon the scapula; it sends off two branches, one on either hand at right angles; and of these one goes along the upper border of the scapula towards its basis, the other goes in the other direction towards the shoulder-joint, and circles round the upper side of the spine or ridge of the scapula.

The main artery, having first passed the scapular notch, and given these two small branches, next makes a second perforation, viz. by passing under the root of the acromion process: and then it again divides into large branches, in which it ends. The one branch runs all along the root or base of the spine or high ridge; the other branch runs nearly in the same direction, but lower down, viz. nearer that edge where the great sub-scapular artery runs; and with which, of course, it makes many free inosculations.

This artery lies so across the neck that it may be cut, especially in wounds with the sabre; and in a big man it is of such size as to pour out a great quantity of blood. It is necessary for the surgeon to remember the great size of this supra-scapular artery, its long course over the shoulder, at what place it arises within the chest, and how it may be compressed. But in another sense also it is peculiarly important; for the supra-scapular artery makes inosculations with the lower scapular artery, freer and fuller than in almost any other part of any limb. One can hardly force tepid water through those small arteries which support the arm after the operation for aneurism; but the inosculations of this supra-scapular artery are so free, that often, though I have tied the arteries with great care, the very coarsest injection has gone round by it; and when I desired only to inject the head, I have found the arteries of the arm entirely filled. The conclusion which this leads to in wounds of the axillary artery is too obvious to need any further explanation.

RECAPITULATION AND PLAN OF THE BRANCHES OF THE

THYROIDEA INFERIOR.	1. Transversalis Humeri or Supra-Scapularis.* 2. Transversalis Colli. 3. Thyroideæ Ascendens. 4. Ramus Thyroideæ Thyroideus, or Proprius.

GENERAL PLAN OF THE PRIMARY BRANCHES OF THE

SUBCLAVIAN ARTERY.	1. Arteria Mammaria Interna. 2. Arteria Thyroidea Inferior. 3. Arteria Intercostalis Superior. 4. Arteria Vertebralis. 5. Arteria Cervicalis Profunda. 6. Arteria Cervicalis Superficialis.

II. OF THE AXILLARY ARTERY.

This artery assumes the name of axillary, where it lies in the arm-pit or axilla. The scaleni muscles being attached to the ribs, the artery passes first through betwixt the first and second scalenus; next it passes out from under the arch of the clavicle, where it was protected: then it falls over the breast in a very oblique direction; it inclines outwards towards the axilla, lies flat upon the slanting convexity of the chest, is covered by the pectoral muscles, and the great pectoral muscle arises from the clavicle, under which the artery passes; but far from being protected, it is so far exposed as to be easily felt beating, and it is at this point only that it can be rightly compressed. It declines still outwards and downwards, till at last it gets so deep into the arm-pit, and so much under the scapula, as to lie betwixt the serratus anticus and sub-scapular muscles. There it is rightly called the axillary artery. In this hollow it lies safe, protected by the deep borders of the pectoral muscle before, and of the latissimus dorsi behind, surrounded with fat and glands, inclosed within the meshes of the plexus, or great conjunction of nerves which go to the arm, surrounded also by all the veins of the arm, which twine round it in a wonderful manner. Here it gives off the thoracic arteries to the thorax, and the scapular arteries to the shoulder. In short, the axilla itself is a complicated study; but in all that respects the arteries it may be made very easy and plain. But let the surgeon remember that it is only by a perfect knowledge of the arteries, a bold stroke of the knife, and a masterly use of the needle, that the patient is to be saved from bleedings after wounds hereabouts: for the old story

* As my reader has seen, this artery comes off sometimes from the subclavian as a distinct branch; and then its size in a manner deranges the relative magnitude of the other branches.

of compressing the axillary artery above the clavicle is now of no credit with any surgeon of knowledge or good sense.

As the artery turns over the borders of the chest, it gives one or two twigs to the adjacent parts, as to the scaleni, and to the great nerves which lie over the artery, and to the serrated muscle, where it lies under the scapula; but these branches are so small that it is unnecessary either to number or describe them. The thoracic or external mammary arteries are the first important branches; they are four in number, and they are named after their place or office.

1. ARTERIA THORACICA SUPERIOR.

The UPPER THORACIC ARTERY, being the first, lies of course deep in the axilla. It comes off about the place of the first or second rib; it lies betwixt the lesser pectoral and the great serrated muscle; it gives its chief branches to these muscles, and it also gives other branches to the intercostal muscles and the spaces betwixt the ribs. But, upon the whole, it lies very deep, is small, and is so short that the next is entitled thoracica longior. It is an artery of little note.

2. ARTERIA THORACICA LONGIOR.

The LONG THORACIC ARTERY is more important, supplying all the great pectoral muscles and the mamma. It was named the external mammary artery; but we are the more willing to change the name, since it has no likeness to the internal mammary artery, and is in no respect a counterpart to it; it might be named the pectoral artery. It is long, not tortuous, but straight and slender, and about the size of a crow-quill. It is needless to describe an artery so variable in its branches as this is; it is sufficient to say, that after giving small twigs to the axillary glands, it terminates with all its larger branches in the pectoral muscle, mamma, and skin, and in inosculations with the intercostals and internal mammary; it is very long, descending sometimes so low as to give branches to the oblique muscles of the belly.

3. ARTERIA THORACICA HUMERARIA.

The THORACIC ARTERY of the shoulder goes off from the upper and fore part of the axillary artery. Its place is exactly opposite to that of the mammaria externa, viz. under the point of the coracoid process, insomuch that Haller has named it thoracica acromialis. It is a short, thick artery; it bursts through the interstice between the pectoral and deltoid muscles, and appears upon the shoulder almost as soon as it comes off from the main artery; it resembles the thyroid in shape, being a short thick artery, terminating all at once in a leash of slender branches, which go over the shoulder in various directions; but I never could observe any order worth describing. One deeper branch goes to the serratus major, a branch goes along the clavicle, gives it the nutritious artery, and then goes on to the pectoral muscle, and to the skin of the breast: it gives small branches to the axillary glands, and larger ones to the deltoid and pectoral muscles and skin of the shoulder, for this is very much a cutaneous artery. The chief branch is that which is last named, running down betwixt the deltoid and pectoral muscles; and the most curious branch is a small artery which accompanies the cephalic vein, and runs backwards along the course of the vein, a small and beautiful branch.

4. ARTERIA THORACICA ALARIS.

Sometimes, though not always, there is a fourth thoracic artery. When it exists, we find it close by the last artery; its branches, which are sometimes numerous, belong entirely to the cup or hollow of the axilla; it goes to the glands and fat, and thence its name of ALARIS or AXILLARIS. This is the deepest or backmost of these mammary arteries; it attaches itself to the lower border of the scapula, and we often see it running along the lower border a considerable length, and giving branches chiefly to the sub-scapularis muscle.

These are the four mammary arteries which go to the breast. The arteries which go to the scapula follow next, and are only three in number; one, which is the counterpart of the supra-scapular artery, is the greatest branch from the axillary artery, supplies the lower surface of the scapula, and thence is named SUB-SCAPULAR ARTERY; one, which, as it is reflected round the joint by the outside, is named the EXTERNAL CIRCUMFLEX ARTERY; and one, which, as it turns round the inner side of the joint, is named the INTERNAL CIRCUMFLEX ARTERY.

5. ARTERIA SUB-SCAPULARIS.

The SUB-SCAPULAR ARTERY is of a great size: it is hardly described in books; I might say was hardly known to the older anatomists. Douglas, and most especially Sabbatier, have scarcely named it, though it is in fact one of the largest arteries in the body, being nearly as large as the axillary artery, from which it takes its rise.*

The greatest mass of flesh in almost any part of the body is that which lies under and around the scapula in a strong man; and this artery supplies almost all that mass. It goes off from the axillary opposite to the neck of the scapula, just under the short head of the biceps brachii: it no sooner comes off from the axillary artery, than it attaches itself to the lower border of the scapula; and as soon as it comes to the edge of the scapula (but sometimes lower down the edge, viz. where the head of the triceps comes off,) it splits into two great branches; one of which goes to the upper, and one to the lower surface. But to describe each little artery among such a mass of flesh, or to expect to find them regular, would be very thoughtless; the general course of them only can be described. First, The greater branch, which goes to the lower surface of the scapula, is the proper trunk of the sub-scapular artery; it divides into two great branches, which course all over the lower or hollow surface of the scapula: one of these is deeper, runs downwards along the

* It is named often scapularis inferior or infra-scapularis; it is better named sub-scapular, both to harmonize with the name sub-scapular muscle, to which it belongs, and also to contrast with its counterpart, the supra-scapular artery, which comes from the subclavian artery.

naked border of the scapula, lies under the muscles upon the flat bone, and supplies the inner surface of the sub-scapular muscle with many branches. It sends a branch upwards, which runs along the inner surface of the neck of the scapula, runs still forwards under the root of the coracoid process, and its extreme branch goes round by the basis of the scapula to make an inosculation with the larger branch.

Secondly, The larger branch keeps nearer the surface, and supplies all the outer side of the sub-scapular muscle. Its general course is round the scapula, down the fore edge, then round by the lower angle, then up by the line of the basis scapulæ, encircling it with what might be named a coronary artery. It first gives branches to the teres major; then passes down along that muscle to the angle of the scapula; then turning along the angle of the scapula (which it does not do without leaving many branches behind), it runs in a waving line all round the basis scapulæ, till it arrives at the upper corner, where it ends in free inosculations, both with its own deeper branch, and also with the supra-scapular artery which comes along the shoulder.

Now this great branch, with all its arteries, belongs entirely to the lower surface of the scapula; but the branch which leaves it at the neck of the scapula turns round under its lower edge, gets to the upper surface of the scapula, runs in under the infra-spinatus and teres minor muscles, betwixt them and the bone; and although the supra-scapular artery from the shoulder supplies chiefly the upper part of the scapula, yet it is chiefly above the spine that that artery circulates, while the lower parts of the infra-spinatus and the teres minor muscles are left to be supplied by this reflected branch of the sub-scapular artery: thus this reflected branch gives its arteries, first to the teres, then it enters into the hollow under the spine, and besides supplying the infra-spinatus and the bone itself, it also makes a circle, though a shorter one, and inosculates with the supra-scapularis, just as the other branch of this same artery does on its lower surface. This branch descends nearly to the corner of the scapula before it begins this inosculating circle; but it sends also another chief branch round the neck of the scapula, which advancing towards the supra-scapular notch, inosculates very largely with the supra-scapular artery.

Thus is the scapula encircled, and supplied with a wonderful profusion of blood by two great arteries; one, the SUPRA-SCAPULAR ARTERY, coming across the neck, over the shoulder, and through the scapular notch; another, the SUB-SCAPULAR ARTERY, which comes from the axilla to the lower flat surface of the scapula, and divides at the edge of the scapula into two great branches; one of which keeps still to the flat surface, while the other turns over the edge of the scapula, and supplies in part its upper or outer surface.

If, instead of attending to the branches of this artery in the order of their size and importance, we arrange them according to their most common succession, then this will be the plan:—

SUB-SCAPULARIS. SCAPULARIS INFERIOR.	1. Ramus Muscularis Irregularis. 2. Ramus Circumflexus Scapularis. 3. Ramus Dorsalis Scapulæ Superior. 4. Ramus Dorsalis Scapulæ Inferior. 5. Ramus Sub-scapularis.

6. ARTERIA CIRCUMFLEXA POSTERIOR.

The POSTERIOR CIRCUMFLEX ARTERY is a very large one. It arises either along with, or immediately after, the great sub-scapular artery; the place of it is of course settled by the place of the shoulder-joint, for it belongs so peculiarly to it that it is sometimes named the Humeralis, sometimes the Articularis, sometimes the Reflexa Humeri. It goes off between the sub-scapularis and teres major muscles; it passes in between them to get to the joint; it then turns round the shoulder-bone, accompanied by the circumflex nerves, just as the supra-scapular artery is accompanied by the supra-scapular nerve; it ends, after having made nearly a perfect circle, upon the inner surface of the deltoid muscle.

Its branches are, first, Twigs to the nerve which accompanies it, and to the capsule of the shoulder-joint. Secondly, Branches to the coraco-brachialis and short head of the biceps, and to the triceps, and a twig to that groove in which the tendon of the long head of the biceps lies. Thirdly, It sends large branches to the sub-scapularis, to the long head of the triceps, &c. And lastly, The artery, far from being exhausted by these branches, goes round the bone, turns over the joint under the deltoid muscle, and ends in a great number of branches, still accompanied by branches of the nerve, which are distributed in part to the capsule, but chiefly to the lower surface of the deltoid muscle, where it lies upon the joint.

7. ARTERIA CIRCUMFLEXA ANTERIOR.

The ANTERIOR CIRCUMFLEX ARTERY, which goes round the fore part of the joint, bears no kind of proportion to that great artery which passes round the back. The anterior goes off from the same point nearly with the posterior, or sometimes arises from the posterior itself; it takes a direction exactly opposite; it keeps close to the shoulder-bone, passes under the heads of the coraco-brachialis and biceps; encircles the head of the os humeri just at the root of the capsular ligament, and goes round till it meets and inosculates with the posterior circumflex artery. I never could find those muscular branches which are said to go to the scapula, or have found them very trivial; the whole artery belongs to the bone and its parts; it encircles the root of the capsule with a sort of coronary artery; it gives twigs to the capsule, the periosteum, and the tendons, which are implanted into the head of the bone; and having given twigs to the heads of the biceps and coraco-brachialis, it gives off its only remarkable branch, which is indeed regular and curious; it is a small branch which runs down along the bone in the groove in which the tendon of the biceps lies.

PLAN OF THE

ARTERIA AXILLARIS.	1. Arteria Thoracica Superior. 2. Arteria Thoracica Longior. 3. Arteria Thoracica Humeraria. 4. Arteria Thoracica Axillaris. 5. Arteria Sub-scapularis. 6. Arteria Circumflexa Posterior. 7. Arteria Circumflexa Anterior.

Concerning the axillary artery in general, there is more to be observed than this occasion will allow. But these things must not be passed over in total silence. In the first place, the artery, as it passes over the border of the chest, and after leaving the arch of the clavicle, is felt beating, and there it can be compressed.

The compressing of the subclavian artery with a tourniquet, or with the thumb, attracted at one time so much attention, and incited so many to speak about it, that it came to be thought important, and has been ever since esteemed practicable; and yet even those who have spoken the most confidently have taken the thing merely upon vague report, have neglected to read the proper books, and have described the way of compressing as above the clavicle, not knowing that it should be done below it. Camper, in his "Fabrica Brachii Humani," first mentioned what he had demonstrated in his class, viz. that he could, by placing the thumb under the point of the coracoid process, so compress the axillary artery against the second rib where it lies upon it, that even the strength of a syringe could not push an injection through it.* And those who learn things by hearsay, have said that "the subclavian artery could be compressed by thrusting the thumb in above the clavicle;" although, in fact, the arch is so deep, the muscles so strong, and the artery so little exposed, that this is absolutely impossible.

From my speaking with a seeming interest about the preference of one of these two places to the other, it may be thought that I believe this piece of knowledge useful: quite the reverse! I know it to be dangerous; I know it to be less practicable than authors report and believe; and I repeat what I said on a former occasion, that "it is easy to stop the pulse of an artery, but quite another matter to stop the flow of blood through it." We thrust down our hands and compresses, and rest with our whole weight upon the artery; it seems stopped, because the pulse is stopped; but the first stroke of the knife shows us how far we are gone in a dangerous mistake. I may say, without breach of confidence, that I have seen one gentleman trust to it, who will never trouble himself about it again. He was a dexterous surgeon; and in a great aneurism of the axilla was deluged with blood at the first stroke of the knife, and saved his patient only by a plunge of the great needle.

Secondly, It is much to be lamented that we cannot really suppress the blood; not merely because it would make every wound less dangerous, but because it would greatly facilitate operations which we are called upon every day to perform. Would it not be pleasant if we could cut the cancerous breast without the loss of blood? or search into the axilla with perfect deliberation, and cut diseased parts out with the knife, not tearing them in a seeming brutal manner with our fingers? Let the sur-

* In cadaveribus plus semel in publico theatro monstravi, comprimi posse integram arteriam; ligabam arteriam aortam infra arcum, resecabam deinde axillarem dextram, ac siphone axillari sinistræ adaptata fortiter aquam impellens, solo digito eo modo moderare potui subclaviam, ut ne gutta quidem efflueret; quod quanti momenti esse queat in amputatione humeri in articulo nemo non videt. In vulneribus sclopetariis, aliisque circa humeri articulum inflictis, sanguinis profusionem similiter compescere, si non penitus sistere possemus. Vid. *Camper*, lib. i. p. 15.—The plain reason why we are able thus to compress the artery in the dead subject is the want of resistance in all the muscles. If ever it be possible in the living body, it must be when the strength is low and the circulation very languid, after the patient has fainted with loss of blood.

geon, instead of trusting to the narration of authors, try the compression of the subclavian artery, in the amputation of the breast, an operation more familiar, and he will learn to appreciate the value of this compression; he will find that the bleeding is as profuse as if no such compression were made. Yet still, by studying this piece of anatomy, the surgeon knows both from what source all the arteries which bleed upon the surface of the amputated breast come; and also that in any very dangerous situation it would be easy to command all the bleeding orifices by one dip of the needle, the axilla being open. He also knows that the thoracica alaris and the short thoracic artery supply all the glands, and that these lurk too deep in the axilla to be secured otherwise than by the compress: so that these arteries are in fact opened by tearing with the fingers, and are stopped by thrusting in a sponge. He knows also how many large arteries there are, especially about the scapula, of which the bleeding must resemble that of the axillary artery itself; he will judge of the nature of the wound by the pulse; and he will act with great advantage in all doubtful cases, by remembering these great arteries of the scapula, which either bleed outwardly most furiously, or if they seem to stop, it is only by filling the axilla with blood.

Thirdly, The connection of the artery with the axillary nerves, though it must be more fully described in another place, must yet be observed here as a relation too important to be omitted. The artery passes along with the nerves through the interstice of the scaleni muscles; the nerves, which consist of no less than nine, make by their mutual connections a sort of net, which is called the plexus of the axillary nerves. This plexus has its meshes formed, not by small divisions, but chiefly by the seven great cords. This broad plexus lies over the artery as it comes out from the chest; the artery perforates the plexus, or passes through one of the largest meshes in the cavity of the axilla; and when we extend the arm, for example, to cut out an axillary gland, the great veins lie nearest the knife, or lowest in the axilla; the plexus of nerves next; and last of all the artery which has just perforated the plexus of these great nervous cords; three nerves are below the artery and two above; and when the arm is luxated, and the shoulder-bone pushed downwards, the head of it is so pressed against the net of nerves, and the artery is so compressed betwixt the head of the bone and the mesh of nerves, that I have very seldom failed to find the pulse almost entirely suppressed in luxations of this kind.

This connection, viz. with the nerves, is a very interesting one. It is plainly such that the artery cannot be hurt without a wound of the nerves; it has never been known that the artery has been cut in the axilla without the arm being lamed by this wound of the nerves: also the nerves cannot be hurt without the artery being in danger; but it does escape sometimes; of which, among other examples, this is one of the most singular.—I have seen the artery escape in wounds when the nerves were hurt; but how it could escape the stroke of a blockhead's needle in the following case, I am at a loss to conceive. A woman came to me with a great string hanging in her axilla, and along with her came her surgeon. He had about three months before cut off her breast for a cancer, and moreover some glands from the axilla, from which there was a bleeding; and of course, as his fingers could not go deep enough, he took a needle proportionably large, struck it down into the arm-pit, and tied all up. When he brought his patient to me, there hung from the arm-pit, not a surgical ligature, but a good large tape; the axilla was a large gaping and terribly fetid ulcer; I passed my finger into it, and felt the arteries beating around it, and the tape firm about some cord of nerves, whether one or more I could not tell; the woman's fingers were as crooked as a bird's talon, and her arm hung by her side quite useless and lame. I made the surgeon feel the nerve with his finger, offered to cut out the ligature safely; but he carried away his patient, that he might, though at a long interval, finish the operation himself.

The breast had been long healed, and the cord acted as an issue in the axilla. How near the edges of this needle must have been to the great artery, it is terrible to think; and it is most providential that such accidents do not happen daily, considering how much this crooked needle is used in deep places, where it is least fit to be used.

III. OF THE BRACHIAL ARTERY.

The brachial artery is that division of the artery which is marked by the tendon of the great pectoral muscle: for as that is the fore border of the axilla, all above that is axillary, and all below it brachial artery, down to the bend of the arm, where it divides into the radial and ulnar arteries. The brachial artery runs on the inner side of the os humeri; here the bone is most naked; and this is the line in which we feel the artery beating, and apply the cushion of the tourniquet.

To describe, as some authors have done, each insignificant and nameless branch which this artery gives off, were to make a simple matter intricate beyond all enduring. The whole matter is this: As the artery goes downwards, lying exactly on the inner side of the arm-bone, and directly in the middle betwixt the biceps on the fore part and the triceps behind, it gives frequent branches to each. Those going to the biceps are short, small, pretty regular, and exceedingly like each other all the way down the arm; and they are thus frequent, and very short, in consequence of the artery adhering closer to the sides of the biceps. Not one of them can be distinguished, or is worth naming. Those which it sends downwards to the triceps are (in consequence of that being a large muscle with several thick and fleshy origins) both longer and more tortuous, and more important; and they accordingly have some of them appropriate names. Of these arteries going down towards the back part of the arm, and working their way among the muscles, three chiefly are to be observed. First, The arteria profunda superior, which goes round the back of the arm to the exterior muscles, and is often named the upper muscular artery. Secondly, Another like it, called arteria profunda inferior, or the lower muscular artery. Thirdly, The ramus anastomoticus major, which anastomoses round the elbow with the branches of the ulnar artery. These three chiefly deserve notice.

1. ARTERIA PROFUNDA HUMERI SUPERIOR.

Those arteries, which in the limbs go deep among the fleshy parts, as in the arm or thigh, have always one of two names, either profunda or muscularis, and often both. The upper deep muscular artery of the arm is about the size of a crow-quill, or larger; it goes off from the inner side of the brachial artery, just where the tendons of the latissimus dorsi and teres are inserted; and very often it arises from the great artery of the scapula, or that of the joint, viz. the sub-scapularis, or reflexa humeri.

