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THE

PRINCIPLES OF PHYSIOLOGY

APPLIED TO THE

PRESERVATION OF HEALTH,

AND TO THE IMPROVEMENT OF

PHYSICAL AND MENTAL EDUCATION.

BY ANDREW COMBE, M.D.,

PHYSICIAN EXTRAORDINARY TO THE QUEEN IN SCOTLAND,
AND
CONSULTING PHYSICIAN TO THE KING AND QUEEN OF THE BELGIANS.

WITH SIX WOODCUTS.

FROM THE SEVENTH EDINBURGH EDITION.

NEW-YORK:

PUBLISHED BY HARPER & BROTHERS,
NO. 82 CLIFF-STREET.

1840.

QT
200
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1840

"Nor is it left *arbitrary*, at the will and pleasure of every man, to do as he *list;* after the dictates of a depraved *humour* and extravagant *phancy*, to live at what rate he pleaseth; but every one is bound to observe the *Injunctions* and *Law of Nature*, upon the penalty of forfeiting their *health*, *strength*, and *liberty*—the true and long enjoyment of themselves."—MAINWAYRINGE.

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TO

HIS MAJESTY

LEOPOLD THE FIRST,

KING OF THE BELGIANS.

SIRE,

IN consenting to ascend the throne, to which you were called by the fervent prayer of the Belgian people, your majesty was graciously pleased to declare, that, having from early life been placed in many difficult and trying situations, you had long learned to value power only as a means of advancing the solid and lasting happiness of your fellow-creatures. How nobly your majesty has redeemed the pledge implied in this generous assurance, the tranquillity, security, and increasing prosperity of your majesty's adopted country proclaim in language which it requires not the aid of individual testimony to confirm; and I venture to refer to it only because your majesty's gracious permission to dedicate to you a work having for its aim the prevention and alleviation of human suffering, is but another proof of the sincerity of the feeling by which it was dictated, and of the deep interest which your majesty takes in everything connected with the welfare and improvement of mankind.

As every amelioration of the physical condition of the people conduces not less to their advancement in

intelligence and good conduct than to their bodily comfort, I am inclined to hope that, even in a moral point of view, some good may be effected by the present exposition of the more important laws of the animal economy, and of the numerous practical advantages to be expected from their regular and adequate fulfilment.

While thus laying my little work before your majesty as a sincere though humble tribute of respect and admiration, may I be farther permitted to express my profound gratitude for the condescending goodness with which you have been pleased to receive my imperfect services, as well as for the professional confidence with which your majesty continues to honour me.

That your majesty may long be spared, in health and happiness, to watch over the interests of the Belgian nation, is the sincere and earnest wish of,

Sire,

Your majesty's most grateful
and devoted servant,
ANDREW COMBE.

EDINBURGH, *November* 1, 1838.

ADVERTISEMENT

TO THE SEVENTH EDITION.

It is now about four years and a half since the present work was first published, and already six editions, consisting together of eleven thousand copies, have been exhausted in this country. In America, a much larger number has been sold; and an edition, prepared with questions and answers at the end of the chapters to adapt it for a school-book, has been successfully introduced into several seminaries of education. In Germany also, where an excellent translation appeared about a year ago, it has been favourably received. These circumstances afford the most gratifying evidence that the importance of physiological knowledge as one of the most useful, if not indispensable, branches of general instruction, is at last beginning to be appreciated among the intelligent classes of society, and that the present attempt to communicate it in a plain and unambitious style has not been unsuccessful.

The approbation bestowed upon this volume by several of the medical journals, and by many of my brethren, is an indication that the want which it endeavours to supply has been extensively felt by the profession as well as by the public; and encourages me to hope that, although designed chiefly for the general reader, it may nevertheless be found useful as a guide to the medical student, in facilitating his acquaintance with a branch of knowledge which,

considering its practical importance in the improvement of man and in the prevention and cure of disease, is certainly too much neglected; and on which he will not, however disposed, easily find elsewhere the means of obtaining adequate information.

Various and extensive additions have been made to the work since it was first published; and to increase its usefulness, a comprehensive index was annexed to the fourth edition. With these improvements it has since been stereotyped; and in fulfilment of an intention formerly announced, a treatise on Diet on the same general plan, and entitled "The Physiology of Digestion considered in relation to the Principle of Dietetics," was published some time ago, and is now in its second edition.

EDINBURGH, *Nov.*, 1838.

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PREFACE.

THE object of the present volume is to lay before the public a plain and intelligible description of the structure and uses of some of the more important organs of the human body, and to show how information of this kind may be usefully applied both to the preservation of health and to the improvement of physical and mental education. In selecting the functions to be treated of, I have preferred to examine those which are most influential in their operation on the general system, and, at the same time, least familiarly known. Some, accordingly, whose sphere of action is comparatively subordinate, I have not even named; and to others of essential consequence in the animal economy, such as that of digestion, I have merely alluded. To have included the first would have added to the difficulties of the reader by the multiplicity of unimportant details; and to have treated of the latter would have been, in a great measure, a work of supererogation, as treatises on the digestive organs are already in extensive circulation.*

* Notwithstanding the above expression of opinion, so many suggestions have been made to me since the publication of the former editions to continue the work, and give a similar account of the functions of digestion, nutrition, circulation, &c., that I have nearly completed the preparation of another volume for that purpose, to be entitled "The Physiology of Digestion considered with reference to the principles of Dietetics." In this work I have insisted more on the general laws of digestion, and on the adaptation of diet to different ages, constitutions, and conditions of life, and less on the qualities of individual articles of food than is usually done; and hope thus to have given it somewhat of the same plain and practical character which has contributed so much to the success of the present.

In offering practical rules for the guidance of the reader, it has been my constant endeavour to exhibit the relation subsisting between them and the particular laws of the organization according to which their influence is exerted, that the recommendation given may rest, as far as possible, on the foundation of nature, and not on the doubtful authority of any individual. Many of the valuable treatises which have already appeared on the subject of health and of education, seem to me to have failed in making an adequate impression on the public mind chiefly from this basis not having been brought sufficiently into view; and thus not only have the evils arising from defective education been unjustly and invidiously charged against education itself, but the most opposite methods have been advocated and practised with equal earnestness and plausibility, where a direct reference to the laws of organization would have at once revealed the source of the error, and afforded a protection against its occurrence.

It is not uninstructive to remark, that in the case of the lower animals, the necessity of modifying the method of cultivation according to the peculiarities of constitution which they present, has been long perceived and consistently acted on, and with such success as to afford us good reason for applying the same rule to our own species, and for considering every mode of education as erroneous and inefficient which is not in harmony with the higher nature of man. The extent, indeed, to which, by following this plan, we can carry our influence over the lower animals, and secure the development and efficiency of almost every organ, has often been the theme of admiration and surprise; and there can scarcely be a doubt, that were the same principle followed in the cultivation of the physical, moral, and intellectual powers of man, and were no rule received which is not in accordance with the laws of his constitution, a much higher degree of success would reward our exertions than has ever yet been experienced.

The little regard which has hitherto been paid to

the laws of the human constitution, as the true basis on which our attempts to improve the condition of man ought to rest, will be obvious from the fact that, notwithstanding the direct uses to which a knowledge of the conditions which regulate the healthy action of the bodily organs may be applied in the prevention, detection, and treatment of disease, there is scarcely a medical school in this country in which any special provision is made for teaching it; the pupil being left to elaborate it for himself from amid information communicated to him for other purposes. It is, therefore, only too true, that "*preventive medicine*, the destined guardian of infancy, youth, manhood, and old age, adapted to the interior of families, has yet no existence."* In some of the foreign universities, indeed, chairs have been instituted for diffusing instruction of this description; and in France, a journal of Hygiène has existed for a short time. But in this country, with the exception of Sir John Sinclair's elaborate *Code of Health*, and one or two other publications of a late date, the subject has never been treated with anything like the regard which it assuredly deserves. In one point of view, indeed, the omission is not so extraordinary as it may at first sight appear. The prominent aim of medicine being to discriminate and to cure *disease*, both the teacher and the student naturally fix upon that as their chief object; and are consequently apt to overlook the indirect but substantial aid which an acquaintance with the laws of health is calculated to afford in restoring the sick, as well as in preserving the healthy from disease.

It is true, that almost every medical man, sooner or later, works out this knowledge for himself; but, in general, he attains it later than he ought to, and seldom so completely as he would have done had it been made a part of his elementary education, to which he saw others attach importance. In my own instance, it was only when entering upon practice that

* Lecture introductory to a course of popular instruction on the constitution and management of the human body, by Dr. Thomas Beddoes, 1797, p. 58.

I had first occasion to feel and to observe the evils arising from the ignorance which prevails in society in regard to it. Impressed afterward more deeply than ever with the interest and utility of the study, I contributed two or three articles on the subject to one of our periodical journals, and resolved to make them the basis, at some future time, of a more detailed and connected exposition. This I have now attempted; not, I need scarcely add, with the view of superseding the physician by making "every man his own doctor," or of recommending the general perusal of professional treatises—for both practices induce many more ailments than they cure—but simply with the hope that the method which I have followed, of connecting physiological details with practical applications, may be found useful and interesting to both the student and the general reader.

There is a tendency in the minds of many, when a new subject is presented to them, to run away with a part of a proposition or with an individual illustration, and to condemn as unsound the principle in elucidation of which it is adduced, because they happen to know facts which are at variance with the particular example brought forward. In this way, there is perhaps no one rule which I have advanced to which some individual case may not be plausibly opposed. But it does not necessarily follow that the principle or rule is thereby disproved. An example may be badly chosen, and yet the truth it is meant to convey may be as much a truth as before. Instead, therefore, of at once condemning a proposition on account of a single apparent exception, it will be better to extend the inquiry, and discover whether any peculiarity of situation or constitution has interfered to modify the result, and to condemn only when evidence of inaccuracy is obtained. Thus, because some drunkards have enjoyed good health, and lived to an unusually old age, we are by no means entitled to infer that drinking was the cause of the good health, and that, if we would all drink as freely, we should all live as long. An example of this kind, far from disproving

the principle that ardent spirits are prejudicial to the human frame, only establishes the fact that individuals exist who, from some idiosyncrasy, are better able than others to resist their bad effects; and, in like manner, when I state, as a general proposition, that severe muscular exertion is hurtful during rapid growth, I do not consider it as any argument against the fact to say that A. B. underwent great exertion when growing, without being injured by it. The general principle obviously remains unaffected by single instances of this kind, for the apparent exception can almost always be explained, and, even when it cannot, it occurs so rarely as to be entitled to no practical weight.

It has been objected, that to teach any one how to take care of his own health, is sure to do harm by making him constantly think of this and the other precaution, to the utter sacrifice of every noble and generous feeling, and to the certain production of hypochondriacal peevishness and discontent. The result, however, is exactly the reverse; and it would be a singular anomaly in the constitution of the moral world were it otherwise. He who is instructed in and familiar with grammar and orthography, writes and spells so easily and accurately as scarcely to be conscious of attending to the rules by which he is guided; while he, on the contrary, who is not instructed in either, and knows not how to arrange his sentences, toils at the task, and sighs at every line. The same principle holds in regard to health. He who is acquainted with the general constitution of the human body, and with the laws which regulate its action, sees at once his true position when exposed to the causes of disease, decides what ought to be done, and thereafter feels himself at liberty to devote his undivided attention to the calls of higher duties. But it is far otherwise with the person who is destitute of this information. Uncertain of the nature and extent of the danger, he knows not to which hand to turn, and either lives in the fear of mortal disease, or, in his ignorance, resorts to irrational and hurtful precautions,

to the certain neglect of those which he ought to use. It is ignorance, therefore, and not knowledge, which renders an individual full of fancies and apprehensions, and robs him of his usefulness. It would be a stigma on the Creator's wisdom if true knowledge weakened the understanding and led to injurious results. And, accordingly, the genuine hypochondriac, whose blind credulity leads him to the implicit adoption of every monstrous specific, is not the person who has gained wholesome knowledge by patient study in the field of nature; but he, and he alone, who has derived his notions of the human constitution and of the laws of nature from the dark recesses of his own crude imagination.

Those who have had the most extensive opportunities of forming an opinion on this subject from experience, bear unequivocal testimony to the advantages which knowledge confers in saving health and life, time and anxiety. Thus Dr. Beddoes, in alluding to the delicate constitutions of females of the higher ranks in this country, remarks, that he cannot "conceive how they can be rendered more hardy or *less nervous*, if that term is preferred, otherwise than by being seasonably taught the *principles* of self-management." And adds, that he specifies "the principles," because "little good can be expected unless we proceed as in other instances where we exhibit to sense that connexion between cause and effect which constitutes the order of nature" (p. 26). In like manner, Dr. Davies, of the East India Company's Depôt at Chatham, distinctly states, that the man of mature age, who has been some years at a trade before enlisting, and who has consequently gained some knowledge of his own constitution, always makes the most valuable soldier, because "he not only conforms with more ease to the system of diet and restraint necessary to subordination, but, having more experience, he is *more observant of health, learns sooner how to take care of himself, to avoid or diminish causes of disease, and when ill, he gives more aid in bringing about a state of convalescence.*" Dr. Davies adds afterward, that this "*knowing how to manage* is an *invaluable qualification*

to a soldier embarking for service in a tropical climate;" and if it is invaluable to the soldier, it is assuredly not less safe and advantageous to the civilian.

If, indeed, ignorance were itself a preventive of the danger, or could provide a remedy when it approached, then it might well be said that "ignorance is bliss;" but as it gives only the kind of security which shutting the eyes affords against the dangers of a precipice, and, consequently, leaves its victim doubly exposed, it is high time to renounce its friendship and protection, and to seek those of a more powerful and beneficent ally. If ignorance could divest us even of the sense of anxiety attending the apprehension of evil, the consequent tranquillity of mind, deceptive though it were, would be at least some compensation for submitting to its rule. But, unhappily, so far from ignorance of the nature and extent of the threatening danger saving us from gloomy anticipations, the fact is notoriously the reverse; for the darkest picture ever drawn is assuredly that devised by an unenlightened imagination. Every medical man can testify, that, natural character and other circumstances being alike, those whose knowledge is the most limited are the fullest of whims and fancies, the most alarmed at every trifling ailment, the most credulous respecting the efficacy of every senseless and preposterous remedy, the most impatient of restraint, and the most discontented at suffering. There are some, no doubt, whose constitutional sensibility prevents them ever controlling their feelings or being guided by the dictates of reason; but such persons are comparatively few in number, and even they become more tractable, as well as more comfortable in spirit, when their minds are enlightened and their true situation is distinctly understood.

If any of my readers be still doubtful of the propriety or safety of communicating physiological knowledge to the public at large, and think that ignorance is in all circumstances to be preferred, I would beg to ask him whether it was knowledge or ignorance which induced the poorer classes in every country of

Asia and of Europe, to attempt to protect themselves from cholera by committing ravages on the medical attendants of the sick, under the plea of their having poisoned the public fountains? And whether it was ignorance or knowledge which prompted the more rational part of the community to seek safety in increased attention to proper food, warmth, cleanliness, and clothing? In both cases, the desire of safety and the sense of danger were the same, but the modes resorted to by each were as different in kind as in result; the efficiency of the one having formed a glaring contrast to the failure of the other.

In thus strongly advocating the benefits to be obtained by the wide diffusion of a general knowledge of the laws of health, I must, however, express my belief, that the study of *diseases* and their modes of cure by unprofessional persons, is not only unprofitable, but often deeply injurious—just because such persons cannot possibly possess the collateral knowledge required to form a correct judgment of all the attending circumstances, and are therefore extremely liable to fall into error, where every error is attended with risk. Let us suppose, for example, what I have seen and what has often happened, that a person of an apprehensive disposition, who has been occasionally subject to palpitation, takes up a medical treatise, and there finds that palpitation is a symptom commonly present where the heart is diseased. It is almost certain that such a person will, in his ignorance, make no farther distinction, but hurry at once to the conclusion that his own heart is affected, and that he must speedily die. The notion being once implanted in his mind, he will become anxious and watchful of every sensation, deny himself necessary exercise from fear of over-exertion, and necessary food from fear of a bloodvessel giving way, and in no long time will fall into a state of weakness and disease which will confirm every one of his apprehensions. But had this individual, instead of acting on his own *imperfect* knowledge, consulted his medical adviser, whose business it is to make himself acquainted with the *whole* of the case, he would have discovered im-

mediately that the dreaded source of all this suffering was originally a simple fit of indigestion, which nature would have cured in three days, had not the machine been so perversely deranged by the very want of exercise and food, in which the patient was ignorantly seeking for safety. Even here, be it observed, the danger arises from the *incompleteness* of the knowledge possessed; and I would condemn the perusal of medical books only because the general reader cannot, except by going through a course of professional study, become qualified to make a proper use of their contents. And, accordingly, it is well known that few students escape fits of hypochondriacal apprehension when they first seriously enter on the study of diseases; and that they become free from them almost in proportion as their knowledge advances.*

Various repetitions occur in the course of the present work, which to some may seem unnecessary, and for which I ought to solicit the indulgence of the reader. These have arisen chiefly from the intimate manner in which the different functions are connected with each other, rendering it impossible to explain one without constantly referring to the rest. Occasionally, also, the novelty and importance of the subject have led me to risk repetition, in order to ensure attention; but I trust that these faults, if felt as such, will be forgiven.

Those who desire to obtain farther information of a general nature in regard to the structure and func-

* The number of the Metropolitan Magazine for July, 1834, contained a very favourable review of the first edition of this work, which it recommended to the attention, especially of medical men. But it went on to caution *ladies* and unprofessional persons from dipping into its pages, not because they would find in them anything indelicate, unintelligible, or devoid of interest, for it expressly acquitted the book of all these faults; but because they would immediately afterward fancy themselves ill, and be afraid to move from fear of deranging some part of the bodily machinery! To those whose curiosity should get the better of their discretion, the reviewer recommended, as an antidote, the perusal of Shakspeare, Don Quixote, or some entertaining novel, to raise their spirits. I mention this to show that the remarks in the text (which, by a curious coincidence, were first published in the second edition simultaneously with the review) are not uncalled for.

tions of Man, may refer to Mr. Lord's "Popular Physiology," Dr. Hodgkin's "Lectures on the Means of Promoting and Preserving Health," and also to an excellent treatise on Animal Physiology, in four of the earlier numbers of the Library of Useful Knowledge. The last is understood to be from the pen of Dr. Southwood Smith, the able author of a volume entitled "The Philosophy of Health," which was published in London simultaneously with the third edition of the present work, and with whose sentiments on the subject now before us, as expressed in the following extract from the concluding page of his earlier treatise, I need hardly say I entirely concur:

"The obvious and peculiar advantages of this kind of knowledge are, that it would enable its possessor to take a more rational care of his health; to perceive why certain circumstances are beneficial or injurious; to understand, in some degree, the nature of disease, and the operation as well of the agents which produce it as of those which counteract it; to observe the first beginnings of deranged function in his own person; to give to his physician a more intelligible account of his train of morbid sensations as they arise; and, above all, to co-operate with him in removing the morbid state on which they depend, instead of defeating, as is now, through gross ignorance, constantly done, the best concerted plans for the renovation of health. It would likewise lay the foundation for the attainment of a more just, accurate, and practical knowledge of our intellectual and moral nature. There is a physiology of the mind as well as of the body; both are so intimately united, that neither can be well understood without the study of the other; and the physiology of man comprehends both. Were even what is already known of this science, and what might be easily communicated, made a part of general education, how many evils would be avoided, how much light would be let in upon the understanding, and how many aids would be afforded to the acquisition of a sound body and a vigorous mind; pre-requisites more important than are commonly supposed, to the attainment of wisdom and the practice of virtue."

CHAPTER I.

INTRODUCTORY REMARKS.

Physiology, Vegetable, Comparative, and Human.—Animate and Inanimate Bodies.—Objects of Physiology.—Usefulness of Physiological Knowledge. — Illustrations. — Evils of Ignorance. — Error in separating Anatomy and Physiology from their Practical Applications.—What Health is—And how to be preserved.

PHYSIOLOGY, from *Φυσις, nature*, and *λογος, discourse*, signifies literally a discourse about natural powers, but, as now used, it applies exclusively to the doctrine of the uses or functions of the different constituent parts of beings endowed with the principle of life. As applied to the vegetable kingdom, it is called *Vegetable* Physiology; to the lower animals, *Comparative* Physiology; and to man, *Human* Physiology. In all of these instances, however, the objects of physiology are the same, viz., the exposition of the mechanism and laws by which the various functions which characterize living bodies are carried on, so as to fit each individual for the particular sphere in which the Creator intended it to exist.

The grand mark of distinction between animate and inanimate bodies is to be found in the different relations in which they stand to the ordinary laws of the material world. Inanimate or inorganized bodies have no internal power of action, and of themselves can effect no change. Possessed of certain fixed and invariable properties, they stand uniformly in the same relation to each other, and act invariably according to the same general laws, so that what is once ascertained of them can be predicted with certainty to hold true for ever after; and therefore, in conducting our investigations, we know that the same effects will always follow the same causes with mathematical precision. But when the same elementary material

becomes part of a living body, this rule no longer holds; the laws of chymical and physical action are greatly modified, or for a time counteracted, and the now organized matter obeys the law of vegetable or animal life, and is not again subjected to those of purely chymical action, either till eliminated from the body, or till life is extinct; and, in point of fact, the putrefaction which instantly follows the extinction of the vital principle is neither more nor less than the ordinary laws of inanimate matter resuming their dominion when no longer opposed by a higher power.

An example or two will render the difference more apparent. All bodies gravitate towards the earth, according to a constant and well-known law. But animals are able to resist this law, so far as to preserve an attitude at variance with its tendency, or even to rise, like the eagle, many thousand feet in the air in opposition to their natural weight; but on the extinction of life they lose this power, and again become subject to the full influence of gravitation. In the same way many animals preserve an elevated and steady temperature, whether exposed to severe cold or to excessive heat; but, when life ceases, rapidly assume that of the objects by which they are surrounded. A human being may, for instance, be exposed to the intensest cold of the Polar Regions without having his own internal temperature reduced by a single degree so long as life endures; but from the moment when life ceases, his body begins to part with its heat, and ere long it becomes frozen and stiff like the inanimate masses by which it is surrounded.

Here, then, is a grand boundary line dividing the organized from the inorganized, the animate from the inanimate body. Chymistry and natural philosophy investigate the laws and conditions which regulate the action and movements of inanimate or inorganized objects; but, from what we have seen of the power of the vital principle in modifying these, it will be manifest that, however extensive and accurate our knowledge of the properties of the element-

ary materials of living bodies, considered separately, may be, we can thence infer nothing in regard to the qualities of the animal compound when endowed with life, but must resort to observation and study for the discovery of the conditions by which life is characterized and under which it is carried on.

Physiology, or the history of the functions which characterize *living* beings, is thus a subject of peculiar interest; and human physiology, or that which is about to engage our attention, is as important in its practical consequences as it is attractive to rational curiosity. In its widest sense it comprehends an exposition of the functions of the various organs of which the human frame is composed; of the mechanism by which these are carried on; of their relations to each other, or the means of improving their development and action; of the purposes to which they ought severally to be directed; and of the manner in which exercise ought to be conducted, so as to secure for the organ the best health, and for the function the highest efficiency. A true system of physiology comes thus to be the proper basis, not only of a sound physical, but of a sound moral and intellectual education, and of a rational hygiène; or, in other words, it is the basis of everything having for its object the physical and mental health and improvement of man; for, so long as life lasts, the mental and moral powers with which he is endowed manifest themselves through the medium of organization, and no plan which he can devise for their cultivation, that is not in harmony with the laws which regulate that organization, can possibly be successful.

But besides the power of resisting the operation of the ordinary chymical and physical laws, living bodies are distinguished by other properties peculiar to themselves. Unlike inorganized matter, which exists in the same form from the beginning, bodies endowed with the principle of life derive their origin from previously-existing living bodies of the same nature as themselves; and they in their turn give birth to others, and in this way the succession is kept up.