The PROFUNDA turns downwards and backwards round the bone: it glides in betwixt the first and second head of the triceps; there it divides within the thick flesh of that muscle into two chief branches, or the two branches sometimes part immediately after their common origin, or sometimes they go off apart from the humeral artery. One of these, perforating the biceps muscle, turns quite round the bone; and Monro the Father, who gave us the name of spiral nerve, named this also, very properly, the muscular spiral artery: so this artery also, as well as the supra-scapular and circumflex arteries, has its accompanying nerve. This long artery runs down the back and outside of the arm: it descends quite to the outer condyle of the os humeri, and by branches round the olecranon, and over the outer condyle, it inosculates very freely with the radial artery.

The other branch of the profunda superior runs down the inner side of the arm, gives many branches to the triceps and coraco-brachialis; gives a few also to the biceps and deltoid muscle: its longest branch, the proper termination of the artery, runs downwards till it touches the inner condyle, as the posterior branch does the outer condyle; and this inner artery communicates with the outer branch round the olecranon, making small but frequent and beautiful inosculations; and it also inosculates over the condyle with the reflected branch of the ulnar artery. In short, the profunda superior turns down towards the back part of the arm, buries itself under the triceps muscle, supplies all the flesh of the triceps, and divides in the heart of that muscle into two branches, both of which go down to the elbow-joint, and inosculate; the one, round the outer condyle with the radial artery; the other, round the inner condyle with the ulnar artery.

2. ARTERIA PROFUNDA HUMERI INFERIOR VEL MINOR.

The LESSER PROFUNDA, or the lower muscular artery, is so named because it resembles the former in almost all points. It is smaller, being not half the size (viz. of a crow-quill), and goes off, in general, about two inches lower down the arm. Its course, also, is exactly similar, except in this, that it is single, does not divide into two branches; it gives twigs to the muscles of the arm; runs down to the inner condyle, and after touching it, makes a sudden and serpentine turn, by which it gets upon the back part of the elbow-joint. Its chief inosculations are with the upper profunda, and with the recurrens interossea upon the back part of the joint.

Betwixt the upper and lower profunda there generally is sent off that artery which is to nourish the bone. It is named ARTERIA NUTRITIA HUMERI; but is not of sufficient importance to be numbered among the main branches of the artery. The nutritious artery sends off small branches, or rather small twigs, to the brachialis, or that muscle which lies under the biceps, and to the triceps; and it perforates the bone about its middle in one larger artery, and sometimes there are also one or two smaller ones.

3. RAMUS ANASTOMOTICUS MAJOR.

The GREATER ANASTOMOSING ARTERY is one of three or four which anastomose round the elbow-joint; for as the humeral artery advances towards the bend of the arm, it begins, about three inches above it, to give off sideways, and almost at right angles with the trunk, three or four small arteries, more or fewer according to the size of the arm. Each of these sends its little twigs round the condyle, to inosculate with the arteries of the fore-arm both radial and ulnar. Among these, one is distinguished for its size and importance; it is one of the largest of these arteries, and thence named ANASTOMOTICUS MAGNUS; it arises from the humeral artery about three inches above the joint; it lies close by the side of the brachialis internus, and gives many branches to it and to the triceps; but it is chiefly expended in three branches, one of which turns backwards, and, running up the arm, gives branches to the muscles, and inosculates with the profunda: another goes downwards towards the middle of the bend of the arm, and gives branches to the pronator teres and the flexor digitorum; and then going deeper, it touches the capsule, and makes a beautiful inosculation over the fore part of the joint with the radial recurrent or inosculating artery; another branch, the most important, and the chief termination of the artery, runs down betwixt the olecranon and the condyle, in the hollow where the ulnar nerve lies. It first contributes to that network of inosculations which covers the back of the joint over the olecranon; it inosculates very freely with the recurrens ulnaris; and it is this inosculation that gives the artery its importance and its name. This is the channel through which the blood goes after the operation for the aneurism, as we know from preparations; and I have several times felt for it, and found it after the operation, while the arm was still very small, having been wasted by the disease and by the suppuration.

I have not, in describing these arteries of the arm, once mentioned the name of collateral artery; for it is a name which must be entirely dropped, because it has been much abused. Sabatier, Murray, Haller, and all the French and German anatomists, have named the arteriæ profundæ COLLATERAL ARTERIES; because they lie alongside of the great artery, running along with it down the arm. Douglas, and the English anatomists and surgeons, have called the three or four short anastomosing branches near the elbow the collateral arteries; because, though they run off at right angles or obliquely from the trunk, yet they run parallel with each other. Dropping this name, then, we find no more than three arteries in the arm, of any note: the upper or greater pro-

profunda, with its two branches; the lower or lesser profunda; and the great anastomosing artery.

We are obliged to add, however, that the branches of the humeral or brachial artery are exceedingly irregular.

RECAPITULATION AND PLAN OF THE

ARTERIA BRACHIALIS.	1. Rami Musculares Irregulares. 2. Arteria Profunda Humeri Superior. 3. Arteria Profunda Humeri Inferior. 4. Anastomotica Magna.

OF THE ARTERIES OF THE FORE-ARM, VIZ. OF THE RADIAL, ULNAR, AND INTEROSSEUS ARTERY.

The place and condition of this artery at the bend of the arm is as interesting as where it lies in the axilla; for while bleeding is allowed, or is practised by low and ignorant people, operations at this point must be more frequent than at any other, and must be easy or successful only in proportion as the artery and all its relations are well understood.

The humeral artery still continues an undivided trunk, lower than the bend of the arm; though we are accustomed to name that as the place at which it divides. The whole arm, it must be remembered, is covered with a fascia, and that fascia lies over the artery; but at the bend of the arm there is a peculiar fascia, or at least the round tendon of the biceps so strengthens the general fascia, by sending a broad expansion obliquely across the bend of the arm, (which fascia is fixed into the condyle and down the edge of the ulna,) that we call this expansion peculiarly the tendon of the biceps, and say that the artery is at the bend of the arm covered and protected by the tendon of the biceps muscle. The condition, then, of the artery is shortly this: it comes from the inside of the arm, inclining all along towards the middle of the bend or folding of the fore-arm; there, without any particular ring or aperture for its admission, it passes under the aponeurosis of the biceps muscle; for the aponeurosis of the biceps and of the arm in general are one continued sheath. When thus lodged behind the tendon, it lies in a deep hollow betwixt the flexors and extensors of the arm, or, in other words, betwixt the muscles of the upper and of the lower edge; the tendon of the biceps covers this triangular hollow; the floor or bottom of it is the coronary process of the ulna, and the fore part of the elbow-joint, and there the artery lies imbedded in cellular substance, encircled by those veins which accompany the artery particularly, and which are thence named venæ comites; and it carries along with it a nerve in diameter equal to itself, and this nerve is named the great radial nerve.

The artery does not divide immediately, even after it has thus passed the bend of the arm, but goes down deep among the flesh of the fore-arm, and there divides; the ulnar artery being lodged under the thick flesh of the pronator and flexor sublimis muscles, and the radial artery under the strong fleshy belly of the flexor radialis and of the supinators, not absolutely within their substance, nor passing below them, but under cover of their fleshy bellies, which swell out into a great thickness at this part of the arm, and in a manner enclose the artery. The only part of the artery which is exposed, the point which we feel beating, is that where the single and undivided trunk first begins to pass under the thicker fascia of the biceps muscle; and there the artery is pushed forwards, raised, and made to appear superficial by the projection of the coronoid process and brachialis muscle, or, properly speaking, by the protrusion of the fore part of the elbow-joint. This is just before it sinks into the triangular hollow betwixt the muscles.

This artery is singular in one kind of lusus naturæ, which never happens, nor any thing similar to it, in the lower extremity, viz. that the trunk of the artery forks into two great branches high in the arm; sometimes in the axilla, but often in the middle of the arm, or opposite to the pectoral muscle; and I have constantly observed, when this happened, that the radial artery was, as it were, the accidental branch, and passed across the arm near the bend of the elbow, so as to traverse the ulnar or main artery; and that the radial artery passes quite on the outside of the fascia, which binds down the ulnar or main branch of the artery.

This short description involves many points which the surgeon should think of, and more than can be touched upon in this place. The following consequences certainly follow from this arrangement of parts.

First, The artery, lying thus deep under the biceps, cannot be hurt by any skilful surgeon, though bleeding the very vein under which it beats, and at the most critical point; it is hurt, as far as I have observed, only by the rudest stroke of very ignorant fellows; I have seen in six cases a wound in it little less than a quarter of an inch in length. In one of the operations I found it absolutely transfixed; the blood had been poured out from the orifice behind; I felt with surprise the artery running over the tumour, not under it; and, having opened the sac, I passed a probe through the artery from side to side.

Secondly, Since the artery divides only after it has gone deep, where its great branches are protected by the muscles of the fore-arm, the trunk only is wounded in bleeding; the branch is never wounded; and we cannot but be surprised that Hunter, Haller, Sharp, and others, who ought to have studied this point, believed it to be sometimes at least wounded in one of its branches; nor can we think, without surprise, of the arteries being so little understood in the time of Dr. Monro the Father, that he is forced to argue the propriety of doing the operation of aneurism from this fact. "That though it were dangerous to trust to the common anastomosis round the elbow, yet it sometimes happens, that the two branches of the radial and ulnar are set off in the axilla." This surely must have been but a cold assurance to the surgeon in those days, viz. that he was to trust chiefly to the chance of a lusus naturæ for the success of one of his greatest operations.

Thirdly, It must follow, since the artery lies behind the fascia, and is wounded through it, that the blood, being poured out behind the fascia, must raise it into a hard, firm, and (in time) inelastic tumour, growing every day firmer and harder. If surgeons will but think of this, they will go through their operation more correctly. It makes a point of vast importance in the description of aneurism, since it gives outwardly the true character, and inwardly the true shape and appearance of the tumour, when the operation is begun, the outward incision being performed. Had it been but attended to rightly, what noise and wrangling might it not have saved about the nature and names of the disease (yet still the older surgeons knew and described this piece of anatomy, though they made but a poor use of it)? and what idle and stupid descriptions might it not have prevented, such as we have never seen in surgical books till now, of diffused aneurism, and the operation for diffused aneurism; when in truth the first stroke of the knife shows it to be a tumour very different from that which such names, and such formal divisions, and old-fashioned descriptions, must convey? The cup of an aneurism is the triangular hollow which I have described, and the bag of the tumour is the extended fascia, with the cellular membrane extended, and bent into a firm capsule.

Fourthly, The course of this double artery tempts me to believe, that in those few cases where the blood of an aneurism was truly diffused, where it was an ecchymosis, where the blood was not confined by the fascia, but poured out under the skin, and driven upwards to the shoulder, and downwards to the fingers, giving the whole arm the appearance of mortification; that in such rare cases, there must have been a high division, and that the preternatural artery had been wounded, for it lies above the fascia, it is lodged in no hollow, such as might receive its blood, nor covered by any membrane which might confine it: but at all events, I am persuaded that Hunter is wrong in suspecting that, since the pulse so seldom returns instantly, this preternatural artery and the true one must be often tied together; for if the preternatural artery were wounded, it would be a very diffused aneurism, under the skin and above the fascia; but the main artery would be found in its place, under the fascia, quite safe; whereas, if the true artery were wounded, the tumour would be under the true fascia, the preternatural artery would cross by the side of the tumour, over it, and the wounded artery being at the bottom of its own tumour, the two arteries would be a great way apart. Besides, the necessity of supposing this is not so strong as Hunter believed; I have seen the pulse return during the dressing of the arm, when the dissection was so wide and free that I am sure there could be no lusus naturæ, but one artery dividing in the common place.

Fifthly, The close connection of the artery with the great radial nerve must always be considered in all wounds at the bend of the arm; and especially it constitutes a difficulty in the operation of aneurism, of which authors of great eminence have spoken far too lightly; and surgeons of character have tied it in with their great ligatures, as if for amusement, or that they might see what would ensue. But, as I have said on another occasion, "a man must show me either some positive necessity for doing this, or some positive good consequences which will result from it, before I admit him to argue about the bad effects which may ensue." Will any man persuade me, after the case which I have just related, that it is good or harmless to tie in the largest nerve of the arm? We see by that case, that the ligature's remaining firm in its place for three months is one of the least of the ill consequences, and the others may easily be conceived. Of these ill consequences I have seen more than I will venture to tell.

The humeral artery having left this most critical point at the bending of the arm, divides into three great branches, the radial, ulnar, and interosseous arteries; at least the ulnar gives off the interosseus so soon, and the interosseus is so large, and has so pointed a destination, that I take the privilege of describing the three branches apart. The ULNAR ARTERY, which we may regard as the continuation of the main artery, makes its way through the thickest flesh of the fore-arm, under the pronator teres and the flexor digitorum sublimis, goes along the ulnar edge of the arm, appears again from under the edge of the flexor carpi radialis muscle, about three or four inches above the wrist; it goes down by the side of the pisiform bone into the palm of the hand and to the root of the little finger, and gives the chief arches in the palm of the hand, and all the arteries of the fingers, saving only the side of the fore-finger. The RADIAL ARTERY goes off like a branch from the ulnar, or, in other words, the ulnar seems to continue in the course of the main artery, while the radial goes off to one side; it makes its appearance as a superficial artery much higher in the fore-arm than the ulnar does; it turns backwards over the wrist, or root of the thumb, and it gives all the arteries of the thumb and fore-finger, as the ulnar does of the other fingers. The INTEROSSEUS, again, is truly a branch from the ulnar; it comes off where the ulnar lies deepest; it runs along the interosseous membrane, whence its name; it belongs to the deep muscles of the arm.

These are the great divisions of the artery; but before entering upon these, it will be well to set apart and describe one particular set of arteries, viz. the recurrent; both because they belong in a peculiar manner to the joint, and because the recurrents, from whichsoever of the great arteries they come, still serve the same office, viz. of inosculating with those from the above joint; though, after all, this part of their office attracts our attention chiefly because we depend upon these inosculations for our success in operations for aneurism, though unquestionably the chief use of these arteries is to supply the joint and adjacent parts; and there inosculations are but a secondary office.

ARTERIÆ RECURRENTES.

The recurrent arteries are small arteries corresponding with the anastomosing arteries from above. They turn quickly backwards almost as soon as they are clear of the main arteries from which they arise: they encircle the whole joint, for they are no less than four, or sometimes five in number; one from the radial, two from the ulnar, and one from the interosseous artery.

RECURRENS RADIALIS ANTERIOR.

The ANTERIOR RECURRENT of the RADIAL artery is the first branch which it sends off, excepting a small branch to the supinator and skin. The place where the radial recurrent is to be found, is deep in the hollow betwixt the brachialis internus muscle of the arm, and the extensor radialis or first muscle of the fore-arm, viz. that which constitutes its outer edge. The recurrent lies upon the fore part of the joint, where the outer condyle is; the muscles which lie over this recurrent artery, or near it, are the two flexors of the wrist, the supinator longus, and the biceps, and these receive its first branches; and one of its branches runs down along the tendon of the supinator. Its next branches go less regularly to the other muscles of the fore-arm, as to the pronator teres, and to the flexors of the fingers; it has one SUPERFICIAL ANASTOMOSING artery, whose anastomoses are not upon the naked joint; but, on the contrary, the branch mounts along the fore part of the brachialis internus muscle, and inosculates under the biceps with the lesser or lower profunda. A second anastomosing branch goes deeper; it passes through the flesh or belly of the brachialis, and anastomoses with the ramus anastomoticus major from above. A third anastomosing branch is the chief branch; it lies deeper still upon the fore part of the joint, in the hollow which I have lately mentioned: it runs up under the belly of the supinator, along the fore part of the shoulder-bone, where it inosculates with the upper profunda humeri, and chiefly with its greater branch called spiral artery, which turns round the bone, and ends here over the outer condyle.

This is the recurrens anterior of the radial artery; but none of these branches have I ever seen or felt to be enlarged after operations for aneurism. The success of that operation depends entirely upon the arteries next to be described, viz. the ulnar recurrents, which are always two in number; but sometimes these two recurrents go off in one branch from the ulnar; in which case, viz. of a single recurrent coming off from the ulnar, it divides immediately into two branches, and the one takes the fore and the other the back part of the joint.

RECURRENS ULNARIS ANTERIOR.

The ANTERIOR RECURRENT of the ULNAR artery goes off the first of the branches, immediately before it gives off the interosseous, and where the artery lies deep in its triangular hollow. This anterior artery passes up under cover of the pronator teres, lies close upon the fore part of the inner condyle, and is of importance, not only by its own size, but also by its anastomosing with the ramus anastomoticus major, which is the largest of the arteries from above.

RECURRENS ULNARIS POSTERIOR.

The POSTERIOR RECURRENT of the ULNAR artery is often a branch of the anterior one, coming off with it in one common trunk. When it comes off apart, it arises a little lower; it is a larger and stronger artery, *i. e.* it makes as full inosculations, goes farther, and gives more branches to the muscles. This posterior recurrent arises from the ulnar at that place where it perforates the bellies of the flexor muscles; it also dives through betwixt the two bellies of the flexor muscles of the fingers; it thus gets round the condyle, for these two muscles arise together from the condyle: the artery gives many branches both to the pronator and flexor muscles, and to the periosteum, and capsule of the joint; it then lodges itself in that deep hollow which is betwixt the olecranon and the condyle, where the ulnar nerve lies (that nerve which we feel so benumbed when we strike the inner side of the elbow). The artery stretching upwards along the bone meets a similar descending branch from the upper profunda, and inosculates with it. As far as we yet know, the whole weight of the business in saving the arm after aneurisms depends upon these two arteries. In Mr. White's preparation it is the anterior branch which is enlarged, inosculating with the anastomoticus major over the fore part of the inner condyle. In a preparation which I have, it is the posterior artery which runs tortuous and enlarged behind the inner condyle: but I must add to the authencity of this preparation, by noticing, that I have several times felt distinctly, after successful operations for the aneurism, that it was this posterior artery that was enlarged.

RECURRENS INTEROSSEA.

The RECURRENT of the INTEROSSEOUS artery is the first of its branches, though sometimes this recurrent rises from the ulnar a little above the interosseous. This artery, going to the middle and back part of the joint, is very constant; it first sends one smaller branch forwards towards the root of the brachialis internus muscle, which inosculates over the fore part of the joint with the ramus anastomoticus magnus, and with the ulnar and the radial recurrents; but these inosculations and this anterior branch are of small importance. The chief branch goes through that lacerated-like hole which is in the upper end of the interosseous ligament; and the artery having passed through this hole, and got to the back of the joint, it runs for two inches upwards along the back of the olecranon, contributing greatly to form, by its inosculations with both branches of the profunda superior, that net-work of arteries which covers all the back part of the joint, and which belongs chiefly to the joint, to the capsule, and to the bones which form the joint.

From these anastomosing branches which belong to all the three arteries, we now return to describe the general course of the three great arteries; and first, of the radial.

ARTERIA RADIALIS.

The RADIAL ARTERY is properly the first branch of the ulnar; it goes off from it at a pretty obtuse angle in the bend of the arm: it passes over the insertion of the pronator radii teres and under the edge of the supinator longus. It then takes its course to the wrist, parallel to the tendon of the flexor carpi radialis, and about a quarter of an inch to the outside of that tendon. It is here covered with a regular fascia. It is at the root of the thumb only that it divides into its great branches: and a clear proof that in its course down the fore-arm it gives off none but small and irregular muscular branches, is this, that it preserves almost an equal diameter in all its progress from the elbow to the wrist.

This is the artery which lies naked upon the radius at the wrist, where we feel the pulse. It lies more superficial, less imbedded in muscles than the ulnar artery; for six inches above the wrist there is to be felt nothing but the naked artery, the sharp tendon of the supinator, and the bone. The radial artery, as to its course down towards the wrist, is direct; but with regard to itself, it is tortuous, with short and gentle wavings. Of its branches, as it moves down the fore-arm, there is not one that is worthy to be named. First, it gives a branch to the supinator, and to the extensors of the carpus; then it gives the radial recurrent, already described; then having gone a little deeper among the muscles, it repeats its branches to the supinator and extensors; but being deep, it gives also twigs to the pronator and to the flexor radialis, inosculating with the interosseous arteries. Next, the radial artery, emerging from among the thickest of the muscles of the fore-arm becomes superficial, touches the naked radius, and runs along it, with the belly of the flexor pollicis below it, and the long tendon of the supinator above it. Here are no muscles lying on the outside of it, nothing but the tendon; and therefore all its twigs are downwards to the flexor pollicis, upon which it lies; to the flexor digitorum, which lies next to that; and to the flexor radialis and the palmaris longus. Next it gives deeper branches, viz. to the pronator quadratus; and also it gives small twigs, which accompany the several tendons along the naked bone. Arrived at the wrist, it does not divide, as authors have represented, into two branches, viz. a palmar and a dorsal artery; this is indeed a very rare occurrence: the radial artery passes on undivided to the root of the thumb, and there divides into three great branches; one to the thumb, one to the fore-finger, and one to the palm of the hand: it does, indeed, while it is passing the wrist, give two considerable branches, one to the palm, and one to the back of the hand; yet they are but branches.

ARTERIA SUPERFICIALIS VOLÆ.

The first branch, then, of the radial artery, after arriving at the wrist, is that which goes across the palm of the hand, and may be named the SUPERFICIAL artery of the PALM. It goes off just where the main artery is about to turn over to the back of the hand: it passes in general through the flesh of the thumb, going under the root of the ABDUCTOR BREVIS POLLICIS. This artery we generally find dividing into three branches: The first is a more superficial branch, which crosses the palm of the hand, and gives its twigs to the skin, palmar aponeurosis, annular ligament, and all the tendinous parts about the joint: The second is a larger and more important branch; it is the middle branch of these three; it goes deep; and having given several branches to the muscles about the root of the thumb, and to one or two of the interossei muscles, it makes a large inosculation with the great palmar arch, which seems to be indeed the chief tendency of the whole artery: The third branch is less regular than the others; it mounts along the root of the thumb, and belongs to its outer edge.*

The next branches of the radial artery are very small and nameless twigs, which go to the naked part of the wrist, to the tendons, ligaments, and the bones; and then comes the artery opposite to this artery of the palm, viz. the artery of the back of the hand.

ARTERIA DORSALIS CARPI.

The ARTERY of the BACK of the HAND comes off from the radial, just

* This branch, anatomists have thought fit to call ARTERIA ULNARIS RADIALIS POLLICIS, which involves such a complication of contradictions, that, upon reading it, one would naturally turn to the table of errata. The artery is called radialis, because it comes from the radial artery; and ulnaris pollicis, because it goes upon the ulnar side of the thumb.

after it has turned over the radial edge of the wrist. It takes its course directly across the back of the hand, over the carpal bones; and by its frequent inosculations with branches from the ulnar artery, and with the dorsalis metacarpi or dorsalis manus, it makes beautiful net-works across all the naked part of the back of the hand.

DORSALIS METACARPI.

The RADIAL ARTERY, continuing its course under the extensor tendons of the thumb, sends off the dorsalis metacarpi, which is an artery generally larger than the last: it takes its course across the back of the hand and over the metacarpal bones, and from this artery are given off the interosseous arteries.

The first interosseous artery of the hand is large, long, goes up in a direct course to the fork betwixt the fore and mid-fingers, and plunges into the cleft of the digital artery at right angles with it. A second twig like this, and then a third, are given off; named the first, second, and third interosseous arteries: but they are all smaller than the first, and all the three communicate with the arteries from the palm.

Before the final division of the radial artery* into its three branches, it gives a third artery; or, as often happens, two arteries to the back of the thumb.

ARTERIA DORSALIS POLLICIS.

The small artery, or the two small arteries, which, from going along the back of the thumb, are named arteriæ dorsales pollicis, come off either along with, or immediately after, the dorsalis carpi. When there are two, they run both along the back of the thumb, one on one side, the other on the opposite side; that which runs along the outer edge of the thumb passes through under the tendons, and is rather shorter; that which inclines to the inner side of the thumb is rather longer. These small arteries on the back inosculate round the edges of the thumb with the great artery on the inner side; which is next to be described.

Thus we have seen that the radial artery, having advanced to the wrist, turns quick round the wrist, over the head of the radius, and under the tendons of the thumb; it gives immediately before it passes, the artery of the palm; it gives immediately after it passes, the artery of the back of the wrist; it gives immediately after that, the artery to the back of the hand; and then the little arteries for the back of the thumb; it then mounts along the thumb in that hollow which is by the side of the metacarpal bone of the hand; and then the little arteries for the back of the thumb, till it arrives at the cleft betwixt the thumb and fore finger. Here it divides into three arteries; one to the inner side of the thumb, very large; another to that side of the fore finger which is next the thumb, which branch is much smaller; and one which exceeds these in importance, for it dives down into the palm of the hand, forms what is

* Notwithstanding the inconsistency of retaining the name of radial artery, after the artery has passed the wrist, and begun to run along the thumb, I venture to sacrifice verbal accuracy, and would make much greater sacrifices to obtain a clear arrangement.

called the deep arch of the palm; and which, having crossed the palm, forms on the side next the little finger, that inosculation betwixt the upper and lower arches which is so much celebrated.

ARTERIA RADIALIS INDICIS.

The artery of the fore finger proceeding from the radial artery is the first and smallest of these three branches. It goes off at the root of the metacarpal bone of the fore finger, goes up along its interosseous muscle, and runs along all the edge of the fore finger next the thumb, inosculating with the artery of the opposite edge, which comes from the ulnar arch: it sends off twigs at its root, which inosculate with the small dorsal arteries of the thumb; and it gives a branch to the abductor indicis.

ARTERIA MAGNA POLLICIS.

The CHIEF ARTERY of the THUMB rises along its metacarpal bone, a single artery, and there splits commonly, I think, into three smaller branches. Two of these run along the fore part of the thumb up to its extremity, and inosculate there; the one running along the radial, the other along the ulnar side, till they meet at the point. These are, as it were, counterparts of the dorsal arteries, but greatly larger; the thumb being naked on the back, but fleshy where it looks towards the palm. Another branch of the arteria pollicis is one which turns to the palm of the hand, and runs towards the fore finger.

ARTERIA PALMARIS PROFUNDA.

The third branch of the radial artery and that by which it ends, immediately succeeds the artery of the thumb. It crosses the palm of the hand so as to form the deep arterial arch, or the radial arch of the palm; it lies under the aponeurosis, and all the tendons and muscles, close upon the metacarpal bones. Having gone its circle so as to complete the arch, and having arrived at the root of the little finger, or rather lower, near the pisiform bone, it turns backwards with a sudden serpentine turn, and enters into the side of the ulnar arch, so as to make a complete inosculation.

This deep palmar arch gives out many arteries; but as it lies close upon the bones, they are all of the smallest order of arteries, and go only to the bones, and to the joints of the carpus and metacarpus. Those branches, again, which run upwards, give little arteries to the interossei muscles, to the lumbricales, to the long tendons, and to the interstice of each bone. Small twigs are sent through to the back of the hand, which are named arteriæ perforantes, and which inosculate with the dorsalis carpi, or artery of the back of the wrist; they also inosculate with the arteries of the fingers.

PLAN OF THE

ARTERIA RADIALIS.	1. Ramus ad Musculum Supinatorem.		
	2. Arteria Recurrens Radialis.		
	3. Rami Musculares Irregulares.		
	4. Arteria Superficialis Volæ.		
	5. Arteria Dorsalis Pollicis.		
	6. Arteria Dorsalis Carpi.	Dorsalis Metacarpi.	
	7. Arteria Magna Pollicis.	Ramus ad Indicem.	
	8. Arteria Radialis Indicis.		
	9. Ramus Anastomoticus Ulnaris Superficialis.		
	10. Ramus Anastomoticus Profundus.		

ARTERIA ULNARIS.

The ULNAR ARTERY, both from its size and its direction, is to be considered as the continued trunk of the humeral artery. It dives downwards and backwards into the triangular hollow which has been described, till it touches the interosseous membrane: it first gives off a small branch to the pronator teres and common origin of the flexor muscles, before it passes through them: sometimes it gives off here the recurrent which should come from the interosseous artery; in which case that branch, as it passes backwards through the interosseous membrane, is named interossea posterior suprema. Next the ulnar gives off the proper interosseous artery, which is named INTEROSSEA COMMUNIS, because both the anterior and posterior arteries are branches of it. Then the ulnar artery is lodged deep under the muscles which go off from the inner condyle, as the palmaris, pronator teres, flexor ulnaris, and flexor digitorum sublimis. But though it passes betwixt the upper and lower flexor, it does not, like the radial, appear immediately as a superficial artery; it shows itself only about three inches above the wrist. The ulnar artery, running along by the tendon of the flexor carpi ulnaris, passes forward from the wrist to the palm of the hand, by the side of the pisiform bone; it then forms the superficial arch of the palmar arteries, and supplies all the fingers, as the radial supplies the thumb.

The arteries which the ulnar gives out after it passes through the muscles, and before it arrives at the wrist, are merely muscular branches, extremely variable in size and number. To enumerate these would be but to repeat the names of all the muscles which lie upon the flat part of the fore-arm.

As the radial sends a branch over the back of the hand, named dorsalis radialis; so does this send a branch round the back of the little finger, named dorsalis ulnaris.

ARTERIA DORSALIS ULNARIS.

The DORSALIS RAMUS ULNARIS is a small branch which goes off from the ulnar artery as it advances towards the wrist. The ulnar artery goes forwards towards the pisiform bone; while this little artery turns off about two inches below, passes under the tendon of the flexor ulnaris, and round the head of the ulna, to the back of the hand; it then goes upwards along the back of the little finger, where it ends. It gives branches as it passes along to the pronator quadratus, to the extensor ulnaris, to the joints about the lower part of the wrist, and especially to the joining of the radius with the ulna; and it finishes on the back of the hand by arteries given to the tendons and capsule, by inosculations with the rete which is formed upon the back of the wrist, by the radial artery, and by giving the dorsal artery of the little finger.

Next, the ulnar artery, before it begins its arch, gives small branches to the flexor tendons and fore part of the wrist; others to the pisiform bone, to the annular ligament, and to the palmaris cutaneus; and then branches to the flexor, abductor, and adductor of the little finger; or, in other words, to all that mass of muscular flesh which surrounds the root of the little finger; and still, before it begins to bend into an arch, and just beyond the pisiform bone, it gives off that branch which may be called ARTERIA PALMARIS PROFUNDA.

ARTERIA PALMARIS PROFUNDA.

The description of this artery is shortly this: It is but a small artery; it comes off a little lower than the pisiform bone; it often gives the last lateral artery of the little finger; it then turns downwards and backwards with a large circle, passes through betwixt the two heads of the flexor digiti minimi; by this it gets into the deepest part of the palm, and there joins itself with that palmar branch of the radial artery which comes off at the root of the thumb; and by this inosculation the deep palmar arch is completed.

The ulnar artery having now arrived at the root of the metacarpal bones, but above the tendons of the fingers, forms a great arterial arch across the palm of the hand, which is named the SUPERFICIAL PALMAR ARCH; and this arch gives out the arteries for the fingers after the following order: it does not give off two arteries to each finger, one for each side, because it does not lie at the root of the fingers; but instead of this it sends out three single arteries; each of these goes to the cleft betwixt two of the fingers; and when arrived at the roots of the fingers, these branches divide uniformly and regularly into two branches; of which one goes up along the side of one finger, while the other goes up the opposite side of the next finger; and thus all the fingers are supplied each with two arteries, one running along either edge of each finger. To number them according to the fingers, one, two, three, were mere drudgery and waste of time; and to name and describe them were an absolute abuse, since they are so uniform in all points: it is sufficient to observe, that a long and slender artery runs along each edge of each finger; that generally at each joint or division of the finger the two arteries make arches to meet each other across the hollow where the tendons lie, supplying the tendons and ligaments at the same time; and that the fork of each digital artery receives a branch from the deeper arch of the palm. That the arteries are each accompanied with corresponding nerves, one for each side of each finger; for the ulnar nerve accompanies the ulnar artery down the fore-arm, and branches along with it in the palm into the form of an arch, with three branches; which three branches are afterwards divided, like the arteries, each into two twigs at the roots of the fingers.

The superficial palmar arch finishes with a small branch, which makes another inosculation at the root of the thumb with that superficial palmar branch which comes off from the artery of the thumb, near the place where the artery of the fore finger also comes off.

ARTERIA ULNARIS.
1. Ramus ad Musculum Pronatorem Teretem.
2. Arteria Recurrens Anterior.
3. Arteria Recurrens Posterior.
4. Arteria Interossea.
5. Arteria Dorsalis Ulnaris.
6. Ramus ad Musculos Minimi Digiti.
7. Arteria Palmaris Profunda.
8. Arcus Superficialis Palmaris.
    1. Ulnaris Minimi Digiti.
    2. Digitales Tres.
    3. Ramus Anastomoticus.

ARTERIA INTEROSSEA.

The INTEROSSEOUS ARTERY is, after the radial and ulnar, the last of the arteries of the fore-arm. It is but a branch of the ulnar; it arises from the ulnar just where it lies in the very deepest part of the arm, and touches the interosseous ligament. This artery is named INTEROSSEA COMMUNIS, because of two lesser interosseous arteries into which it divides. First, the interossea communis divides about an inch below the elbow into the interossea anterior and interossea posterior; next, the interossea posterior gives off the posterior or interosseus recurrent. That artery is already described; and I proceed to describe now the course of the two interosseous arteries.

First, the anterior interosseous artery is the continued trunk, for it goes straight forwards, and is larger; while the posterior interosseous is smaller, turns out of the straight course to perforate the membrane, and is exhausted before it reaches the wrist.

The anterior interosseous artery lies flat upon the fore part of the interosseous membrane; is larger than a crow-quill, or about half the diameter of the radial artery. As it goes down the fore-arm, it gives branches to all the muscles; it gives the nutritious arteries to the radius and ulna; it goes forwards; and, ending in small branches under the annular ligament of the wrist, it makes beautiful net-works and anastomoses over the capsular joints of the carpus.

Secondly, the posterior interosseous artery turns through the interosseous ligament about two inches below the elbow-joint. It instantly gives off the interosseous recurrent; which being very large, the artery seems to be divided into two equal branches, of which one is the recurrent, turning upwards towards the elbow-joint; the other is the posterior interosseous itself, running downwards, and distributing its branches among all the great bellies of the extensor muscles which lie on the outside of the fore-arm.

Thirdly, there is something like a second interossea posterior; for the anterior interosseous artery sends off, about four inches above the wrist, another artery, but much smaller, which perforates the interosseous membrane: might be called a second posterior interosseus; though it is rather to be reckoned among those smaller twigs which, coming off from the anterior interosseus, and perforating the ligament, go through it to the extensor muscles, and are named PERFORATING ARTERIES, being from about four to seven in number.

ARTERIA INTEROSSEA COMMUNIS.	1. Ramus Muscularis. 2. Arteria Perforans Superior. 3. Ramus Muscularis. 4. Arteria Perforans Inferior. 5. Arteria Carpi Anterior.

OF THE ARTERIES OF THE THORAX, ABDOMEN, AND PELVIS.

ARTERIES OF THE THORAX.

AORTA THORACICA.

THE aorta from the arch (after the subclavians and carotids go off) bends downwards and backwards, and touches the left side of the spine. The two membranes called pleuræ, of the right and left side, meet in the middle to form the mediastinum; but as they do not meet immediately, they leave a triangular space, the basis of which triangle is the spine; the sides are the two membranes or pleuræ, inclining towards each other; and there, in the interstice betwixt them, the aorta is lodged, and along with it lies the œsophagus, which runs downwards towards the stomach. The thoracic duct, which is passing upwards to the subclavian vein, and the vena azygos, which returns the blood of the thorax, and brings it into the descending cava; these parts are all involved in cellular substance, and inclosed in this triangular space betwixt the two membranes.

The aorta, as it goes thus downwards beside the spine, gives the following branches: First, as it lies immediately behind the root of the lungs, it gives small arteries which nourish the proper substance of the lungs, the BRONCHIAL ARTERIES: Secondly, as it lies by the side of the œsophagus, it supplies it with small twigs, the ŒSOPHAGEAL ARTERIES: Thirdly, the aorta, as it moves downwards through the thorax, gives off a small and regular artery to the interstice of each rib as it passes it; and these are the INTERCOSTAL ARTERIES.

The BRONCHIAL arteries are always three, and sometimes four, in number. Their office is not to contribute to the oxydation of the blood; that office belongs peculiarly to the pulmonic artery; while the small bronchial arteries are for nourishing the proper substance of the lungs; for which end they attach themselves immediately to the trachea, and follow its branches, twisting round them through all the substance of the lungs.

1. ARTERIA BRONCHIALIS COMMUNIS.

The COMMON BRONCHIAL ARTERY, so named because it gives branches to both sides of the lungs, arises highest from the fore part of the aorta; it gives two branches, one to the right side of the lungs, and one to the left; the right branch gives an artery to the œsophagus, and sometimes the whole of the right branch goes to that part.

2. ARTERIA BRONCHIALIS DEXTRA.

The RIGHT BRONCHIAL ARTERY sometimes, like the common bronchial, comes off from the aorta; but very often it comes off from the upper intercostal artery. It goes round the right branch of the trachea, and belongs to that side of the lungs alone: but it gives, notwithstanding, some branches to other parts, especially to the œsophagus, to the back of the pericardium, and to the posterior mediastinum, or membrane which strides across the aorta.

3. ARTERIA BRONCHIALIS SINISTRA.

The LEFT BRONCHIAL ARTERY comes off along with the bronchialis communis from the fore part of the aorta; it goes to the left side of the lungs, and also affords small branches to the œsophagus and neighbouring parts.

4. ARTERIA BRONCHIALIS INFERIOR.

Often there is a fourth bronchial artery, which we would call BRONCHIALIS INFERIOR, or the LOWER BRONCHIAL ARTERY, because it comes off lower than these, commonly about the place of the fifth rib. It goes to the back of the heart, where the pulmonic vein of the left side expands into the auricle, and taking the pulmonic vein as a conductor, creeps backwards along it into the substance of the lungs.

These bronchial arteries are the least regular in all the body, coming off usually from the aorta, but sometimes from the mammary, and often from the upper intercostal artery; sometimes also they arise from the intercostals of the aorta. But from one or other of these sources we usually have three or four bronchial arteries, which are so named from their belonging to the branches of the trachea or bronchiæ.

Ruysch, who first discovered this artery, and Sylvius de la Boe and others, who followed Ruysch and used his words in describing the artery, explained its office truly: they said it was for nourishing the substance of the lungs. But this sensible opinion was disputed by many physicians of very great reputation; who maintained that it was quite disproportioned to the size of the lungs, and that it nourished the trachea only; and they gave a most whimsical reason for believing all this. The lungs they consider as made of very coarse stuff, which the half elaborated blood of the right ventricle and pulmonic artery might serve;

while the harder and more perfect substance of the trachea required a more perfect and finer blood.

5. ARTERIA ŒSOPHAGEÆ.

The ŒSOPHAGEAL ARTERIES are generally five or six in number. They are small twigs which come off from the aorta below the bronchial arteries ; they encircle the œsophagus, and make anastomoses with each other ; and very generally they pass off from the œsophagus to the posterior mediastinum, or that double membrane under the interstice of which the aorta lies. These secondary arteries, along with very small twigs which come off from the aorta itself, some anatomists choose to describe apart under the title of posterior mediastinal arteries.

6. INTERCOSTALES INFERIORES.

The LOWER INTERCOSTAL ARTERIES are nine or ten in number, according to the number of ribs which are not supplied by the upper intercostal artery (for the upper intercostal, which comes downwards from the subclavian artery, supplies usually the intercostal spaces of the two first ribs, but sometimes of three, and sometimes of one only). The aorta, in its course down the back, gives out, as it passes each vertebra, one artery for each rib ; as it goes down along the loins it still gives off an artery at the interval of each vertebra ; in the thorax they are named INTERCOSTAL, and in the loins the LUMBAR arteries.

The right intercostals are longer, because they have to mount over the ridge of the vertebræ ; the left ones are shorter, because the aorta lies on that side of the spine : the intercostals often give small twigs to the œsophagus and mediastinum ; but besides these, each intercostal artery gives three principal branches.

1. By the head of each rib it gives a small artery, which belongs entirely to the spine, and this artery sends one twig to the substance of each vertebra ; another twig goes to the sheath or dura mater of the spinal marrow ; the third, following each intercostal nerve backwards, enters into the substance of the spinal marrow itself.

2. Each intercostal gives next a larger artery, which perforates near the head of each rib, and passes through to the back, and supplies the longissimus dorsi, latissimus dorsi, sacro-lumbalis, and all the great muscles of the back, which have indeed no other source whence they can derive arteries ; and though these are apparently small for so great a mass of muscular flesh, the smallness of the branches is compensated for by their frequency.

3. The intercostal artery proceeds, after giving these branches, along its proper intercostal space, where it gives an immense number of small arteries to the intercostal muscles ; and as each artery passes round the thorax along the ribs, it splits into two branches ; one attaches itself to the lower edge of the rib above it, where there is a sort of groove to receive it, *i. e.* the larger artery, and the artery which is to be feared in wounds or operations ; the other attaches itself to the upper sharp edge of the lower rib, where there is no groove ; this of course is the smaller branch, much less important in all respects. These two, accompanying

each rib, run round the circle of the thorax to its fore part, and inosculate with the mammary and epigastric arteries.

Aorta Thoracica Descendens.	1. Arteriæ Pericardiacæ. 2. Arteria Bronchialis Dextra. 3. Arteria Bronchialis Sinistra. 4. Arteriæ Œsophageæ. 5. Arteriæ Intercostales Aorticæ. 6. Rami Irregulares.

ARTERIES OF THE ABDOMEN.

AORTA ABDOMINALIS.

The aorta descends into the belly under that arch which is formed by the legs of the diaphragm. It passes along the left side of the spine; but now upon emerging into the abdomen, it inclines nearer to the middle of that ridge which is formed by the vertebræ. The flat and tendinous legs of the diaphragm not only stride over the aorta, so as to form an arch, apparently for its protection, but the uppermost part of the crura turns flat under it, so as to embrace it. No vein goes along with the aorta; for the cava, which returns all its blood, leaves it a little above the pelvis, and inclines towards the right side, that it may enter into the right side of the heart, which it does by passing under the liver.

But the aorta has other very important connections; for as one of its first arteries is the great artery of the intestines, of course the root of the mesentery (the membrane which conducts the arteries of the intestines) lies over the aorta; and as the mesentery conducts the lacteals from the intestines, of course the meeting of the lacteals and of the lymphatics, or, in other words, the beginning of the thoracic duct, is at the side of the aorta. Again, as the great nerves which come down from the breast into the abdomen are destined chiefly for the viscera, they have no other way of reaching the viscera than by taking the direction of the several branches which the abdominal aorta gives out. There are three great branches: the cœliac, the superior mesenteric, and the inferior mesenteric arteries. Of course there are three great plexuses of nerves; the cœliac plexus, the superior mesenteric plexus, and the inferior mesenteric plexus. As these net-works all come from the greater net-work which covers the aorta itself, that plexus is named, from its great size and from its many radiated nerves, the solar plexus; and the semilunar form of the two great nerves which supply the whole gives them the name of semilunar ganglions.

These connections of the aorta, deduced in this general way, will be easily understood; will show the importance of studying this point, where there are so many intricate parts; and will explain also the necessity of mentioning this group of difficult parts at once.

The aorta then passes from the thorax into the abdomen, through betwixt the legs of the diaphragm; the beginning of the thoracic duct lies a little below this point, and the duct itself runs up by the side of the aorta.

The aorta, having come out into the abdomen, the first branch which it gives off is a small one to the diaphragm as it passes under it. The next branch which it gives off is the most important of all, viz. the cœliac artery; and it supplies the stomach, the liver, and the spleen, because they lie in the upper part of the abdomen. Next it gives a great artery to the intestines, which is named the superior mesenteric artery; for it goes to the intestines which lie within the abdomen. Then it gives the arteries to the kidneys and the spermatic vessels. And, lastly, it gives off a great artery, which is named lower mesenteric; because it supplies chiefly the lower part of the great intestines, and most especially the rectum, where it goes down into the pelvis.

Then the aorta divides into the two iliac arteries, and of course has no longer the name of abdominal aorta.

ARTERIÆ PHRENICÆ.

The diaphragm has in nine of ten bodies two arteries named the PHRENIC ARTERIES; one going to the right side, the other to the left. The varieties of this artery are too great almost to be mentioned; but, however, these are the chief: generally the phrenic arteries are two small arteries arising from the aorta, one going to the right side, another to the left; often there is one artery going off from the fore part of the aorta, and dividing immediately into two arteries, right and left; sometimes one arises from the aorta itself, another from the cœliac artery; sometimes the cœliac artery, which has properly but three branches, has a fourth added, which is the phrenic artery: sometimes there are three phrenic arteries; sometimes even four; and the diaphragm, it is always to be remembered, receives often smaller branches from the intercostal and lumbar arteries, or from the capsular arteries, besides those which it gets from the thorax accompanying its nerves and coming along the pericardium.