Unlike the inert material which retains its properties unaltered throughout endless ages, the living body is constantly undergoing changes from the first to the last moment of its existence; and these are exemplified, on the large scale, in the great stages of youth, maturity, old age, and death. Unlike inorganized matter, which neither grows nor decays, living bodies require a constant supply of nourishment to admit of their growth in youth, and to replace the worn-out particles which are regularly thrown off at every period of life; and unlike inanimate objects, the properties of which never alter, living bodies cease at last to exist, and their component elements, deprived of the principles of life, again become subject to the ordinary laws of matter, and are speedily decomposed and scattered about, as if life had never been. The above properties, it may be observed, are common to vegetable and animal life; but animals possess others peculiar to themselves. Among the most remarkable of these are sensation, thought, voluntary motion, and the faculty of communicating to each other their thoughts and feelings, through the medium of natural or artificial language. These are great marks of distinction, and, considered in a general point of view, amply suffice to divide the two great classes of animated beings; and while some animals exhibit individual powers in higher perfection, man stands far their superior, not only in combining in his own person all the senses and faculties which they possess, but in being endowed with moral and intellectual powers which are denied to them, and which at once place him at the head of the living creation, and constitute him a moral, religious, intelligent, and responsible being.

So numerous and important are the various organs of which the human frame is composed, and so closely are they linked with each other in their action, that, in treating of them, it is difficult, or, rather, impossible to follow any arrangement which shall not involve considerable repetition, or which shall admit of every statement being at first fully under-

stood. On the present occasion, however, a systematic mode of proceeding is not essential, my object being merely to communicate a general knowledge of a few of the more important functions, partly with a view to the direct practical purposes to which such information may be applied, and partly for the sake of rousing public attention to the necessity of including this branch of science in every plan of what is called a liberal education.

Let it not be said that knowledge of this description is superfluous to the unprofessional reader; for society groans under the load of suffering inflicted by causes susceptible of removal, but left in operation in consequence of our unacquaintance with our own structure, and of the relations of the different parts of the system to each other and to external objects. Every medical man must have felt and lamented the ignorance so generally prevalent in regard to the simplest functions of the animal system, and the consequent absence of the judicious co-operation of friends in the care and cure of the sick. From unacquaintance with the commonest facts in physiology, or incapability of appreciating their importance, men, of much good sense in every other respect, not only subject themselves unwittingly to the active causes of disease, but give their sanction to laws and practices destructive equally to life and to morality, and which, if they saw them in their true light, they would shrink from countenancing in the slightest degree.

For proof of this I need only refer to the evidence on the Factories' Regulation Bill, which lately occupied so much of public attention. The law then in operation authorized the working of children between the years of eight and sixteen, in the close-heated atmosphere of a cotton-mill, for twelve hours a day; and as a great boon, no children are now employed under nine years of age, while between that and fourteen the period of daily labour is not to exceed eight hours. Had our legislators been instructed in anatomy and physiology so far as to obtain even the most general notion of the constitution of the human body,

and had they been aware of the intimate dependance of the mind on the condition of the bodily organization, they would at once have perceived the destructive tendency of the former system of labour and confinement, and the utter impossibility of combining with it that moral and intellectual cultivation which is so imperatively required. Instead of objecting to the limitation when it was proposed, they would have looked forward with dread to the physical and moral degradation which the system then in operation was fast effecting in the multitudes under its influence; and their only doubt would have been, whether even *eight* hours' labour in a close atmosphere was not too much for undeveloped children. The evidence in the printed report to the House of Commons is said to have been partially got up; but granting that it was so, it nevertheless contains a multitude of facts so entirely in accordance with the soundest and best understood principles in physiology, and which no counter-evidence can rebut, that one can only lament the ignorance which prevented many able and benevolent but prejudiced men from perceiving its true character, and yielding at once to the imperious dictates of nature and of duty. That there were great difficulties in the way of every alteration is quite true; but surely no question of mere gain to any or to every class ought to be allowed to stand *for ever* in the way, when the lives and happiness of multitudes of our fellow-creatures, and the tranquillity and real prosperity of the country, are at stake. Unless we *begin* somewhere, how can any improvement ever be accomplished?

Another instance of the dangers of ignorance lately presented itself. In the Edinburgh Advertiser of 1st March, 1833, we are informed that "a distressing occurrence was discovered on Wednesday forenoon, on board the Magnus Troil, Shetland trader, Captain Ganson, lying at Leith. The master and mate, who are brothers, went as usual on Tuesday night to sleep in the cabin of the vessel; but, not appearing at the customary hour in the morning, the crew thought

they had merely slept beyond their time. A little time having elapsed, they were repeatedly called; but, no answer being returned, one of the men went into the cabin, where *he found the two brothers almost dead through suffocation.* It is thought that they had shut the companion and skylights so close, that they had during the night *exhausted the whole of the vital air necessary for respiration* contained in their confined situation. Medical aid was procured, and hopes are entertained of their recovery. Both were much respected." Captain Ganson, however, did not recover, but died convulsed on the following morning.

Since the publication of the preceding statement, doubts have been entertained whether the catastrophe resulted simply from confined air, or from the stove not having been extinguished, or from impure air proceeding from the bilge water. But as all agree that the accident could not have happened if there had been a proper supply of fresh air from without, it matters little from which of these sources the impure air was derived; for it is quite certain that, had Captain Ganson and his brother possessed the slightest acquaintance with the nature of the atmosphere, and the relation of its elements to the function of respiration, they would have seen too clearly the danger of shutting themselves up in a confined space, ever to have risked their lives in the way they did. A constant supply of pure air is indispensable to the formation of proper blood in the lungs, and, consequently, to the preservation of life and the well-being of the whole body; but formerly, when this condition was as little known or regarded as it was by Captain Ganson, many persons were shut up together in small ill-ventilated rooms in schools, jails, and hospitals, and the natural result was a degree of mortality from fevers and other diseases which, now that the laws of respiration are better known and more attended to, is never heard of.

From the same hurtful absence of knowledge, a law exists, or lately existed, in France, by which infants must be taken within a very short time after be-

ing born to the office of the *Maire*, if it is wished to have their births registered. But there is another and higher law, made by the Creator, with which this enactment is at variance; and that law renders the infant incapable of bearing exposure to a low temperature without injury. The result is, that in winter, especially in places where the *Maire* resides at a distance, and where, consequently, the exposure is increased, a greater mortality takes place than is observed among infants placed under more favourable circumstances. Had the nature of the living functions been generally understood by the framers of such a law, it is obvious that it could never have been enacted; for to have done so knowingly would have been in substance to legalize infanticide.

One additional example may be given. It is well understood among professional men, that in speaking, singing, and playing on wind instruments, the lungs are called into play as powerfully as in running or any other species of severe muscular exercise. From not adverting to this fact, a strongly constituted individual, who brought on spitting of blood by bodily labour to which he had not been accustomed, conceived himself perfectly safe and even cautious when he gave up the spade, and confined himself to talking a great deal, which he did daily to numerous visiters, in explanation of favourite views then occupying all his thoughts. The consequence was, that the prescribed treatment was without effect, and a fatal illness was brought on. When the action of the lungs was subsequently explained to this individual, he saw at once the error into which he had fallen, and lamented the ignorance which had led to it, but too late to derive any advantage from his knowledge.

We are constantly meeting with anomalies in practical life, in the case of individuals little accustomed, when in health, to observe or to reflect on the influence of external circumstances and modes of life in disturbing the action of the various animal functions, but at the same time easily and deeply impressed by all *extraordinary* occurrences affecting them. Thus,

when any one is taken ill, his relatives or friends become extremely anxious to have his room properly ventilated; his body-clothes frequently changed and carefully aired; his food properly regulated in quantity and quality; his skin cleaned and refreshed; his mind amused and tranquillized; his sleep sound and undisturbed, and his body duly exercised; and they state, as the reason for all this care, and most justly, that pure air, cleanliness, attention to diet, cheerfulness, regular exercise, and sound sleep, are all highly conducive to health. And yet such is the inconsistency attendant on ignorance, that the patient is no sooner restored, than both he and his guardians are often found to become as careless and indifferent in regard to all the laws of health, as if these were entirely without influence, and their future breach or observance could in no way affect him! Just as if it were not better by a rational exercise of judgment to preserve health when we have it, than first to lose it, and then pay the penalty in suffering and danger, as an indispensable preliminary to its subsequent restoration!

One cause of such anomalous conduct is the dangerous and prevalent fallacy of supposing that, because glaring mischief does not *instantly* follow every breach of an organic law, no harm has been done. Thus, what is more common than to hear a dyspeptic invalid, who seeks to gratify his palate, say, that vegetables, for example, or pastry, or heavy puddings, do not disagree with him, as he ate them on such a day, and felt no inconvenience from them? and the same in regard to late hours, heated rooms, insufficient clothing, and all other sources of bad health, every one of which will, in like manner, be defended by some patient or other, on the ground that he experienced no injury from them on a *certain specified occasion;* while all, when the rule is not directly applied to themselves, will readily admit that such things are, and *must be*, very generally hurtful.

Happy would it often be for suffering man could he see beforehand the modicum of punishment which his

multiplied aberrations from the laws of physiology are sure to bring upon him. But as, in the great majority of instances, the breach of the law is limited in extent, and becomes serious only by the frequency of its repetition; so is the punishment gradual in its infliction, and slow in manifesting its accumulated effect; and this very gradation, and the distance of time at which the full effect is produced, are the reasons why man in his ignorance so often fails to trace the connexion between his conduct in life and his broken health. But the connexion subsists, although he does not regard it, and the accumulated consequences come upon him when he least expects them.

Thus, pure air is essential to the full enjoyment of health; and reason says, that every degree of vitiation must necessarily be proportionally hurtful, till we arrive at that degree at which, from its excess, the continuance of life becomes impossible. When we state this fact to a delicately constituted female, who is fond of frequenting heated rooms, or crowded parties, theatres, or churches, and call her attention to the hurtful consequences which she must inflict on herself by inhaling the vitiated air of such assemblies, her answer invariably is, that the closeness and heat are very disagreeable, but that they rarely injure *her:* by which she can only mean, that a single exposure to them does not always cause an illness serious enough to send her to bed or excite acute pain, although both results are admitted sometimes to have followed. An intelligent observer, however, has no difficulty in perceiving that they do hurt her, and that, although the effect of each exposure to their influence is so gradual as not to arrest attention, it is not the less progressive and influential in producing and maintaining that general delicacy of health by which she is characterized, and from which no medical treatment can relieve her so long as its causes are left in active operation.

The debility so generally complained of in spring by invalids and persons of a delicate constitution, and which renders that season of the year so formidable

in prospect, and in reality so fatal, seems in numerous instances to result more from the accumulated effects of neglect during the preceding winter months, than from anything directly inherent in the season itself. At the commencement of winter, such persons feel comparatively strong from the beneficial exposure to the open air, light, and exercise, which they enjoyed during the summer and autumnal months. But in proportion as they are deprived of these advantages by the advance of winter, and are subjected to the evil consequences of confinement, deficient exercise, cold damp air, and deprivation of the stimulus of light, the stamina of the constitution become impaired, and debility and relaxation begin to be felt, and make progress from day to day, till on the arrival of spring they have reached their maximum, and then either give rise to positive disease, or again gradually disappear at the return of the invigorating influence of longer and warmer days. Where, however, pulmonary disease or any unusual susceptibility pre-exists, this principle will not apply; for in such cases, the east winds prevalent in spring are directly injurious.

If the above view be correct, it is obvious that, in most cases, the hurtful cause is not, as is commonly supposed, so much any positive quality of the season, as the accumulated mass of the winter influences then reaching their maximum; and this is not perceived, only because the effect from day to day, although perfectly real, is too small to attract notice, while the aggregate result of the many days composing winter is striking enough. The fact that those who deny themselves the delight of late parties and crowded rooms, and are sufficiently robust to undergo the necessary exposure in winter, suffer much less in spring, seems to corroborate the above explanation.

We must not suppose, then, that because a *single* excess of any kind does not produce a *direct* attack of disease, it is therefore necessarily harmless; for it is only when the noxious agent is very powerful indeed that its deleterious influence on the system becomes instantly sensible. In the great majority of

situations to which man is exposed in social life, it is the continued or the reiterated application of less powerful causes which gradually, and often imperceptibly, unless to the vigilant eye, effects the change and ruins the constitution before danger is dreamed of; and hence, the great mass of human ailments is of slow growth and slow progress, and admits only of a slow cure; whereas those which are suddenly induced by violent causes, are urgent in their nature and rapid in their course. And yet so little are we accustomed to trace diseased action to its true causes, and to distinguish between the essential and the accidental in the list of consequences, that, as already observed, if no glaring mischief has followed any particular practice within, at most, twenty-four hours, nine out of ten individuals will be found to have come to the conclusion that it is perfectly harmless, even where it is capable of demonstration that the reverse is the fact.

The benevolence and wisdom of this arrangement are very conspicuous. There are many casual influences from the agency of which man will never be able entirely to protect himself. If they are speedily withdrawn from him, the slight disorder which they produce quickly ceases, and health remains essentially undisturbed. But, if they be left in operation for a considerable length of time, the derangement which they excite gradually and slowly increases, till at last a state of disease becomes established, which requires an equally long or longer period, and a steady observance of the laws of health, for its removal.

Such is the history of the rise and progress of most of the ailments which afflict the human family, and the source of the grand distinction between *acute* and *chronic* diseases. We are apt to wonder that a severe disease like inflammation should run its course in a few days, while dyspeptic and nervous ailments require months for their cure. But our wonder is diminished when we attend to the fact, that the one generally dates its rise from a strong cause applied within perhaps a few hours or a few days; while the others are the slow and gradual results of months of

previous anxiety or neglect of dietetic rules and exercise, during which the ailment was maturing unnoticed and unsuspected. Had the real state of the matter been early perceived, and the causes been removed, the dyspeptic and the nervous invalids would have regained health and serenity in proportionally little time and with proportionally little suffering. In such cases, Nature kindly allows some latitude of action free of serious penalty, as if on purpose to protect us from being hurt by such occasional exposure as we are necessarily subjected to by the ordinary vicissitudes of life; but it is always on condition of returning to obedience the moment the necessity is over. If we presume on the indulgence being permanent, the evil accumulates and health is destroyed; but if we return in time to the right path, little inconvenience results. Where, however, the injurious influences are of a more energetic kind, equal latitude of exposure is obviously incompatible with safety. Were they not to enforce immediate notice, our corporeal organs might be irrecoverably altered by disease before we took the alarm, and it is therefore the purest benevolence to attach immediate suffering to them, in order to ensure that instant attention which alone can stay the rapidity of their progress.

In chronic or slowly arising diseases, then, the separation of the effect from its cause is only apparent and not real, and in practice it is essential to keep this in mind. A fit of insanity, for example, is often said to have come on *without any cause*, when, on minuter examination, causes can be easily traced operating through many previous months, only not of so violent a nature as to have at once upset reason, and the same will be found to hold in almost all those slow and insidious illnesses which so often baffle our best efforts; and although at present we cannot always discover their true origin, it is clear that we shall ultimately succeed much better if we believe them to have causes which *may* be found out, than if we regard them as mysteries which no study or attention can ever explain.

It is this apparent but unreal separation of the effect from its cause which has given rise to the variety of opinions entertained in regard to the qualities of the same agents, and which has, perhaps, tended more than anything else to discourage rational regard to the means of preserving health; and yet this very variety is a proof at once of the absence of sound views of our own nature, and of the urgent necessity of possessing them. In society, accordingly, nothing is more common than to hear the most opposite opinions expressed in regard to the evils or advantages of particular kinds of clothing, food, and exercise. One person will affirm, with perfect sincerity, that flannel is pernicious, because it irritates the skin, and uniformly causes an eruption over the whole body; and that linen or cotton is an excellent article of dress, because it produces no such consequences. Another will tell us, with equal truth, that flannel is a capital thing, because it is pleasant to the feeling, and affords protection from cold and rheumatism, which linen does not. One will affirm that a long walk or violent muscular exercise is an excellent tonic, because it gives a keen appetite, and a vivacity and alertness which are delightful. But another will declare that a long walk or severe exercise is exceedingly injurious and debilitating, because it destroys his appetite, and unfits him for exertion of mind or body, and always gives him headache. One will, in like manner, praise vegetable as the best diet, and another animal food as infinitely superior, and so on through the whole range of the physical objects which act upon the human frame; and the natural consequence of these apparent anomalies and contradictions is, that, when in health, we come practically to look upon the effects of air, food, exercise, and dress, as very much matters of chance, subject to no fixed rule, and therefore little worth attending to, except when carried to palpable extremes, or in the cure of disease.

In this way, man, instead of being able to protect his children by the results of his own experience in

his journey through life, goes on from generation to generation, groping a little, then seeing a little, then groping again, till he arrives, often prematurely, at the end of his existence, when he stumbles into his grave, leaving his posterity to pass unaided through the same series of experiments, and arrive at the same termination, as himself.

This unnatural result must arise either from the laws which regulate the animal functions and the operations of external objects being variable and ever changing, or from the conditions of the living body on which they act being different in different persons, or in the same person at different ages or seasons; and it is not difficult to determine to which of these it is to be ascribed. It cannot be the first, for the laws of nature are invariable and unbending. The food which to-day nourishes and sustains the body, and which to-morrow, when sickness is present, raises the pulse and excites the heart to febrile action, has not altered its qualities or changed its relation to the healthy body. It is the state of the body that has changed, and caused the apparent discrepance of effect. In judging, therefore, of the propriety, advantages, or evils of exercise, food, and clothing, we must take into consideration not only the kind of exercise, the kind of food, and the kind of clothing, but also the age, health, and kind of constitution of the individual who uses them, and adapt each to the degree in which it is required; and then we may rest assured that many of our difficulties will vanish, and certainty and consistency come proportionally into view.

Were the intelligent classes of society better acquainted with the functions of the human body, and the laws by which they are regulated, many of these anomalies in practice would disappear, the sources of much suffering would be dried up, and the happiness of the community at large be essentially promoted. Medical men would no longer be consulted so exclusively for the cure of disease, but would also be called upon to advise regarding the best means of strengthening the constitution, from an early period, against

any accidental or hereditary susceptibility which might be ascertained to exist. More attention would be paid to the *preservation* of health than is at present practicable, and the medical man would then be able to advise with increased effect, because he would be proportionally well understood, and his counsel, in so far at least as it was based on accurate observation and a right application of principles, would be perceived to be, not a mere human opinion, but, in reality, an exposition of the will and intentions of a beneficent Creator, and would therefore be felt as carrying with it an authority to which, as the mere dictum of a fallible fellow-creature, it can never be considered as entitled.

It is true that, as yet, medicine has been turned to little account in the way of directly promoting the physical and mental welfare of man. But the day is perhaps not far distant, when, in consequence of the improvements both in professional and in general education now in progress, a degree of interest will become attached to this application of its doctrines far surpassing what those who have not reflected on the subject will be able to imagine as justly belonging to it, but by no means exceeding that which it truly deserves.

The practical importance of physiological knowledge in the training and education of the young, has been overlooked chiefly, I think, from the unnatural separation of the different branches of medical science from each other by its cultivators and teachers, and the exclusive devotion of each to his own favourite department. The Anatomist, for example, teaches structure, and structure only, and refers to the Physiologist for an account of the uses to which it is subservient; and the Physiologist, on the other hand, expounds functions, but scarcely touches upon the instruments by which they are executed. The consequence is, that the student often becomes disgusted with what he considers dry anatomical details, when perhaps nothing would interest him more deeply were the purposes which the structure fulfils in the animal

economy taught to him at the same time. Many, in like manner, fail to take any pleasure in the study of physiology, who would be truly delighted to hear the truths of which it treats expounded in connexion with peculiarities of organization, and with more frequent reference to their practical applications. The Anatomist and Physiologist err, in short, in limiting themselves too exclusively to their own particular pursuits, and devoting too little attention to the relations which these bear to each other and to the great unit, the living being, of which they form a part. So far, indeed, has this separation been carried, and so injurious is the habit thence arising of contemplating objects under the narrowest point of view, that very lately an able teacher of physiology, in his public lectures, ridiculed the very notion of laying down general rules for the preservation of health, and imagined that he had set the matter entirely at rest by the simple assertion that *variety* is advantageous, and affirming that, therefore, *uniformity of obedience to any rules must be prejudicial*; as if it were not of the very essence of general laws to be modified in their operation and results by the circumstances under which they act; and as if, because of such modifications, their influence might with safety be entirely neglected.

The result of this erroneous system is, as already hinted, that the young practitioner is educated without having made himself sufficiently familiar with the conditions on which the *healthy* action of the animal economy depends, or having even rightly appreciated the importance of such knowledge; and that, consequently, in common with his patient, he sometimes unwittingly allows the operation of morbid causes to go on without interference, where, by a timely warning on his part, serious illness might have been averted; or unconsciously permits the gradual ripening of hereditary tendencies into active disease, which rational precautions, early resorted to, might have kept in subjection throughout a long period of existence.

Some practitioners, I am aware, object to unprofessional persons attempting to make themselves ac-

quainted with the structure or functions of the human body, and, in practice, think it best never to give any explanation to the patient of the principles on which it is proposed to conduct the treatment. But, generally speaking, it will be found that the cheerful co-operation of the patient is never so effectually secured as by addressing his understanding, and giving him an intelligible interest in what is proposed for his relief. In acute diseases, of course, explanation of any kind is often precluded. Here the professional man must act, and act with decision. But the great majority of ailments are of a chronic character, in the cure of which the steady co-operation of the patient is almost indispensable. And even when the malady is acute, the patient will submit to severe measures much more readily when ordered by an adviser who has been in the habit of addressing his reason when opportunity occurred, than when prescribed by one who has always followed the system of dictation.

So far from the rational care of health being justly chargeable with the imputation of selfishness, so often ignorantly thrown out against it, there is nothing which tends so much to relieve society from the burden of miseries not its own, as each individual taking such care of his constitution as shall enable him to cope successfully with the duties and difficulties of the situation in which he is placed. No man is so thoroughly selfish as he who, in the ardent pursuit of pleasure or of profit, heedlessly exposes his life to the hazard of a die, regardless of the suffering which he may entail upon those who depend on him for support. In the abstract, we all admit that the enjoyment of health is the first of earthly blessings, and that without it all others may be lavished in vain; and yet it has been quaintly asked, "Who is he that values *health* at the *rate* it is *worth?* Not *he* that hath it; he reckons it among the *common ordinary* enjoyments, and takes as *little notice* of it, or *less* regards it, than his long-*worn clothes:* perhaps more *careful* of his *garments*, remembering their *price;* but thinks his *health* costs him *nothing*, and, coming to him at so easy

a *rate*, values it accordingly, and hath little *regard* to keep it: is never truly sensible of what he *enjoyed* until he finds the *want* of it by *sickness;* then *health*, above *all things*, is earnestly desired and wished for."

In proportion, however, as we consider the matter with that attention which its importance really deserves, we shall become anxious rather to take care of health when we have it, than first to lose it, and then exert ourselves to recover it. Such was evidently the feeling which elicited the following remarks from the same clear-sighted author:

"You that have health," says he, "and know not how to *prize* it, I'll tell you what it is, that you may love it better, put a higher *value* upon it, and endeavour to *preserve* it with a more *serious*, *stricter* observance and tuition.

"*Health* is *that* which makes your *meat* and *drink* both *savoury* and *pleasant*, else Nature's injunction of *eating* and *drinking* were a hard task and slavish custom.

"*Health* is *that* which makes your *bed easy* and your *sleep refreshing;* that revives your *strength* with the rising sun, and makes you *cheerful* at the light of another *day;* 'tis that which fills up the hollow and uneven places of your carcass, and makes your body *plump* and *comely;* 'tis that which *dresseth* you up in Nature's *richest attire*, and *adorns* your face with her *choicest* colours.

"'Tis *that* which makes *exercise* a *sport*, and walking abroad the enjoyment of your *liberty*.

"'Tis *that* which makes *fertile* and increaseth the natural *endowments* of your mind, and preserves them *long* from *decay*, makes your *wit* acute, and your *memory retentive*.