These varieties being mentioned, the history of the regular phrenic arteries may be very short. One goes round the right side of the diaphragm, and the other round the left, with very little variety. First, the phrenic artery crosses what is called the fleshy part of the crus diaphragmatis of its own side, and goes bending along to what is called the ala or wing of the diaphragm, and gives a great many arteries in all directions into these fleshy sides of the diaphragm; the artery then turns round, and encircles the great central tendon, where the two phrenic arteries begin to turn round; they give one branch particularly large to the fleshy sides of the diaphragm, which arise from the ribs; then bending round the central tendon, they spread all their remaining branches forwards upon the central tendon, and upon that part of the muscle which arises from the sternum, and meet in large inosculations with each other. One branch often pierces the diaphragm, goes into the pericardium where it is attached to the diaphragm, and unites with that artery which comes down along with the phrenic nerve, then comes nervi phrenici.

But still it is to be remembered, that the phrenic arteries, before they enter into the diaphragm, give small arteries to the capsulæ renales, and to the œsophagus and neighbouring parts; the œsophageal branch running upwards into the thorax, to inosculate with the upper arteries of the œsophagus.

OF THE ARTERIES OF THE STOMACH, LIVER, AND SPLEEN.

The upper part of the abdomen is occupied entirely by the stomach, liver, and spleen; the stomach in the middle, the liver on the right hand, and the spleen on the left. The cœliac artery supplies all these parts; it rises up from the fore part of the aorta a short thick artery encircled by the lesser arch of the stomach; and immediately splits into three branches, of which the middle branch goes to the stomach, the left goes to the spleen, the right goes to the liver; and thus we have all the branches of the cœliac artery neatly and simply arranged.

ARTERIA CŒLIACA.

The CŒLIAC ARTERY is so important, that its place and connections must be more minutely described. It arises from the fore part of the aorta, just at that place where the aorta is closely embraced by the crura diaphragmatis, and over the eleventh vertebra of the back; it juts directly forwards, almost at right angles from the aorta, and is encircled by the lesser arch of the stomach; the artery standing up betwixt it and the diaphragm. The cœliac trunk, then, is so placed as to be surrounded by these parts; it has the œsophagus on the left hand; the lobulus Spigelii, or lobulus papillaris of the liver, on the right hand; it has the lesser arch of the stomach making its turn under it; and it has the diaphragm above and the pancreas running across below; it is covered by the delicate web of the omentum, named omentum minus, which goes from the lesser arch of the stomach to the liver and to the spine.

Now this short jutting out or stump we call the trunk of the cœliac artery; or we call it axis arteriæ cœliacæ, for there is no other artery of the body that divides like it: the stump, which is less than half an inch in length, serving as an axis, from which the three great branches, viz. to the stomach, liver and spleen, go off all at once, in a tripod-like form; one upwards, one to the right, and one to the left. The hepatic, which goes to the right, is largest in the child, because of the great bulk of its liver; the splenic, which goes to the left, is larger in the adult; the gastric is almost always the smallest of the three.

1. ARTERIA CORONARIA VENTRICULI.

The CORONARY ARTERY of the STOMACH is the central artery of the tripod. When it belongs entirely to the stomach, it is smaller than the splenic or hepatic arteries: but when it gives (as often it does) a branch to the liver, it is the largest of the three. This gastric artery, or coronary artery of the stomach, is generally the smallest, not very much larger than a crow-quill; it rises upwards, and turns a little towards the left side, because the cardiac orifice of the stomach is there.

Before it reaches the cardiac orifice of the stomach, it divides itself into two great branches; one going round the cardiac orifice of the stomach, and the other returning along the lesser arch.

CORONARIA SUPERIOR VENTRICULI.

The branch which belongs to the cardiac orifice of the stomach attaches itself to the œsophagus, just where it emerges from the diaphragm, and is joined to the stomach: the artery turns round the œsophagus, passes first under and behind it, and then turns round and appears on the fore part, or rather on the left side, of the stomach, to spread over it. In the middle of this turn it gives off an artery which runs backwards along the œsophagus, takes directly the line of the œsophagus, runs up with it into the thorax a considerable way, inosculates with the upper œsophageal arteries, and though a small branch, it is long, and seldom wanting. The second branch is a continuation of the same artery encircling the cardiac orifice, sending its arteries down over the large and bulging part of the stomach, somewhat in the form of a crown. As the spleen is attached to this end of the stomach, this artery inosculates with what are called the vasa brevia, or short vessels coming from the artery of the spleen; and so it ends, having the name of CORONARIA SUPERIOR VENTRICULI.

The second branch of the coronary returns along the lesser arch of the stomach; it is so connected with the last that it may be called ramus coronariæ dexter, though properly it is not a branch, but the continued trunk of the gastric artery. As the first branch turns round behind the œsophagus, this stops and turns to the lesser arch of the stomach, touches it just at the cardiac orifice, *i. e.* at the root of the œsophagus; turns with a gentle turn round the lesser arch of the stomach, bending as the arch bends, giving its branches down both forwards and backwards over each side of the stomach. As it runs along the stomach it is sensibly exhausted by these arteries, so that it arrives very small at the lower or pyloric orifice of the stomach; there it turns over from the stomach upon the small gut in such a way as to belong to the pylorus or union of the gut with the stomach; and, though small and trivial, it has an appropriated name, ARTERIA PYLORICA SUPERIOR, and thus the gastric artery ends.

But sometimes, as has been mentioned in the general description, this gastric artery sends a branch to the liver; yet, in that case the order of these arteries already enumerated is in no degree disturbed; the artery running along the œsophagus, the artery running round the cardia and in form of a crown, the artery returning along the lesser arch, are still the same; only, after giving off this last artery, the trunk of the gastric goes off from the stomach, continues its course towards the liver, and passes into it.

2. ARTERIA HEPATICA.

The HEPATIC ARTERY goes off from the cœliac axis, where it almost touches the point of the Spigelian lobe. The pancreas covers the root of the hepatic artery; it then turns a little forwards, and rising somewhat upwards at the same time, it passes under the pylorus, *i. e.* under the stomach and duodenum; it passes behind the omentum minus and biliary ducts; it arrives at the porta where the great vena portæ enters the liver, and where the great biliary ducts come out; it passes the vein, and to the left of the biliary ducts; and having a little before divided into two great branches, these now enter into the right and left lobes of the liver. In this place it is inclosed along with all the other vessels in that sheath of cellular substance which is called the capsule of Glisson.

Thus the artery finally terminates near the liver in two great branches, right and left; but before it does so, it gives, as it passes the stomach, duodenum, and pancreas, very important branches to these parts. Before it gives these more important branches, it gives small twigs to the vena portæ and to the head of the pancreas; then it gives off the great artery which is the source of these lesser arteries, (to the pylorus, pancreas, and duodenum,) viz. the ARTERIA DUODENO-GASTRICA, which, soon after it goes off from the hepatic artery, divides into two chief branches. One turns backwards along the duodenum to the stomach, and from supplying the stomach and epiploon, is named GASTRO-EPIPLOIC ARTERY. The other, turning downwards along the duodenum, gives at the same time arteries to the pancreas, and so is named ARTERIA PANCREATICO-DUODENALIS. The trunk which divides into these two arteries may be described thus: The duodenum begins from the pylorus: the pancreas pours its liquor into the duodenum; and therefore the head of the pancreas is attached to the duodenum: this marks the point at which the trunk of the ARTERIA DUODENO-GASTRICA goes off; for it rises at right angles from the hepatic; it lies behind the lower end of the stomach, just between the pylorus and pancreas; there it splits into its two great branches, viz. to the duodenum and to the stomach. But besides these two great banches there are subordinate arteries, which must be enumerated together with them.

One artery goes off to the upper and back part of the duodenum over the biliary ducts; next go off small arteries to the duodenum, of still less importance, and nameless; and at the same place small twigs are often given to the pancreas.

The first which is distinguished or regular, or has a name, is the PYLORICA INFERIOR, the lower pyloric artery. It goes off from the PANCREATICO-DUODENALIS almost as soon as it touches the duodenum; there are sometimes two or more pyloric arteries going off at this point; they encircle the pylorus with delicate branches; and at the same time turn obliquely upwards, to receive inosculations from the upper pyloric, which comes from the artery of the stomach.

The next artery to be distinguished by a peculiar name is one which goes off directly opposite to this, belongs to the pancreas, and is named, from its running transversely across the pancreas, the TRANSVERSE PANCREATIC ARTERY. It is a neat small branch, which passes under the pancreas, runs along its back part, gives its arteries into the substance of the pancreas from side to side; and yet is not exhausted till it has run along more than two thirds of the length of this long gland.

The next branch is that from which the whole artery has its name: for the artery having given off the lower pyloric artery, and the transverse artery of the duodenum, turns downwards, bending according to the circle which the duodenum makes, lying in the hollow side of that circle just as other mesenteric arteries lie along their proper intestines.

In all this circle it gives continual arteries outwards to the duodenum: it gives also frequent arteries inwards to the pancreas. From these two connections this branch is peculiarly named ARTERIA PANCREATICO-DUODENALIS. It ends in inosculation with the mesenteric artery.

At the place where this pancreatico-duodenalis turns downwards, the other great branch turns backwards and upwards to reach the stomach. It is so great that it must be considered as the continuation and ultimate part of the artery. It goes to the stomach and epiploon, and thence is named gastro-epiploic artery.

The course of the gastro-epiploic artery is along the lower part of the stomach, and is most beautiful; it makes a broad sweep round all the greater arch of the stomach; it lies in that line where the great omentum comes off from the stomach; it sends many and large branches upwards upon the stomach, both on its fore and on its back surfaces; it sends opposite branches, very frequent and considerable, down into the web of the omentum or epiploon; it runs along the stomach till it meets with a similar branch from the splenic artery; and the inosculation between them is so large and perfect, that we cannot tell where the one artery ends or the other begins. This branch from the hepatic artery is named the right artery of the stomach, or the right GASTRO-EPIPLOIC ARTERY, while that from the splenic artery is the left.

Besides this great artery to the duodenum and stomach, the hepatic artery, before it plunges into the liver, gives another branch, but small; it is named pylorica superior hepatica.

PYLORICA SUPERIOR HEPATICA.

The PYLORICA SUPERIOR HEPATICA is so named to distinguish it from that upper pyloric artery which comes down from the stomach, and sometimes it is called GASTRICA vel CORONARIA MINOR. It comes off from the hepatic artery just before it divides, or immediately after, from the left hepatic. It turns backwards at an acute angle to the lesser arch of the stomach, and, having given small twigs to the omentum minus, it goes directly to the pylorus, inosculating with its upper and lower arteries.

HEPATICA SINISTRA.

The hepatic artery, now advanced to within about two inches of the liver, divides into its two great arteries. Both go to the porta of the liver; but the one belongs to the right lobe, the other belongs to the left. The artery which belongs to the left lobe of the liver is smaller, and when there is a hepatic artery from the stomach it is very small; it mounts over the vena portæ, and enters into the liver at the fossa umbilicalis; its branches within the liver go chiefly to the left lobe, lobulus Spigelii, and anonymous lobe.

HEPATICA DEXTRA.

The right branch of the hepatic artery passes under the biliary ducts, enters along with them into the right lobe of the liver, and before it does so it gives off the arteria cystica, or artery of the gall-bladder, one of the most beautiful little arteries in the body. The cystic artery branches over the gall-bladder, betwixt its coats, in the form of a coronary artery, and having made a beautiful tree of branches over the gall-bladder, it passes off from it, and goes to the substance of the liver.

ARTERIA SPLENICA.

The SPLENIC ARTERY is one of the most remarkable in the human body. The spleen is tied down to the left side of the diaphragm by a proper ligament; it is also connected with the greater or bulging end of the stomach by processes of the omentum and by vessels. The splenic artery, the largest branch of the cœliac, as large as a goose-quill, turns off from the cœliac trunk almost at right angles, and runs across the abdomen to get to the spleen. It is in all this course exceedingly tortuous; it runs along the upper edge of the pancreas, (which also lies across the abdomen,) and gives arteries to it; when it approaches the spleen, it gives off that great artery which returns along the lower border of the stomach, and when it actually arrives at the spleen, it divides into a great many branches, which enter by the concave surface of the spleen, and plunge into its substance.

The branches, then, of the splenic artery, are these: 1. It gives a great artery to the pancreas, named PANCREATICA MAGNA, which passes to the right under the pancreas, and belongs chiefly to the head of the pancreas, or that rounded end which is next to the duodenum. Though named magna, it is a variable artery, and of little importance. 2. All along, as the splenic artery is passing to the left by the border of the pancreas, it sends short branches into it. They are named PANCREATICÆ PARVÆ, or SMALL PANCREATIC ARTERIES. 3. It often sends small arteries upwards to the back part of the stomach, named POSTERIOR GASTRIC ARTERIES. 4. The GASTRO-EPIPLOICA SINISTRA, or the left gastro-epiploic artery, is a very large and principal branch of the splenic artery. It arises under the stomach, a little beyond the left or larger head of the pancreas; it makes a large arch, and then turns with a serpentine turn towards the stomach, returns along the lower border of the stomach, within the doubling of the omentum, and gives its arteries upwards to the stomach and downwards upon the omentum, so much like those of the right gastro-epiploic artery, that when they meet in the middle of the great arch of the stomach, and inosculate, we cannot distinguish where either of them ends; the chief difference is, that some of the epiploic branches of this artery are particularly large. 5. The VASA BREVIA are a set of three or four arteries which the splenic gives off just before it enters the spleen; and as the artery lies close to the stomach, these arteries which go to the great bulging of the stomach are exceedingly short, and are thence named vasa brevia. The artery ends by eight or ten branches, which plunge into the spleen. Sometimes we see the artery pass, almost undivided, or divided into one or two branches only, into the bosom or sinus of the spleen.

These are all the arteries of the stomach, liver, and spleen, the viscera which fill the upper region of the abdomen.

RECAPITULATION OF THE BRANCHES OF THE

ARTERIA CŒLIACA.	1. Arteria Coronaria Ventriculi.	1. Ramus to the Stomach.		
		2. Ramus ascending to the Œsophagus.		
		3. Ramus to the Diaphragm and Omentum Minus.		
		4. Ramus to the lesser Curvature of the Stomach.		
		5. Arteria Pylorica Superior.		
	2. Arteria Hepatica.	1. Arteria Hepatica Dextra—Arteria Cystica.		
		2. Arteria Hepatica Sinistra.	1. Coronaria Dextra.	
			2. Duodeno Gastrica.	1. Pylorica Inferior.
				2. Pancreatica Duodenalis.
				3. Gastro-Epiploica.
	3. Arteria Splenica.	1. Pancreaticæ.		
		2. Vasa brevia.		
		3. Arteria Gastro-epiploica Sinistra.		

OF THE ARTERIES OF THE INTESTINES.

OF THE UPPER AND LOWER MESENTERIC ARTERIES.

The bowels are so disposed within the abdomen, that the largest of them, viz. the colon, the great intestine, encircles all the others. It begins on the right side in a blind sac called the caput coli, or head of the colon: it goes upwards, and crosses the belly, so as to support the stomach, and separate the stomach, liver, and spleen, from the small intestines: it descends again into the pelvis at the left side, forming the rectum; and all the small intestines hang by their mesentery in the central part of the abdomen, surrounded by this great intestine; and the arteries lie within the two lamellæ of the mesentery or supporting membrane of the intestines, so that they are called mesenteric arteries; and they follow the intestines in the order in which I have named them.

The GREAT OF SUPERIOR MESENTERIC ARTERY gives its first branches to the caput coli; its next branch to the middle of the colon under the stomach; the thousand turns of the small intestines next absorb all its other branches. The LOWER MESENTERIC ARTERY, which gives no branches to the small intestines, attaches itself to the left side, and especially to the lowest part of the colon, and goes down with the rectum into the pelvis, and ends there. This, then, may serve as a general plan or arrangement for the intestines and for the two mesenteric arteries.

1. MESENTERICA SUPERIOR.

It is not surpising that the UPPER MESENTERIC is the largest of all the abdominal arteries. It arises from the aorta, where it is still betwixt the legs of the diaphragm, and not more than half an inch below the cœliac artery. The cœliac and mesenteric arteries lie close upon each other; only we are less sensible of their nearness by the axis cœliacæ jutting perpendicularly forwards, and by the trunk of the mesenteric running very obliquely downwards, and by the head of the pancreas lying immediately over the mesenteric and hiding its root. The trunk of the mesenteric artery passes under the pancreas, then through the mesocolon or mesentery of the colon, then into the proper mesentery of the small intestines. It turns first to the left; and then, by a second gentle bending, it turns again towards the right side of the abdomen. It runs very low into the abdomen before it gives out any branches; and then it gives them off in the following order.

From the right ride it gives branches to the great intestines, of which there are three chief arteries; but from the left side, where it gives arteries to the small intestines, it gives innumerable branches, very large, and so inosculated with each other, that they form a sort of mesh or immense plexus in the mesentery before they go onwards to the guts. The undivided trunk of the artery is very large and long; the gentle curvature of it from left to right, gives it the form of an Italic *f*; the prodigious size of that mesh or plexus of vessels which goes to the great intestines is such as to carry the artery down to the left ilium or flank, where the caput coli or conjunction of the ilium with the colon lies.

It is from the convex of this gently bending arch, and from the right or outer side of the artery, that the following arteries to the great intestines go off.* The COLICA MEDIA to the middle of the great intestine, the COLICA DEXTRA to the right side of the great intestine, the ILEO-COLICA to the joining of the ilium with the caput coli, or beginning of the great intestine.

COLICA MEDIA.

1. The MIDDLE COLIC ARTERY passes along in the doubling, *i. e.* betwixt the two lamellæ of the meso-colon. It goes with a circular sweep upwards towards that part or corner (as we may call it) of the colon which lurks under the liver; but before it touches the intestine, and generally at the distance of about three or four inches from it, this artery divides into two great branches; one turning backwards, along the right side of the colon, inosculates with the colic arteries; the other, more like the continued trunk, turns upwards, bending according to the curvature of the arch of the colon, which supports the stomach; and having rounded the concave of this arch, and arrived at the left side, it there makes a great inosculation with the left colic artery, which is a chief branch of the lower mesenteric; and so completes the great mesenteric arch, one of the most celebrated inosculations in the whole body, that of the circle of Willis hardly excepted.

COLICA DEXTRA.

2. The RIGHT COLIC ARTERY is enumerated as a distinct artery chiefly for the sake of plainness; for though sometimes it arises apart from the general mesenteric trunk, yet in ninety-nine of one hundred bodies it proceeds from the upper or middle colic artery. It is a very large branch; it is set off from the colica media at a very acute angle; it moves along the right side of the colon, inclining also a little upwards towards the liver; it also splits when it approaches the gut into two branches; one turning towards the upper side to inosculate with the middle colic artery, the other turning downwards towards the ilium or flank to inosculate with the ileo-colic artery.

ARTERIA ILEO-COLICA.

3. The ILEO-COLIC ARTERY arises about an inch lower than the last. It is a long, small, and slender artery, compared with the two last; which are short, stumpy, and with contorted angles. This artery goes to the place where the small intestines end, and the great ones begin; of course, the membrane which holds the intestines at this corner (I mean in the right haunch) changes its name from MESO-COLON (in the middle of the colon) to mesentery, or MESO-ENTERON (in the middle of the intestines); and of course the ileo-colic artery runs down, not along the meso-colon, but along the mesentery. It goes directly down towards the joining of

* Often before giving off its greater arteries, the mesenteric gives to the pancreas several small arteries; and to the duodenum two or three, which are sometimes named under the title of duodenales inferiores.

the ilium with the colon; it ends in three regular branches; one passes straight onwards to the junction of the ilium and colon, splits into two branches, one going over the fore and the other over the back part of the caput coli, and having a very curious correspondence with the valve within, so that it might be called ARTERIA VALVULÆ COLI. While this branch goes straight forwards over both sides of the caput coli, another branch runs backwards along the colon, and inosculates with the right colic artery; and another runs downwards along the ilium, and inosculates with the common branches of the mesenteric artery. It is from these two branches, which diverge like the rest of the colic arteries, that this is called ILEO-COLICA. Even the appendix vermiformis has its little mesentery tying it down to the caput coli, and from the back of the caput coli a little artery runs down upon that mesentery to the appendix, passing along the whole legth of that process.

From this point all the remaining arteries of the mesenterica superior go to the small intestines; and they are so undistinguished, and so prodigiously numerous, that no branches can be described or named; there is nothing but a great net-work of arteries to describe. The first or radical branches which go to the small intestines, are thick, large, short, and vary from twelve to fifteen or twenty in number. But it is not these that make this vast appearance of a net-work; these twelve branches are first joined to each other, as it were, mouth to mouth, forming one great confluence of arterial arches: from these, secondary branches arise, and they unite again in like manner, and make a second row of arches; from the union of these still other arteries arise, and make a third, or fourth, and even a fifth row of arches, before any arteries go to the intestines; till at last the proper arteries of the intestines go out in straight lines from the last arch, and spread upon the coats of the intestine. In short, the mesentery has a very intricate and matted appearance from the redoubling of these arches, which are more and more numerous as the artery proceeds lower. The last of the twelve radical branches makes an arch, which serves the ileon or lowest of the small intestines, and inosculates with the ILEO-COLIC ARTERY.

2. MESENTERICA INFERIOR.

The LOWER MESENTERIC ARTERY is that which is named by Haller the left colic artery, because it goes only to the left side of the colon. It arises from the fore part of the aorta, below the two emulgent arteries, *i. e.* pretty low down. It goes off rather from the left side of the aorta; it goes off very obliquely, and keeps close to the left side of the aorta for a great way; and when it has descended as low as the bifurcation of the aorta, it gives off its great branch to the left side of the colon, viz. the LEFT COLIC ARTERY; and then turning down over the iliac artery of the left side it descends into the pelvis, along with the rectum, and ends there.

1. Its first branch is the ARTERIA COLICA SINISTRA. The lower mesenteric has run a considerable length, has passed as low as the bifurcation of the aorta, before this branch is given off. This artery soon divides into three large branches; the trunk itself is short and stumpy, the branches go off like those of the other side, at very acute angles:

First, One branch ascends towards the angle of the colon, under which the spleen lies, and there divides itself into two branches; one keeping closer to the intestine, nourishes it; the other keeping more to the middle of the meso-colon, or broad membrane of the colon, meets the branch of the upper mesenteric, and completes with it the mesenteric arch, being indeed the larger and more important artery of the two. Secondly, Another branch goes directly across to the right side of the colon, and when it approaches the gut, splits (as usual with the colic arteries) into two lesser branches, one turning upwards and the other downwards. Thirdly, The third branch of this left colic artery goes obliquely downwards to that part of the gut which lies in the hollow of the left haunch-bone, and which forms the turn named sigmoid flexure of the colon; and the membrane of the colon is here so fast braced down to the loins that this artery gives twigs to the loins inosculating with the lumbar arteries.

ARTERIÆ HÆMORRHOIDALES.

The INTERNAL HÆMORRHOIDAL ARTERY is one of considerable size: it is just the trunk of the lower mesenteric artery, descending into the pelvis; it is often as large as a writing quill; it applies itself closely to the back part of the rectum; it arrives at it by turning obliquely over the pelvis, and under the rectum, and passes down its whole length quite to the anus. It encircles the rectum completely on each side with its large branches, which meet again upon the fore part of the gut, and its branches lower down in the pelvis inosculate with the middle hæmorrhoidal artery, and sometimes with those of the bladder and womb. This is the artery which prevents us from operating when a fistula in ano has gone deep by the back of the rectum; and which has given occasion to the establishing of something like a general rule in surgery, that one should not operate when the fistula is more than two or three inches deep. It is the last of the arteries belonging to the loose and floating viscera.

OF THE REMAINING ARTERIES OF THE ABDOMEN, VIZ. TO THE KIDNIES, TESTICLES, &c.

ARTERIÆ CAPSULARES.

The capsulæ atrabiliares are two small bodies of a triangular form, of thick walls and small cavities, filled in general with a black and bilious-looking liquor. The ancients thought this the atrabilis, and named them the capsulæ atrabiliares: the moderns, from seeing them placed immediately above the kidney, and observing no apparent connection but with that gland, have named them capsulæ renales. They lie, then, above the kidney, are, like the kidney, surrounded with fat, have straggling arteries from various sources, but none regular or important.

First, They have, very generally, some small branches from the phrenic arteries. These are the highest of the capsular arteries; they touch the uppermost point of this glandular body. They are named the upper CAPSULAR ARTERIES. Secondly, They often have small arteries from the aorta peculiar to themselves, which come off about the root of the upper mesenteric artery, go to the fat and glands, and play over the vena cava, (at least those of the right side do,) and go to the middle parts of the gland, whence they are named CAPSULARES MEDIÆ. Thirdly, They have their last arteries sent upwards to them from the emulgent artery, or artery of the kidney. They are named the lower CAPSULAR ARTERIES.

ARTERIÆ RENALES.

The two RENAL OF EMULGENT ARTERIES, the two arteries of the kidneys, go off from the sides of the aorta, midway betwixt the upper and lower mesenteric arteries. Each goes to its kidney almost at a right angle, arching a little over the bulging belly of the psoas muscle. The aorta is still a little inclined to the left side, and so the left emulgent is shorter, and mounts over its accompanying vein; while the right kidney, being further off from the aorta, and somewhat lower, on account of the liver being on that side, the right artery is longer, and is covered by its emulgent vein. When the emulgent artery, which is short and very thick, arrives at the concave edge of the kidney, it is divided into three or four large branches, which surround the pelvis, or beginning of the ureter, plunge into the substance of the kidney, and inosculate and make arches with each other. Thus, in supplying the kidney within its substance, they form circles and arches over the roots of the papillæ uriniferæ.

Before the emulgent arteries enter into the substance of the kidney, they usually give off small arteries, as has been already mentioned, to the lower part of the capsulæ renales, to the upper part of the ureters, and to the fat surrounding the kidneys.

ARTERIA SPERMATICA.

The SPERMATIC ARTERY, or artery of the testicle, is one of the most singular, both for its extreme smallness and great length, and for its important office. It arises on each side from the lateral parts of the aorta, a little above the lower mesenteric artery. The left spermatic artery rises somewhat higher, and often comes from the emulgent artery; it descends from the aorta almost in the same line with itself; it crosses the vena cava, and meets its accompanying vein upon the surface of the psoas muscle; it then forms the spermatic cord, and passes obliquely through the spermatic passage and abdominal ring; before it goes down into the testicle, it gives out many very small twigs. First, it gives small twigs to the fat of the kidneys; secondly, it gives small branches to the ureters; thirdly, small twigs to the peritonæum; and lastly, small twigs to nourish the spermatic cord itself. When it has passed through the ring, it soon after divides into many small arteries for the several parts of the testicle, four or five in number; two of which go to the epidydimis, and two others, particularly large, go to the testicle; the largest of these branches turns round the testicle in a beautiful and serpentine form, waving along the upper part of the testicle, viz. just under the epidydimis, and sending beautiful coronary branches downwards all over the semicircle or convex surface of the testis.

These are the chief arteries, viz. those of the kidney and testicle. Those of the renal capsule I hold to be so irregular, that they hardly deserve the short description which I have given of them. The following classes of small and irregular arteries are equally insignificant; for few authors have been at the pains to enumerate the arteries going to the fat of the kidney; and none (except Murray) have been at the pains to gather together into one class or description the trifling arteries of the ureter.

ARTERIÆ ADIPOSÆ.

The ARTERIES of the FAT of the kidney are extremely small, but numerous. The upper arteries come from the capsular and diaphragmatic arteries, which are above the kidney; the middle arteries of the fat come from the renal artery itself, from the spermatic, or even from the aorta; the lower arteries come from the colic arteries, and one from the spermatic, which comes off below the kidney, and turns up towards its lower end.

ARTERIÆ URETERICÆ.

As the ureter is a long canal, its arteries come off from various parts which it passes. Its upper arteries are from the renal artery itself, before it enters the kidney; and also from the capsulars and spermatics. The middle arteries of the ureter are more particular and more important: they arise either from the aorta itself, or from the iliac artery, where the ureter crosses it; and they run far, both upwards and downwards, along the canal. The lowest arteries of the ureter arise from those of the bladder itself.

ARTERIÆ LUMBALES.

The LUMBAR ARTERIES are those which succeed to the intercostal arteries, and which run parallel with them; performing the same office in the loins which the intercostals do in the thorax, viz. nourishing the spine and the muscles.

The lumbar arteries arise from the sides of the abdominal aorta. The first arteries go off at right angles; the lower ones are a little inclined downwards. The right ones are longer, because they have to rise over the spine. The arteries of both sides, as soon as they have left the spine, sink under the psoas muscle, and go onwards behind it, round the side, till they terminate in the lateral muscles of the abdomen. The uppermost lumbar artery is large; and as it runs along the lowest rib but one, it of course gives arteries both to the transverse or innermost muscle of the belly, and also to the diaphragm, which indigitates with it in consequence of their both taking their origin from the same ribs. The two lower lumbar arteries are small, and begin to inosculate with the lesser arteries about the top of the pelvis.

Each lumbar artery gives out, like the intercostals, two chief arteries: 1. One which goes to the spine, and which, splitting into two, gives a larger twig to the vertebra itself; and a smaller one, which enters the sheath, lies by the nerve, and passes into the spinal marrow. 2. A muscular branch which is also divided; for one branch of it supplies the psoas muscle, and then runs round within the muscles of the abdomen; while the other pierces the back, and supplies the sacro-lumbalis, longissimus dorsi, and other muscles of the loins.

RECAPITULATION AND PLAN OF THE BRANCHES OF THE

Aorta Abdominalis.	1. Arteria Phrenica Dextra.	
	2. Arteria Phrenica Sinistra.	
	3. Arteria Cœliaca.	
	4. Arteria Mesenterica Superior.	
	5. Arteria Mesenterica Inferior.	
	6. Arteriæ Capsulares.	
	7. Arteria Renalis Dextra.	
	8. Arteria Renalis Sinistra	Arteria Spermatica Sinistra.
	9. Arteria Spermatica Dextra.	
	10. Arteriæ Lumbales.	
	11. Arteria Sacro-Media.	
	12. Rami Irregulares, to the ureter, peritonæum, &c.	

ARTERIES OF THE PELVIS.

The aorta divides into two great arteries, named iliac arteries. The two iliac arteries move downwards to the brim of the pelvis, where they meet the veins of the lower extremity ascending to form the cava, and also a vast plexus of lymphatics from the legs and pelvis, which twist round the arteries and veins. The two iliac veins lie upon the inner sides of the two arteries; and since these veins meet on the right side of the aorta to form the cava, of course the right iliac artery crosses the trunk of the cava. This bifurcation of the aorta is much higher than the pelvis; it begins upon the fourth vertebra of the loins, so that the abdominal aorta is short, notwithstanding the great number of its branches, and the iliac arteries go off at such an angle, that they diverge very gradually; so that when they arrive at the top of the pelvis, they are just over the joining of the haunch-bone with the sacrum; and it is but a very little below this again that they divide into their two great branches; the one, named the external iliac, which passes straight forwards into the thigh; the other, the internal iliac, which dives immediately down into the pelvis to supply the internal parts.

ARTERIA SACRO-MEDIA.

The bifurcation of the aorta gives off only one artery, which proceeds exactly from the fork; and being in the middle, it is a single or azygous artery, which has not a fellow. It is small, long, very regular, and passes down so correctly in the middle of the bone, that it is named the MIDDLE SACRAL ARTERY. It is about the size of a crow-quill; passes directly over the middle of that projecting point which is named the promontory of the sacrum; it descends expressly in the middle of the bone, quite to the point of the os coccygis. At the place of each vertebra, (for the sacrum consists of vertebræ now united together,) it gives off cross branches, which go across the body of the sacrum to inosculate with the lateral sacral arteries. Besides these, it gives arteries to the substance of the bone, and not unfrequently small arteries to the rectum. This artery ends near the point of the os coccygis in a forked or double inosculation with the lateral sacral arteries of each side.

ILIACA INTERNA.

The INTERNAL ILIAC ARTERY is of vast size; it not only supplies all the parts within the pelvis, but sends out by the several openings of the pelvis those great arteries which supply both the private parts, and the immense mass of muscle which surrounds the haunch. Thence the necessity and the usefulness of arranging them under two classes: first, of the lesser arteries which go to parts within the pelvis, as to the loins, to the sacrum, to the bladder, and to the womb; and, secondly, those larger arteries which go out through the several openings of the pelvis, the hips, the haunch, and the private parts.

This artery we cannot describe in the adult, without attending to its condition and function in the child; for it is that indeed which gives it the peculiar form which we have to describe; and which especially gives it that arch downwards, from the convexity of which all the great branches go off. For in the child, the internal iliac or hypogastric artery is extremely large: first, it turns down into the pelvis with a large circle; then it goes close to the side of the bladder very low into the pelvis; then it begins to rise again by the side of the bladder, out of the pelvis, and going along by the urachus (which is a tube or ligament rather leading upwards from the bottom of the bladder,) it goes out by the navel, forming the umbilical artery. Now this sudden turn by the side of the bladder makes the artery convex downwards, *i. e.* towards the parts which it has to supply. The artery keeps this same form in the adult; both in the child and in the adult all the great branches come off from the back of this arch.

ORDER FIRST.

THE BRANCHES OF THE HYPOGASTRIC OR INTERNAL ILIAC ARTERY, WHICH REMAIN WITHIN THE PELVIS.

1. ILEO-LUMBALIS.

THIS artery is so named, because it so resembles the lumbar arteries that it might be mistaken for the last of them; and because it belongs equally to the haunch-bone and to the loins. It goes off from the outer side of the iliac artery, about an inch below the bifurcation; it is about the size of the lumbar arteries, or a little larger; it turns in behind the iliac artery, and passes under the psoas muscle; its trunk is short, for it splits immediately into its iliac and lumbar branches. The lumbar branch goes off betwixt the last vertebra of the loins and the inner end of the ilium, and goes directly upwards; it gives its branches about the psoas muscle. The iliac branch, setting off from the same point, runs straight outwards, lodges itself under the edge or crista ilii, and supplies the iliacus internus muscle by a superficial branch; and it nourishes the bone by a deeper branch, which lies close in the hollow of the haunch.

2. ARTERIÆ SACRÆ LATERALES.

The LATERAL ARTERIES of the SACRUM are very generally three or four in number. Sometimes we find one general artery coming off from the iliac, or from the ileo-lumbar artery, running down all the side of the sacrum, and giving off the lateral sacral arteries; but much more frequently we find three distinct arteries coming off from the sides of the iliac artery, which run across the sacrum in the following manner, to inosculate with the middle sacral artery: First, each lateral sacral artery has one large branch, which runs along the fore part of the sacrum, runs along the naked bone, and inosculates with the middle sacral artery: Secondly, another branch, still larger, dives into each of the sacral holes, which not only nourishes the nerves, and the sheath of the cauda equina, and the bone itself, by one branch, but penetrates by another branch through the posterior sacral hole, and supplies the periosteum, the great ligaments which join the ilium to the sacrum, and the root also of the sacro-lumbalis, and glutæal muscles. From these two branches, (viz. to the spine and to the posterior muscles,) and from the regularity of these five arteries, (going from some artery or other into each sacral hole,) they resemble the intercostal and lumbar arteries, to whose office and place they have succeeded.

ARTERIA HYPOGASTRICA.

The HYPOGASTRIC ARTERY, or the umbilical artery, is of great size and importance in the child; and even in the adult it still remains, in this sense at least, that though the fore part of it (where it turns up by the side of the bladder) is closed, even that part is still known by a round ligamentous substance, into which it is converted, and which we easily trace up to the navel, where the artery meets its fellow of the other side.

This artery is even in the adult body pervious down to the side of the bladder, where in Man it gives one long and slender artery, sometimes two, which go to the sides of the bladder; and in Women, small arteries to the womb, sometimes to the rectum; but these branches are quite irregular in number and size.

ARTERIÆ VESICALES.

The ARTERIES of the BLADDER are extremely irregular both in number and size; for it is to be considered, that the bladder being a round body placed amidst great arteries, and being itself membraneous, and needing but few or but small branches, it gets them from various sources. Very generally the hypogastric, just before it closes into a ligament, sends one or more small arteries downwards and forwards to the neck of the bladder, at that part where the vesiculæ seminales lie; and of course the vesiculæ and the prostate gland get small twigs from this artery of the bladder; sometimes also the bulb of the urethra has a small artery from it.

ARTERIÆ HÆMORRHOIDALES.

The arteries of the rectum are all named hæmorrhoidal arteries. The upper hæmorrhoidal artery is the great branch of the lower mesenteric continued to the pelvis. The middle hæmorrhoidal artery is one which sometimes comes from the hypogastric artery, but very often from the pudic artery, insomuch as to be reckoned among its regular branches. The lower, or the external hæmorrhoidal artery, almost always is a branch of the pudic artery, or that artery which goes to the penis. Two great arteries, one going to the rectum and another to the womb, are the last which the hypogastric gives off before it degenerates into a ligament.

ARTERIA HÆMORRHOIDEA MEDIA.

The middle hæmorrhoidal artery is not a large branch. Often we do not find it, but other arteries supplying its place; sometimes again it is so large as to give off both the uterine and the lateral sacral arteries; but in general it is small. It comes off from the hypogastric opposite to the glutæal artery (presently to be described); it touches the rectum below its middle, and descends curling and winding chiefly along its fore part quite to the anus; and often it gives, as it runs betwixt the rectum and bladder, arteries to the bladder, prostate gland, and vesiculæ seminales. It is this artery also which in women gives small branches to the vagina.

ARTERIA UTERINA.

The womb has four arteries, two from each side; the uppermost that which enters by the upper corners of the womb, comes from the aorta, corresponds with the spermatic in Man, runs along the broad ligament towards the ovaria. The lower artery of the womb, and the largest, comes from the hypogastric, enters the womb where it is connected with the vagina, and runs upwards along the sides of the womb to meet the spermatic; and it sends also at the same time branches downwards into the vagina, and forwards upon the bladder, where it adheres to this part of the womb.

This uterine artery arises from the hypogastric near the origin of the hæmorrhoidal artery; and when it enters the womb it becomes very tortuous.

These, then, are the chief arteries of the rectum, bladder, womb, vesiculæ seminales, and other parts within the pelvis.

ORDER SECOND.

OF THE ARTERIES WHICH GO OUT FROM THE PELVIS TO THE HAUNCHES, HIPS, AND PRIVATE PARTS.

In this second class or order there are just four great arteries; one which goes over the back of the haunch-bone to the glutæal muscle, named Glutæal artery; one going downwards over the tuber ischii to the hip, named the Ischiatic artery; one which goes out of the pelvis, returns into it again, and passes out a second time by the root of the penis, named the Pudic artery; and one which passes out through the thyroid hole into the deep muscles at the top of the thigh, named Obturator artery. All these larger arteries go off from the convex of that arch which the hypogastric forms, and move backwards and downwards, in order to escape from the pelvis.

Let it be remembered, that the iliac artery forks just at the meeting of the ilium and sacrum; that the great sacro-sciatic notch is formed by this joining of the ilium and sacrum, and is just under the junction of these two bones: that the glutæal artery passes out by this sacro-sciatic hole; and that of course it is the first, as well as the greatest, of those three arteries which turn backwards out of the pelvis.

ARTERIA GLUTÆA.

The GLUTÆAL ARTERY goes off from the internal iliac immediately after the lateral sacral arteries. It is exceedingly large, thick, and short, within the pelvis, for it immediately turns over the bone: the turn which it makes over the naked bone is backwards and upwards; it instantly divides itself into a great leash of vessels, which spread in every direction, supply the two glutæal muscles, and turn and ramify upon the back of the haunch-bone, just as the great scapular arteries play over the surface of the scapula.

The pyriform muscle goes out from the pelvis at the same great opening with the glutæal artery, and the artery is accompanied by some of the roots of the great sciatic nerve: the artery passes out over the pyriform muscle, betwixt it and the bone; and when the glutæal artery is to give out its branches, it splits into two great branches at the edge of the glutæus medius muscle. By this splitting, the glutæal artery is arranged thus: First, one great branch passes under the glutæus medius, of consequence it is naked upon the back of the ilium; it sends one large and beautiful artery, which courses round the bone according to the line of the crista ilii, which supplies all the upper half of the haunch-bone with its nutritious arteries, and supplies of course all the upper half of the great or outermost glutæal muscle, where it arises from the spine and dorsum of the ilium. Another large bunch, still belonging to this deeper artery, passes under the thickest part of the belly of the glutæus medius, lies upon the small fan-like muscle named glutæus minimus, and gives innumerable great branches to the middle and lesser glutæi muscles, and to the joint of the thigh-bone.

The other great branch of the glutæal artery slips in betwixt the glutæus major and the glutæus medius; and as it lies betwixt these two great muscles, it gives a prodigious number of branches to each, but chiefly to the great glutæal muscle.

ARTERIA ISCHIATICA.

The SCIATIC ARTERY is so named, because, instead of going upwards with this crooked turn towards the haunch, it goes obliquely downwards to the hip, in the direction of the main artery from which it comes. It comes off from the iliac about an inch lower than the glutæal, and is next to it in size, almost equal, when (as it often happens) the pudic artery is derived from it. The glutæal artery should be contrasted with it thus: the glutæal goes out above the pyriform muscle; the sciatic goes out below it; the glutæal turns upwards over the haunch-bone, the sciatic turns downwards along the hip; the glutæal spreads its arteries wide with sudden and crooked angles; the sciatic sends its arteries downwards in a gentle waving form, or almost straight, and so numerous as to be compared with a lash of many thongs proceeding from one shaft.

Often the glutæal artery, before it passes out of the pelvis, gives small twigs to the rectum, to the bone, and to the pyriform muscle; and in like manner the ischiatic, before it escapes from the pelvis, gives also trivial branches to the rectum, and to the pyramidal muscle.

The branches of so great an artery, ramifying merely among muscles, and among such a vast variety of muscles, can neither be named, nor are worth naming. All that is to be desired is, to know the trunk, and the general direction in which its greater branches go. Among these branches there are few remarkable.

First, The COCCYGEAL ARTERY turns quick backwards upon the sciatic ligaments, and lying under the glutæus magnus; and passing along by the direction of the ligament, it arises at that part of the sacrum whence the ligament takes its rise; and turning downwards upon the coccyx, and upwards upon the back of the sacrum, it inosculates with the sacral arteries through the posterior holes. Secondly, Another branch, more remarkable for its office than its size, runs downwards along the sciatic nerve, supplying its coats and substance. But the great branch of this artery sends a confused lash of arteries downwards, which give arteries, first to the glutæal muscles and pyriformis, and then downwards to all those muscles of the back of the thigh which arise about the knob or tuber of the ischium. In short, all its chief branches are muscular; and the artery is remarkable for no other peculiarity than this, that its inosculations downwards with the reflected arteries of the thigh are so frequent, that these alone may save the limb in wounds of the femoral artery above its profunda, or that great branch which belongs to the thigh.

ARTERIA PUDICA COMMUNIS.

The COMMON PUDIC ARTERY*, or the artery of the external parts of generation, is the third great artery which goes out from the pelvis backwards. And there is in the course of this artery a peculiarity which is never fully explained; and being unexplained, makes the succeeding description quite defective and lame: and it is this. The pudic artery (which is nearly of the size of a writing quill) usually comes off as a branch from the sciatic artery: it goes out from the pelvis along with the sciatic artery through the lower part of the sciatic notch, under the

* It is named often the circumflex pudic artery, the internal pudic artery, the middle pudic artery, the great pudic artery.

lower edge of the pyriform muscle, over the upper sacro-sciatic ligament. But no sooner has it made its appearance along with the sciatic artery, and emerged from the pelvis, than it returns into the pelvis again: it does not go over the outside of the tuber ischii, and so down to the perinæum; but it just appears out of the pelvis, rises over the upper sacro-sciatic ligament, gives out a few branches, turns in again under the lower sacro-sciatic ligament, or rather under the spine or sharp ridge of the tuber ischii, whence that ligament arises: it is now within the pelvis again; it lies flat against the inner surface of the ischium; it runs along by the direction of that bone till it approaches the symphisis pubis, where the root of the penis is. It there dives into the root of the penis, having just before given off that branch which goes to the perinæum. It is this long artery, running naked and unprotected along the whole inner side of the ischium, bending as the arch of the ischium and pubis bends, that is cut by ignorant lithotomists, which a broad gorget is sure to wound, and which can be safe only by our exchanging the gorget for the knife.