"'Tis *that* which supports the *fragility* of a corruptible body, and *preserves* the *verdure*, *vigour*, and *beauty* of youth.

"'Tis *that* which makes the *soul* take delight in her *mansion*, sporting herself at the casement of your eyes.

"'Tis *that* which makes *pleasure* to be *pleasure*, and delights delightful, without which you can sol-

ace yourself in nothing of *terrene* felicities or enjoyments."

But "now take a view of yourself when *health* has turned its back upon you, and deserts your *company*; see then how the *scene* is changed, how you are robbed and spoiled of all your comforts and *enjoyments*.

"Sleep that was stretched out from *evening* to the *fair bright day*, is now broken into pieces, and *subdivided*, not worth the accounting; the *night* that before seemed *short* is now too *long*, and the downy bed presseth hard against the bones.

"*Exercise* is now *toyling*, and *walking abroad* the carrying of a *burthen*.

"The *eye* that flasht as lightning is now like the *opacous* body of a thick cloud; that rolled from *east* to *west*, swifter than a *celestial orb*, is now tired and weary with standing still; that penetrated the *centre* of another *microcosm*, hath lost its planetary influence, and is become obtuse and dull," &c.

If such, then, be a true picture of the opposite conditions of health and disease, what stronger inducements can any one require to give him an interest in the "study and observance of Nature's institutions," seeing that they are the only means by which "the beloved ends and wished-for enjoyments" can be attained, and that we "may as likely keep or acquire *riches* by *prodigality*, as preserve *health* and obtain *long life* by *intemperance*, inordinate passions, a noxious air, and such like injurious customs, ways, and manner of living?"*

* Maynwaringe on the Method and Means of Health, 1683.

CHAPTER II.

STRUCTURE AND FUNCTIONS OF THE SKIN.

The Skin—composed of three Layers.—The Cuticle—its Structure and Uses.—The Mucous Coat—the Seat of Colour.—The True Skin—its Structure—the Seat of Perspiration—its Nature—Consequences of Suppressed Perspiration.—Sympathy between the Skin and other Organs.—The Skin a Regulator of Animal Heat.—The Seat of Absorption.—Touch and Sensation.—Connexion between the Skin and Nervous System.

In selecting the subjects of the following essays, I shall, as hinted in the preface, be guided partly by the intrinsic importance of the functions of which they treat to the well-being of the animal economy, and partly by the comparative ignorance which prevails in regard to them. Hitherto the digestive functions have formed the most prominent topic of disquisition, and a great mass of information has, from time to time, been laid before the public, with a view to induce greater attention to the regulation of diet and regimen; and the action of digestive disorder, in deranging the general health and modifying the progress of disease, has also been sedulously pointed out. But there are other organs and functions, of nearly equal interest, which have been much less attended to than they deserve, and with which the general reader is very little familiar. Among these the Skin, the Muscles, the Bones, the Lungs, and the Nervous System, may be mentioned as most worthy of notice, and I shall accordingly endeavour to give such an account of them in succession, as will be both intelligible and of direct practical utility to every one. I shall commence with an explanation of the structure and functions of the Skin.

The skin is that membranous covering which is spread over the whole surface of the body, and which

serves to bind together and to protect from injury the subjacent and more delicate textures. In different animals and at different parts of the body, it assumes different appearances. It is smooth, soft, and delicate in youth and in females; firmer and more resisting in middle age and in males; flabby and wrinkled in old age and after disease; puckered or disposed in folds in places that admit of extensive flexion, as over the finger-joints and in the palm of the hand; and thick and horny where it is subjected to the influence of pressure, as in the soles of the feet.

The structure of the skin, like that of every other part of the animal frame, displays the most striking proofs of the transcendent wisdom and beneficence of its great Creator. Though simple in appearance and design, it is a compound of many elements, and the seat of as great a variety of functions. It is composed of three layers of membrane, viz., the thin *scarf-skin* or *cuticle*, the *mucous coat*, and the thick *true skin*, as it is called, which immediately encompasses the body. These distinctions should be kept in view; for, as it is a general law of the animal economy that every part has a use or function peculiar to itself, the various uses of the compound can be understood only by attending to those of the simple elements.

The *epidermis*, *cuticle*, or *scarfskin*, is the outermost of the three layers, and is that which is raised in blisters. It is a thin, continuous, and insensible membrane, and has no perceptible bloodvessels or nerves, and, consequently, neither bleeds nor feels pain when cut or abraded. Being homogeneous in structure, it is supposed by many to be merely an exudation of albuminous mucus; and although depressions are obvious on its surface, and exhalation and absorption are proved to be carried on through its substance, it is still in dispute whether it be actually porous or not. Probability is in favour of the affirmative, and the circumstance of the pores not being visible is no proof of the contrary: for the cuticle is so elastic, that it may be perforated by a needle, and yet the hole not be discernible even under the microscope. The ques-

tion is, however, one of little moment, provided it be remembered that its texture, whether perforated or not, is such as to admit of exhalation and absorption taking place through its substance.

The structure of the cuticle is in admirable harmony with its uses. Placed as an insensible intermedium between external objects and the delicate nervous expansion on the surface of the subjacent true skin, it serves as a physical defence against friction; and while, by impeding evaporation, it preserves the true skin in that soft and moist state which is essential to its utility, it also, by impeding absorption, enables man to expose himself without injury to the action of numerous agents, which, but for its protection, would immediately be absorbed, and cause the speedy destruction of health and life. This is remarkably exemplified in several trades, where the workman is unavoidably exposed to an atmosphere loaded with metallic and poisonous vapours, or obliged to handle poisonous substances; and where, without the obstruction of the cuticle, the evils to which he is subjected would be aggravated a hundred fold. Being destitute of nerves, the cuticle is not hurt by the direct contact of external bodies; and being very thin, it blunts without impairing the distinctness of the impression made on the nerves of sensation. The necessity of this latter provision becomes very obvious, when the cuticle is abraded or removed by vesication. The surface below is then found to be too tender and irritable for the exercise of touch, and conveys to the mind scarcely any other sensation than that of pain.

For the same reason, those parts of the skin which are most exposed to pressure and friction, such as the palms of the hands and soles of the feet, are provided with a thicker cuticle to defend them from injury. The greater thickness of the cuticle in such situations is manifestly the intentional work of the Creator, for it is perceptible even at birth, before use can have exercised any influence. Indeed, were the tender skin not so protected, every violent contraction of the hand upon a rough and hard surface, and

every step made on uneven ground, would cause pain, and disable us for exertion.

By another beneficent provision, calculated to afford increased protection according to the necessities of the individual, it happens that, when a part is much used, the cuticle covering it becomes thicker and thicker within certain limits, till in extreme cases it becomes as thick, hard, and resisting as horn. It is this thickening of the epidermis on the lady's finger that alone enables her to wield with impunity that important instrument the needle. And it is the same thickening that fits the blacksmith and the mason, the stone-breaker and the boatman, to ply their trades, without that painful blistering which the young apprentice or unaccustomed labourer so regularly undergoes, and which must have continued to recur for ever had the cuticle been organized with bloodvessels and nerves, or not subjected to this law of becoming thicker wherever increased protection is required.

Another modification of the cuticle to suit a modification of circumstances, is that observed in the nails. These belong to the cuticle, and separate with it; and, like it, they have neither bloodvessels nor nerves, and may be cut or bruised without pain. When the hand or foot is macerated in water, the nails and the cuticle show their identity of organization, by separating together from the dermis or true skin below. The nails, like the cuticle, serve chiefly to protect the subjacent parts from injury; and accordingly, in those lower animals whose manner of life subjects their feet to continual pressure, and requires no nice exercise of touch, Nature has provided horny and resisting hoofs for their protection instead of merely a thickened epidermis.

To produce thickening of the cuticle, exercise must be gradual, and not too severe. If, for example, a person takes a very long walk, rows a boat, or makes use of a heavy hammer for a few hours, without having been accustomed to such an effort, there is no time for the cuticle to thicken, and defend itself from

the unusual friction. The parts below, being inadequately protected, become irritated and inflamed, and throw out a quantity of watery fluid or serum on their surface, which raises up the cuticle in blisters, and, by making it painful to continue the pressure, obliges the person to desist from an exercise which, if continued, would evidently soon alter the structure of the sentient nervous filaments, and for ever unfit them for their proper uses: so that even in this result, beneficence and wisdom are prominently displayed.

Immediately beneath the scarfskin, and between it and the true skin, is the *mucous coat*, *rete mucosum*, or *mucous network*, which is remarkable chiefly as being the seat of the colouring matter of the skin. It is seen with difficulty on dissection except in negroes, in whom it is thick. It is exceedingly attenuated in albinoes, and is, in fact, thick in proportion to the depth of colour. It is destitute of bloodvessels and nerves, but, like the epidermis, is permeable by other bodies. The colouring matter is said to be the same as that of the blood; Davy and Blumenbach, however, regard it as carbon.

From all that is known regarding the mucous coat, it may be viewed generally as merely a thin soft covering, placed between the outer and the inner skin, to protect the nerves and vessels of the latter, and give them their requisite softness and pliancy. Being of a dark colour in the negro, it has been supposed to diminish the heating influence of the sun's rays in tropical climates by the higher radiating power which is possessed by a black than by a light surface; but there is reason to doubt the soundness of the theory at least, for black is well known to excel in *absorbing*, as well as in radiating, heat; and late experiments on the coast of Africa seem to show, that the temperature of the negro is actually about two degrees higher than that of the European under the same circumstances.

The mucous coat is the seat of the beautiful and variegated colouring observed in the skins of many fishes and other animals, in which it has often a high and almost metallic splendour.

The third or inmost layer, called the *true skin*, *cutis*, *dermis*, or *corion*, constitutes the chief thickness of the skin, and is by far the most important of the three, both in structure and functions. Unlike the cuticle and mucous coat, which are homogeneous in their whole extent, and apparently without organization, the true skin, or simply, as we shall sometimes call it for brevity's sake, *the skin*, is very delicately organized, and endowed with the principle of life in a very high degree. Not only is it the beautiful and efficacious protector of the subjacent structures, but it is the seat of sensation and of touch, and the instrument of a very important exhalation, viz., perspiration, the right condition or disturbance of which is a most powerful agent in the preservation or subversion of the general health. The dermis is a dense, firm, and resistant tissue, possessed of great extensibility and elasticity, and of a colour more or less red in proportion to the quantity of blood it receives and contains. Its looser internal surface, which is united to the cellular membrane in which the fat is deposited, presents a great number of cells or cavities, which penetrate obliquely into the substance, and towards the external surface of the skin, and also contain fatty matter. These areolæ or cells are larger on some parts of the body than on others: they are very small on the back of the hand and foot, the forehead, and other places where fat is never deposited and the skin has much tenuity; while they are large in the palm of the hand and sole of the foot, where the skin is consequently thicker and fat abounds. These cells are traversed by innumerable bloodvessels and filaments of nerves; the latter passing through to be ramified on the outer surface of the skin, where they show themselves in the form of numerous small papillæ or points, which are very visible on the surface of the tongue, and on the fingers and palm of the hand. These papillæ constitute the true organs of touch and sensation, and are therefore most thickly planted where these senses are most acute.

The true skin is so abundantly supplied with blood

and nervous power, that, for practical purposes, it may almost be regarded as composed of vessels and nerves alone; and it is important to notice this fact. The universal and equal redness of the skin in blushing is itself a proof of great vascularity; but a still stronger consists in our being unable to direct the point of the finest needle into any spot without puncturing a vessel and drawing blood. The same test proves the equal abundance of nervous filaments in the skin; for not a point can be punctured without transfixing a nerve and causing pain; and it is well known that, in surgical operations and accidental wounds, the chief pain is always in the skin, because it is profusely supplied with nerves of sensation on purpose to serve as an instrument of feeling. From these examples, it is plain that the skin may be truly considered as a network of bloodvessels and nerves of the finest conceivable texture; and, taking the vast extent of its whole surface (estimated to exceed in a man of average size 2500 square inches) into account, we can easily understand how these minute ramifications may really constitute a larger mass of nervous matter than what is contained in the original trunks of the nerves from which they are incorrectly said to arise, and also how so large a proportion of the whole blood may be circulated through the skin at one time.

To understand the important purposes of the true skin, we must distinguish between its constituent parts, and consider it in virtue of each of them, 1*st*, As an exhalant of waste matter from the system; 2*dly*, As a joint regulator of the heat of the body; 3*dly*, As an agent of absorption; and, 4*thly*, As the seat of sensation and touch.

Besides performing the mechanical office of a shield to the parts beneath, the skin is admirably fitted, by the great supply of blood which it receives, for its use as a secreting and excreting organ. The whole animal system is in a state of constant decay and renovation; and while the stomach and alimentary canal take in new materials, the skin forms one of the prin-

cipal outlets or channels by which the old, altered, or useless particles are eliminated from the body; and hence, as all the secretions and excretions are derived directly from the circulating blood, the skin obviously requires a supply large in proportion to the extent of its function. Every one knows that the skin perspires, and that checked perspiration is a powerful cause of disease and of death; but few have any just notion of the real extent and influence of this exhalation such as we shall attempt to exhibit it. When the body is overheated by exercise in warm weather, a copious sweat soon breaks out, which, by evaporating and so carrying off the superfluous heat, produces an agreeable feeling of coolness and refreshment.* This is the higher and more obvious degree of the function of exhalation; but, in the ordinary state, the skin is constantly giving out a large quantity of waste materials by what is called *insensible* perspiration, a process which is of great importance to the preservation of health, and which is called insensible because the exhalation, being in the form of vapour, and carried off by the surrounding air, is invisible to the eye; but its presence may often be made manifest, even to the sight, by the near approach of a dry cool mirror, on the surface of which it will soon be condensed so as to become visible.

Many attempts have been made to estimate accurately the amount of exhaled matter carried off through the skin; but so many difficulties stand in the way of obtaining precise results, and the difference in different constitutions, and even in the same person at different times, is so great, that we must be satisfied with an approximation to the truth. Sanctorius, who carefully weighed himself, his food, and his excretions, in a balance every day for thirty years, came to the conclusion that *five* out of every eight pounds of substances taken into the system passed out of it again by the skin, leaving only three to pass off by

* The effect of evaporation in reducing temperature is explained more fully on p. 59.

the bowels, the lungs, and the kidneys. The celebrated LAVOISIER and M. SEGUIN afterward entered on the same field of inquiry, and with greater success, as they were the first to distinguish between the cutaneous and pulmonary exhalations. M. SEGUIN shut himself up in a bag of glazed taffetas, which was tied over his head and provided with a hole, the edges of which were glued to his lips with a mixture of turpentine and pitch, so that the pulmonary exhalation might be thrown outward, and the cutaneous alone be retained in the bag. He first weighed himself and the bag in a very nice balance, at the beginning of the experiment; then at the end of it, when he had become lighter in proportion to the quantity of exhalation thrown out by the breathing; and, lastly, he weighed himself out of the bag, to ascertain how much weight he had lost in all; and by subtracting the loss occasioned by the lungs, the remainder, of course, exhibited the amount carried off by the skin. He attended minutely also to the collateral circumstances of diet, temperature, &c.; and allowance being made for these, the results at which he arrived were the following:

The *largest* quantity of insensible perspiration from the lungs and skin together amounted to thirty-two grains per minute, three ounces and a quarter per hour, or five pounds per day. Of this, the cutaneous constituted three fourths or sixty ounces in twenty-four hours. The *smallest* quantity observed amounted to eleven grains per minute, or one pound eleven and a half ounces in twenty-four hours, of which the skin furnished about twenty ounces. The *medium* or average amount was eighteen grains a minute, of which eleven were from the skin, making the cutaneous perspiration in twenty-four hours about *thirty-three ounces*. When the extent of surface which the skin presents is considered, these results do not seem extravagant. But even admitting that there may be some unperceived source of fallacy in the experiments, and that the quantity is not so great as is here stated, still, after making every allowance, enough re-

mains to demonstrate that exhalation is a very important function of the skin. And although the precise amount of perspiration may be disputed, the greater number of observers agree that the cutaneous exhalation is more abundant than the united excretions of both bowels and kidneys; and that, according as the weather becomes warmer or colder, the skin and kidneys alternate in the proportions of work which they severally perform; most passing off by the skin in warm weather, and by the kidneys in cold. The quantity exhaled increases after meals, during sleep, in dry warm weather, and by friction or whatever stimulates the skin; and diminishes when digestion is impaired, and in a moist atmosphere.

What we have considered relates only to the *insensible* perspiration. That which is caused by great heat or severe exercise, is evolved in much greater quantity; and by accumulating at the surface, it becomes visible, and forms sweat. In this way, a robust man may lose two or three pounds' weight in the course of one hour's severe exertion; and if this be suddenly checked, the consequences in certain states of the system are often of the most serious description. When the surface of the body is chilled by cold, the bloodvessels of the skin become contracted in their diameter, and hinder the free entrance of the red particles of the blood, which are therefore of necessity collected and retained in greater quantity in the internal organs, where the heat varies very little. The skin, consequently, becomes pale, and its papillæ contract, forming by their erection what is called the goose's skin. In this state it becomes less fit for its uses; the sense of touch can no longer nicely discriminate the qualities of bodies, and a cut or bruise may be received with comparatively little pain. From the oppression of too much blood, the internal parts, on the other hand, work heavily: the mental organs are weakened, sleepiness is induced, respiration is oppressed, the circulation languishes, and digestion ceases; and if the cold be very intense, the vital functions are at last extinguished without pain

and without a struggle. This is a picture of the extreme degree; but the same causes which, in an aggravated form, occasion death, produce, when applied in a minor degree, effects equally certain, although not equally marked or speedy in their appearance.

According to THENARD, the cutaneous exhalation is composed of a large quantity of water and a small portion of acetic acid, of muriates of soda and potass, of an earthy phosphate, a little oxyde of iron, and some animal matter; but BERZELIUS considers the acid as lactic, and not the acetic. Some carbonic acid and oily matter also are excreted. It is probable, however, that the composition of the perspiration varies both at different ages and on different parts of the skin, as is presumable from the peculiarity of odour which it exhales in some situations. The armpits, the groins, the forehead, the hands, and the feet, perspire most readily, and for this purpose receive a proportionally larger supply of blood. Everything tends to show that perspiration is a direct product of a vital process, and not a mere exudation of watery particles through the pores of the skin.

Taking even the lowest estimate of LAVOISIER, we find the skin endowed with the important charge of removing from the system about twenty ounces of waste matter every twenty-four hours; and when we consider that the quantity not only is great, but is sent forth in so divided a state as to be invisible to the eye, and that the whole of it is given out by the very minute ramifications of the bloodvessels of the skin, we perceive at once why these are so extremely numerous that a pin's point cannot touch any spot without piercing them; and we see an ample reason why, independently of the impression made through the medium of the nervous system, checked perspiration should prove so detrimental to health—because for every twenty-four hours during which such a state continues, we must either have twenty ounces of useless and hurtful matter accumulating in the body, or have some of the other organs of excretion grievously overtasked, which obviously cannot happen with-

out disturbing their regularity and well-being. People know the fact, and wonder that it should be so, that cold applied to the skin, or continued exposure in a cold day, often produces a bowel complaint, a severe cold in the chest, or inflammation of some internal organ: but were they taught, as they ought to be, the structure and uses of their own bodies, they would rather wonder that it did not always produce one of these effects.

In tracing the connexion between suppressed perspiration and the production of individual diseases, we shall find that those organs which possess some similarity of function sympathize most closely with each other. Thus the skin, the bowels, the lungs, the liver, and the kidneys, sympathize readily, because they have all the common office of throwing waste matter out of the system, each in a way peculiar to its own structure; so that if the exhalation from the skin, for example, be stopped by long exposure to cold, the large quantity of waste matter which it was charged to excrete, and which in itself is hurtful to the system, will most probably be thrown upon one or other of the above-named organs, whose functions will, consequently, become excited; and if any of them, from constitutional or accidental causes, be already weaker than the rest, as often happens, its health will naturally be the first to suffer. In this way, the bowels become irritated in one individual, and occasion bowel complaints; while in another, it is the lungs which become affected, giving rise to catarrh or common cold, or perhaps even to inflammation. When, on the other hand, all these organs are in a state of vigorous health, a temporary increase of function takes place in them, and relieves the system, without leading to any local disorder; and the skin itself speedily resumes its activity, and restores the balance among them.

One of the most obvious illustrations of this reciprocity of action is afforded by any convivial company seated in a warm room in a cold evening. The heat of the room, the food and wine, and the excitement of the moment, stimulate the skin, cause an af-

flux of blood to the surface, and increase in a high degree the flow of the insensible perspiration; which thus, while the heat continues, carries off an undue share of the fluids of the body, and leaves the kidneys almost at rest. But the moment the company goes into the cold external air, a sudden reversal of operations takes place; the cold chills the surface, stops the perspiration, and directs the current of the blood towards the internal organs, which presently become excited; and, under this excitation, the kidneys, for example, will in a few minutes secrete as much of their peculiar fluid as they did in as many of the preceding hours. The reverse of this, again, is common in diseases obstructing the secretion from the kidneys; for the perspiration from the skin is then altered in quantity and quality, and acquires much of the peculiar smell of the urinary fluid.

When the lungs are weak, and their lining membrane is habitually relaxed, and secretes an unusual amount of mucus from its surface, the mass of blood thrown inward upon the lungs by cold applied to the skin, increases that secretion to a high degree. Were this secretion to accumulate, it would soon fill up the air-cells of the lungs and cause suffocation; but, to obviate this danger, the Creator has so constituted the lungs, that accumulated mucus, or any foreign body coming in contact with them, excites the convulsive effort called coughing, by which a violent and rapid expiration takes place, with a force sufficient to hurry the mucus or other foreign body along with it: just as pease are discharged by boys with much force through short tubes by a sudden effort of blowing. Thus, a check given to perspiration, by diminishing the quantity of blood previously circulating on the surface, naturally leads very often to increased expectoration and cough, or, in other words, to common cold.

The lungs excrete, as already noticed, and as we shall afterward more fully see, a large proportion of waste materials from the system; and the kidneys, the liver, and the bowels have in so far a similar office. In consequence of this alliance with the skin,

these parts are more intimately connected with each other in healthy and diseased action than with other organs. But it is a general law, that whenever an organ is unusually delicate, it will be more easily affected by any cause of disease than those which are sound: so that, if the nervous system, for example, be weaker than other parts, a chill will be more likely to disturb its health than that of the lungs, which are supposed, in this instance, to be constitutionally stronger; or, if the muscular and fibrous organizations be unusually susceptible of disturbance, either from previous illness or from natural predisposition, *they* will be the first to suffer, and rheumatism will ensue; and so on. And hence the utility to the physician of an intimate acquaintance with the previous habits and constitutions of his patients, and the advantage of adapting the remedies to the nature of the cause, when it can be discovered, as well as to the disease itself. A bowel complaint, for instance, may arise from overeating as well as from a check to perspiration; but although the thing to be cured is the same, the *means* of cure ought obviously to be different. In the one instance, an emetic or laxative to carry off the offending cause, and in the other a diaphoretic to open the skin, will be the most rational and efficacious remedies. Facts like these expose well the glaring ignorance and effrontery of the quack, who affirms that his one remedy will cure every form of disease. Were the public not equally ignorant with himself, their credulity would cease to afford to his presumption the rich field in which it now revels.