The branches of the pudic artery are chiefly these: First, Before it proceeds out of the pelvis, it usually sends branches inwards to the neck of the bladder, vesiculæ seminales, and prostate gland. Secondly, When it emerges from the pelvis, and while bending over the sacro-sciatic ligament, it gives, like the sciatic artery, chiefly muscular branches: it gives twigs to the sacro-sciatic ligament and pyriform muscle; others go to the gemini muscles, and turn over them to the great trochanter, and to the hip-joint, reaching as far as the acetabulum; others spread over the tuber ischii, to which they give arteries, which go outwards along the three muscles of the thigh which arise from this point; and it sends inwards from this part an artery which encircles the verge of the anus, and belongs to the sphincter and levator ani muscles. This branch is named the LOWER OF EXTERNAL HÆMORRHOIDAL ARTERY: and other branches it sends forwards into the perinæum; but these are smaller and less regular arteries: they are not what are distinguished by the peculiar name of perinæal arteries. This artery, like the ischiatic, ends every where in inosculations with the reflected arteries of the thigh.

Thirdly, The artery returning again into the pelvis, and running along under the flat internal surface of the ischium, gives off many small branches to the bladder, prostate gland, vesiculæ seminales, and rectum. But when it has reached the perinæum, and is about to emerge from the pelvis a second time, and go into the root of the penis, it gives out three chief arteries; one to the perinæum, one to the body of the penis, one to the back of the penis, thus:

When the artery has approached nearly to the musculus transversalis perinæi, it splits into two branches; one of which is the artery of the perinæum, the other is the proper artery of the penis.

ARTERIA PERINÆI.

The ARTERY of the PERINÆUM passes under the transversalis perinæi, and betwixt the accelerator and erector penis; in short, it comes out from that triangular cavity which we cut into in lithotomy: in which operation of course this branch cannot escape. The artery having escaped from this triangular cavity, runs forwards along the perinæum for two or three inches, according to the size of the subject, growing very sensibly smaller as it goes along. It is chiefly for supplying the skin and muscles of the perinæum; and gives these branches: 1. When it has just come out from the triangular hollow, it gives off from its root one branch at right angles, which goes directly across the perinæum; it keeps the course of the transverse muscle; it may be named ARTERIA TRANSVERSALIS PERINÆI, and ends about the sphincter ani. 2. It gives branches to the accelerator and erector muscles. 3. It gives branches to the scrotum; and being continued along the corpus cavernosum of each side, it ends upon the tendinous sheath which binds the corpora cavernosa. Thus ends the perinæal artery.

ARTERIA PENIS.

The PROPER ARTERY of the PENIS is the continued trunk of the pudic artery. It is much larger than this perinæal branch; is as big as a crow-quill; it keeps still close to the bone, while the perinæal artery goes outwards; it at last touches the symphisis pubis, and of course pierces the corpus cavernosum, just where it takes its rise from the leg of the pubis: and here it splits into two great branches; one to the corpus cavernosum, and one to the back of the penis, or rather into three, since there is one also for the bulb of the urethra.

The bulb of the urethra is quite insulated in the perinæum, while the corpora cavernosa arise from the bone. Now, first, as the artery of the penis is passing by the side of the bulb, it gives off an artery to the bulb sidewise, which in part plunges into the bulbous substance, and in part is scattered upon the accelerator, prostate gland, &c.

Secondly, The artery having risen to the place where the root of the corpus cavernosum is, gives off that artery, which runs small and delicate along all the back of the penis, till it ends at last in a branch which encircles the corona glandis. This is named the arteria dorsalis penis.

Thirdly, The artery now plunges deep into the proper substance of the penis; the artery of each side goes into each corpus cavernosum at its root, and splits into two branches; these run chiefly along the septum, or partition betwixt the corpora cavernosa, of each side. It is this artery which pours out blood so freely into the cells of the penis, and causes erection.

These three, the glutæal, the sciatic, and the pudic arteries, are the only ones which go out from the pelvis behind, and one only goes out by an opening on its fore part, or rather its lower part, viz. the obturator artery.

ARTERIA OBTURATORIA.

The OBTURATOR ARTERY is so named from its passing through the thyroid hole. No artery is less regular in its origin; arising sometimes from the iliac, sometimes from the hypogastric, and not unfrequently from the root of the epigastric artery: in which case it turns back again over the pubis, coming into the pelvis behind the ring. But no artery is more regular in its destination; a considerable artery always passes through the thyroid hole, to supply the muscles which take their origin from the membrane, and from the ramus of the os pubis.

The obturator artery, arising from the iliac or hypogastric, runs along the upper edge of the pelvis, by the lower edge of the psoas muscle, accompanied with the obturator nerve, which is to go through the hole along with it. Having arrived at the fore part of the pelvis, it slips through the oval hole by a very small opening, which is in the upper part of the tendinous membrane, which closes that hole, and which is consequently at the upper edge of the obturator internus muscle. The artery, before it passes out of the pelvis, often gives branches of considerable size downwards to the neck of the bladder, prostate gland, and vesiculæ; to the iliacus internus, and psoas muscles, and to the lymphatic glands which lie upon them; and there is always a branch, which encircles the upper part of the foramen thyroideum, lies close upon the bone, and gives its twigs upwards into the muscles of the belly.

After the artery has passed along with its nerve through the thyroid hole, it comes into the very heart or central part of the thigh. Almost all its branches are muscular; none are worth distinguishing by name; it is only the general tendency of the artery that needs to be explained. It divides into two chief branches, taking opposite directions. The first is deeper; it turns downwards and outwards towards the hip-joint. It performs three services here; it gives, first, arteries to the periosteum, to the capsule, and to the gland within the acetabulum; it gives also large branches to the obturator, quadratus femoris, and all the great muscles which immediately surround the joint; it also forms very large and important anastomoses round the joint, with the sciatic and pudic arteries, from the pelvis, and with the reflected arteries from the thigh.

The more superficial branch of the thyroid sends all its branches into the great muscles upon the inner side of the thigh coming from the pubis. Its chief branches are to the upper part of the triceps muscle; it sometimes gives branches even to the superficial muscles, as the gracilis and sartorius; always, at least, small twigs pass through these muscles to the skin of the thigh and to the scrotum. Of these two arteries, this superficial one encircles the inner edge of the thyroid hole, or that which is next the pubis, with one of its branches; while the deeper artery encircles the outer edge, or that which is next to the hip-joint; so that they meet upon the bone inosculating with each other.

The following is a very common order of the branches of the

ARTERIA ILIACA INTERNA.
1. Arteria Ilio-lumbalis.
2. Arteriæ Sacræ Laterales.
3. Arteria Hypogastrica.
4. Arteria Obturatoria.
5. Arteria Glutæa.
6. Arteria Ischiatica.
7. Arteria Pudica Communis.

ARTERIES OF THE LOWER EXTREMITY.

ILIACA EXTERNA.

The EXTERNAL ILIAC ARTERY is that branch of the common iliac which descends under Poupart's ligament into the thigh. The internal iliac or artery of the pelvis parts from this within the pelvis at the joining of the ilium and sacrum. The external iliac passes down into the thigh, not bending along the upper edge or brim of the pelvis, directed by the lower edge of the psoas muscle, which also descends into the thigh. This great artery is accompanied by the anterior crural nerve; its corresponding vein lies by the side of it; the lymphatics of the thigh creep upwards along this artery into the pelvis; and when the artery descends into the thigh, it passes so over the bulging part of the acetabulum and head of the thigh-bone, that it is felt projecting there and beating with amazing force.

ASTERIA EPIGASTRICA.

The EPIGASTRIC ARTERY, so named from its running up along the belly, goes off from the inner side of the external iliac artery about an inch before it passes out into the thigh.

The epigastric, when first given off, turns downwards with a full round turn till it touches Poupart's ligament. The peculiarity of its course here must be very carefully attended to. The femoral artery lies at the very outer margin* of the opening, called the crural arch. The Fallopian ligament forms the upper line of the crural arch. The epigastric artery moves inwards and downwards with the Fallopian ligament, running along its lower edge; then it crosses the opening called the abdominal ring, behind the ring, and also behind the spermatic cord which passes through the ring; then it mounts by the border of the transverse muscle, and gets to the rectus muscle of the belly; but it is pretty high before it touches the side of the rectus, and lying on the outside of the peritonæum, and on the inner surface of the rectus muscle, and keeping in the direct line of the rectus muscle near its centre, or rather nearer the outer edge of the muscle, and inclining inwards, it mounts from the groin to a little below the borders of the thorax, where it inosculates very freely with the internal mammary artery. These are the inosculations which were mentioned in speaking of the internal mammary artery. Through its whole course this artery is so large as to make its wounds important: we should know where to stop it in wounds; we should remember to avoid it in opening or extirpating tumours. I have seen some confusion and much loss of time during an operation, from not attending to this. The main artery must be remembered: its branches are of little value. The only branches which it is at all necessary to mention are, first, one small twig, which it sends downwards along the spermatic cord; soon after entering under the abdominal muscle, it

* Viz. that end of the slit or arch which is nearest to the haunch-bone.

gives off a large branch almost equal to the artery itself, which goes directly towards the navel, and ends there. This branch goes obliquely across the muscle, while the main artery follows the general line of the muscle, and gives branches on every side to the rectus, transversalis, obliquus; in short, to all the muscles of the abdomen, and spreads its last branches very freely about the lower border of the chest.

ARTERIA CIRCUMFLEXA ILII.

The CIRCUMFLEX ARTERY of the HAUNCH is named CIRCUMFLEXA from its turning directly backwards, and ILIUM from its passing along the hollow of the haunch-bone.

It is smaller than a crow-quill; it goes off from the outside of the external iliac artery opposite to the epigastric, or rather a little lower; exactly at that point where the outer end of the Fallopian ligament begins in the haunch-bone. It runs backwards in a curved line along the hollow of the haunch-bone, curving along the crista ilii, or ridge of the ilium, under which it lies. Its line is along the most naked part of the bone, where the internal iliac muscle begins on one hand, and the transverse muscle of the belly on the other: in short, it runs along all the upper edge of the internal iliac muscle, quite round almost to the lumbar spine, where it joins the ileo-lumbar artery by small inosculations; for at this place the reflected iliac artery, which grows gradually and sensibly smaller, is almost spent. There are no remarkable branches which deserve to be described, or even to be named, unless it be one which goes off early, near the head of Poupart's ligament, and gives branches to the ligament, to the sartorious muscle which arises at the same point of the haunch-bone, and to the edge of the iliac muscle. And as it runs along betwixt the iliac muscle on the one hand, and the transverse of the belly on the other, it gives many branches downwards to the internal iliac and psoas muscles, and to the substance of the bone; and upwards it gives three or four branches into the abdominal muscles, which go so far along the belly as to inosculate with all its other arteries.

THE CRURAL ARTERY.

The projection of that part of the great artery which is very often called the femoral artery, but with more propriety the crural artery, is occasioned not merely by the naked pelvis and the head of the femur; these parts are covered by the flesh and tendons of the psoas magnus and iliacus internus, which also come out from the pelvis to the thigh. The artery lies cushioned upon these muscles; the muscles dive very deep to get at the trochanter minor or inner trochanter of the thigh-bone. The artery follows them; and thus it is plunged as it were into a deep cavity, assumes a new position, and this constitutes a second point of description.

The hollow in which the artery now lies may be compared with that of the bend of the arm. The artery now takes the name of femoral, lies deep in a hollow surrounded by much fat and many glands; the cavity is covered with a very strong fascia, or tendinous sheath, which descends from the muscles of the belly over Poupart's ligament, and which is greatly strengthened at this point by the general fascia of the thigh. Here the femoral artery, instead of sending off less effectual branches from point to point as it moves downwards, and which could not have conveniently penetrated through all the thickness of the thigh, sends off one great branch, which furnishes the thigh, whence it is named the muscular artery of the thigh. This great artery goes off from the femoral artery just like the ulnar from the artery at the bend of the arm, *i. e.* very deep among the muscles, in the triangular cavity above described. Thence it is oftener named profunda than muscular artery.

The artery having sent down this great branch, equal almost to itself in size, is now properly the femoral artery (arteria superficialis femoris): and now it inclines outwards again, meets the inclined line of the sartorius, and passes obliquely under it, and is covered by it and by the fascia. It is felt beating along the line of the sartorius muscle; and by that line we apply the cushion of our tourniquet. It retires from our feeling only about two hands' breadth, or a little more, above the joint of the knee; at which place it perforates the triceps or great muscle of the thigh, gets from the fore to the back part, or, in other words, forsakes the thigh to go down behind into the ham, where it exchanges its name for that of popliteal artery.

The popliteal artery, when it has got into the ham, meets with its corresponding nerve, which is of vast size; and the artery lies now flat upon the back part of the thigh-bone, passes down in a hollow formed betwixt its great condyles, lies flat upon all the back of the knee-joint, is enclosed by the two great ham-string muscles from above, and by the two great heads of the gastrocnemii muscles below. But although we say it is protected, yet in truth it is not tightly bound down by a fascia embracing it, but lies on the contrary so loose and unsupported among the cellular substance, that we have the most certain evidence of its being often racked and strained in sudden or awkward motions of the joint.

From the ham, the artery descends into the leg, under the heads of the gastrocnemii muscles; and being lodged behind the great bulging, or head of the tibia, below the joint, it there divides into three great arteries. One passing down behind the tibia is named posterior tibial artery; one perforating the interosseous membrane goes down along the fore part of the tibia, is named tibialis antica; the third artery passing down behind the fibula, is named the fibular or peronæal artery. These may be justly compared with the three arteries of the fore-arm; and as those meet in arches upon the palm of the hand, these meet and form similar arches on the sole of the foot.

Even from this slight and general description of this important artery, many conclusions may be deduced not indifferent to the surgeon; for there are several points in the course of this artery very peculiarly marked.

First, It is thrown so forwards by the bulging of the pubis, where it forms the socket for the thigh-bone, it beats so strongly under the rim of the belly, that we cannot, at least till we try, doubt of its being easily compressed. I see, indeed, that Acrel, in very desperate circumstances, when his ligatures had given way even before his eyes, and the arteries burst, and after the surgeons had been twice deluged with the blood of the femoral artery, thought that he had suppressed this artery, by resting on it with his thumbs. But indeed the poor patient, under these horrible circumstances, as Acrel justly calls them, must have fallen so faint and low, by a tedious alarming operation, and by the repeated bleedings, that any thing might have suppressed the pulse in the femoral artery when that of the heart itself was well nigh gone.* But this is one of the points in which it is the most necessary for every man to speak from his own experience. I have tried it in the most favourable circumstances in a slender young man; and when I thought myself sure of the point, behold the blood gushed out with a whizzing noise and prodigious force. I have seen others try it, and fail. It is perhaps not impossible to compress the femoral artery; but it is not an easy thing, and is an expedient never to be trusted where the life of a fellow-creature is immediately in danger.† Secondly, The strong covering of

* "His in horrendis angustiis, cum nec nova ligatura, nec torcularis contractione hæmorrhagia sisti posset, in trunco ipso, dum ex inguine prolabitur, pollicibus firmiter admotis, compressionem instituere placuit, quo effluxus substitit."

† It is strange that my brother came here so near the truth, and yet permitted it to escape him, and that those who followed him, when they thought that they were very sore upon him, were propagating the same error. Thus we know that a celebrated surgeon, in a public Hospital, gave this reproof to a pupil who still held out for the opinion of Mr. John Bell, "That it was dangerous to trust to compression." He was amputating without the tourniquet, and having by mere compression near the groin, stopped the bleeding from the femoral artery, he directed the stump in the face of the student, and let off a jet of blood upon him.

The fact is, as it is strongly expressed by my brother, the blood will flow, notwithstanding the utmost compression of the thumb or knuckle on the inguinal artery; and this he is quite right in asserting, "though as many devils as there are tiles in Bath were combined against him." The truth of the matter is, that if the inguinal artery were squeezed with a vice, the vessels of the thigh would bleed notwithstanding. Of this I had a good example to the point. A little fellow, a French doctor, allowing that he was not heavy, said confidently he could compress the great artery; for which purpose he mounted over my patient. I said to myself, "My little friend, do your best, but I wont trust to you." I began the high amputation by a cut with a scalpel, which laid bare the artery. I passed a ligature round it, and tied it. Then taking the amputating knife, I placed the edge in the first incision, and cut across the artery just below the ligature, and the muscles of the inside of the thigh, by one sweep; of course not a drop of blood flowed down from the artery, but it flowed the other way! it flowed back in pulses from the lower orifice! I remarked it to Mr. Shaw at the moment, who was assisting me, and he caught the orifice betwixt his finger and thumb. My reader will understand what happened. If I had made my incision in the usual way, I should have fallen into the belief of the surgeon who squirted the blood in the face of all unbelievers in his doctrine and practice. But as I had not divided the collateral branches, and only the trunk itself, the reason of the discrepancy of opinion was apparent; compress the trunk ever so securely, if you leave the circuitous circulation free, the blood will flow during any operation on the thigh; and, practically considered, my brother is quite right: do not trust to compression, or you will be convinced of your improper boldness, by being deluged with blood. You may, in any operation, grasp the thigh with your hands, as surgeons did before the invention of the tourniquet, and stop the hæmorrhage from the face of the stump. Under this security, if you can trust to the strength of your assistant's grasp, you may perform any operation. But if you compress the femoral or crural artery alone, and if you allow the vessels of the perineum, and hip and thyroid hole, to be free in their connexion with the vessels of the thigh, you will have a full tide of blood, and all the consequences which you might expect from an unrestrained femoral artery.—C. B.

the fascia gives a peculiar form to the aneurism of the thigh ; it keeps it flat, forces the blood to spread abroad into the surrounding parts ; and this deep driving of the blood among the muscles, together with the great size of the sac, and the putrefaction of three or four pounds of blood, causes that gangrenous and sloughing condition of the parts, by which we are so often foiled in our best concerted operations, and after the artery has been well and fairly tied. Thirdly, It is very obvious that the profunda might with more propriety be named the femoral artery, since it is the proper artery of the thigh ; and though Heister, and some of the best among the old surgeons, spoke of this division as one which only sometimes took place, we know that a leg could no more be without a profunda than without what we call the femoral artery ; and we also perceive, notwithstanding the doubts and fears of some modern surgeons, that when the femoral artery is wounded, it is, after all, only a wound of the artery of the leg. Fourthly, The large branches which the profunda sends upwards round the haunch, inosculating with the sciatic and pudic arteries, and the branches which it sends downwards to the knee, inosculating round that joint with the arteries of the leg, make this branch of peculiar importance to the surgeon ; for when the artery is wounded in the groin, above the profunda, this branch saves the thigh, by its inosculations round the haunch ; and when the artery is wounded in the thigh, below the profunda, or in the ham, it saves the leg by its inosculations round the knee ; and when the whole line of the femoral artery has been obliterated, it has saved the whole extremity, as I have elsewhere proved, by receiving the blood from the arteries round the haunch, and conveying it down to the arteries below the knee, being thus an intermedium betwixt the internal iliac artery and the arteries of the leg, capable of forming a new line of circulation behind the thigh when that before is shut up. Nor should it be forgotten, that the aneurism on the fore part of the thigh may proceed from the profunda ; and then the femoral artery which lies before it may be cut across by a rash or ignorant surgeon.

Fifthly, The place of the femoral artery passing through the triceps muscle is next to be observed, for these reasons. At that point it lies close upon the bone ; and as this happens exactly at that distance above the knee at which we usually amputate, we expect in such amputations to find the great artery close by the bone. As the artery is at this point tied down by the tendon of the triceps, and is in fact passing through a tendinous ring, it sometimes happens that when we have cut near this, but not upon it, the flesh shrinks in such a way that even this great artery, though it bleeds, is not easily found ; but one stroke of the scalpel, running along the bone, cuts the tendon up, and exposes the artery with open mouth. This single point makes all the difference betwixt an aneurism of the thigh and of the ham ; it is peculiarly necessary to mark this, in order to ascertain the extent of the disease before beginning an operation. Nothing can have a worse appearance than that which has actually happened, viz. a surgeon beginning that operation in the ham, which he should have attempted rather on the fore part of the thigh ; and being forced to change his ground, and to begin a second operation on the fore part of the thigh, or, what is worse, to cut up the tendon, and follow the diseased artery to the fore part of the thigh, cutting, in short, first, longitudinally betwixt the hamstrings, and, after an hour's working, perhaps cutting, cross-wise to reach the fore part of the thigh.*

Sixthly, Is it not a matter of very high importance to study the ham still more carefully than the axilla, since the artery is so often hurt at this place by rude motions of the joint? For it is a narrow cavity; the artery lies close upon the joint and bones; and when it is allowed to remain long in a diseased state, enlarging and dilating the ham, we perform in the end a hopeless operation: or if we had hopes when we began our operation, they are all over before it is ended: for the parts are found to be diseased, the bones carious, the joint spoiled; there are no hopes even of present safety, and of the ligature holding, and much less any expectation of a permanent cure. Often the greatest surgeons have been contented to finish such an operation by cutting off the limb! †

Seventhly, When the artery has gone down beyond the ham, and seems lodged safely under the gastrocnemii muscles, still it is not safe: it is bended tense over the back of the joint; it is pressed by the gastrocnemii stretching over it; and their violent action has often been such, as to have torn the artery with a tumour so immediate, and with such excruciating pain, that the surgeon has been constrained in a manner to cut off the limb even upon the spot.

Eighthly, Very often we are obliged to decide whether a tumour of the thigh or a tumour of the ham can be cut away, only by our knowledge of these arteries. How often the anterior arteries of the leg are cut by workmen, and how much they are exposed to the stroke of the adze or axe, every practical surgeon must know: but the mischances that open arteries are quite unthought of. I have known a man standing carelessly by his scythe, which was set upright, the blade along the ground, and the shaft resting upon his arm, cut the artery behind the outer ancle so as to form (when the wound healed) a large, livid, and strong beating aneurism ready to burst, and requiring immediate operation.

The epigastric artery is in danger in operations for hernia. The femoral artery is the subject of operation for aneurism; the popliteal aneurism is a disease of this artery in the ham; and even the simple operation of amputating either the limb itself, or tumours in the thigh or ham, requires a perfect knowledge of all these arteries.

But although no formal operation affected these lesser arteries, yet the main artery itself is so exposed, and so superficial where it runs down the thigh, that it is wounded in a hundred various ways. It is very singular how often it has been wounded by one particular accident, viz. the dropping of a pair of scissors, and with a sudden instinctive effort, clapping the knees together to catch them. It has been wounded once or twice by a shoemaker clapping his knees thus together to catch his sharp-pointed paring knife. One of my pupils lay three months in London, uncertain whether his femoral artery was wounded; for he had in this way caught his penknife, the point of which had run into his thigh, and wounded some great artery. It has been cut across by balls; it has been wounded even by a single slug; it has been uncovered by wounds

* Such operations certainly were performed before the improvement of Mr. Hunter, and from the inflammation produced, the operation could not succeed.

† Again this refers to the miserable operations for popliteal aneurism performed before the time of Mr. John Hunter.

which yet did not touch its coats, and has in consequence dilated into an aneurism. I have known a boy stab another with a penknife in the thigh, and strike so critically as to open the artery with a wound like that of a lancet. My friend Mr. Harkness gave me the privilege of dissecting an aneurismal limb which he was obliged to cut off; and in which the artery was (if I may use such an expression) broken or torn across the upper end of the thigh bone, which had been broken by a fall about three weeks before.

All these accidents must come upon the surgeon very suddenly; and if they come upon him unprepared, all is in a moment lost. I once saw a fine young fellow die from this alarm of the attendants and confusion of the surgeon. He was a tall, stout, young man, who was sitting at table with his companions, eating bread and cheese, taking his glass and telling his tale. He had in his hand a sharp-pointed table-knife, which he happened to hold dagger-wise in his hand, and in the height of some assertion or oath he meant to strike the table, but the point missed, and slanted over the table; he had stabbed himself in the femoral artery, and with one gush of blood he fell to the ground. When I came, I found the young man stretched out upon the floor: he was just uttering his last groan; the floor was deluged, all slippery, and swimming with blood. The wound was covered with a confused bundle of clothes, which I instantly whirled off; and in that moment two gentlemen, who had been first called, and who had both run off for tourniquets, (because tourniquets are used to stop bleedings,) returned, and had the unhappiness to see that the hole was no bigger than what I could close, and had actually shut up with the point of my thumb; and which, had it been shut and put together with a good compress, would have healed in three days, forming a large beating aneurism within, allowing time for a deliberate operation. Or it would have been better still, if by compressing the artery above, and enlarging the wound, a ligature had been put on both ends of the divided vessel.

In short, to enumerate the variety of accidents, which may affect this artery, would be impossible; but surely, from the little that I dare venture to say in this place, it must seem one of the largest, the most exposed, and most dangerous, and by all this the most important, artery in the body; and from these previous hints and general descriptions, the value of the several branches which are now to be enumerated will be more easily felt and understood.

BRANCHES OF THE CRURAL ARTERY.

The great crural artery, until it gets down into the hollow which I have described, gives no branches, or none with which I would choose to confound the description of the profunda or great artery of the thigh. The crural artery betwixt the point where it comes out from under the Poupart ligament, and where it sends off the profunda femoris, gives out several small arteries:

Arteria Cruralis.
1. Rami Inguinales.
2. Ramus Major.
3. Arteriæ Pudendæ Externæ.
4. Arteria Circumflexa Externa.
5. Arteria Profunda.

First, Twigs go out along the femoral ligament, and terminate in the skin. Secondly, Twigs go to the fat, and lymphatic glands of the groin. Thirdly, There ascends a small branch, sometimes towards the origin of the sartorius, to the middle glutæal muscles, and to the beginning of the fascia lata. Fourthly, Of those branches which go across the upper part of the thigh to the genitals, and which are named PUDICÆ EXTERNÆ, to distinguish their branches from those of the pudica communis, there are usually three. The uppermost is scattered about the fat of the pubis. The middle one goes across the heads of the triceps; it is longer and larger than the others; it goes to the side of the scrotum and penis in Men; in Women it is large, and runs into the labium pudendi. The lower one of the three goes to the lower parts of the scrotum, and to the skin of the thigh near it.

ARTERIA PROFUNDA FEMORIS.

Then comes off the profunda femoris, the DEEP OF MUSCULAR ARTERY of the THIGH. It arises from the femoral artery about four inches below the groin, more or less, according to the size of the subject. It turns off from the femoral artery with a bulging, which looks backwards and towards the outside of the thigh. It lies deep in the triangular cavity, upon the face of the iliacus internus and pectinalis muscles. It presently gives off two great arteries, which turn upwards along the joint; one round the outer side, the other round the inner side, of the joint. Then it passes downwards, turns in behind the femoral artery, sinking deeper and deeper towards the back parts of the thigh. It passes down along the face of the triceps muscle; and as it moves along its fore part, it sends through three or four great arteries to the back part, which are called the perforating arteries of the thigh. And, lastly, the profunda itself, or its last branch, passes through the triceps; and this last branch is named perforans ultima vel descendens femoris.

ARTERIA CIRCUMFLEXA EXTERNA.

The CIRCUMFLEX ARTERY, which goes to the outside of the hip-joint, proceeds from the very highest point of the profunda. It takes its course outwards, passing under the sartorius, fascialis, and head of the rectus: it runs over the tendinous head of the vastus externus, where that muscle takes its rise from the outer trochanter: it divides very early into the following branches. First, Branches go to the inner side, to the internal iliac muscle, upon which this artery lies; and round it they bend over the lessser trochanter, making inosculations with the internal circumflex artery. Secondly, An artery goes in the opposite direction, viz. outwards, to the iliac muscle, the sartorius, the head of the rectus, the fascialis, and round to the glutæal muscles. Thirdly, It sends many lesser branches upwards and forwards into the heads of those muscles which I have just enumerated, and which lie immediately over the artery. Fourthly, It sends large branches round the root of the great trochanter, some of them going into the hollow above the trochanter; others keeping so low as the root of the trochanter, where the greater glutæus is inserted. Fifthly, The most important of all its branches is a very long one, which it sends directly downwards under the rectus, or betwixt it and the vastus internus muscle. This artery is divided into two great branches, which run down the whole length of the thigh, somewhat resembling in their shape the PROFUNDA HUMERI: they are named the greater and lesser descending branches of the circumflex artery, and they inosculate in a most particular manner with a large anastomosing branch from the femoral artery. The larger branch of this artery emerges from betwixt the rectus and vastus externus, a little above the knee, to inosculate with one of the articular arteries of the knee. Its smallest branch inosculates with the anastomosing branch of the femoral artery. These two anastomoses seem to be the chief use of these two long arteries, though they do also send some branches to the muscles.

But to give a more simple notion of this circumflex artery, it should be described thus. It is divided into three chief branches: 1st, A descending branch, which goes down to the knee-joint; 2d, A transverse branch, which crosses the upper part of the thigh, and turns round the neck of the thigh-bone; 3dly, It sends a less important branch up upon the dorsum ilii.

ARTERIA CIRCUMFLEXA INTERNA.

The INTERNAL CIRCUMFLEX ARTERY is a thick short artery, which goes off opposite to the ball of the thigh-bone; and as the external one goes round the great trochanter, this goes round the lesser trochanter. It is a smaller artery; it has not so many muscular branches; it keeps closer to the joint; it goes off from the inner side of the profunda, just opposite to the circumflexa externa, or a little lower, but never more than an inch lower; it passes over the insertion of the psoas muscle, and under the belly of the pectinalis; it attaches itself then to the lesser or inner trochanter, and goes round the neck of the thigh-bone round the joint, and is expended on the muscles at the back of the joint, as the quadratus femoris, gemini, &c.

The artery having turned towards the inside, the muscles which lie there are the triceps, gracilis, &c. The first branches, therefore, which this artery gives off before it passes under the pectinalis, are to the triceps and gracilis. After having passed under the pectinalis, and while it is turning round the root of the lesser trochanter, it gives branches to the pectinalis and triceps; and especially it gives to the capsular ligament of the hip-joint an artery which is named articularis acetabuli.

The artery now lying upon the pelvis, under the neck of the thigh-bone, divides itself into two chief arteries; one goes upwards and forwards along the triceps, till it ends at last round the symphysis pubis. The chief muscular twigs of this branch are given to the triceps, and to the obturator muscles; it is this branch which inosculates so freely with the branches of the obturator artery; it is a twig of this artery which enters into the cavity of the hip-joint by that breach which is in the inner edge of the acetabulum; and this branch, entering then by its proper hole, goes to the gland in the bottom of the socket, or chiefly to it. The other branch turns away in the opposite direction, viz. backwards betwixt the little and the great trochanter, turning round the neck of the thigh-bone. It gives branches also to the triceps and obturator, inosculating with the obturator artery. But its chief branches are towards the other side, as to the capsule of the hip-joint, to the neck of the thigh-bone, to the quadratus femoris. It is this artery which gives most of those branches about the roots of the trochanters named trochanteric arteries; and it is from this artery that many branches go backwards along the tuber ischii, to unite with those of the sciatic and pudic arteries.

OF THE PERFORATING ARTERIES.

The two first perforating arteries are very large; the two next perforating arteries are smaller and less regular; the fifth perforating artery is just the termination of the profunda. But still it must be understood that these perforating arteries are extremely irregular in place, size, and number, as indeed all muscular arteries must be; and that there are, besides the greater perforating arteries, many like them in this part of the thigh, though not distinguished by name.

ARTERIA PERFORANS PRIMA.

The FIRST PERFORATING ARTERY is the largest branch of the profunda, bigger than both the articular arteries joined. It arises from the profunda, just under the lesser trochanter, betwixt the pectinalis and triceps brevis; and perforates the triceps about an inch below the trochanter, and close upon the thigh-bone. Here the artery lies under the lower edge of the glutæus, and close by the origin of the biceps, semi-tendinosus and semi-membranosus muscles, the three muscles which form the ham-strings; and the chief division of the artery is into one great branch, going upwards along the glutæus, and another going downwards along the flexor muscles. First, The artery which goes upwards turns over the glutæus, spreads innumerable branches about the great trochanter; and, meeting with the trochanteric branches of the arteriæ reflexæ, make a most beautiful inosculation, or rather net-work of inosculations, over the trochanter. Another transverse branch of this upper artery turns quite round the lower part of the trochanter, and round the thigh, among the flesh of the vastus internus; and a third branch of the same artery meets in inosculation with the lower branches of the sciatic artery.

The lower or descending branch of the perforans prima goes down along the three flexor muscles of the leg, viz. the biceps, semi-tendinosus, and semi-membranosus; nourishes their fleshy bellies, and plays over their surface in beautiful net-work.

ARTERIA PERFORANS SECUNDA MAGNA.

The SECOND OR GREAT PERFORATING ARTERY is a much larger and more important branch of the profunda than this first, at least it is so when the other perforating branches are wanting, and when this, as often happens, represents the continued trunk of the artery: but I shall describe it as a second perforating artery to be succeeded by others.*

* My reason for saying this is, that sometimes there are but two perforating arteries, while there are often five which need to be described.

The second perforating artery comes off from the profunda, about two inches lower than the first; it passes through betwixt the first and second heads of the triceps, or through the flesh of the second; and, turning obliquely downwards and backwards, close by the thigh-bone, it passes into the cellular interstice betwixt the flexor muscles of the opposite sides, *i. e.* betwixt the bellies of the hamstring muscles, and ends there.

Before it passes through the triceps, it gives branches to the triceps and vastus, and to the great trochanter, and to the thigh-bone. Its two chief branches, after it perforates the triceps, are, first, one great transverse branch, which goes directly across below the tendon of the glutæus, and gives one great branch up upon the glutæus, and another to the vastus externus, making inosculations with the reflected arteries of the joint. Secondly, Its descending branch goes down in the hollow betwixt the great hamstring muscles, and its branches go into both muscles, but chiefly into the biceps, and in these the artery is exhausted.

ARTERIA PERFORANS TERTIA.

The THIRD PERFORATING ARTERY comes off about a finger's breadth lower than the former; it makes a gentle waving turn inwards before it pierces the triceps; and, after having perforated the triceps, it gives its branches to both the hamstring muscles, but chiefly to the semi-tendinosus.

ARTERIA PERFORANS QUARTA.

The FOURTH PERFORATING ARTERY may be regarded as the last, or as the termination of the profunda, though sometimes there is a fifth. It perforates again still lower, about a finger's breadth below the last, through the flesh of the triceps magnus. Its first branch, while on the fore part of the triceps, is the nutritia magna femoris, or proper nutritious artery of the thigh-bone; and, after it perforates the triceps, it gives its arteries to the two hamstring muscles, but more especially to the biceps; and so this last branch of the profunda ends.

But this minute description of any important set of arteries never presents any clear idea to the reader's mind, nor any knowledge which he can easily retain; I expect rather to do so by one short description.

The title of PERFORATING ARTERIES is one which comprehends all the great muscular branches of the profunda, except the two circumflex arteries belonging to the joint. They vary in number, as all muscular branches must do, and are proportioned in size and number to the bulk of the thigh. The profunda passes down along the fore part of the triceps, while it is giving off these arteries; they must, of course, perforate the triceps before they can get to the back part of the thigh. When they do perforate, they come into a great muscular interstice or hollow which is formed by the hamstring muscles of opposite sides, by the biceps on one side, and by the semi-membranosus and semi-tendinosus on the other. It is to these two great muscles of the back part of the thigh that the branches of all the perforating arteries are chiefly directed. Each perforating artery succeeds another at about the distance of an inch or more; each successively coming out into this interstice at a lower and lower point. Each artery gives branches to the triceps, &c. before it perforates, and to the hamstring muscles, &c. after it has come into the hollow. The two first perforating arteries are the only arteries which are large and absolutely certain; the third is always very much smaller; the fourth is generally the termination of this great artery; the fifth perforating artery is rare.

Such a general idea as this of their size and value, and situation in the very heart or deepest part of the thigh, (for the profunda turns backwards from the very first, and all its branches keep the same direction,) is of more importance than a particular knowledge of every branch of each perforating artery; a thing really unattainable, since they vary more in their ultimate branches than almost any other arteries in the whole body; for they have more space, and a greater mass of irregular muscle to wander in, and produce varieties.

ARTERIA FEMORALIS.

Though the profunda is plainly the artery of the thigh, yet, from the ignorance of anatomists and surgeons, (who never knew till about twenty years ago that there was more than one great artery,) the superficial artery has been named the artery of the thigh.

The femoral artery makes a spiral or serpentine turn round the whole thigh. It appears first on the fore part; it turns obliquely round to the inner side, following the lower edge of the sartorius muscle; it passes through the triceps, after it has got about two-thirds down the thigh, by which it gets into the ham, and its spiral turn is completed. It lies deep where it is giving off the profunda; it rises then, and is superficial all along the middle of the thigh; and when it has advanced two-thirds down the thigh, it again gets too deep to be felt; but all along it is covered by the thick strong fascia of the thigh. Through the whole of this course it gives no one branch out that is of any considerable importance. They are all muscular arteries, very small, nearly of one size, nameless, and undistinguished, going into the muscles of the fore part of the thigh; or if any are distinguished, it is only by their relation to other arteries, when the trunk gets low enough to make anastomoses with the arteries of the joint.

The nameless muscular branches of the femoral artery go, in one word, to all the muscles on the fore part of the thigh; to the rectus, sartorius, vasti, gracilis, and triceps; to the glands, fascia, fat, and skin; and it thus continues giving successive branches to each of these long muscles as it passes the several points of them.

There is no distinguished branch till, having arrived within two hands' breadth of the knee-joint, it gives out (just where it is about to pass through the tendon of the triceps) a larger branch, named (like a similar branch of the humeral artery) RAMUS ANASTOMOTICUS MAGNUS.

This branch goes out from the inner side of the femoral artery just where it is about to perforate the triceps; it passes into the flesh of the vastus internus; it first sends smaller branches to the vastus internus and sartorius, and through the interstice of these two muscles to the skin of the knee. But, having penetrated into the fleshy belly of the vastus internus, this artery, which is itself very short and thick, sends out its slender inosculating branches: one goes downwards along the tendon of the great triceps; and when the tendon of that muscle stops above the inner condyle, this artery goes forwards over the condyle, makes a network upon it, joining in numberless inosculations with the articular arteries from below, and gives twigs also into the joint. The other branches of this ramus anastomoticus tend all forwards and upwards to join the descending branches of the circumflexa externa, which come down along the rectus muscle.

There are two other arteries lying close upon the joint, remarkable enough to deserve a name, and they are called perforating arteries; not perforating like the branches of the profunda, to get deeper among the flesh; but perforating so as to get out from the cavity of the ham, upon the surface of the thigh again.

The UPPER PERFORATING ARTERY arises from the inner side of the popliteal artery, just after it has perforated the triceps; but it must not be accounted a popliteal branch, because it immediately perforates the triceps muscle again. It gives branches to the semi-tendinosus, semi-membranosus, and sartorius; in short, it turns its branches towards the muscles on the inner side of the knee, and is a smaller artery.

The LOWER OR SECOND PERFORATING ARTERY goes off nearly opposite to this. It is a much larger artery. In order to escape from the ham, it perforates the shorter head of the biceps, or outer hamstring muscles. It first crosses the ham at its very upper point, and within the substance of the triceps; it then perforates the shorter head of the biceps flexor-cruris; it then emerges upon the thigh by the belly of the vastus externus muscle. Before it passes across the ham, it gives a branch to the semi-membranosus: while it is passing through the flesh of the biceps, it gives a lower nutritious artery to the lower and back part of the thigh-bone: after it perforates the biceps, all its branches are to the flesh of the biceps and vastus externus, and its extreme branches are spent in inosculations with the descending branch of the circumflex or articular artery of the hip-joint.

But these branches, which are the last of the femoral artery, are extremely irregular. There is no artery from the profunda downwards worth naming, not even those which I have just described.*

POPLITEAL ARTERY.

The artery having passed through the sheath or canal formed by the tendon of the triceps, or rather having passed betwixt the triceps and the bone, lies flat against the flat part of the thigh-bone as deep as possible in the cavity of the ham. There, as no muscles are lodged, it can give no muscular arteries of any importance; none but trivial ones to the ham-

* "Confiteri tamen oportet, binos ultimos ramos in distribuendis suis surculis infinite ludere, ita ut descriptione ad quodcunque cadaver adaptata vix, ac ne vix quidem comprehendi possint. Ex repetitis tamen meis dissectionibus id pro certe habeo, duos vel tres, quos perforantes appellare vellum, exoriri, hos trunculis suis ad externum latus præcipue conflecti cumque rete vasculoso genu jungi, nutritiant inferiorem ex iisdem gigni, et ramo insuper, nunc pauciores, nunc numerosiores, communicantes ad flexores cum profunda clevari."—*Avidson*, p. 36.

strings or to the heads of the gastrocnemii. In its whole length from the place of its perforating the triceps tendon to its great division, which is under the longer head of the solæus muscle, it gives none but articular arteries, *i. e.* small arteries to the knee-joint, which are no less than five in number, and encircle it in all directions.

First, the popliteal artery sends off from each side two muscular branches, not deserving a particular name nor description: the one goes to the biceps or muscle of the outer hamstring, the other to the semi-tendinosus and sartorius, or inner hamstring muscles.

Then come off the arteries of the joint, which are thus arranged: 1. The upper arteries coming off above the joint, are three in number; one turning round the inner side of the joint, and one round the outer side, and one in the middle; whence it is named azygous, as having no fellow. 2. The arteries below the joint are two only in number; one to the inner side, and one to the outer side, of the joint: and these directions of the arteries settle both the order of description and also their names.

ARTERIA ARTICULARIS SUPERIOR EXTERNA.

That upper articular artery which comes off above the knee, and which turns round the outer side of the joint, arises from the popliteal artery above the outer condyle: its trunk is, like all these arteries about the joints, short and stumpy; but its branches long and slender. It passes under the flesh of the biceps; it appears again at the edge of the vastus externus: one branch plunges into the vastus externus, mounts upwards, and, besides supplying the muscle, inosculates with the long descending branch of the circumflexa externa; while another branch turns as directly downwards over the face of the outer condyle, and spreads beautifully over the side of the joint, inosculating in many networks with the corresponding artery from below.

ARTERIA ARTICULARIS SUPERIOR INTERNA.

The UPPER ARTICULAR ARTERY of the INNER side goes off in like manner over the inner condyle, pierces the tendon of the triceps, where it is implanted into the condyle, and, passing under the edge of the vastus internus, turns towards the fore part of the knee, proceeds towards the patella, and covers chiefly the inner side of the joint with its net-work of inosculations: its little twigs slip in under the great lateral ligament, and under the sides of the patella, to the cavity of the joint itself. It inosculates, like the outer artery, with the lower arteries of its own side.

ARTERIA ARTICULARIS MEDIA.

The MIDDLE OF AZYGOUS ARTICULAR ARTERY usually arises from the back part of the popliteal artery, but sometimes from one or other of those last described; but this branch, at all events, is seldom wanting. It runs down behind the main artery upon the back part of the joint, into the great hollow betwixt the condyles; and all its branches are expended upon the back of the capsule, the posterior crucial ligament, the semilunar cartilages, and the fat about the back of the joint.

LOWER ARTICULAR ARTERIES.

The lower articular arteries are more slender, longer, run downwards very slow, and return upwards with a very sudden angle.

ARTERIA ARTICULARIS INFERIOR EXTERNA.

The external ARTICULAR ARTERY below the KNEE goes off from the popliteal at the middle or centre of the joint, turns downwards along with the popliteal artery for a considerable way, passes under the heads of the small plantar muscle and the outer head of the gastrocnemius, and, having passed through, encounters the head of the fibula, and passes above it to the side of the joint, spreading its branches towards the patella.

In the ham this artery gives muscular branches to the heads of the muscles, as of the gastrocnemius, solæus, plantaris, and the popliteal muscle, that muscle which lies obliquely across the ham. When it reaches to the side of the joint, it passes under the external lateral ligament; and several of its branches, besides their external anastomoses, go into the cavity of the joint, one of which, within the joint, is especially large.

ARTERIA ARTICULARIS INFERIOR INTERNA.

The INTERNAL ARTICULAR ARTERY below the knee is larger than the external one. Like it, it bends downwards, passes under the inner head of the gastrocnemius muscle, and crosses behind the head or rather neck of the tibia, on the inner side of the knee. It first gives arteries to the back of the joint; then it communicates downwards with a large recurrent artery from the tibialis antica: it inosculates upwards with the articularis superior interna; it contributes (as all the other articular arteries do) to the forming of that profuse net-work of arteries which is spread over the whole of the capsule of the knee-joint. It sends also, like the others, certain twigs, which creep under the internal lateral ligament, and go into the cavity of the joint along the borders of the semilunar cartilages.

Before the popliteal artery passes under the head of the solæus, it gives two long arteries, which run down upon the two heads of the gastrocnemii muscles. It often also sends small twigs to the head of the solæus, and to the popliteal and plantar muscles. These are of size to require ligatures in an amputation below the knee, and are named surales.