The close sympathy between the skin and the stomach and bowels has often been noticed, and it is now well understood that most of the obstinate eruptions which appear on the face and rest of the surface owe their origin to disorders of the digestive organs, and are most successfully cured by treatment directed to the internal disease. Even among the lower animals, the sympathy between the two is so marked as to have arrested attention. Thus, in speaking of the horse, Delabere Blaine says, "by a well-

known consent of parts between the skin and alimentary canal in general, but between the first passages and the stomach in particular, it follows, in almost every instance, that when one of these becomes affected, the other takes on a sympathetic derangement also, and the condition is then morbid throughout. From close observation and the accumulation of numerous facts, I am disposed to think, that so perfect is this sympathetic consent between these two distant parts or organs, that they change the order of attack as circumstances occur. Thus, when the skin is primarily affected, the stomach becomes secondarily so, and *vice versa*," so that "a sudden check to the natural or acquired heat of the body, particularly if aggravated by the evaporation of a perspiring state," as often brings on disease of some internal organ, as if the cause were applied directly to the organ itself.*

In noticing this connexion between the suppression of perspiration and the appearance of internal disease, I do not mean to affirm that the effect is produced by the physical transference of the suppressed exhalation to the internal organ. In many instances, the chief impression seems to be made on the nervous system; and the manner in which it gives rise to the resulting disease is often extremely obscure. Our knowledge of the animal functions is, indeed, still so imperfect, that we daily meet with many occurrences of which no explanation can be given. But it is nevertheless of high utility to make known the fact, that a connexion does exist between two orders of phenomena, as it calls attention to their more accurate observation, and leads to the adoption of useful practical rules, even when their mode of operation is not understood. Nothing, indeed, can be more delusive than the rash application of merely physical laws to the explanation of the phenomena of living beings. Vitality is a principle superior to, and in continual warfare with, the laws which regulate the actions of inanimate bodies; and it is only after life has become

* Blaine's Outlines of the Veterinary Art. Third edition, p. 65.

extinct that these laws regain the mastery, and lead to the rapid decomposition of the animal machine. In studying the functions of the human body, therefore, we must be careful not to hurry to conclusions, before taking time to examine the influence of the vital principle in modifying the expected results.*

It is in consequence of the sympathy and reciprocity of action existing between the skin and the internal organs that burns and even scalds of no very great extent prove fatal, by inducing internal, generally intestinal, inflammation. By disordering or disorganizing a large nervous and exhaling surface, an extensive burn causes not only a violent nervous commotion, but a continued partial suspension of an important excretion; and, when death ensues at some distance of time, it is almost always in consequence of inflammation being excited in the bowels or sympathizing organ. So intimate, indeed, is this connexion, that some surgeons of great experience, such as the late Baron Dupuytren, of the Hôtel Dieu, while they point to internal inflammation as in such cases the general cause of death, doubt if recovery ever takes place when more than one eighth of the surface of the body is severely burned. And whether this estimate be correct or not, the facts from which it is drawn clearly demonstrate the importance of the relation subsisting between the skin and the other excreting organs.

In some constitutions, a singular enough sympathy exists between the skin and the bowels. Dr. A. T. Thomson, in his work on Materia Medica (p. 42), mentions that he is acquainted with a clergyman who cannot bear the skin to be sponged with vinegar and water, or any diluted acid, without suffering spasm and

* After the corresponding sheets of the first edition were printed, I met with some excellent practical remarks on the sympathy between the skin and the thoracic and abdominal viscera, in Dr. James Johnson's "Treatise on Derangements of the Liver, Internal Organs, and Nervous System," published some years ago. They deserve every attention on the part of the profession, as showing how affections of different organs influence each other.

violent griping of the bowels. The reverse operation of this sympathy is exemplified in the frequent production of nettle-rash and other eruptions on the skin, by shellfish and other substances taken into the stomach. Dr. Thomson tells us, that the late Dr. Gregory could not eat the smallest portion of the white of an egg without experiencing an attack of an eruption like nettle-rash. According to the same author, even strawberries have been known to cause fainting, followed by a petechial efflorescence of the skin.

We have seen that the insensible perspiration removes from the system, without trouble and without consciousness, a large quantity of useless materials, and at the same time keeps the skin soft and moist, and thereby fits it for the performance of its functions as the organ of an external sense. In addition to these purposes, the Creator has, in his omniscience and foresight, and with that regard to simplicity of means which betokens a profoundness of thought inconceivable to us, superadded another, scarcely less important, and which is in some degree implied in the former; I mean the proper regulation of the bodily heat. It is well known that, in the polar regions and in the torrid zone, under every variety of circumstances, the human body retains nearly the same temperature, however different may be that of the air by which it is surrounded. This is a property peculiar to life, and, in consequence of it, even vegetables have a power of modifying their own temperature, though in a much more limited degree. Without this power of adaptation, it is obvious that man must have been chained for life to the climate which gave him birth, and even then have suffered constantly from the change of seasons; whereas, by possessing it, he can retain life in a temperature sufficiently cold to freeze mercury, and is able for a time to sustain, unharmed, a heat more than sufficient to boil water or even to bake meat. Witness the wintering of Captain Parry and his companions in the Polar Regions; and the experiments of Blagden, Sir Joseph Banks, and others, who remained for many minutes in a room heated to

260°, or about 50° above the temperature of boiling water. The chief agents in this wonderful adaptation of man to his external situation, are undoubtedly the skin and the lungs, in both of which the power is intimately connected with the condition of their respective exhalations. But it is of the skin alone, as an agent in reducing animal heat, that we are at present to speak.

The sources of animal heat are not yet demonstrably ascertained; but that it is constantly generated and constantly expended has been long known; and if any considerable disproportion occurs between these processes, it is at the immediate risk of health. During repose or passive exercise, such as riding in a carriage or sailing, the surplus heat is readily carried off by the insensible perspiration from the lungs and skin, and by the contact of the colder air; but when the amount of heat generated is increased, as during active exercise, an increased expenditure becomes immediately necessary: this is effected by the skin and lungs being excited to higher action; by the latter sending out the respired air loaded with vapour, and the former exhaling its fluid so rapidly as to form a sweat. Accordingly, we find that in cold countries and in frosty weather, the exhalation from the skin is reduced to a very moderate amount, the superabundant heat being rapidly carried off by contact with a cooler air; and that, in warm climates, where the heat is not carried off in this way, the surface is constantly bedewed with perspiration, and a corresponding appetite exists for liquids by which the perspiration may be kept up to a sufficient degree. Every one must have experienced the grateful effects of this provision, in passing from the dry, restless, and burning heat, like that of fever, to the soft and pleasant coolness which follows the breaking out of the sweat.

Attention to the order of events affords the requisite knowledge of the means employed for carrying off the increased heat which is produced when a person is exposed to a warm air and powerful sun, or engaged in severe exercise. At first, the body is ac-

tually felt to be warmer, the skin becomes dry and hot, and the unpleasant sensation of heat is soon at its maximum. By-and-by a slight moisture is perceived on the surface, followed by an immediate increase of comfort. In a short time afterward this moisture passes into free and copious perspiration; and if the heat or exertion be still kept up, the sweat becomes profuse, and drops from the body or wets the clothes which envelop it. A decrease of animal heat unavoidably accompanies this, because, independently of any vital action contributing to this effect, as is most probable, the mere physical evaporation of so much fluid is itself sufficient to carry off a large quantity of caloric. The curious experiments of Edwards tend to show that evaporation is really the only means required for reducing animal heat to its proper degree; but the results obtained by him require to be confirmed, and the experiments varied and carried farther, before the inquiry can be considered as completed. The sagacity of Franklin led him to the first discovery of the use of perspiration in reducing the heat of the body, and to point out the analogy subsisting between this process and that of the evaporation of water from a rough porous surface, so constantly resorted to in the East and West Indies, and other warm countries, as an efficacious means of reducing the temperature of the air in rooms, and of wine and other drinks, much below that of the surrounding atmosphere. The quantity of fluid evaporated from the skin during profuse sweat so far exceeds that given out during the highest insensible perspiration, that two pounds in weight have been lost by this means in a couple of hours; an amount evidently sufficient to carry off the largest quantity of superfluous animal heat which can ever be present. In the performance of this function, the skin is, indeed, assisted by the exhalation from the lungs; but as both act on the same principle, the explanation is not affected by this circumstance.

In very warm weather, the dog is always seen with the tongue lolling out of his mouth, and copiously

covered with frothy secretion. This is merely another modification of the means used for reducing animal heat. The dog perspires very little from its skin, and the copious exhalation from the mouth is the expedient resorted to by Nature for supplying its place.

Bearing in mind the preceding explanation of the functions of the skin, the reader will peruse with interest the following remarks from Dr. Thomson's work* formerly quoted. "Dr. Davy, in his Travels in Ceylon, states, from his personal observation, that on first landing in a tropical climate, the standard heat of the body of a European is raised two or three degrees, and febrile symptoms occur, which require temperance, the avoiding every cause of excitement of the vascular system, and the use of aperient medicines. All authors, and indeed every observing person, who has visited the torrid zone, agree that with the languor and exhaustion resulting from the high temperature of the atmosphere, there is a greatly increased mobility of the nervous system. *The action of the cutaneous vessels amounts to disease*, and produces that eczematous or vesicular eruption of the skin known by the name of prickly heat, which occurs in Europeans who visit the West Indies on their first landing. On the other hand, this function of the skin is so much weakened, almost paralyzed, when the climate from which a person is passing is dry and bracing, and that into which he has passed is humid and relaxing, that congestions of blood take place in the larger vessels, the body becomes susceptible of the least impression of marshy exhalations, and agues and similar diseases are produced."

We shall now be able to understand why in summer we suffer most from heat in what is called moist close weather, when no air is stirring; and why warm climates, that are at the same time moist, are proverbially the most unwholesome. The chief reason is the diminished evaporation from the skin which such a condition of the atmosphere produces, partially shut-

* P. 66.

ting up the natural outlet of the superfluous heat of the body; and as it at the same time checks the exit of the waste matter which ought to be thrown out, and which is known to be as injurious to the system as an active poison taken into the body from without, the hurtful consequences of such weather and climates, and the fevers, dysenteries, and colds to which they give rise, are partly accounted for. A moist state of the atmosphere is also favourable to *absorption*; and hence, if noxious effluvia are at the time floating in the air, they are more easily received into the system. It is on this account that night air is so unwholesome, particularly in malaria districts, which are loaded with moisture and miasma, or marsh poison; for when the air is dry as well as hot, free evaporation takes place, and absorption is almost null, so that little or no inconvenience is felt, and health often remains uninjured. Delaroche has established this point conclusively by experiment. He exposed animals to a very high temperature in a dry air, and found them to sustain no mischief; but when he exposed them, in an atmosphere saturated with moisture, to a heat only a few degrees above that of their own bodies, and greatly lower than in the former instance, they very soon died. Here we see also the reason why, in ague and other fevers, the suffering, restlessness, and excitement of the hot stage can never be abated till the sweat begins to flow, after which they rapidly subside; and why the remedies which, when given in the hot stage, added to the excitement and distress, may now be productive of the best effects.

The function next to be noticed, viz., *Absorption*, is in some measure the opposite of the last. By its instrumentality, substances placed in contact with the skin are taken up and carried into the general circulation, either to be appropriated to some new purpose or to be thrown out of the body.

In the vaccination of children to protect them from smallpox, we have a familiar example of the process of absorption. A small quantity of cowpox matter is inserted under the cuticle on the surface of the true

skin, and there left. In a short time it is acted upon, and taken into the system by the absorbent vessels. In like manner, mercurial preparations, rubbed on the skin for the cure of liver complaint, are absorbed, and affect the constitution precisely as when received into the stomach. Many even of the common laxatives, such as rhubarb and croton oil, have of late been successfully administered in the same way, and the rapid absorption of poisons from bites of rabid animals and wounds in dissection, through the same channel, is familiar to every one. It is from the active principle of the Spanish flies used in blisters being taken up by the cutaneous absorbents, that irritation of the kidneys and urinary organs so often attends the employment of that remedy.

The process of absorption is carried on by vessels fitted for the purpose, which are thence named *absorbent vessels*, or simply *absorbents*. In the skin they are so exceedingly small and numerous, that, when injected with mercury, the surface is said by Dr. Gordon to resemble a sheet of silver. In health they are of too small a size to admit the red particles of the blood, and hence, from their contents being nearly transparent, they are sometimes named *lymphatics*.

Some ascribe great importance, and others very little, to cutaneous absorption. In some diseases, such as diabetes, in which, occasionally for weeks in succession, the urinary discharge exceeds, by many ounces daily, the whole quantity of food and drink, without the body losing proportionally in weight, we can account for the system being sustained only by supposing moisture to be extensively absorbed from the air by the skin and lungs. The ancients, indeed, believed that, when food could not be retained in the stomach, a person might be nourished by placing him in a bath of strong soup or milk ; but recent experiments serve to show that, in such circumstances, absorption is too trifling in amount for any such result. Some indeed deny that any absorption would take place at all, because it is observed as a general fact that the body does not gain in weight by immersion

in a warm bath. But the inference is not well founded, for occasionally weight *is* gained; and even when it is not, as much water must have been absorbed as would make up the loss sustained during immersion by perspiration, which is believed to go on more rapidly in warm water than in the open air.

That animals absorb copiously when immersed in water, has been amply proved by Dr. Edwards and other physiologists. Dr. Edwards selected lizards as the subjects of experiment, because he regarded their scaly skins as unfavourable for absorption. After reducing the bulk of a lizard by several days' exposure to a dry air, he immersed its tail and hind legs in water, and found that absorption took place to such an extent as to restore the original plumpness of *all* parts of the body. The same result attended a variety of other trials, so that the fact does not admit of doubt. In man, absorption from the surface is greatly retarded by the intervention of the cuticle; and it is universally admitted that, when this obstacle is removed, the process goes on with great vigour. Thus arsenic applied to cancerous sores, and strong solutions of opium to extensive burns in children, have been absorbed in quantities sufficient to poison the patients. Colic in its severest forms has followed similar external applications of the salts of lead. Mercury, also, in the form of fumigation, has often been used where rapid action was required, because in the state of vapour it is very speedily taken up by the cutaneous absorbents.

It is quite certain, then, that the skin does absorb. The only doubt is as to what extent the cuticle operates in preventing or modifying that action. When friction accompanies the external application, the cuticle, as we see exemplified in the use of mercurial and other liniments, is not an efficient obstacle. But when friction is not resorted to, and the substance applied is of a mild, unirritating nature, such as oil, it may remain in contact with the skin for a long time without being taken into the system in appreciable quantities. If, however, it is irritating, like Spanish

flies, absorption speedily begins, and is carried on through the cuticle, as is proved by the effects produced on the urinary organs.

When the perspiration is brought to the surface of the skin, and confined there either by injudicious clothing or by want of cleanliness, there is much reason to suppose that its residual parts are again absorbed, and act on the system as a poison of greater or less power, according to its quantity and degree of concentration, thereby producing fever, inflammation, and even death itself; for it is established by observation, that concentrated animal effluvia form a very energetic poison. The fatal consequences which have repeatedly followed the use of a close water-proof dress by sportsmen and others, and the heat and uneasy restlessness which speedily ensue where proper ventilation is thus prevented, seem explicable on some such principle.

It is believed by many, that marsh miasmata and other poisons are absorbed by the skin as well as by the lungs, and Bichat considered the fact as established in regard to the effluvia of dissecting-rooms. There are many reasons for concurring in this belief. The plague, for instance, is much more readily communicated by contact than by any other means, and this can happen only through the medium of absorption. Besides, it is observed that those who work with oil, and other greasy substances which obstruct the pores of the skin, often escape the contagion when all around them suffer. Flannel and warm clothing, in like manner, which have been proved to be extremely useful in preserving those who are unavoidably exposed to the action of malaria and of epidemic influences, manifestly act chiefly by protecting the skin. A late writer on the Malaria of Rome strongly advocates this opinion, and expresses his conviction that the ancient Romans suffered less from it, chiefly because they were always enveloped in warm woollen dresses. This opinion, he says, is justified by the observation, that since the period at which the use of woollen clothing came again into vogue, intermittent

fevers have very sensibly diminished in Rome. Even in the warmest weather the shepherds are now clothed in sheepskins. Brocchi, who experimented extensively on the subject, obtained a quantity of putrid matter from the unwholesome air, and came to the conclusion that it penetrated by the pores of the skin rather than by the lungs. Brocchi ascribes the immunity of the sheep and cattle, which pasture night and day in the Campagna, to the protection afforded them by their wool.* These remarks deserve the serious attention of observers; particularly as, according to Patissier, similar means have been found effectual in preserving the health of labourers digging and excavating drains and canals in marshy grounds, where, previously to the employment of these precautions, the mortality from fever was very considerable.

It is a general law, that every organ acts with increased energy when excited by its own stimulus; and the application of this law to the different functions of the skin may help to remove some of our difficulties. The skin exhales most in a warm dry atmosphere, because the latter dissolves and carries off the secretion as fast as it is produced; and the same condition is unfavourable to absorption, because nothing is present upon which the absorbents of the skin can act. In a moist atmosphere, on the other hand, the absorbents meet with their appropriate stimulus, and act powerfully; while exhalation is greatly diminished, because the air can no longer carry off the perspiration so freely. Apparently from this extensive absorption, we find the inhabitants of marshy and humid districts remarkable for the predominance of the lymphatic system, as has long been remarked of the Dutch; and, as malaria prevails chiefly in situations and seasons in which the air is loaded with moisture, and is most energetic at periods when absorption is most active and moisture is at its maximum, the probability of its being received into the system chiefly by cutaneous absorption is greatly in-

* Edin. Phil. Journ., January, 1833.

creased, and the propriety of endeavouring to protect ourselves from its influence by warm woollen clothing becomes more striking. In the army and navy, accordingly, where practical experience is most followed, the utmost attention is now paid to enforcing the use of flannel and sufficient clothing as a protection against fever, dysentery, and other diseases, particularly in unhealthy climates. In the prevention of cholera, flannel was decidedly useful.

From the above exposition of the laws of absorption, and from the facts referred to at page 61, may it not be feasibly inferred, that the efficacy of great heat in preventing contagion from the plague is partly owing to the consequent dryness of the atmosphere no longer presenting the requisite stimulus to the absorbents, but, on the contrary, powerfully exciting the action of the exhalants? Damp directly stimulates the absorbents, and hence may arise its hurtfulness as a vehicle. The system, too, it is well known, is peculiarly susceptible of infection when the stomach has been for some time empty, as before breakfast. May not this be accounted for by the then greater activity of absorption?

From grouping all the constituent parts of the skin into one whole, and perceiving so many operations connected with that tegument, some may be apt to suppose it an exception to the principle laid down, that no single part can execute more than a single direct function. In reality, however, it is only by taking the guidance of this principle that we can extricate ourselves from the apparent confusion. We have already seen that exhalation and absorption are each connected with distinct textures in the skin. On farther examination, we shall find the office of Touch and Sensation intrusted exclusively to another constituent part, *the nervous*; for, in serving as the instrument of feeling, the skin acts in no other way than by affording a suitable surface for the distribution and protection of the nerves which receive and transmit to the brain and mind the impressions made on them

by external bodies. In this respect the skin resembles the other organs of sense, in all of which the nerve is the true instrument of the sense; the eye, the ear, the nose, and the skin, being simply structures fitted to bring the nerve into relation with the qualities of colour, sound, smell, roughness, and smoothness, by which they are respectively affected; and they differ from each other, because sound differs from colour, colour from smell, and smell from roughness or smoothness; and because sound or colour can be taken cognizance of by its own nerve, only when the latter is provided with an apparatus fit to be acted upon by the vibrations of the air or by the rays of light. In every instance, it is the external object acting upon a *nerve* which gives rise to the impression received from the organs of sense.

Every part of the skin, however remote, is provided with filaments from the nerves of sensation, in order that we may become immediately sensible of the presence and action of external bodies. If any part were destitute of this property, its texture and vitality might be destroyed without our being conscious of the fact; whereas, in consequence of this provision of sensitive nerves, no object can touch the skin without our being instantly made aware of its presence and properties. A case described by Dr. Yelloly, in the third volume of the Medico-Chirurgical Transactions, illustrates in a striking manner the great utility of these nerves in warning us of danger. "The patient's hands," says Dr. Yelloly, "up to the wrists, and the feet half way up the legs, are perfectly insensible to any species of injury, as cutting, pinching, scratching, or burning. . . *He accidentally put one of his feet, some time ago, into boiling water, but was no otherwise aware of the high temperature than by finding the whole surface a complete blister on removing it.*"

While, however, sensation is common to the whole surface of the body, there are parts of the skin more immediately destined by Nature for the exercise of Touch, and for the better appreciation of all the qualities of which it is cognizant. Such are the hands and

tongue in man, the proboscis in the elephant, the tail in some of the monkey tribes, and the tentacula in fishes. Now, in accordance with the explanation given of the dependance of sensation upon nervous endowment, it is remarkable that all the parts destined for this special exercise of touch receive the most abundant supply of sensitive nerves. Thus the nerves going to the hand and arm, the most perfect instruments of touch and sensation in man, are at their dorsal roots five times larger than those which are destined for its motion; and, in like manner, the nerve supplying the tactile extremity of the proboscis of the elephant exceeds in size the united volume of all its muscular nerves. On the other hand, in animals covered with hair or feathers, whose touch and sensation are comparatively defective, the muscular nerves far exceed in size those of sensation; and wherever Nature has endowed any particular part with high sensitive powers, she is invariably found to have distributed to that part, and to it alone, a proportionally higher nervous endowment. In man, the innumerable nervous papillæ destined for the exercise of touch may be distinctly seen in parallel irregular rows on the fingers and palm of the hand, and everybody knows how acute the sense is in these parts. In fishes, on the other hand, no nervous papillæ can be detected on the surface of the skin; but many of them have tentacula or projections generally about the mouth, for the special purpose of exercising touch, and these are always plentifully supplied with branches from the fifth pair of nerves.

The nervous tissue of the skin is thus not only an important instrument for receiving and conveying to the mind accurate impressions in regard to the properties of external objects, but it is even essential to our continued existence. The pain which is caused by injuries is no doubt very disagreeable, but in its uses it is a positive blessing, in warning us against the danger, and even certain destruction, which would speedily overtake us if we had no such monitor at hand. If we had no nerves on the surface to com-

municate to us a lively impression of cold, we might inadvertently remain inactive in a temperature which would not only suspend perspiration, but benumb the powers of life; or we might, as we have already seen, approach so near the fire or boiling fluids, as to have the organization destroyed before we knew: whereas, by the kind interposition of the nerves, we cannot, when perspiring freely, be exposed to the cold air without an unpleasant sensation being experienced, impelling us to attend to our safety, and to keep up our heat either by additional clothing or by active exercise. When both the nervous and the vascular parts of the skin are in healthy action, a pleasant soft warmth is felt over the body, which is in itself a delight, and which gives to the mind a lightness and hilarity, or pleasant consciousness of active existence, the very opposite of the low and languid depression which so generally accompanies continued defective action in the skin, and which forms a marked feature in many nervous affections.

For the due exercise of sensation, the nerves must be in a proper state of health. If, for example, the cuticle protecting the nervous papillæ be abraded or removed by vesication, the naked nerves are too powerfully stimulated by the contact of external bodies, and, instead of receiving and transmitting the usual impressions of heat, cold, and configuration, they communicate scarcely any feeling except that of pain; while, if the cuticle become thickened by hard labour, the impression made on the nerves is proportionally lessened, and little information is conveyed by them to the mind.

A due supply of arterial blood is another requisite for the action of the nerves of sensation. If they be deprived of this, as by exposing the body to a degree of cold sufficient to drive the blood from the surface, the nerves become almost insensible, and severe wounds may be received in this state without the individual being conscious of the accident, or feeling the slightest pain. For the same reason, severe cold, after a certain time, ceases to be painful, and death

ensues like deep sleep and without suffering. But when a frozen limb is thawed, and the returning circulation begins to set the nerves in action, suffering forthwith commences, and the overaction is in danger of leading to inflammation. The same phenomena, in an inferior degree, must be familiar to every one, in the prickling and tingling so commonly complained of on heating cold hands or feet too rapidly at a good fire; symptoms which arise from the return of the blood stimulating the nerves to undue action.

It is the nervous tissue of the skin which takes cognizance of the temperature of the bodies by which we are surrounded, and imparts to the mind the sensation of warmth and coldness. In the healthy state, the sensation is a correct index of the real temperature; but in disease, we often complain of cold and shivering when the skin is positively warmer than natural. In this way, people whose digestion is weak and circulation feeble, complain habitually of cold and of cold feet, where others, differently constituted, experience no such sensations. Exercise dissipates this feeling and increases heat, by exciting the circulation of the blood, throwing more of it to the surface, and thereby increasing the action of the cutaneous vessels and nerves.