RECAPITULATION AND PLAN OF THE

FEMORAL and POPLITEAL ARTERY.	1. Rami Irregulares Musculares.	
	2. Ramus Anastomoticus Magnus.	
	3. Rami Perforantes.	
	4. Arteria Articularis Superior Externa.	Ramus Profundus. Ramus Superficialis.
	5. Arteria Articularis Superior Interna.	Ramus Profundus. Ramus Superficialis.
	6. Arteria Articularis Media.	
	7. Arteria Articularis Inferior Externa.	
	8. Arteria Articularis Inferior Interna.	
	9. Surales.	

OF THE THREE ARTERIES OF THE LEG AND FOOT.

The three arteries are, the tibialis antica, going on the fore part of the leg; the tibialis postica, passing deep along the back part of the leg; and the peronea, which is the smallest and least regular artery of the leg, and which has its name from passing down behind the fibula. The popliteal artery divides below the ham, under the longer head of the solæus muscle, into two arteries, the tibialis antica, and tibialis postica. The tibialis postica continues its natural direction downwards under the solæus muscle, and behind the tibia.

ARTERIA TIBIALIS ANTICA.

The TIBIALIS ANTICA makes a sudden turn forwards, perforates the interosseous membrane just under the lower edge of the popliteal muscle, and passes out towards the fore part of the leg, betwixt the heads of the tibia and fibula: but still it does by no means become a superficial artery; on the contrary, it lies deep under the heads of the tibialis anticus, and the extensor of the toes, which are covered here with a very strong fascia. It is only about two inches above the ancle that the leg grows tendinous and naked; there this anterior artery can be felt beating: it lies betwixt the tendons of the tibialis anticus muscle and that of the extensor of the toes; it passes down along with these tendons through the annular ligament, and over the bones of the tarsus: it sends one branch across the foot, another forward to the great toe; but the artery itself divides betwixt the first and second metatarsal bone in the middle of the foot, and so gets to the sole, where it ends in inosculations with the plantar arteries.

The tibial artery, before it passes out of the ham, gives a small branch which ascends towards the back part of the joint, and is distributed to the heads of the bones, viz. the tibia and fibula, and to the origin of some of the muscles.

ARTERIA RECURRENS.

There is here an ANTERIOR RECURRENT, larger than any in the arm, and much resembling the recurrens interossea. It is a branch which comes off from the fore part of the tibial artery, instantly after it has perforated the interosseous membrane; it turns immediately upwards under the flesh of the tibialis anticus; it gives many muscular branches, some to the head of the tibialis, others to the upper part of the extensor digitorum, and branches go round the head of the fibula to the origin of the long peronæus muscle. One branch goes directly upwards, and spreads all over the lower part of the knee-joint, mixing its branches in the common vascular net-work.

The tibialis antica gives no other branch of importance, or which should be named, even from the place of this recurrent quite down to the ancle-joint; for this, like the radial or femoral, or any long muscular artery, continues giving off branches from either hand to the muscles betwixt which it runs, of nearly equal size, and all equally unimportant. The tibial artery, then, as it runs down the fore part of the leg, gives branches to the Tibialis Anticus on one hand; to the Common Extensor of the toes on the other; and to the Extensor of the great toe, which is the last of the three muscles that occupy the fore part of the leg. It also gives little arteries to the tibia, to the fibula, and to the interosseous membrane which lies betwixt them; but still it arrives unexhausted at the fore part of the ancle-joint.

But before it crosses the joint, (which it does by passing obliquely along with the tendon of the great toe,) it gives out two malleolar arteries, *i. e.* two arteries, one to the outer, and one to the inner ancle.

ARTERIA MALLEOLARIS INTERNA.

The ARTERY of the INNER ANCLE goes off just where the head of the tibia begins to bulge. It turns over the inner ancle in many small branches; some mounting upwards along the tibia, but more going downwards over the inner side of the joint, *i. e.* over the tibia or inner ancle, over the astragalus, and some down as low and as far backwards as the heel-bone.

ARTERIA MALLEOLARIS EXTERNA.

The ARTERY of the OUTER ANCLE goes off a little lower down. It sends smaller branches upwards round the outer ancle, which go to the Peronæus Brevis muscle, to the joint, and to the common extensor of the toes, inosculating round the outer ancle with the fibular arteries. But its chief branch descends along the fore part and outer side of the foot, gives twigs to the short extensor of the toes, and ends in inosculations with the tarseal arteries, or arteries belonging to the fore part of the foot.

The arteries which belong to the fore part of the foot are usually three in number: one goes off from the tibial artery a little above the ancle-joint, and is named Arteria Tarsea, because it crosses the foot over the bones of the tarsus. To this succeeds a second about the distance of half an inch from it, and which crosses the foot at the place of the metatarsal bones; it is named Arteria Metatarsea: and the one or other of these gives the interosseous arteries, according as the one or the other is small or wanting. The third is that remarkable branch which goes forwards along the great toe, whence it is named Arteria Halucis.

ARTERIA TARSEA.

The TARSAL ARTERY, which is sometimes of a very considerable size, almost equal to the tibialis itself, comes off a little below the ancle, upon the fore part of the foot. It lies upon the second row of the tarsal bones; it passes under the head of the extensor brevis of the foot; it crosses the foot obliquely, so as to end in the abductor muscle of the little toe, and in inosculations with the arches of the sole of the foot.

This branch gives small inosculating arteries upwards, which first give branches to the joint, and then join with the external malleolar and peroneal arteries. Next it gives branches to the bones and joints of the tarsus, which it lies upon; as the cuboid and cuneiform bones, and their joints. Thirdly, It gives small arteries to the bellies of the extensor brevis, where it lies under it.

But its greatest arteries are the interosseous arteries, which it sends along the interstices betwixt the metatarsal bones. These interosseous arteries are three in number; they run along in that interstice which holds the interosseous muscles; and when they arrive at the end of that furrow, or, in other words, at the place of the forking of the toes, each interosseous artery turns down to the sole of the foot, and goes into the fork of each digital arch, on the lowest side of the toes. Sometimes these arteries give also small dorsal arteries to the backs of the toes.

The tibial artery having proceeded along the tarsal bones, and arrived at the lower heads of the metatarsal bones, and having first given off some trivial branches to the joints of the foot on its inner side, and to the bones and muscles about the root of the great toe, next gives off a metatarsal artery.*

ARTERIA METATARSEA.

The ARTERY of the METATARSUS or instep goes off at the head of the first metatarsal bone. It bends across the roots of the metatarsal bones to the root of the little toe; and it distributes branches to the tendons of the peronæi muscles, and ends in the abductor of the little toe, and in the skin over the outer edge of the foot. But sometimes it is a larger and more important artery; for when the tarsal artery is small or wanting, this metatarsal one gives off the interosseæ, and supplies its place.

DORSALIS EXTERNA HALUCIS.

The third branch is the ARTERY of the BACK of the GREAT TOE. This artery is of very considerable size; it gives no muscular branches, because it lies upon the bony part of the foot; it runs all along the metatarsal bone which supports the great toe; and it ends at the forking of that toe in two great branches; one the dorsal artery of the great toe, which goes along it to the point; another to the side of the toe next the great toe, which it also runs along, somewhat like the forking arteries of the thumb and fore finger.

The anterior tibial artery ends here (*i. e.* where it gives off the artery of the great toe). By sinking in betwixt the metatarsal bones of the great toe and of the toe next to it, and going directly into the arches of the sole of the foot, it produces a great and important anastomosis, similar to that of the radial and ulnar arteries.

I have given here the most common distribution of these arteries on the back or upper part of the foot, but they are very irregular.

* *N.B.*—Betwixt the tarsal and metatarsal artery, there is usually a small branch going outwards to the outer edge of the foot, *i. e.* in the same direction with both these arteries, but very small.

Arteria Tibialis Antica.

1. Arteria Articularis Tibialis.
2. Arteria Recurrens Tibialis.
3. Arteriæ Musculares.
4. Arteria Malleolaris Interna.
5. Arteria Malleolaris Externa.
6. Arteria Tarsea.
7. Arteria Metatarsea. { Interosseæ. Dorsales Digitorum.
8. Arteria Dorsalis Halucis.
9. Arteria Profunda Anastomotica.

ARTERIA TIBIALIS POSTICA.

The POSTERIOR TIBIAL ARTERY is so named from its passing along the back part of the tibia. The anterior tibial artery passes through the interosseous membrane only at the lower edge of the popliteal muscle : this artery comes off from the general trunk at the upper edge of the popliteal muscle, and passes obliquely towards the inside of the tibia, to take its place behind that bone. Its whole situation and general course is this : It lies under the fascia which covers the three lesser muscles on the back of the tibia, consequently under the solæus muscle, but over the tibialis posticus and flexor digitorum ; coming near the foot, it turns round the inner ancle close upon the bone. Having passed the lower head of the tibia, it goes down along the inside of the heel-bone, in its deep arch, upon which the body is supported ; it divides at the heel-bone, and advances along the sole of the foot in two great branches ; one running along the sole, next the outer edge of the foot ; the other along the inner edge of the foot ; whence they are named external and internal plantar arteries. From this arch the artery gives branches to all the toes, and so it ends.

This posterior artery is chiefly a muscular one, at least in its course down the leg ; and though it gives many branches as it passes along, there are hardly any worthy of being described : and from the knee to the ancle-joint there is one only which needs be distinguished by name, viz. the artery which nourishes the tibia.

First, The tibialis postica often gives arteries to the heads of the gastrocnemii muscles ; next it gives off the ARTERIA NUTRITIA TIBIÆ, which begins a little below the lower edge of the popliteal muscle, runs downwards along the interosseous ligament, gives muscular branches to the popliteus, solæus, and tibialis posticus, and then sends the nutritious artery into the great hole in the middle of the tibia. It gives many branches to the periosteum of the tibia, and to the interosseous membrane all down the leg, and it ends near the lower end of the tibia in inosculations with the peroneal artery. This nutritious artery of the tibia is very important, from the peculiarity of its situation more than its size, for an artery in a bone being wounded or torn, bleeds in an extraordinary manner. I have seen the compound fracture of the tibia where this artery was torn, bleed so as to make the consultants imagine the main artery was torn.

Other nameless muscular arteries succeed to this, going to the tibialis posticus, to the flexor communis, and to the flexor of the great toe. When the artery arrives near the ancle-joint, it gives many small twigs to the periosteum, tendons, sheaths, and bursæ mucosæ behind the ancle ; and then passing in the very deepest part of the ancle, under the annular ligament, and betwixt the tibia or process of the inner ancle and the heel-bone, it adheres closely to the bones and capsule of the joint ; and there gives a great many little tortuous arteries, making net-works over this joint and its bones, as over the other joints already described. But especially two delicate arteries go out at this hollow at the side of the heel-bone : one forwards towards the side of the ancle-joint, the other downwards and backwards over the heel-bone, which ramify very profusely and very beautifully.

The artery now lying deep under the abductor magnus of the great toe, which arises from the heel-bone, forks into its two great branches, the external and internal plantar arteries.

ARTERIA PLANTARIS INTERNA.

The INTERNAL PLANTAR ARTERY is much the smaller branch, not to be compared in importance (though their names are contrasted) with the external plantar artery ; and it is named internal, because as it runs along the sole of the foot it keeps to the inner edge, viz. that to which the great toe belongs. It comes off under the head of the abductor of the great toe, and under the belly of that muscle, and close upon the bone ; its branches run forwards, quite up to the root of the toe, all along its metatarsal bone. The internal plantar artery has in general four branches, which all run pretty nearly in the same direction, viz. straight forwards.

It gives, while under the head of the abductor, small branches, which go backwards to the joint, its capsule, and tendons, and some into the spongy substance of the heel-bone ; some also to the short flexor of the foot, and to the massa carnea. But its four greater and more regular branches are these :

The first lies nearer the inner edge of the foot ; is the largest and most considerable ; it runs along under the inner border of the abductor ; it goes quite up to the ball of the great toe, and unites with the proper artery of the toe. As it goes along, it gives small twigs to the periosteum and bone.

The second resembles the former, except that it does not come off so early by two inches ; it is of course shorter, but it passes along in the same direction, only a little distant from the first, lying along the middle of the metatarsal bone. It also advances up to the root of the great toe, and runs also into the proper artery of the great toe (which comes from the external plantar branch) so as to enlarge and strengthen it.

The third lies still nearer to the centre of the foot, and deeper among the muscles. It runs the same general course, viz. along the side of the metatarsal bone up to the ball of the great toe, and ending like the others in the artery of the great toe ; but as it lies deeper, it gives branches to the short flexor, to the tendons, and to the inner surface of the aponeurosis plantaris, forming a sort of superficial arch.

From these three arteries, much of the skin on the sole of the foot has its branches.

The fourth and last branch of the plantaris interna, is one which goes down deep into the centre of the foot ; it lies close upon those ligaments which bind together the bones of the tarsus, and under all the tendons, except those of the tibial muscles, which are like ligaments to the bones. Its destination is chiefly to the tarsal joints and capsules ; its inosculations with the external plantar artery can be of no importance.

PLANTARIS EXTERNA.

The EXTERNAL PLANTAR ARTERY is the greater artery of the sole of the foot, from which the arches of the foot and the inosculations with the anterior tibial artery are formed.

It turns outwards towards the outer edge of the foot ; it runs its great circle round by the metatarsal bone of the little toe ; and its plantar arch, or the arch of the sole of the foot, passes over the middle of all the other metatarsal bones. It receives the anterior tibial artery under the middle of the metatarsal bone of the great toe. It is this great curve of the artery turning round in the sole of the foot that we name the plantar arch ; and it is from it that all the proper arteries of the toes arise, expressly after the same order in which the fingers receive their arteries.

The great or external plantar artery lies deep, but not upon the naked bones like the former. It passes through betwixt the heads of the short flexor and massa carnea ; it turns its first turn outwards till it gets under the flexor and abductor of the little toe ; then it turns inwards towards the centre of the foot, and lies between the tendons of the flexor muscles, and the metatarsal bones and their interosseous muscles.

First, It sends a large branch backwards to the heel-bone, which belongs entirely to that spongy bone, and forms, like all such arteries, a sort of net-work over all the surface of the bone ; it first touches the bone under its extreme point, or that which rests upon the ground ; and it goes branching over it so high as to inosculate round the ancle with twigs of the tibialis antica ; it gives branches also hereabout to the great ligament of the heel-bone. The external plantar artery next gives branches to those muscles betwixt which it lies imbedded, viz. the flexor accessorius and flexor brevis ; then advancing to the side of the flexor digiti minimi, it gives out two or three branches, which first go into the flesh of the abductor and flexor of the little toe, and then turning over the edge of the foot, terminate in inosculations with the arteries of the fore part of the foot and in the skin.

It then begins from the root of the metatarsal bone of the little toe to form that great circle, which is named the arch of the foot, and which gives out two ranks of arteries : first, of interosseous arteries going to the spaces betwixt the metatarsal bones, upon which the toes stand ; and, secondly, the proper arteries of the toes themselves.

The first of these arteries proceeding from the tarsal arch is a small one, the artery of the little toe. It begins at the lower head of the metatarsal bone, lies under the flexor and abductor muscles, gives branches to these muscles and to the skin, and to the bone itself ; it runs up the outer edge of the little toe, and this is immediately succeeded by the first interosseous artery ; which lies deeper, passes along the first interosseous space, gives branches to the bones and interosseous muscle, and inosculates betwixt the toes with the branches of the anterior tibial artery.

The next artery is properly the first of the great arch. It is what is called the RAMUS DIGITALIS, or proper artery of the toes. It is a long artery; it runs over the interosseous space lying upon the interosseous muscles; it advances to the root of the little toe, and, like those of the fingers, divides into two branches, one to the inner side of the little toe, and the other to the side of the toe next it. A second and a third DIGITAL ARTERY go out in the same manner, and split at the roots of the toes into two branches, and with so little variety that it is needless to describe each part.

In the interstices of each of these arteries lie two or three small perforating arteries, which, perforating betwixt the metatarsal bones, inosculate with the interosseous arteries which lie on the fore part of the foot.

But the great external plantar artery, while it is giving out these arteries alternately, *i. e.* large branches to the toes, and smaller twigs to the interosseous muscle, and some smaller still which go off from the concave part of the arch, and go into the sole of the foot to the ligaments and joints, the principal artery goes still onwards, and completes its arch at the middle of that metatarsal bone which supports the great toe. There, a little behind the ball of the great toe, it receives an anastomosing branch of the tibialis antica, which perforates from the fore part of the foot. This completes the arch of the anterior and posterior arteries, and permits the blood to pass, according to the pressure, or other accidents, in either direction; and this union strengthens and enlarges the artery of the plantar arch so much, that it is not exhausted by the many branches which it has given off, but gives at this point the largest artery of all, viz. the artery which supplies the great toe, one side of the toe next it. This artery of the great toe is the very last or extreme branch of the aortic system. It very closely resembles the great artery of the thumb; it gives out three chief branches, viz. one to each side of the great toe, and one to the inner side of the toe next it. This ARTERIA POLLICIS PEDIS sometimes seems to proceed entirely from the perforating branch of the anterior tibial artery; at other times it arises fairly from the plantar arch.

These lesser branches in the foot require a description as tedious as the larger arteries, and we have the more occasion for a plan, serving at the same time as a recapitulation.

ARTERIA TIBIALIS POSTERIOR.	1. Rami Musculares.	
	2. Arteria Peronæa.	Rami Musculares. Arteria Peronæa Anterior. Arteria Peronæa Posterior.
	3. Arteria Nutritia Tibiæ.	
	4. Arteria Calcanea.	
	5. Arteria Plantaris Externa	Ramus Transversus. Anastomoticus. Rami Profundi. Arteriæ Digitales 4tæ. Arteriæ Interosseæ.
	6. Arteria Plantaris Interna.	Ramus Anastomoticus Profundus.

ARTERIA PERONÆA.

The FIBULAR ARTERY, or the third artery of the leg, which is much smaller than the other two, in its course and connections, and its being exhausted nearly by the time it reaches the ancle-joint, greatly resembles the interosseous artery of the fore-arm.

It comes off from the posterior tibial artery, near the head or origin of the tibialis posticus muscle, and accompanies that muscle down to the ancle-joint, lying betwixt the flexor pollicis and the acute edge or spine of the fibula.

This is entirely a muscular artery for supplying those deeper parts which the other arteries do not supply. Its branches, like those of all muscular arteries, are extremely irregular; its chief branches are to the solæus, to the peronæi muscles, to the tibialis posticus, and to the flexor of the great toe. Several little arteries turn round the fibula from point to point, going to the fore part of the leg. All the way down the leg it is giving off repeated branches to the same muscles; and in this course it gives some little arteries, which pierce through the interosseous membrane, and also gives the nutritious artery of the fibula.

When it approaches the ancle-joint, the fibular artery gives off an anterior branch, which perforates the interosseous membrane, passes through betwixt the tibia and fibula nearly where they are joined, and turns downwards over the outer side of the ancle, by the extensor communis and peronæus brevis tendons. This is named PERONEA ANTERIOR, though it is an artery of little importance. Its branches are given not to muscles, for this is a naked and bony part of the foot, but are expanded upon the lower heads of the tibia and fibula, and upon the os cuboides. They nourish the tendons, ligaments, and bursæ of the outer ancle; they end in inosculations with the malleolar artery, from the tibialis anterior, and with the tarsal artery.

ARTERIA PERONEA POSTERIOR.

As this ANTERIOR FIBULAR ARTERY branches over the fore part of the outer ancle, the POSTERIOR FIBULAR ARTERY passes deep behind the same ancle, and is just the continuation of the main artery; which having passed down behind the acute angle of the fibula, sinks into that deep hollow which is behind it upon the side of the heel-bone. Behind the tibia the artery makes large inosculations with the posterior tibial artery, and gives many branches to the tendons. Branches also turn round the ancle, making a net-work of vessels upon it, and inosculating with the anterior tibial artery.

It continues to give the same small arteries to the outer ancle, to the peronæi tendons, to the outer side of the heel-bone, and to the abductor of the little toe. It ends usually in that muscle, and in inosculations with that branch of the external plantar artery which turns backwards upon the heel-bone and ramifies upon it so beautifully.

These are the last branches of the three great arteries of the leg and of the aortic system.

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ARTERIA PERONÆA.

The PERONEAL ARTERY is the third artery of the leg, which is much smaller than the other two. It is regular and continues far, and so being exhausted mostly by the small branches, gives little, or greatly resembles the interosseous artery of the arm.

It comes off from the posterior tibial artery, near the head of the fibula, and accompanies the muscle down to the ancle joint, lying betwixt the bone and the edge of the fibula.

It is chiefly a muscular artery for supplying those muscles which the other arteries do not supply. Its branches therefore are numerous, and are extremely irregular; it gives branches to the soleus, to the peronei, to the tibialis posticus, and to the flexor pollicis; and little arteries then penetrate the interosseous ligament, going to the fore part of the leg. At the very lower end of the fibula, it is joined by the anastomoses, and gives the nutritious artery of the fibula.

When it approaches the ancle joint, the peroneal artery gives off an artery which perforates the interosseous ligament, passes between the tibia and fibula, nearly where they are joined, and turns downwards over the outer side of the ancle, by the extensor communis, and peroneus tertius tendons. This is named PERONEA ANTERIOR, though it is an artery of little importance. Its branches are given out to muscles, for this is a naked and bony part of the foot, but are dispersed upon the lower heads of the tibia and fibula, and upon the os cuboides. They supply the tendons, ligaments, and bones of the outer ancle; they end in inosculations with the malleolar artery from the tibialis anterior, and with the tarsal artery.

ARTERIA PERONEA POSTERIOR.

As the ANTERIOR FIBULAR ARTERY branches over the fore part of the outer ancle, the POSTERIOR FIBULAR ARTERY passes deep behind the outer ancle, and is just the continuation of the main artery; which having passed down behind the outer angle of the fibula, sinks into that deep hollow which is behind it upon the side of the heel-bone. Behind the tibia the artery has a large inosculation with the posterior tibial artery, and gives many branches to the tendons. Beneath the tendon of the soleus, making a net-work of vessels upon it, and inosculating with the anterior tibial artery.

It continues to give the same small branches to the outer ancle, to the peronei tendons, to the outer side of the heel-bone, and to the abductor of the little toe. It ends usually in that muscle, and in inosculations with that branch of the external plantar artery, which turns backwards upon the heel-bone and ramifies upon it so beautifully.

These are the last branches of the three great arteries of the leg, and of the aortic system.

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