Some mental emotions operate upon the skin, and impair its functions much in the same way as cold. Grief, fear, and the depressing passions, by diminishing the afflux of arterial blood, render the skin pale, and, at the same time, diminish perspiration and nervous action; while rage and other violent passions, by augmenting the afflux of blood, elevate the temperature of the surface, and give rise to the red flush, fulness, and tension so characteristic of excitement. Sometimes, indeed, the effect of mental emotions on the skin is so great as to induce disease. In speaking of impetigo, Dr. Bateman alludes to two gentlemen in whom the eruption arose from "great alarm and agitation of mind;" and adds, that he "witnessed some time ago the extraordinary influence of mental alarm on the cutaneous circulation, in a poor woman

who became a patient of the Public Dispensary. A sudden universal anasarca (dropsy under the skin) followed, *in one night*, the shock occasioned by the loss of a small sum of money, which was all she possessed."* Facts like these establish a connexion between the brain and nervous system and the skin, which it is important not to overlook.

The reverse influence, which the condition of the nervous matter distributed over the surface of the body exerts on the rest of the system, is also well known, and is exemplified in the effects of exposure to intense cold. The first sensation of chill excited in the nerves of the skin is quickly succeeded by that of numbness and insensibility; and if the exposure be continued, the impression is speedily communicated to the brain, and confusion of mind, followed ultimately by the extinction of life, comes on. When, on the other hand, as in tropical climates, the surface is relaxed by excessive heat, the brain speedily participates in the relaxation, and the mind is unfitted for sustained or vigorous action.

Invalids and literary men often suffer severely from excess of action in the brain, and deficiency of activity in the nerves of the skin and remoter organs. The nervous stimulus, which is essential to digestion and to the health and warmth of the skin, cannot be provided when the brain is too exclusively exercised in thinking or feeling; and for want of this stimulus, the tone of the digestive and cutaneous organs is greatly reduced; the surface of the body becomes cold, shrunk, and uncomfortable; and the individual is subject to annoyance and painful sensations from trifles which formerly gave pleasure. Bad digestion and deficient warmth of surface are thus proverbially complained of among literary and sedentary persons, and can be removed only by exciting the nervous and vascular functions of the skin, and diminishing those of the brain.

Such are the direct and important uses of the skin.

* Bateman on Cutaneous Diseases, p. 150.

But in addition to the parts already noticed, there are numerous small follicles or glands contained in its substance, more abundant where hairs are implanted, and in the vicinity of the orifices of natural canals, than in other regions, but existing in all parts except the palms of the hands and soles of the feet. They are about the size of a millet seed, and the skin which contains them is thin, reflected on itself, and very vascular. Their cavities are filled with an oily humour, and each opens by an orifice at the external surface of the skin. It is this oily matter which prevents water from penetrating easily and relaxing the cuticle, and the absence of which, when it has been removed by the soda used in washing clothes, allows the skin of the hands and fingers to assume that wrinkled and shrivelled appearance common among washerwomen.

CHAPTER III.

HEALTH OF THE SKIN, AND ITS INFLUENCE ON THE GENERAL SYSTEM.

Mortality in Infancy from Cold.—Animal Heat lowest at that Age.—Too little and too much Clothing equally bad.—Rules for Dress.—Advantages of Flannel in preventing Disease.—Ventilation of Beds and Clothing.—Influence of Light.—Importance of Ablution and Bathing.—Cold, Tepid, and Warm Bath.—Sponging with diluted Vinegar.—Friction of the Skin.—Vapour Bath and Warm Bath useful in preventing and curing Nervous Diseases and liability to Cold.—Sailing and Riding useful by acting on the Skin.

As it is only in its useful applications to the improvement and happiness of man that knowledge truly becomes power, I proceed, in accordance with this principle, to point out some of the advantages derivable from the information which I have attempted to communicate.

It appears from the London Bills of Mortality, that between a fourth and a fifth of all the infants baptized die within the first two years of their existence. This extraordinary result is not a part of the Creator's designs; it does not occur in the lower animals, and must have causes capable of removal. One of these, to speak only of what relates to the present inquiry, is unquestionably the inadequate protection afforded, especially among the poorer classes, to the newborn infant, against the effects of the great and sudden transition which it makes in passing at once from a high and almost unvarying temperature in the mother's womb, to one greatly inferior and constantly liable to change. At birth the skin is delicate, extremely vascular, and highly susceptible of impressions, so much so that cases have occurred in which a leech bite has caused a fatal hemorrhage. The circulation

is, in fact, cutaneous; for the lungs, the stomach, the liver, and the kidneys, are as yet newly brought into activity, and feeble in their functions. If the infant, then, be rashly exposed to a cold atmosphere, the mass of blood previously circulating on the surface of the body is immediately driven inward by the contraction of the cutaneous vessels, and, by over stimulating the internal organs, gives rise to bowel complaints, inflammation, croup, or convulsions, which sooner or later extinguish life. This shows the inexpressible folly of those who bathe infants daily in cold water, even in winter, and freely expose them to the open air, or to currents from open doors or windows, with a view to harden their constitutions; since it is quite certain that no more effectual means could be resorted to, in the earlier months of life, to undermine the general health, and entail future disease on the unhappy subjects of the experiment.

This hurtful practice has perhaps arisen in some degree from the prevalent error of supposing that infants have naturally a great power of generating heat and resisting cold. That the very opposite is the fact, has been established by the experiments of Dr. Milne Edwards, which show that "the power of producing heat in warm-blooded animals is *at its minimum at birth, and increases successively to adult age*;" and that young animals, instead of being warmer than adults, are generally a degree or two colder, and part with their heat more readily. In ten healthy infants, from two hours to a few days old, the mean temperature was observed by Dr. Edwards to be only 94.55° Fahr., that of adults being 97° or 98°; and in a seven months' child, three hours after birth, he found the temperature so low as 89.6°, although the child was well clothed and near a good fire. That exposure to cold is really so injurious to infancy, is unhappily proved by a multitude of facts. In France, as already alluded to in the first chapter, it is the custom to carry every infant, within the first few days of its existence, to the office of the *Maire*, that its birth may be registered. Suspecting that the exposure consequent upon

such a practice must be pernicious to health, especially in winter, and where the distance is great, Dr. Edwards was induced to consult the returns made to the Minister of the Interior, from which he found that the proportion of deaths within a very limited period after birth was much greater in winter than in summer, and in the northern than in the southern departments; and on farther inquiry, he discovered that the mortality was greater in parishes where the inhabitants were scattered at a distance from the Maire, than where they were congregated near him: so that the number of deaths in infancy seemed to be influenced by the degree and duration of the exposure to the cold air. What more striking proof than this can be required of the evils arising from the ignorance of legislators in regard to the constitution of the human body? No man who understood physiology could ever have sanctioned a law, the practical effect of which is to consign annually so many victims to an untimely grave.

Many parents, from over-anxiety to avoid one form of evil, run blindfold into another scarcely less pernicious, and not only envelop infants in innumerable folds of warm clothing, but keep them confined to very hot and close rooms. It would be well for them to recollect, however, that extremes are always hurtful, and that the constitution may be enfeebled, and disease induced, by too much heat and clothing, and too close an atmosphere, as effectually as by cold and currents of air. The skin, thus opened and relaxed, perspires too easily, and is readily affected by the slightest variations of temperature, whence arise colds and other ailments, which it is their chief intention to guard against; and the internal organs, being at the same time deprived of their fair proportion of blood, become enfeebled, and afford inadequate nourishment and support to the rest of the body.

The insensible perspiration being composed of a large quantity of water, which passes off in the form of invisible vapour, and of various salts and animal matter, a portion of which remains adherent to the

skin, the removal of this residue by washing becomes an indispensable condition of health, the observance of which, particularly in early life, when waste and nutrition are both very active, prevents the appearance of cutaneous and other diseases common in infancy. Not only, therefore, is daily washing of the body required at that age, but a frequent change of clothing is essential, and everything in the shape of dress ought to be loose and easy, both to allow free circulation through the vessels, and to permit the insensible perspiration to have a free exit, instead of being confined to and absorbed by the clothes, and held in contact with the skin, as often happens, till it gives rise to irritation.

In youth, the skin is still delicate in texture, and the seat of extensive exhalation and acute sensation; but it is, at the same time, more vigorous in constitution than it was during infancy; and the several animal fuctions being now more equally balanced, it is less susceptible of disorder from external causes, and can endure with impunity changes of temperature which, at either an earlier or a more advanced age, would have proved highly injurious. The activity and restless energy of youth keep up a free and equal circulation even in the remotest parts of the body, and this free circulation in its turn maintains an equality of temperature in them all. *Cold* bathing and lighter clothing may now be resorted to with a rational prospect of advantage; *but when, from a weak constitution or unusual susceptibility, the skin is not endowed with sufficient vitality to originate the necessary reaction, which alone renders these safe and proper—when they produce an abiding sense of chillness, however slight in degree—we may rest assured that mischief will inevitably follow at a greater or shorter distance of time.* Many young persons of both sexes are in the habit of going about in winter and in cold weather with a dress light and airy enough for a northern summer, and they think it manly and becoming to do so; but those who are not very strongly constituted suffer a severe penalty for their folly. The necessary effect of deficient

circulation and vitality in the skin is, as we formerly saw, to throw a disproportionate mass of blood inward; and when this condition exists, insufficient clothing perpetuates the evil, until internal disease is generated, and health irrecoverably lost. Insufficient clothing not only exposes the wearer to all the risk of sudden changes of temperature, but it is still more dangerous (because in a degree less marked, and therefore less apt to excite attention till the evil be incurred) in that form which, while it is warm enough to guard the body against extreme cold, is inadequate to preserve the skin at its natural heat. Many youths, particularly females, and those whose occupations are sedentary, pass days, and weeks, and months without ever experiencing the pleasing glow and warmth of a healthy skin, and are habitually complaining of chillness of the surface, cold feet, and other symptoms of deficient cutaneous circulation. Their suffering, unfortunately, does not stop here, for the unequal distribution of the blood oppresses the internal organs, and too often, by insensible degrees, lays the foundation of tubercles in the lungs, and other maladies which show themselves only when arrived at an incurable stage. Young persons of a consumptive habit will generally be found to complain of this increased sensibility to cold, even before they become subject to those slight catarrhal attacks which are so often the immediate precursors, or, rather, the first stages of pulmonary consumption. All who value health, and have common sense and resolution, will therefore take warning from signs like these, and never rest till equilibrium of action be restored. For effecting this purpose, warm clothing, exercise in the open air, sponging with vinegar and water, the warm bath, regular friction with a flesh-brush or hair glove, and great cleanliness, are excellently adapted.

But while sufficiency of clothing is attended to, excessive wrapping up must be as carefully avoided. Great differences in the power of generating heat and resisting cold exists in different individuals, and it would be absurd to apply the same rules to those who

never feel cold, as to those who are peculiarly sensitive. The former may be benefited by cold bathing and degrees of exposure which would be fatal to the latter. The rule is, therefore, not to dress in an invariable way in all cases, but to put on clothing in kind and quantity *sufficient in the individual case to protect the body effectually from an abiding sensation of cold, however slight.* Warmth, however, ought not to be sought for in clothing alone. The Creator has made exercise essential as a means; and if we neglect this, and seek it in clothing alone, we act at the risk, or, rather, with the certainty, of weakening the body, relaxing the surface, and rendering the system extremely susceptible of injury from the slightest accidental exposures, or variations of temperature and moisture. Many good constitutions are thus ruined, and many nervous and pulmonary complaints brought on, to imbitter existence, and to reduce the sufferer to the level of a hothouse plant.

Female dress errs in one important particular, even when unexceptionable in material and quantity. From the tightness with which it is made to fit on the upper part of the body, not only is the insensible perspiration injudiciously and hurtfully confined, but that free play between the dress and the skin, which is so beneficial in gently stimulating the latter by friction at every movement of the body, is altogether prevented, and the action of the cutaneous nerves and vessels, and, consequently, the heat generated, rendered less than that which would result from the same dress more loosely worn. Every part and every function are thus linked so closely with the rest, that we can neither act wrong as regards one organ without all suffering, nor act rightly without all sharing in the benefit.

We can now appreciate the manner in which wet and cold feet are so prolific of internal disease, and the cruelty of fitting up schools and similar places without making adequate provision for the welfare of their young occupants. The circumstances in which wet and cold feet are most apt to cause disease, are

those where the person remains inactive, and where, consequently, there is nothing to counterbalance the unequal flow of blood which then takes place towards the internal parts: for it is well known that a person in ordinary health may walk about or work in the open air with wet feet for hours together without injury, provided he put on dry stockings and shoes immediately on coming home. It is, therefore, not the mere state of wetness that causes the evil, but the check to perspiration and the unequal distribution of blood to which the accompanying coldness gives rise. I am acquainted with an instance in which a robust and healthy tradesman, by incautiously standing in the sea, when in a state of profuse perspiration, for five minutes, in repairing a steamboat, brought on severe constitutional disturbance, followed by pulmonary disease, which confined him to the house during the whole of *four* winters. Nineteen years have now elapsed since the cause was applied; but although his health is gradually improving, he still suffers from cough and breathlessness, and is very susceptible of cold and illness from every trifling exposure. This person instantly shifted himself on coming out of the water, which at the time he had been led to believe was a sufficient precaution. But had he known something of his bodily constitution, he would have seen the danger before he exposed himself to it, and would have escaped the heavy penalty which his ignorance brought upon him.

The advantages of wearing flannel next the skin are easily explicable on the principles expounded above. Being a bad conductor of heat, flannel prevents that of the animal economy from being quickly dissipated, and protects the body in a considerable degree from the injurious influence of sudden external changes. From its presenting a rough and uneven, though soft surface to the skin, every movement of the body in labour or in exercise gives, by the consequent friction, a gentle stimulus to the cutaneous vessels and nerves, which assists their action, and maintains their functions in health: and being, at the same time, of a

loose and porous texture, flannel is capable of absorbing the cutaneous exhalations to a larger extent than any other material in common use. In some delicate constitutions, it proves even too irritating to the skin, and in hot climates sometimes excites too great a flow of perspiration. In the former case, fine fleecy hosiery, and in the latter cotton, will in general be easily endured, and will greatly conduce to the preservation of health. Many are in the custom of waiting till winter has fairly set in before beginning to wear flannel. This is a great error in a variable climate like ours, especially when the constitution is not robust. *It is during the sudden changes from heat to cold, which are so common in autumn, before the frame has got inured to the reduction of temperature, that protection is most wanted and flannel is most useful.*

The advantages of flannel as a preservative from disease, in warm as well as in cold climates, are now so well understood, that in the army and navy its use is cogently, and with great propriety, insisted on. Sir George Ballingal, in his valuable *Lectures on Military Surgery* (p. 92), has some very judicious remarks on the influence of warm clothing in preserving the health of soldiers. After adducing the testimony of Sir James Macgrigor, to show that in the Peninsula the best clothed regiments were generally the most healthy, Sir George mentions that, when in India, he had himself a striking proof of the utility of flannel in checking the progress of a most aggravated form of dysentery in the second battalion of the Royals. Captain Murray also, late of H. M. S. Valorous, told me that he was so strongly impressed from former experience with a sense of the efficacy of the protection afforded by the constant use of flannel next the skin, that when, on his arrival in England in December, 1823, after two years' service amid the icebergs on the coast of Labrador, the ship was ordered to sail immediately for the West Indies, he directed the purser to draw two extra flannel shirts and pairs of drawers for each man, and instituted a regular daily inspection to see that they were worn. These precau-

tions were followed by the happiest result. He proceeded to his station with a crew of 150 men; visited almost every island in the West Indies, and many of the ports in the Gulf of Mexico; and, notwithstanding the sudden transition from extreme climates, returned to England without the loss of a single man, or having any sick on board on his arrival. It would be going too far to ascribe this excellent state of health solely to the use of flannel; but there can be little doubt that this was an important element in Captain Murray's success. Far, however, from trusting to it alone, Captain Murray was as careful in guarding against other sources of disease as against variations in temperature; and with this view every precaution was at the same time used, by lighting stoves between decks and scrubbing with hot sand, to ensure the most thorough dryness, and proper means were put in practice to promote cheerfulness among the men. When in command of the Recruit gun-brig, which lay about nine weeks at Vera Cruz, the same means preserved the health of his crew, when the other ships of war anchored around him lost from twenty to fifty men each.

That the superior health enjoyed by the crew of the Valorous was attributable chiefly to the means employed by their humane and intelligent commander, is shown by the analogy of the Recruit; for although constant communication was kept up between this vessel and the ships in which sickness prevailed, and all were exposed to the same external causes of disease, yet no case of sickness occurred on board of it. Facts like these are truly instructive, by proving that man possesses much power of protecting himself from injury when he has received the necessary instruction, and chooses to adapt his conduct to circumstances.

The exhalation from the skin being so constant and extensive, the bad effects of it, when confined, suggest another rule of conduct, viz., that of frequently changing and airing the clothes, so as to free them from every impurity. In the case of flannel, for example,

which imbibes perspiration very readily, it is an excellent plan, instead of wearing the same for several successive days, either to change it frequently, or to make use of two sets of flannel, each being worn and aired by turns on every alternate day. A frequent change, however, is certainly the preferable practice. For the same reason, a practice common in Italy merits universal adoption. Instead of beds being made up in the morning the moment they are vacated, and while still saturated with the nocturnal exhalations, which, before morning, even become sensible to smell in a bedroom, the bedclothes are thrown over the backs of chairs, the mattresses shaken up, and the window thrown open for the greater part of the day, so as to secure a thorough and cleansing ventilation. This practice, so consonant to reason, imparts a freshness which is peculiarly grateful and conducive to sleep, and its real value may be inferred from the well-known fact that the opposite practice, carried to an extreme—as in the dwellings of the poor, where three or four beds are often huddled up with all their impurities in a small room—is a fruitful source of fever and bad health, even where there is no deficiency of nourishment or of ventilation during the day. In the abodes of the poor Irish residing in Edinburgh, I have seen bedding for fourteen persons spread over one floor not exceeding twelve feet square: when morning came, the beds were huddled above one another to make sitting room during the day, and at night were again laid down, charged with accumulated exhalations. If fever were not to appear in such circumstances, it would be indeed marvellous; and we ought to learn from this, that if the extreme be so injurious, the lesser degree implied in the prevalent practice cannot be wholesome, and ought, therefore, not to be retained when it can be so easily done away with.

The salutary influence of the solar light as a stimulus to the skin has been much overlooked, and yet it must be obvious to every one after a moment's reflection. Those who live in mines or dark caves, and

who are rarely exposed to the light of day, present a pale, relaxed sallowness of skin, which contrasts with the ruddy freshness of country people and others living much in the open air. The inhabitants of towns may be known by the light colour and delicacy of skin which confinement induces. Part of the effect is owing, no doubt, to the agency of the external air, in the constitution of which the skin seems to produce changes analogous to those which take place in the lungs during respiration; but much is also attributable to deprivation of the stimulus of light. Even vegetables become pale, watery, and feeble in the dark; and, in like manner, men who work during the night and sleep during the day never present the vigorous look of health which distinguishes well-fed day labourers. The squalid paleness and depression of the poor population resident in the dark lanes of large and crowded cities, show the necessity of consulting the wants of nature more than is generally done when erecting new streets and manufactories, and providing playground for the young.

When the saline and animal elements left by the perspiration are not duly removed by washing or bathing, they at last obstruct the pores and irritate the skin. And it is apparently for this reason that, in the eastern and warmer countries, where perspiration is very copious, ablution and bathing have assumed the rank and importance of religious observances. Those who are in the habit of using the fleshbrush daily, are at first surprised at the quantity of white dry scurf which it brings off; and those who take a warm bath for half an hour at long intervals, cannot have failed to notice the great amount of impurities which it removes, and the grateful feeling of comfort which its use imparts. The warm, tepid, cold, or shower bath, as a means of preserving health, ought to be in as common use as a change of apparel, for it is equally a measure of necessary cleanliness. Many, no doubt, neglect this, and enjoy health notwithstanding; but many, very many, suffer from its omission, and even the former would be benefited by employing it. The

perception of this truth is gradually extending, and baths are now to be found in fifty places for one in which they could be obtained twenty years ago. Even yet, however, we are far behind our Continental neighbours in this respect. They justly consider the bath as a necessary of life, while we still regard it as a luxury. I believe that I am within the truth when I say, that in one hospital in Paris, a greater number of baths have been administered to the poor during the last year, than to the whole working population of Great Britain during the last ten years.

When we consider the importance of the exhaling functions performed by the skin, the extent to which ablution and bathing of every description are neglected in charitable institutions, in seminaries for the young, and even by many persons who consider themselves as patterns of cleanliness, is almost incredible. Mr. Stuart, in speaking of the North Americans, remarks, that "the practice of travellers washing at the doors, or in the porticoes or stoops, or at the wells of taverns and hotels once a day, is most prejudicial to health; the ablution of the body, which ought never to be neglected, *at least twice a day* in a hot climate, being altogether inconsistent with it. In fact," he adds, "I have found it more difficult, in travelling in the United States, to procure a liberal supply of water at all times of the day and night in my bedchamber, than to obtain any other necessary. *A supply for washing the face and hands once a day seems all that is thought requisite.*"* But bad as this is, I fear that numbers of sensible people may be found much nearer home, who limit their ablutions to the *visible* parts of their persons, and would even express surprise if told that more than this is necessary to health. Certain it is, that many never wash their bodies unless they happen to be at seabathing quarters in summer, or are oppressed with heat, when they will resort to bathing as a means of comfort, but without thinking at all of its efficacy as a means of cleanliness in pre-

* Three Years in America, vol. ii., p. 440.

serving health. In many public charities and schools, in like manner, bathing or ablution is never thought of as a proper or practicable thing, except for the sick; and yet it is obviously of great importance to every one, especially to the young.*

For *general* use, the tepid or warm bath seems to me much more suitable than the cold bath, especially in winter, and for those who are not robust and full of animal heat. Where the constitution is not sufficiently vigorous to secure reaction after the cold bath, as indicated by a warm glow over the surface, its use inevitably does harm. A vast number of persons are in this condition; while, on the contrary, there are few indeed who do not derive evident advantage from the regular use of the tepid bath, and still fewer who are hurt by it.

Where the health is good and the bodily powers are sufficiently vigorous, the cold bath during summer, and the shower bath in winter, may serve every purpose required from them. But it should never be forgotten, that they are too powerful in their agency to be used with safety by *every one*, especially in cold weather. In proportion as cold bathing is influential in the restoration of health when judiciously used, it is hurtful when resorted to without discrimination: and invalids, therefore, ought never to have recourse to it without the sanction of their professional advisers.

Even where cold bathing is likely to be of service when judiciously employed, much mischief often results from prolonging the immersion too long, or from

* While revising these pages, a friend has mentioned to me a case strikingly illustrative of the necessity of attending to the condition of the skin, and of the sympathy subsisting between it and the bowels. A lady, who is in other respects very cleanly in her habits, has never been accustomed to the use of the bath or to general ablution of any kind, and, in consequence, the action of the skin is very imperfect. As a substitute, however, for its exhalation, she has all her life been affected with *bowel complaint*, which no treatment directed to the bowels has been able to remove. It is probable that the natural course of the exhalation could not now be restored.

resorting to it when the vital powers are too languid to admit of the necessary reaction—before breakfast, for example, or after fatigue. For this reason, many persons derive much benefit from bathing early in the forenoon, who, when they bathe in the morning before taking any sustenance, do not speedily recover their natural heat and elasticity of feeling.

For those who are not robust, daily sponging of the body with cold water and vinegar, or with salt water, is the best substitute for the cold bath, and may be resorted to with safety and advantage in most states of the system; especially when care is taken to excite in the surface, by subsequent friction with the fleshbrush or hair-glove, the healthy glow of reaction. It then becomes an excellent preservative from the effects of changeable weather. When, however, a continued sensation of coldness or chill is perceptible over the body, sponging ought not to be persisted in: dry friction, aided by the tepid bath, is then greatly preferable, and often proves highly serviceable in keeping up the due action of the skin.

For habitual use, the tepid or warm bath is certainly the safest and most valuable, especially during the autumn, winter, and spring, and for invalids. A temperature ranging from 85° to 98°, according to the state of the individual, is the most suitable; and the duration of the immersion may vary from fifteen minutes to an hour or more, according to circumstances. As a general rule, the water ought simply to be warm enough to feel pleasant without giving a positive sensation of heat; the degree at which this happens varies considerably, according to the constitution and to the state of health at the time. Sometimes, when the generation of animal heat is great, a bath at 95° will be felt disagreeably warm and relaxing; while, at another time, when the animal heat is produced in deficient quantity, the same temperature will cause a chilly sensation. The rule, then, is to avoid equally the positive impressions of heat and of cold, and to seek the agreeable medium. A bath of the latter description is the reverse of relaxing; it gives a cheer-

ful tone and activity to all the functions, and may be used every day, or on alternate days, for fifteen or twenty minutes, with much advantage.

A person of sound health and strength may take a bath at any time, except immediately after meals. But the *best* time for valetudinarians is in the forenoon or evening, two or three hours after a moderate meal, when the system is invigorated by food, but not oppressed by the labour of digestion. When the bath is delayed till five or six hours after eating, delicate people sometimes become faint under its operation, and, from the absence of reaction, are rather weakened by the relaxation it then induces. As a general rule, active exertion ought to be avoided for an hour or two after using the warm or tepid bath; and, unless we wish to induce perspiration, it ought not to be taken immediately before going to bed; or, if it is, it ought to be merely tepid, and not of too long duration.

These rules apply, of course, only to persons in an ordinary state of health. If organic disease, headache, feverishness, constipation, or other ailment exist, bathing ought never to be employed without medical advice. When the stomach is disordered by bile, it also generally disagrees. But that it is a safe and valuable preservative of health in ordinary circumstances, and an active remedy in disease, is most certain. Instead of being dangerous by causing liability to cold, it is, when well managed, so much the reverse, that the author of these pages has used it much and successfully for the express purpose of diminishing such liability, both in himself and in others in whom the chest is delicate. In his own instance, in particular, he is conscious of having derived much advantage from its regular employment, especially in the colder months of the year, during which he has uniformly found himself most effectually strengthened against the impression of cold, by repeating the bath at shorter intervals than usual.*

* I am delighted to find my opinion of the value of the bath, in the prevention of pulmonary disease, and indeed the whole prac-

In many manufactories where warm water is always obtainable, it would be of very great advantage to have a few baths erected for the use of the operatives. Not only would these be useful in promoting health and cleanliness, but they would, by their refreshing and soothing influence, diminish the craving for stimulus which leads so many to the ginshop; and, at the same time, calm the irritability of mind so apt to be induced by excessive labour. Where the trade is dirty, as many trades necessarily are, it is needless to say how conducive to health and comfort a tepid bath would be on quitting it for the day.*

On the Continent, the vapour and hot air baths are had recourse to, both as a means of health and in the cure of disease, to a vastly greater extent than they are in this country. Their use is attended by the very best effects, particularly in chronic ailments, and where the water-bath is felt to be oppressive by its weight; and there can be no question that their action is chiefly on the skin, and, through its medium, on the nervous system. As a means of determining the blood to the surface, promoting cutaneous exhalation, and equalizing the circulation, they are second to no remedy now in use; and, consequently, in a variety of affections which the encouragement of these processess is calculated to relieve, they may be employed with every prospect of advantage. The prevalent fear of catching cold, which deters many from using

tical doctrines of the present chapter, corroborated by the authority of Dr. James Clark, in his admirable work on Consumption and Scrofula; a work well deserving the attention of parents and others interested in the health of the young, and especially of those who are delicately constituted.

* Since the publication of the third edition in February, 1835, I have heard with great satisfaction that the above recommendation has been acted upon in several manufactories, in which the waste warm water from the steam engine is made use of at a very trifling expense. At the Caledonian Pottery in Glasgow, the Messrs. Murray have fitted up comfortable baths, to which the whole of their work-people, with their wives and families, amounting in all to several hundred, have weekly access. I trust that, ere long, their excellent example will be extensively followed.

the vapour-bath, even more than from warm bathing, is founded on a false analogy between its effects and those of profuse perspiration from exercise or illness. The latter weakens the body, and, by diminishing the power of reaction, renders it susceptible of injury from sudden changes of temperature. But the effect of the vapour-bath, properly administered, is very different. When not too warm or too long continued, it increases instead of exhausting the strength, and by exciting the vital action of the skin, gives rise to a power of reaction which enables it to resist cold better than before. This I have heard many patients remark; and the fact is well exemplified in Russia and the north of Europe, where, in the depth of winter, it is not uncommon for the natives to rush out of a vapour-bath and roll themselves in the snow, and be refreshed by doing so; whereas, were they to attempt such a practice after severe perspiration from exercise, they would inevitably suffer. It is the previous stimulus given to the skin by the vapour-bath which is the real safeguard against the coldness of the snow.

Common experience affords another illustration of the same principle. If, in a cold winter day, we chance to sit for some time in a room imperfectly warmed, and feel, in consequence, a sensation of chillness over the body, we are much more likely to catch cold on going out than if we had been sitting in a room comfortably warm. In the latter case, the cutaneous circulation and nervous action go on vigorously; heat is freely generated, and the vital action of the skin is in its full force. The change to a lower temperature, if accompanied with exercise to keep up vitality, is then felt to be bracing and stimulating rather than disagreeable. But it is widely different when the surface is already chilled before going out. The vitality of the skin being diminished, reaction cannot follow additional exposure; the circulation leaves the surface and becomes still more internal; and if weakness exist in the throat or chest, cold is the almost certain result. Many suffer from ignorance of this principle.

The vapour-bath is thus calculated to be extensively useful, both as a preservative and as a remedial agent. Many a cold and many a rheumatic attack arising from checked perspiration or long exposure to the weather, might be nipped in the bud by its timely use. In chronic affections, not only of the skin itself, but of the internal organs, with which the skin most closely sympathizes, as the stomach and intestines, the judicious application of the vapour-bath is productive of great relief. Even in chronic pulmonary complaints, it is, according to the Continental physicians, not only safe, but very serviceable, particularly in those affections of the mucous membrane which resemble consumption in so many of their symptoms. Like all powerful remedies, however, the vapour-bath must be administered with proper regard to the condition and circumstances of the individual; and care must be taken to have the feet sufficiently warm during its use. If, from an irregular distribution of the steam, the feet be left cold, headache and flushing are almost sure to follow.

It happens occasionally, either from some peculiarity of constitution, or from some unusual condition of the skin, indicated by great dryness and a liability to erysipelatous and scaly eruptions, that the moisture of the water or vapour-bath is at first rather prejudicial and unpleasant, and becomes grateful only in proportion as the skin regains its healthy state. In such cases the warm *air-bath* is said to be remarkably successful, and it is gaining ground very rapidly in the metropolis.

Although the preceding remarks apply specially to the skin considered as an *exhalant*, yet most of them are equally applicable to it when viewed as the seat of an important *nervous* function. For so intimately and beautifully are all the parts of the frame connected with each other, that what is really good for one, rarely if ever fails to be beneficial to the rest. Thus while exercise, adequate clothing, the bath, friction, and cleanliness, are very efficacious in promoting the insensible perspiration and equalizing the circulation,

they are almost equally influential in promoting the vital action of the innumerable nervous filaments ramified on the skin, and the tone of which is as essential as that of the bloodvessels to the proper discharge of the cutaneous functions. In the large and afflicting class of nervous and mental diseases, attention to the skin becomes, therefore, almost a *sine qua non* of successful treatment. As a preservative, too, it is influential. In most nervous ailments, languor and inaction of the skin show themselves simultaneously with the earliest dawn of mental uneasiness, and often attract notice before the morbid feelings of the mind have acquired either permanence or strength. At this early period the use of the bath will frequently prove very efficacious in restoring health.

Many imagine the tepid and warm bath to be weakening, but experience shows that they are so only when abused. When not too warm, and not prolonged beyond 15 or 20 minutes, the tepid bath may be employed daily with advantage and perfect safety by persons in health; while invalids, whose condition requires its use, are often strengthened by a much longer and equally frequent immersion. I have seen it resorted to for an hour daily, for months in succession, by nervous invalids, with much benefit to health and strength; and in France it is employed to a much greater extent. At the vast hospital of Salpétrière at Paris, and also at Charenton, M. Esquirol has for many years directed it to be extensively used for two, three, and even five or six hours a day, and with excellent effect. When I visited the hospital for the insane at Charenton, and M. Esquirol's admirable private asylum at Ivry, in September, 1831, that gentleman spoke to me in very strong terms of the benefits resulting from the practice, and declared that he had ever found it, when used with ordinary prudence, a safe and valuable remedy; and that, in reality, it failed to do good in some cases more from the patient remaining in it too short a time, than from its want of power to relieve.

In the Medico-Chirurgical Review for January and

April, 1833, a very interesting outline is given of an article published in the *Revue Medicale*, illustrative of the efficacy of the tepid bath and the affusion of cooler water on the head during the last few minutes of immersion, in the cure of a variety of nervous and head affections of considerable obstinacy and severity. Dr. Johnson, the editor of the Review, adds his testimony to the success of the practice, and the results obtained agree entirely with my own experience; but, as these papers relate to the treatment of *disease*, it would be out of place to do more here than recommend them to the attention of the professional reader. I may mention, however, that Dr. Recamier frequently orders the bath to be repeated two, three, or even four times in a day. So little reality is there in its supposed debilitating effect.

I notice these facts to show that attention to the health of the skin is really influential in preserving the tone of the nervous system, and in contributing to mental and bodily comfort, and not for the purpose of inducing persons in bad health to have recourse to the bath of their own accord, which they ought never to do, as they may chance to suffer from using it unseasonably. No rules of universal application can be laid down, and this is not the place for a professional disquisition.

If the bath cannot be had at all places, soap and water may be obtained everywhere, and leave no apology for neglecting the skin; or, as already mentioned, if the constitution be delicate, water and vinegar, or water and salt, used daily, form an excellent and safe means of cleansing and gently stimulating the skin: to the invalid they are highly beneficial, when the nature of the indisposition does not render them improper. A rough and rather coarse towel is a very useful auxiliary in such ablutions. Few of those who have steadiness to keep up the action of the skin by the above means, and to avoid strong exciting causes, will ever suffer from colds, sore throats, or similar complaints; while, as a means of restoring health, they are often incalculably serviceable. If one tenth

of the persevering attention and labour bestowed to so much purpose in rubbing down and currying the skins of horses, were bestowed by the human race in keeping themselves in good condition, and a little attention were paid to diet and clothing, colds, nervous diseases, and stomach complaints would cease to form so large an item in the catalogue of human miseries. Man studies the nature of other animals, and adapts his conduct to their constitution; himself alone he continues ignorant of and neglects. He considers himself a being of superior order, and not subject to the laws of organization which regulate the functions of the inferior animals; but this conclusion is the result of ignorance and pride, and not a just inference from the premises on which it is ostensibly founded.

The writer of these remarks has, unfortunately for himself, had extensive experience, in his own person, of the connexion between the state of the skin and the health of the lungs; and can, therefore, speak with some confidence as to the accuracy of his observations, and the benefit to be derived from attending to the condition of the skin in chronic pulmonary complaints. Many affections of a consumptive character are preceded or begin by deficiency of vital action in the skin and extremities, and a consequent feeling of coldness in the feet and on the surface, and susceptibility of catarrhal affections from apparently inadequate causes, often long before any pressing symptom, directly connected with the lungs, occurs to attract notice. In this state, means systematically directed to restoring the cutaneous circulation will frequently be successful in warding off consumption; and, even when the disease is formed, the same means will help to prolong life and relieve suffering, while they will go far to effect a cure in those chronic affections of the bronchial membrane which stimulate consumption, and are sometimes undistinguishable from it, and which, when mismanaged, are equally fatal.

The two remedies which enjoy the oldest and most general reputation in the successful treatment of pul-

monary and consumptive disease, have this quality in common, that both owe much of their influence to their exciting the cutaneous functions and equalizing the circulation. I allude to sailing and riding on horseback. Many authors speak of both in the highest terms, and Sydenham is well known to have considered the latter as almost a specific. Dr. Rush, of Philadelphia, too, extols it with nearly equal force. Of late, a regular course of emetics has been very strongly recommended in the early stages of consumption, and apparently on good grounds. In whooping-cough, chronic catarrh, and other obstinate pulmonary affections, they have also been long in vogue, both with the vulgar and with the profession. So far as my observation goes, all of these remedial means are productive of advantage, chiefly in proportion as they determine the blood to the surface, which squeamishness, seasickness, and riding all do in a powerful manner. Riding seems to have this effect, partly from the bodily exercise giving general vigour to the circulation, and partly from the continued gentle friction between the skin and the clothes stimulating the cutaneous vessels and nerves. This latter effect is of more importance than many believe. Those, accordingly, who are proof against seasickness, derive least benefit from a voyage; while those who suffer under it long, are compensated by the amelioration which it induces in the more serious malady. The writer of these remarks became ill in the month of January, 1820, and soon presented many of the symptoms of pulmonary consumption. In spite of the best advice, he continued losing ground till the month of July, when he went by sea to London, on his way to the south of France; but, finding himself unable for the journey, he was obliged to return from London, also by sea. Being extremely liable to seasickness, he was squeamish or sick during the whole of both voyages; so much so as to be in a state of gentle perspiration for a great part of the time. After this he became sensible, for the first time, of a slight improvement in his health and strength, and of a

diminution of febrile excitement. Some weeks afterward, he embarked for the Mediterranean, and encountered a succession of storms for the first four weeks, two of which were spent, in the month of November, in the Bay of Biscay, in a very heavy sea. For more than three weeks he was generally very sick, and always in a state of nausea; and during the whole time, although his bed was repeatedly partially wetted by salt water, and the weather cold, the flow of blood towards the skin was so powerful as to keep it generally warm, always moist, and often wet with perspiration, forced out by retching and nausea. The result was, that, on entering the Mediterranean at the end of a month, and there meeting fine weather, he found himself, though still more reduced in flesh and very weak, in every other respect decidedly improved; and on his arrival in Italy, at the end of seven weeks, recovery fairly commenced, after about ten months' illness; and, by great care, it went on with little interruption till the summer of 1821, when he returned home.

To carry on what was so well begun, riding on horseback in the country was resorted to, and that exercise was found to excite the skin so beneficially as to keep it always pleasantly warm and generally bedewed with moisture, even to the extremities of the toes; and in proportion to this effect was the advantage derived from it in relieving the chest, increasing the strength, and improving the appetite. A second winter was spent in the south with equal benefit; and in the summer of 1822, riding was resumed at home, and the health continued to improve. The excitement given to the skin by riding was sufficient to keep the feet warm, and to prevent even considerable changes of temperature from being felt, and rain was not more regarded, although special attention was of course paid to taking off damp or wet clothes the moment the ride was at an end. Strength increased so much under this plan, combined with sponging, friction, and other means, that it was persevered in through the very severe winter of 1822-3, with the

best effects. For nine years thereafter the health continued good, under the usual exposure of professional life; but in 1831 it again gave way, and pulmonary symptoms of a suspicious character once more made their appearance. The same system was pursued, and the same results have again followed the invigoration of the cutaneous functions and of the general health, by a sea-voyage, horseback exercise, and the regular use of the bath. These, as formerly, have proved beneficial in proportion to their influence in keeping up warmth and moisture of the surface and extremities.

In thus insisting upon the advantages of maintaining the healthy action of the skin, I must not be supposed to ascribe the whole benefit to that circumstance alone. So beautifully is the animal economy constituted, that, as I have already repeatedly had occasion to observe, it is impossible to use rational means for the invigoration of one organ or function without good being done to all; and so closely are the various parts allied to each other, that, to describe fully the functions and sympathies of any one, we would require to make the circle of the whole. From this appears the fallacy of those who select the derangements of any one organ as the origin and source of all existing diseases. Some functions are no doubt more important, and their disorders exercise a wider influence over the general health, than others; but no one who knows the structure of the human body and the relations of its parts, or has carefully observed the phenomena of disease, can be satisfied with such exclusive reasoning. The stomach, the bowels, the liver, and the nervous system, have each had their patrons, and the derangement of each has been specially held out as the grand fountain of human misery. Each doctrine, too, has been demonstrated, by cases and cures, to be superior to all the rest, and each has proved successful in its turn, where the others had been tried and failed. Far, however, from proving the propriety of exclusiveness in favour of any one organ, such facts, rightly considered, demonstrate the

reverse, and show that successful practice requires views and remedies founded on a careful examination of *every* function; and afford a strong presumption that the man who traces every disease to the liver, the stomach, or the nerves, will be at least as often strikingly wrong as strikingly right.

In saying, therefore, that attention to the state of the skin is influential in preserving and restoring health, I wish to represent it as an important, but by no means exclusive condition, and to ascribe to the means used for invigorating its functions their due share of action upon other organs and functions. Sailing, for example, is useful in pulmonary complaints, not only because its accompanying nausea causes a healthful flow of blood from the internal parts to the surface, but because the gentle and constant exercise occasioned by the movement of the ship is admirably adapted to a debilitated state of the system, when other exercise cannot be taken without hurrying the breathing or inducing fatigue; and because pure, fresh, bracing air is of infinite importance in all, and especially in pulmonary affections. Attention to the skin, therefore, must never be considered for a moment as superseding attention to the other functions. That were a pernicious mistake. It must be regarded as a part only, though an important part, of a rational and consistent treatment; and its efficacy will often depend, in no small degree, on the care which is taken to support its effects by a scrupulous attention to the necessities of the rest of the system.

I have often had occasion to remark the powerful influence which free perspiration from natural causes has in relieving acidity in the stomach and promoting digestion, and the fact that acidity is most prevalent when the skin is most inactive; and have thereby been led to prescribe with advantage the frequent use of the tepid and vapour-bath in calculous and other complaints arising from excess of acid. In accordance with the same principle, Lord Byron is found noting in his journal (28th March, 1814), that after having, when previously very unwell, "sparred with

Jackson *ad sudorem*," he felt "much better in health than for many days;" and remarking, that "the more violent the fatigue, *the better his spirits for the rest of the day*," and this, too, at a time when he was deriving little relief from his favourite remedies, abstinence and soda-water.

These results seem to corroborate the doctrine of M. Donné, that in the healthy state an acid humour is secreted from the whole surface of the skin, while the mucus secreted from the digestive canal is everywhere, except in the stomach, of an alkaline nature. I have often noticed that acidity in the stomach was much relieved by free action of the skin, particularly in gouty habits, after the use of the warm bath. On the other hand, the season of the year at which I have always heard most complaints of acidity was towards the end of autumn, when the colder weather was beginning to diminish perspiration and change the balance of the circulation. These facts, if correctly observed, go far to corroborate the accuracy of M. Donné's views. The subject, however, still remains obscure, but its importance entitles it to the most careful examination.

CHAPTER IV.

NATURE OF THE MUSCULAR SYSTEM.

Muscles.—Their Structure, Attachment, and Conditions of Action.—Necessity of Arterial Blood and of Nervous Influence.—Muscles Act by alternate Contraction and Relaxation.—Fatigue consequent on continuing the same Attitude explained.—Injuries of Spine from neglect of this Law, and from Sedentary Occupations in Schools.—The Mind ought to be engaged in Exercise as well as the Body.—Superiority of cheerful Play and amusing Games.—A dull Walk the least useful Exercise.—Influence of mental Stimulus illustrated by Examples.—Exercise to be proportioned to Strength.—Laws of Strength.

HAVING examined the nature and uses of the skin, we may next proceed to consider the important system of organs lying almost immediately under it, viz., the MUSCLES, which, although in constant activity during our waking hours, and of indispensable necessity to man in every movement which he makes, are perhaps less familiarly known than almost any other part of the body. As the study of the muscular system involves an exposition of the principles which ought to regulate exercise, it can scarcely fail to excite the attention of the general reader, and especially of those who, as parents or teachers, are interested in the education of the young.

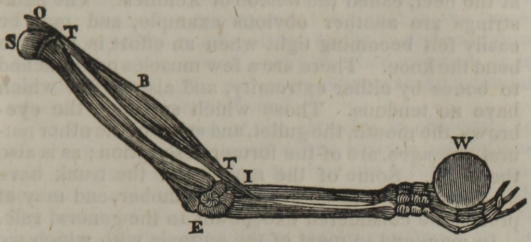
The muscles are those distinct and compact bundles of fleshy fibres which are found on animals immediately on removing the skin and subjacent fat; and which, although perhaps not known to all under their generic or scientific name, are familiar to every one as constituting the red fleshy part of meat.

Every muscle or separate bundle of fleshy substance is composed of innumerable small fibres or threads, each separated from, and, at the same time, loosely connected with, the others by a sheath of cel-

lular membrane enveloping it, but which is so thin as not to obscure the colour of the fibre, or attract notice unless specially looked for. Each muscle is in its turn separated from the neighbouring muscles by thicker layers or sheaths of the same membrane, in some of the cells of which fat is deposited, especially where the interval between the muscles is considerable; and hence the elegantly rounded form of the limbs, which, without this fat, would present the rigid, sharp, and prominent outline which we see occasionally in strong persons of a spare habit of body. From the loose texture of the connecting cellular membrane, the muscles enjoy perfect freedom of motion during life, and admit of being easily separated from each other after death, either by the knife, or by simply tearing the cellular tissue.

Muscles, speaking generally, may be divided into three parts, of which the middle fleshy portion, called the *belly*, is the most conspicuous and important. The other two are the opposite ends, commonly called the *origin* and *insertion* of the muscle. The belly is the bulky and fleshy part, by the contraction or shortening of the fibres of which, the two ends are brought nearer to each other, while the belly itself swells out in a lateral direction. When we attempt to lift a heavy weight in the hand or to overcome any resistance, the muscles which bend the arm may be seen and felt to start out rigid and well defined in their whole extent, while their extremities tend powerfully to approach each other, and, of course, to carry along with them the bones to which they are attached. In consequence of this tendency, if a weight be unexpectedly knocked out of the hand before we have time to obviate the result, the muscles, having then no resistance to overcome, will contract violently, and throw the hand up with a sudden jerk. Voluntary motion is, in fact, effected by the contraction of muscles acting upon and changing the relative positions of the bones or solid support of the system, and therefore almost all muscles are attached to one bone by their *origin*, and to another by their *insertion*; the for-

mer being merely the fixed extremity, towards which the opposite and more moveable end, called the *insertion*, is carried by the shortening of the intervening belly of the muscle.



The figure represents the bones of the arm and hand, having all the soft parts dissected off except one muscle O B I, of which the function is to bend the arm. O the origin of the muscle. B the belly. I the insertion. T T the tendons. S the shoulder-joint. E the elbow. When the belly contracts, the lower extremity of the muscle I, is brought nearer to the origin or fixed point O, and, by thus bending the arm at the elbow-joint, raises up the weight W placed in the hand.

If the muscles are in general attached to bones, it may be asked, How can the bones, which present comparatively so small a surface, afford space enough for the attachment of muscles which are so much larger, and which even appear in successive layers above each other? This difficulty is obviated in two ways. In the *first* place, the heads and other parts of bones to which muscles are attached are enlarged so as to present a greater surface than the body of the bone, and form what are called *processes*, for the express purpose of affording greater room; and, *secondly*, instead of *all* the fleshy fibres of a muscle being prolonged to its points of attachment at the bone, they, with a few exceptions, terminate gradually, as they proceed from the belly, in a white shining *tendon*, of a much smaller size than the muscle, but of great strength, which is inserted into the bone. These ten-

dons, or *sinews* as they are occasionally named, conduce greatly to symmetry, elegance, and freedom of motion; and may be traced under the skin on the back of the hand, and in the very powerful specimen at the heel, called the tendon of Achilles. The hamstrings are another obvious example, and may be easily felt becoming tight when an effort is made to bend the knee. There are a few muscles not attached to bones by either extremity, and also a few which have no tendons. Those which surround the eyebrows, the mouth, the gullet, and some of the other natural passages, are of the former description; as is also the heart. Some of the muscles of the trunk have no tendons, but these are few in number, and may at present be considered exceptions to the general rule.

In man, and in most of the animals with which we are familiar, the muscles are of a red colour. This, however, depends entirely on the blood which they contain; for so far is the colour from being essential to their constitution, that it may be destroyed by washing out the blood which produces it, the muscular substance remaining in other respects unchanged. Hence the colour of the muscles varies with that of the blood; is dark where it is dark, pale where it is pale, and white where it is white. The true characteristic of muscular fibres is *contractility, or the power of shortening their substance on the application of stimuli, and again relaxing when the stimulus is withdrawn.*

The direction in which the fleshy fibres run, determines the direction of the motion effected by their contraction. In some muscles the fibres are nearly parallel, and, consequently, act in a straight line. In others they run obliquely, producing a corresponding obliquity of motion; while in others they are disposed like feathers in relation to a quill, and are therefore styled penniform. A few are circularly disposed round openings, and contract towards a common centre, like the mouth of a purse closed by its strings. When the direction varies, it is always to effect a particular kind of action. Remarkable contrivances appear for this end; one muscle of the lower jaw, for

example, is divided into two distinct fleshy bellies by an intermediate thin strong tendon, which passes through and plays in a pulley adapted for its reception; its two portions being by this means enabled to operate with full effect almost at right angles to each other. A similar arrangement is found in the *trochlearis*, or pulley-muscle of the eyeball; and modifications of a different kind occur in other muscles, as in those of the fingers and toes, wherever a particular object is to be accomplished.

The chief purpose of the muscles is obviously to enable us to carry into effect the various resolutions and designs—or volitions, as they are termed by philosophers—which have been formed by the mind. But while fulfilling this grand object, their active exercise is, at the same time, highly conducive to the well-being of many other important functions. By muscular contraction, the blood is gently assisted in its course through the smaller vessels and more distant parts of the body, and its undue accumulation in the internal organs is prevented. The important processes of digestion, respiration, secretion, absorption, and nutrition, are promoted, and the health of the whole body immediately influenced. The mind itself is exhilarated or depressed by the proper or improper use of muscular exercise; and it thus becomes a point of no slight importance to establish general principles by which that exercise may be regulated.

The first requisite for healthy and vigorous muscular action is the possession of strong and healthy muscular fibres. In every part of the animal economy, the muscles are proportionate in size and structure to the efforts required from them; and it is a law of nature, that whenever a muscle is called into frequent use, its fibres increase in thickness within certain limits, and become capable of acting with greater force and readiness; and that, on the other hand, when a muscle is little used, its volume and power decrease in a corresponding degree. When in a state of activity, the quantity of blood which muscles receive is considerably increased; and, in consequence,

those which are much exercised become of a deeper red colour than those which are less used. The reason of this will be evident, when we recollect that to every organ of the body arterial blood is an indispensable stimulus, and that its supply is, during health, always proportioned to the extent and energy of the action. When any part, therefore, is stinted of its usual quantity of blood, it very soon becomes weakened, and at last loses its power of action, although every other condition required for its performance may remain unimpaired.

It is the infringement of this condition that entails so much misery upon our young manufacturing population, and even upon many of the inmates of our boarding-schools. Wasted by excessive labour, long confinement, and miserable diet, the muscular system is stinted in growth and weakened in structure; and the blood, impoverished by insufficiency of nourishing food and by a vitiated atmosphere, is no longer capable of repairing the waste consequent upon exercise, or of affording a healthy stimulus to the vessels and nerves which animate the muscles. Languor, debility, and exhaustion of mind necessarily follow; and the individual is left susceptible of no stimulus but that of ardent spirits or of excited and reckless passion.

In youth, not only must the waste of materials be replaced, but an excess of nourishment must be provided, to admit of the continued growth which is the chief function of our earlier years. If this be denied, the development of the bodily organs often receives a check which no subsequent treatment can remedy, and a foundation is laid for diseases of debility which afterward imbitter and endanger life. From pretty extensive inquiry, I am satisfied that in boarding-schools, especially for females, this important principle is often disregarded; while the conductors are, at the same time, without the least suspicion of the evil they are producing, and even take credit to themselves for only checking sensual appetites, and promoting temperance in eating as well as in drinking.

Youth requires the best and most nutritious food, and such ought regularly to be provided. Weak broth, twice-cooked hashes, and quantities of vegetables and watery milk, are not sufficient sustenance for a young and growing frame. Can we be surprised that, with such a diet, worm powders and stomachic medicines are in constant demand, and that, even with the assistance of these, the girl shoots up thin, pale, and fleshless? Let it not be supposed that I wish to make a god of the belly; my object is the reverse of this, and I am sure that no better means can be used to effect it than to give a sufficiency (*not an excess*) of wholesome and nourishing food, which alone will satisfy the stomach, and obviate the constant craving which is a frequent and painful concomitant of deficiency of food. Let it be considered how soon, in cases of shipwreck for example, men previously well fed are wasted away by bodily labour, when deprived of a full allowance of food, and it will not be difficult to form some conception of the importance of this condition to the well-being of the muscular system.

Something more than mere muscle, however, is required for the production of regulated or voluntary motion. The muscle itself, though perfect in strength and in structure, would otherwise remain inert. A stimulus is required to excite it to activity and to direct its contraction, and this stimulus is conveyed to it by the *nerves*. As we write, the muscles which move and guide the pen obviously follow the commands of the will; and the moment the will is withdrawn they cease to operate. If the will be feeble and undecided, the muscular movements will be equally weak and irresolute; whereas, if the mind be powerfully excited and the will energetic, strength, rapidity, and decision will equally characterize all the movements of the body. Under the intense excitement and headlong fury of madness, the muscular action of an otherwise feeble man acquires a force often exceeding all our powers of control.

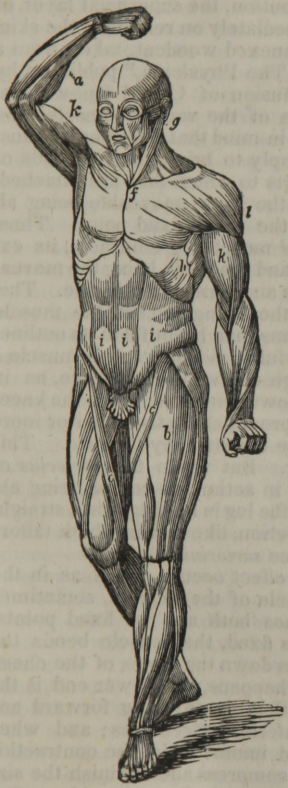
It will be at once perceived from this description,

that, in effecting voluntary motion, we must have in operation, *first*, The brain, or organ of mind, as the *source of the will; secondly*, The nerves, which *convey* the intimations of the will to the muscles; and, *thirdly*, The muscles themselves, by whose contractile powers motion is *produced*. It will be understood, also, why the number and size of the nerves distributed to a muscle are in proportion, not simply to its volume, but to the variety, frequency, and vivacity of the movements required from it; and why some small muscles employed in many combinations are therefore supplied with a greater variety of nerves than others double their size, but with more simple functions.

Muscular power is (other circumstances being equal) proportioned to the size of the muscle; but it often happens that great power is required where bulk of muscle would be inconvenient or cumbersome. In such cases, the muscle is supplied with an increased endowment of nervous filaments, which compensate, by the strength of stimulus, for what it wants in bulk of fibre. Many birds, for example, require great muscular power to sustain them in their long and rapid flights through the air, and owe its possession chiefly to the strong stimulus imparted to moderate-sized muscles by large nerves, which add extremely little to their weight; whereas, had the greater power been obtainable only from an augmentation of fleshy fibres, the consequent addition of weight would, from the greatly increased difficulty the animal must have felt in raising and sustaining itself in the air, have gone far to counterbalance any advantage gained on the side of power. But in fishes, which float without effort in their own element, size produces no such inconvenience; and their strength, accordingly, is made to depend more on the volume of the muscle than on its nervous endowment, showing a beautiful adaptation to the mode of life and wants of the animal.

As voluntary motion depends as much on nervous stimulus as on muscular agency, it happens that whatever interrupts the action of the nerves puts a stop

to motion as effectually as if the muscular fibre itself were divided. Injuries and diseases of the brain, whence the will emanates, are well known to be accompanied with palsy, or want of power in the muscles, although in their own structure the latter remain sound. Sleep and narcotics, too, suspend voluntary motion, solely in consequence of their action on the nervous system. Ardent spirits, in like manner, disturb the regularity of muscular action in no other way than by previously disordering the brain; and hence the unsteady gait and faltering elocution of a semi-intoxicated person are sometimes removed in an instant by some powerful mental impression being suddenly made, sufficient to restore the brain to its natural state, and thereby to give unity and steadiness to the nervous impulse proceeding from it to the muscles. For the same reason, although the brain and muscles be perfectly sound, yet if the communication between them be impaired or destroyed by the compression or division of the nerves, the muscles cease to act.



The muscles of the human body are upward of 400 in number, and form several layers lying over each other. That some conception may be formed of their arrangement and distribution, the superficial layer, or that which appears immediately on removing the skin, is represented in the annexed woodcut, taken from a little volume entitled "The Physician," published by the Society for the Diffusion of Useful Knowledge. To understand the uses of the various muscles, the reader has only to bear in mind that the object of muscular contraction is simply to bring the two ends of the muscle, and the parts to which they are attached, nearer to each other, the more moveable being always carried towards the more fixed point. Thus, when the *sterno-mastoid* muscle *f g* contracts, its extremities approximate, and the head, being the moveable point, is pulled down and turned to one side. This may be easily seen in the living subject, the muscle being not less conspicuous than beautiful in its outline. Again, when the powerful *rectus* or *straight* muscle *b* on the front of the thigh contracts with force, as in the act of kicking, its lower end attached to the knee-pan and leg, tends to approximate to the upper or more fixed point, and pulls the leg strongly forward. This occurs also in walking. But when the *sartorius* or tailors' muscle *c* is put in action, its course being oblique, the movement of the leg is no longer in a straight line, but in a cross direction, like that in which tailors sit; and hence the name *sartorius*.

Another variety of effect occurs, when, as in the *rectus* or straight muscle of the belly *i i*, sometimes one end and sometimes both are the fixed points. When the lower end is fixed, the muscle bends the body forward, and pulls down the bones of the chest. When, as more rarely happens, the lower end is the moveable point, the effect is to bring forward and raise the pelvis and inferior extremities; and when both ends are rendered immoveable, the contraction of the muscle tends to compress and diminish the size of the cavity of the belly, and thus not only assists the natural evacuations, but co-operates in the function of respiration.

In contemplating this arrangement, it is impossible not to be struck with the consummate skill with which every act of every organ is turned to account. When the chest is expanded by a full inspiration, the bowels are pushed downward and forward to make way for the lungs; when the air is again expelled, and the cavity of the chest diminished, the very muscles *i i i*, which effect this by pulling down the ribs, contract upon the bowels also; pushing them upward and inward, as can be plainly perceived by any one who attends to his own breathing. By this contrivance, a gentle and constant impulse is given to the stomach and bowels, which is of great importance to them in contributing to digestion and in propelling their contents; and one cause of the costiveness with which sedentary people are so habitually annoyed, is the diminution of this natural motion in consequence of bodily inactivity.

From the preceding exposition, the action of the muscles *a*, *k*, *l*, which bend the arm and forearm, will be easily understood, and some notion may be formed of the innumerable combinations into which a system composed of upward of 400 pieces may be thrown, in effecting all the movements required from the human frame. In some of the operations in which we engage, nearly the whole, and in others only a part, of the muscles are thrown into action at one time. The simultaneousness of action which obtains in such instances—which occurs in almost every act of life, however simple—and without which no dictate of the will could be harmoniously and successfully obeyed, depends solely on the distribution and connexions of the nerves which animate the muscles. Every individual fibre of every muscle is supplied with nervous filaments, and different fibres of the same muscle are indebted for the simultaneousness of their excitement to the connexion established between each of them by these filaments. Wherever many muscles combine to execute an important movement, they are uniformly found to be provided with, and connected by, branches from the same system of nerves; as,

without this means, simultaneousness and harmony of action could not be ensured. Thus the muscles which cover the upper part of the chest co-operate in the voluntary movements of the arm, and, at the same time, in the respiratory movements of the chest; but these, being two distinct purposes, require different combinations of the muscles among themselves. To effect these combinations, two sets of nerves are provided, as has been shown by Sir Charles Bell; the one regulating the respiratory, and the other the purely voluntary movements of the muscles. This is the true reason why the same muscle sometimes receives nerves from two or three different quarters; a circumstance which, before the principle was discovered, and when all nerves were considered alike, was altogether inexplicable, and seemed a work of mere supererogation.

The influence of the nervous agency may be still farther illustrated. When the trunk of a muscular nerve is irritated by the contact of an external body or by the electric spark, the muscles which it supplies instantly contract, but without either harmony or permanence of motion: the contraction is like the violent and ill-regulated start of convulsion. It is the influence of the brain and mind in the equal diffusion of the required stimulus to each muscle, in the exact proportion needful, that characterizes healthy and sustained voluntary motion, as opposed to the irregular convulsive start. Nothing can be more wonderful than the accuracy with which, in the most delicate movements, this stimulus is adjusted and apportioned to such a variety of parts, particularly where practice, or, in other words, education, has rendered the combination of powers easy and certain. Not to mention the more obvious and graceful movements of dancing, fencing, and riding, we discover, in the management of the hand and fingers by engravers, sculptors, watchmakers, jugglers, and other artists and mechanics, a minute accuracy of muscular adjustment to effect a given end, which is the more surprising the more we consider the complicated means by which it is effected.

In consequence of the co-operation of both nerve and muscular fibre being required to effect motion, excess of action in each is followed by results peculiar to itself. If the NERVES preponderate, either constitutionally or from over-exercise, as they are apt to do in highly nervous temperaments, their excessive irritability renders them liable to be unduly excited by ordinary stimuli; and hence, as in hysteric and nervous females, a proneness to sudden starts, cramps, and convulsions, from causes which would scarcely affect an individual differently constituted. Such persons have little muscular power, except under excitement; they then become capable of great efforts of short duration, but sink proportionally low when the stimulus is past. If, on the other hand, the MUSCLES predominate, as in athletic, strong-built men, the nervous system is generally dull and little susceptible of excitement, and the muscles which it animates are, consequently, little prone to the rapid and vivacious action that accompanies the predominance of the nervous functions. Great strength and capability of bodily labour are then the characteristics.

Great muscular power and intense nervous action are rarely conjoined in the same individual; but, when they do happen to meet, they constitute a perfect genius for muscular exertion, and enable their possessor to perform feats of strength and agility, which appear marvellous to those who are deficient in either condition. The most successful wrestlers and gladiators among the ancients seem to have owed their superiority chiefly to the possession of both endowments in a high degree; and among the moderns, the most remarkable combination of the two qualities is exhibited by some of our harlequins, clowns, rope-dancers, and equestrian performers, and also by those who display their strength and power of equilibrium in balancing wheels, ladders, or other heavy bodies, on the chin; and whose performances require from the small muscles of the jaw and neck a force of contraction which, when reduced to calculation, almost exceeds belief. Belzoni combined both conditions in a high degree.

From the general resemblance which characterizes the different nerves, a similarity in function was long ascribed to them all, and no explanation could be given why one muscle sometimes received filaments from a variety of nervous trunks. Recently, however, the labours of Sir Charles Bell, Mayo, Magendie, and Bellingeri have clearly established that in such cases each nerve serves a distinct purpose in combining the movements of the particular muscles with those of others necessary to effect a given end; and that without this additional nerve, such a combination could not have been produced. The muscular nerves must not be confounded with those which we have seen ramified on the skin for the purposes of sensation. The former are provided for the purposes of motion and not of feeling, and hence muscles may be cut or injured with little pain, compared to what is felt by the skin. Weariness is the sensation recognised by one set of muscular nerves.

So uniformly is a separate instrument provided for every additional function, that there is strong reason to regard the muscular nerves, although running in one sheath, as in reality double, and performing distinct functions. Sir Charles Bell has the merit of this discovery, if such it shall ultimately prove to be. In his work on the Nervous System, he endeavours to show that one set of nervous fibres conveys the mandate from the brain to the muscle, and excites the contraction; and that another conveys from the muscle to the brain a peculiar sense of the state or degree of contraction of the muscle, by which we are enabled to judge of the amount of stimulus necessary to accomplish the end desired, and which is obviously an indispensable piece of information to the mind in regulating the movements of the body. Sir Charles has shown that many of the sensations supposed to be derived from the sense of touch and the skin, arise from the muscular sense, and are wholly imperceptible to the skin, without the co-operation of muscular contraction.

"The muscles have two nerves," says Sir Charles,

"which fact has not hitherto been noticed, because they are commonly bound up together. But whenever the nerves, as about the head, go in a separate course, we find that there is a sensitive nerve and a motor nerve distributed to the muscular fibre, and we have reason to conclude that those branches of the spinal nerves which go to the muscles, consist of a motor and a sensitive filament.

"It has been supposed hitherto, that the office of a muscular nerve is only to carry out the mandate of the will, and to excite the muscle to action; but this betrays a very inaccurate knowledge of the action of the muscular system; for, before the muscular system can be controlled under the influence of the will, there must be a consciousness or knowledge of the condition of the muscle.

"When we admit that the various conditions of the muscle must be estimated or perceived in order to be under the due control of the will, the natural question arises, Is that nerve which carries out the mandate of the will capable of conveying, at the same moment, an impression retrograde to the course of that influence which is going from the brain to the muscle? If we had no facts in anatomy to proceed upon, still reason would declare to us that the same filament of a nerve could not convey a motion, of whatever nature that motion may be, whether vibration or motion of spirits, in opposite directions at the same moment of time.

"I find that, to the full operation of the muscular power, two distinct filaments of nerves are necessary, and that a circle is established between the sensorium and the muscle; that one filament or single nerve carries the influence of the will towards the muscle, which nerve has no power to convey an impression backward to the brain; and that another nerve connects the muscle with the brain, and, acting as a sentient nerve, conveys the impression of the condition of the muscle to the mind, but has no operation in a direction outward from the brain towards the muscle,

and does not, therefore, excite the muscle, however irritated."*

This consciousness of the state of the muscles, or muscular sense, as it may be truly called, is of great importance both to man and to animals, as it is necessarily by information thence derived, that every subsequent exertion is directed and apportioned in intensity to the effort required to be made. If we had no such sense, the delicate and well-directed touches of the engraver, painter, and sculptor, or of the ingenious mechanic, would be at the mercy of hazard; and a single disproportioned movement might ruin the successful labour of months, supposing success to be in reality compatible with chance. Without this sense, man could not deliberately proportion the muscular efforts to his real wants; and, even in walking, his gait would be unsteady and insecure, because there would be no harmony between effort and resistance. The loss of equilibrium, and the concussion and disturbance of the system consequent upon taking a false step, as it is called, are a specimen of what we would always be subject to without the guidance of the muscular sense. When we imagine we have one step more of a stair to descend than really exists, we are placed nearly in the same circumstances as if we had no muscular sense to direct the extent of our intended movement; because, misled by an erroneous impression, we make an effort grievously unsuited to the occasion; and yet so habitually are we protected from this error by the assistance of the sense alluded to, and so little are we conscious of its operation, that it is only after mature reflection that we perceive the necessity of its existence.

In chewing our food, in turning the eye towards an object looked at, in raising the hand to the mouth, and, in fact, in every variety of muscular movement which we perform, we are guided by the muscular sense in proportioning the effort to the resistance to be overcome; and, where this harmony is destroyed

* Bell's Anatomy, seventh edition, vol. ii., p. 372.

by disease, the extent of the service rendered us becomes more apparent. The shake of the arm and hand which we see in drunkards, and their consequent incapability of carrying the morsel directly to the mouth, are examples of what would be of daily occurrence, unless we were directed and assisted by a muscular sense.

Life and the nervous stimulus are essential to muscular power. Separated from the body and deprived of both, the muscle which formerly contracted with a power equal to 100 pounds would be torn asunder by a weight of ten. This fact is of itself sufficient to give a tolerable notion of the extent to which muscular contraction depends on other causes than the mere structure of the fleshy fibres; for that structure continues unaltered for some time after death, and after the nervous communication has been suspended; and yet how feeble is the power of resistance which the muscle then possesses!

The required movement having been once effected by the nervous impulse stimulating the muscular fibre to contraction, relaxation speedily follows, and is in its turn succeeded by a fresh contraction proportioned to the object in view. *Muscular action, therefore, consists properly in alternate contraction and relaxation of the fleshy fibres.* A state of permanent contraction is both unnatural and impossible; and, accordingly, the most fatiguing muscular employment to which a man can be subjected, is that of remaining immoveable in any given attitude. To an unreflecting person it may seem a very easy and pleasant service to stand for half a day in the attitude of an Apollo or a Gladiator, as a model to a statuary; but, on trying it, he will find, to his astonishment, that stonebreaking or the treadmill are pastimes in comparison: in the one case, the muscles which preserve the attitude are kept incessantly on the strain; while in the other, they enjoy that play and variety of motion for which they were destined by nature. We may easily put the fact to the test, by attempting to hold the arm extended at a right angle to the body for the short space of

ten minutes. He whose muscles, if indeed capable of the exertion, do not feel sore with fatigue at the end of that time, may think himself peculiarly fortunate in being blessed with a powerful constitution.

The principle just stated explains very obviously the weariness, debility, and injury to health, which invariably follow forced confinement to one position or to one limited variety of movement, as is often witnessed in the education of young females. Alternate contraction and relaxation, or, in other words, exercise of the muscles which support the trunk of the body, are the only means which, according to the Creator's laws, are conducive to muscular development, and by which bodily strength and vigour can be secured. Instead of promoting such exercise, however, the prevailing system of female education places the muscles of the trunk, in particular, under the most unfavourable circumstances, and renders their exercise nearly impossible. Left to its own weight, the body would fall to the ground, in obedience to the ordinary law of gravitation: in sitting and standing, therefore, as well as in walking, the position is preserved only by active muscular exertion. But if we confine ourselves to one attitude, such as that of sitting erect upon a chair, or, what is still worse, on benches without backs, as is the common practice in schools, it is obvious that we place the muscles which support the spine and trunk in the very disadvantageous position of permanent instead of alternate contraction; which we have seen to be in reality more fatiguing and debilitating to them than severe labour. Girls thus restrained daily for many successive hours, invariably suffer, being deprived of the sports and exercise after schoolhours which strengthen the muscles of boys, and enable them to withstand the oppression. The muscles being thus enfeebled, the girls either lean over insensibly to one side, and thus contract curvature of the spine, or, their weakness being perceived, they are forthwith cased in stiffer and stronger stays, that support being sought for in steel and whalebone which Nature intended they should

obtain from the bones and muscles of their own bodies. The patient, finding the maintenance of an erect carriage (the grand object for which all the suffering is inflicted) thus rendered more easy, at first welcomes the stays, and, like her teacher, fancies them highly useful. Speedily, however, their effects show them to be the reverse of beneficial. The same want of varied motion, which was the prime cause of the muscular weakness, is still farther aggravated by the tight pressure of the stays interrupting the play of the muscles, and rendering them in a few months more powerless than ever. In spite, however, of the weariness and mischief which result from it, the same system is persevered in; and, during the short time allotted to that nominal exercise, the formal walk, the body is left almost as motionless as before, and only the legs are called into activity. The natural consequences of this treatment are debility of the body, curvature of the spine, impaired digestion, and, from the diminished tone of all the animal and vital functions, general ill health; and yet, while we thus set Nature and her laws at defiance, we presume to express surprise at the prevalence of female deformity and disease!

It would be easy, were it required, to prove that the picture here drawn is not overcharged. A single instance, from a note appended by Dr. Forbes to an excellent treatise on "Physical Education," by Dr. Barlow, of Bath, will suffice. After copying the programme of a boarding-school for young ladies, which exhibits only one hour's exercise, consisting of a walk, arm in arm, on the high road, *and that only when the weather is fine at the particular hour allotted to it*, in contrast with *nine* hours at school or tasks, and *three and a half* at optional sudies or work, Dr. Forbes adds: "That the practical results of such an astounding regimen are by no means overdrawn in the preceding pages, is sufficiently evinced by the following fact; a fact which, we will venture to say, may be verified by inspection of thousands of boarding-shools in this country. *We lately visited in a large town a board-*

ing-school containing forty girls; and we learned, on close and accurate inquiry, that there was not one of the girls who had been at the school two years (and the majority had been as long) that was not more or less CROOKED! Our patient was in this predicament; and we could perceive (what all may perceive who meet that most melancholy of all processions, a boarding-school of young ladies in their walk) that *all* her companions were pallid, sallow, and listless. We can assert, *on the same authority of personal observation*, and on an extensive scale, that *scarcely a single girl (more especially of the middle classes) that has been at a boarding-school for two or three years, returns home with unimpaired health;* and for the truth of the assertion we may appeal to every candid *father* whose daughters have been placed in this situation."*

Dr. Barlow justly remarks, that the superintendents of such schools cannot generally be blamed for indifference about the welfare of their pupils; that most of them are extremely anxious to do their utmost to improve those under their charge; and that it is *ignorance* alone which misleads them as to the proper means: he might have adverted also to the ignorance of *parents*, who insist on so many hours a day being dedicated to the study of accomplishments for which their children have neither taste, capacity, nor use. From similar ignorance, the young girls in a public hospital in this country used to be *shut up in the hall and schoolroom during playhours from November till March, and no romping or noise, in other words, no real play, relaxation, or exercise, allowed;* and in 1830, 31, from fear of typhus fever, they were seldom, if ever, out of doors, except at church, from November to April; than which a more efficient method of infringing the laws of health could scarcely have been devised. Here, too, the object was unquestionably benevolent, but the method was radically bad; and, in consequence, a great deal of sickness prevailed.

The reality of the mischief done in this way was

* Cyclopædia of Practical Medicine, Article Physical Education, vol. i., p. 698.

forcibly pointed out by Mr. Carmichael, of Dublin, in his excellent "Essay on the Nature of Scrofula," published so long ago as 1810, and which contains many valuable practical truths, which were then little known and coolly received, but to which great importance is now generally attached. In noticing the want of exercise as a cause of scrofula, Mr. Carmichael mentions, that in St. Thomas's Parochial School, *seven* out of *twenty-four* girls were affected with that disease during the preceding summer, owing to their exercise having been entirely interrupted, first, by the flooding of the playground by heavy rains, and subsequently by the mistress having received orders "*to keep the children perpetually within doors at their schoolbooks.*" In a very short time after "this cruel and impolitic injunction" was acted upon, scrofula began to make its appearance, and afterward affected nearly a third of their number; although none of them had the disease when admitted, and there was no fault of diet or other cause to which it could be ascribed. Mr. Carmichael adds that, in the Bethesda School of the same city (Dublin), *six* out of *thirty* girls, fed in the best possible manner, and free from the disease on their admission, were *badly affected* with it during the same summer. In these cases it evidently arose from their having neither yard nor playground attached to the institution, in consequence of which "the children were necessitated to remain either in the school or bedrooms during playhours." On ascertaining this fact, Mr. Carmichael remonstrated with the governors, and the evil no longer exists; but the circumstance itself affords an instructive example of the extent of misery which may arise, not from the institutions of Nature, as we are so apt to affirm, but from sheer ignorance on our own part of what these institutions are.

Mr. Carmichael adduces other facts of a striking nature, for which I must refer to the work itself, to show the needless suffering which is still inflicted on thousands by the sedentary and unvaried occupations which follow each other for hours in succession in many of our schools, and I agree with him that it is

high time that a sound physiology should step in to root out all such erroneous and hurtful practices. Taken in connexion with the long confinement, the custom of causing the young to sit on benches without any support to the back, and without any variety of motion, cannot be too soon exploded. If the muscles of the spine were so strengthened by the exercise which they require, but which is so generally denied; and if the school employments were varied or interrupted at reasonable intervals, to admit of change of position and of motion, nothing could be better adapted for giving an easy and erect carriage than seats without backs, because the play of the muscles necessary for preserving the erect position would give them activity and vigour; and, accordingly, the want is scarcely, if at all, felt in infant schools, for the very reason that such variety of motion is, in them, carefully provided for. But it is a gross misconception to suppose that the same good result will follow the absence of support, when the muscles are weakened by constant straining and want of play. The incessant and fidgety restlessness observable after the second or third hour of common school confinement, shows the earnest call of Nature for a little wholesome exercise; and the quiet that ensues when it is granted, indicates clearly enough that the restlessness springs even more from bodily than from mental weariness. It is, in fact, a degree of what we all feel when kept long standing on our feet or sitting at a desk. We become weary and uneasy from the continued strain on the same muscles, and feel at once relieved by a walk, a drive, or any change whatever. The same principle explains the fatigue so often complained of, as experienced in "shopping" or in an exhibition-room. We saunter about till the muscles become sore from the fatigue of being always in the same attitude, and we are refreshed by a walk or a dance, or anything which alters the position. The same languor of the muscles is felt after witnessing a pantomime, or other continuous spectacle, by which we are induced to keep the neck for a long time in a

constrained and unvaried position. Children with thin bodies, weak muscles, and large heads, sometimes suffer much by being taken to church, and, that due respect may be shown to the sanctity of the place, not allowed by their parents to lean their heads on the board, or on the arm of the person sitting next them, so as to support themselves more easily.

Instead, therefore, of so many successive hours being devoted to study and to books, the employments of the young ought to be varied and interrupted by proper intervals of cheerful and exhilarating exercise, such as is derived from games of dexterity, which demand the co-operation and society of companions, or from some kind of manual labour in which skill and ingenuity are required, such as carpentry, turning, or gardening. This is infinitely preferable to the solemn processions which are so often substituted for exercise, and which are hurtful, inasmuch as they delude parents and teachers into the notion that they constitute in reality that which they only counterfeit and supersede. We have already seen what an important part the mental stimulus and nervous impulse perform in exciting, sustaining, and directing muscular activity; and observation proves that muscular contraction becomes relatively difficult and inefficient, when the mind, which directs it, is languid, or absorbed by other employments. The playful gambolling and varied movements which are so characteristic of the young of all animals, man not excepted, and which are at once so pleasing and so beneficial, show that, to render it beneficial in its fullest extent, Nature requires amusement and sprightliness of mind to be combined with, and be the source of, muscular exercise; and that, when deprived of this healthful condition, it is a mere *evasion* of her law, and is not followed by a tithe of the advantages resulting from its real fulfilment. The buoyancy of spirit and comparative independence enjoyed by boys when out of school, prevent them suffering so much from this cause as girls do; but the injury inflicted on both is the more unpardonable, on account of the ease with

which it might be entirely avoided. In some infant schools which have no playground attached to them, the necessity of frequent and playful muscular exercise in the open air is shamefully disregarded, to the great injury of the poor children confined in them.

Facts illustrative of the influence of mental, co-operating with and aiding muscular activity, must be familiar to every one; but as the principle on which they depend is not sufficiently attended to, I shall add a few additional remarks.

Everybody knows how wearisome and disagreeable it is to saunter along, without having some object to attain; and how listless and unprofitable a walk taken against the inclination and merely for exercise is, compared to the same exertion made in pursuit of an object on which we are intent. The difference is simply, that, in the former case, the muscles are obliged to work without that full nervous impulse which nature has decreed to be essential to their healthy and energetic action; and that, in the latter, the nervous impulse is in full and harmonious operation. The great superiority of active sports, botanical and geological excursions, gardening, and turning, as means of exercise, over mere measured movements, is referable to the same principle. Every kind of youthful play and mechanical operation interests and excites the mind, as well as occupies the body; and by thus placing the muscles in the best position for wholesome and beneficial exertion, enables them to act without fatigue for a length of time, which, if occupied in mere walking for exercise, would utterly exhaust their powers.

The elastic spring, bright eye, and cheerful glow of beings thus excited, form a perfect contrast to the spiritless and inanimate aspect of many of our boarding-school processions; and the results in point of health and activity are not less different. So influential, indeed, is the nervous stimulus, that examples have occurred of strong mental emotions having instantaneously given life and vigour to paralytic limbs. This has happened in cases of shipwrecks, fires, and

seafights, and shows how indispensable it is to have the mind engaged and interested along with the muscles. Many a person who feels ready to drop from fatigue after a merely mechanical walk, would have no difficulty in subsequently undergoing much continuous exertion in active play or in dancing; and it is absurd, therefore, to say that exercise is not beneficial, when, in reality, proper exercise has not been tried.

The amount of bodily exertion of which soldiers are capable, is well known to be prodigiously increased by the mental stimulus of pursuit, of fighting, or of victory. In the retreat of the French from Moscow, for example, when no enemy was near, the soldiers became depressed in courage and enfeebled in body, and nearly sank to the earth through exhaustion and cold; but no sooner did the report of the Russian guns sound in their ears, or the gleam of hostile bayonets flash in their eyes, than new life seemed to pervade them, and they wielded powerfully the arms which, a few moments before, they could scarcely drag along the ground. No sooner, however, was the enemy repulsed, and the nervous stimulus which animated their muscles withdrawn, than their feebleness returned. Dr. Sparrman, in like manner, after describing the fatigue and exhaustion which he and his party endured in their travels at the Cape, adds, "yet, what even now appears to me a matter of wonder is, that *as soon as we got a glimpse of the game, all this languor left us in an instant.*" On the principle already mentioned, this result is perfectly natural, and in strict harmony with what we observe in sportsmen, cricketers, golfers, skaters, and others, who, moved by a mental aim, are able to undergo a much greater amount of bodily labour than men of stronger muscular frames, actuated by no excitement of mind or vigorous nervous impulse. I have heard an intelligent engineer remark the astonishment often felt by country people at finding him and his town companions, although more slightly made, withstand the fatigues and exposures of a day's surveying better than

themselves; but, said he, they overlooked the fact that our employment gives to the mind as well as to the body a stimulus which they were entirely without, as their only object was to afford us bodily aid when required, in dragging the chains or carrying our instruments. The conversation of a friend is, in the same way, a powerful alleviator of the fatigue of walking.

The same important principle was implied in the advice which the Spectator tells us was given by a physician to one of the eastern kings, when he brought him a racket, and told him that the remedy was concealed in the handle, and could act upon him only by passing into the palms of his hands when engaged in playing with it; and that, as soon as perspiration was induced, he might desist for the time, as that would be a proof of the medicine being received into the general system. The effect, we are told, was marvellous; and, looking to the principle just stated, to the cheerful nervous stimulus arising from the confident expectation of a cure, and to the consequent advantages of exercise thus judiciously managed, we have no reason to doubt that the fable is in perfect accordance with nature.

The story of an Englishman who conceived himself so ill as to be unable to stir, but who was prevailed upon by his medical advisers to go down from London to consult an eminent physician at Inverness who did not exist, may serve as another illustration. The stimulus of expecting the means of cure from the northern luminary was sufficient to enable the patient not only to bear, but to reap benefit from, the exertion of making the journey down; and his wrath at finding no such person at Inverness, and perceiving that he had been tricked, sustained him in returning; so that, on his arrival at home, he was nearly cured. Hence also the superiority of battledore and shuttlecock, and similar games, which require society and some mental stimulus, over listless exercise. It is, in fact, a positive misnomer to call a solemn procession *exercise*. Nature will not be cheated; and the

healthful results of complete cheerful exertion will never be attained where the nervous impulse which animates the muscles is denied.

It must not, however, be supposed, that a walk simply for the sake of exercise can never be beneficial. If a person be thoroughly satisfied that exercise is requisite, and perfectly *willing*, or, rather, desirous, to obey the call which demands it, he is from that very circumstance in a state fit for deriving benefit from it, because the *desire* then becomes a sufficient nervous impulse, and one in perfect harmony with the muscular action. It is only where a person goes to walk, either from a sense of duty or at the command of another, but against his own inclination, that exercise is comparatively useless.

The advantages of combining harmonious mental excitement with muscular activity have not escaped the sagacity of the late Dr. Armstrong, who thus notices them in his frequently reprinted Poem on the Art of Preserving Health, but without giving the physiological explanation:

> "*In whate'er you sweat*
> *Indulge your taste.* Some love the manly toils,
> The tennis some, and some the graceful dance;
> Others, more hardy, range the purple heath
> Or naked stubble, where, from field to field,
> The sounding covies urge their lab'ring flight,
> Eager amid the rising cloud to pour
> The gun's unerring thunder; and there are
> Whom still the mead of the green archer charm.
> *He chooses best whose labour entertains*
> *His vacant fancy most;* THE TOIL YOU HATE
> FATIGUES YOU SOON, AND SCARCE IMPROVES YOUR LIMBS."
> BOOK III.

This constitution of Nature, whereby a mental impulse is required to direct and excite muscular action, points to the propriety of teaching the young to observe and examine the qualities and arrangements of external objects. The most pleasing and healthful exercise may be thus secured, and every step be made to add to useful knowledge and to individual

enjoyment. The botanist, the geologist, and the natural historian, experience pleasures in their walks and rambles, of which, from disuse of their eyes and observing powers, the multitude is deprived. This truth is acted upon by many teachers in Germany. In our own country, too, it is beginning to be felt, and one of the professed objects of infant education is to correct the omission. It must not, however, be supposed that *any* kind of mental activity will give the necessary stimulus to muscular action, and that, in walking, it will do equally well to read a book or carry on a train of abstract thinking, as to seek the necessary nervous stimulus in picking up plants, hammering rocks, or engaging in games. This were a great mistake; for in such cases the nervous impulse is opposed rather than favourable to muscular action. Ready and pleasant mental activity, like that which accompanies easy conversation with a friend, is indeed beneficial by diffusing a gentle stimulus over the nervous system; and it may be laid down as a general rule, that any agreeable employment of the mind that does not require *a considerable effort of attention* adds to the advantages of muscular exercise: but wherever the mind is absorbed in reading or in abstract speculation, the muscles are drained, as it were, of their nervous energy, by reason of the great exhaustion of it by the brain; the active will to set them in motion is proportionally weakened, and their action is reduced to that inanimate kind I have already condemned as almost useless. For true and beneficial exercise, there must, in cases where the mind is seriously occupied, be *harmony of action between the moving power and the part to be moved. The will and the muscles must be both directed to the same end at the same time*, otherwise the effect will be imperfect. The force exerted by strong muscles, animated by strong nervous impulse or will, is prodigiously greater than when the impulse is weak; and as man was made not to do two things well at once, but to direct his whole powers to the one thing he is performing at the time, he has ever excelled most when he has followed this law of his nature.

When a physician urges the necessity of exercise, it is very usual for him to be told by persons of an indolent or sedentary habit, that even a short walk fatigues them so much as to render them unfit for everything for some days after, and that they are never so well as when allowed to remain in the house. But if, in perfect reliance on the regularity of the Creator's laws, we seek out the cause of this apparent exception, we shall almost uniformly find, that, instead of beginning with a degree of exertion proportioned to the weakened state of the system, such persons have (under the notion that it was not worth while to go out for a short time) forced their muscles, already weakened by inactivity and confinement, to perform a walk to which only regularly exercised muscles were adequate. The amount of exertion which is always followed by exhaustion is thus, through mere impatience and ignorance, substituted for that lesser degree which always gives strength; and because the former is followed by headache and debility, it is argued that the latter also must be prejudicial! Many sensible people delude themselves by such puerile plausibilities; and it is only by the diffusion of a knowledge of the laws of exercise as part of a useful education, that individuals can be enabled to avoid such mistakes.

The effects of exercise upon the organs employed are very remarkable, and useful to be known. When any living part is called into activity, the processes of waste and renovation, which are incessantly going on in every part of the body, proceed with greater rapidity, and in due proportion to each other. At the same time the vessels and nerves become excited to higher action, and the supply of arterial or nutritive blood and of nervous energy becomes greater. When the active exercise ceases, the excitement thus given to the vital functions subsides, and the vessels and nerves return at length to their original state.

If the exercise be resumed frequently and at moderate intervals, the increased action of the bloodvessels and nerves becomes more permanent, and does

not sink to the same low degree as formerly; NUTRITION *rather exceeds waste, and the part* GAINS, *consequently, in size, vigour, and activity.* But if the exercise be resumed too often or be carried too far, so as to fatigue and exhaust the vital powers of the part, the results become reversed: WASTE *then exceeds nutrition, and a* LOSS of volume and of power takes place, accompanied with a painful sense of exhaustion and fatigue. When, on the other hand, exercise is altogether refrained from, the vital functions decay from the want of their requisite stimulus; little blood is sent to the part, and nutrition and strength fail in equal proportion. A limb which has been long in disuse becomes weak and shrivelled from this cause, and its muscles present an unusual paleness and flabbiness, strongly contrasting with the florid redness and rigid fulness of the muscles of a well-exercised limb.

Even sensation gives faithful notice of these changes, and therefore serves as a guide to exercise. When muscular employment is neglected, the body becomes weak, dull, and unfit for powerful efforts, and all the functions languish. When exercise is taken regularly and in due proportion, a grateful sense of activity and comfort prevails, and we feel ourselves fit for every duty, both mental and bodily. Lastly, when we are subjected to excessive exertion, a painful sense of weariness and exhaustion ensues, which is not relieved by rest, and which for a long time prevents sleep. A person who has greatly overfatigued himself in walking, for example, is feeble and restless; and, on lying down, either cannot sleep at all, and rises in the morning weak in body and languid in mind, or has uneasy and disturbed sleep till the exhaustion is partially recovered from, after which he may enjoy sound and refreshing repose.

From this exposition of the effects of exercise in its different stages, it becomes easy to deduce rules applicable to all for promoting the healthy development of the muscular system, and to trace the errors by which indolent people are accustomed to maintain that exercise is hurtful to their constitutions. *The*

second stage of exercise, or that in which, by its frequency, moderation, and regularity, nutrition and vigour are preserved at their highest pitch, is, of course, to be aimed at; but the quantity of exercise which corresponds to it must vary according to the constitution and previous habits of the individual, as is well exemplified in training for pedestrian feats, for the ring, and for racing. The assertion made by many, that exercise hurts them, arises entirely from overlooking this circumstance.

A person accustomed to daily activity will feel invigorated by a walk of four or five miles in the open air, whereas the same distance will weaken another who has not been in the habit of walking at all. But instead of inferring from this, as is often done, that exercise in the open air is positively hurtful to the latter, reason and experience coincide in telling us that he has erred only in over-tasking the powers of his system, and that, to acquire strength and activity, he ought to have begun with one mile, and to have gradually extended his walk in proportion as the muscles became invigorated by the increased nutrition consequent on well-regulated exercise. A person recovering from fever begins by walking across his room perhaps ten times in a day, and gradually extends to twenty or thirty times, till he gains strength to go into the open air. On going out, a walk of ten minutes proves sufficient for him at first; but, by degrees, his strength and flesh increase, and his exercise is prolonged till he arrives at his usual standard. Such is the order of Nature; but many sedentary people have no patience for such slow progress, and, when urged to take exercise, they grudge the trouble of going out for a short time, and think that, if a walk of half a mile does them good, one of a whole mile will do more; and when they suffer from the error, they shelter their ignorance under the general assumption that exercise does not agree with them! And the same persons who argue thus would think themselves entitled to laugh at the Irishman who, finding himself relieved by five pills taken at night, inferred

that he would necessarily be cured if he took the whole boxful at once, and, on doing so, narrowly escaped with his life.

From these principles it follows, *first*, that, to be beneficial, exercise ought always to be proportioned to the strength and constitution, and not carried beyond the point, easily discoverable by experience, at which waste begins to succeed nutrition, and exhaustion to take the place of strength; *secondly*, that it ought to be regularly resumed after a sufficient interval of rest, in order to ensure the permanence of the healthy impulse given to the vital powers of the muscular system; and, *lastly*, that it is of the utmost consequence to join with it a mental and nervous stimulus. Those who go out only once in four or five days are always at work but never advancing; for the increased action induced by the previous exercise has fully subsided long before the succeeding effort is begun; and, so far as increased nutrition, strength, and greater aptitude for exertion are concerned, no progress whatever is made.

CHAPTER V.

EFFECTS OF, AND RULES FOR, MUSCULAR EXERCISE.

Effects of Muscular Exercise on the principal Functions of the Body explained.—Shampooing a Substitute for Exercise.—Evils of deficient Exercise.—Best Time for taking Exercise.—Always to be taken in the open Air.—Different Kinds—Walking—Riding—Dancing—Gymnastics—Fencing—Shuttlecock—Reading aloud.—Case illustrative of the Principles of Exercise.—Involuntary Muscles.

We have seen that exercise is necessary for developing and improving the health of the muscular system; but it still remains for us to explain how it acts in imparting tone and strength to the rest of the body, and to mention the circumstances by which its employment ought to be regulated.

Man being intended for a life of activity, all his functions are constituted by Nature to fit him for this object, and they never go on so successfully as when his external situation is such as to demand the regular exercise of all his organs. It is, accordingly, curious to observe the admirable manner in which each is linked in its action and sympathies with the rest. When the muscular system, for example, is duly exercised, increased action in its vessels and nerves takes place, as already observed; but the effect is not by any means limited to the mere organs of motion. The principal bloodvessels in all parts of the body lie imbedded among muscles, both for the protection and for the aid which the latter afford them. Every contraction of the muscles compresses and lessens the diameter of the vessels; and as the blood contained in them cannot retrograde in its course, it is propelled in the arteries from the heart *towards* the extreme parts, and in the veins *from* the latter towards the heart, with greater force and velocity than before.

This will be better understood on examining the annexed engraving of the bloodvessels of the arm, copied from Fyfe's Anatomy. The letters A, B, C, D, E, represent the principal muscles of the arm, and F, G, H, I, K, M, N, those of the forearm; though, as the preparation is dried, and the muscles, consequently, much shrunk, they do not appear in their natural situation. The letters in italics point out the *humeral* artery, which is seen dividing at the elbow into two branches. The one, called the *radial* artery, passes on the outer side of the forearm towards the thumb, and is the branch in which the pulse is generally felt; the other, called the *ulnar*, passes along the inner side of the forearm.

In the natural state, these bloodvessels are covered and protected in almost their whole course by the adjacent muscles. In consequence of this position, the muscles cannot contract without at the same time compressing the bloodvessels and propelling their contents; for, as we saw in a former chapter, the muscles swell out laterally at every contraction. The assistance afforded to the circulation of the blood by this arrangement is familiarly exemplified in the operation of bloodletting from the arm. When the blood stops or flows slowly, it is customary to put a ball or other hard body into the hand of the patient, and desire him to squeeze and turn it round. The utility of this depends simply on the muscles of the arm compressing the interjacent bloodvessels, and forcing onward the current of the contained blood by their successive contractions. Muscular action is, indeed, one of the powers provided for effecting a

regular circulation; and hence, when its assistance is neglected, as it is by those who take no active exercise, the blood begins to flow less freely, till at last it finds some difficulty in returning against the law of gravitation from the lower extremities, which then gradually swell. People engaged for years in sedentary professions are thus very subject to *varicose* or dilated veins and swelled feet.

The chain of connexion among all the living functions is nowhere more visible than in this relation between muscular exercise and the circulation of the blood. Action requires the presence of arterial blood, and, in the case of the muscles, the very circumstance of their being active favours the circulation and increases the supply. This increase, in its turn, enables the parts to which it is sent to act with greater energy and effect, and the augmented action is attended by corresponding waste and exhalation, and proportionate nutrition of the parts. To replenish the blood thus exhausted of its nutritive principle, a greater quantity of food is required: and, to prompt us to attend to this condition, the appetite becomes keener and more imperative, and the power of digestion proportionally vigorous. The food taken is more speedily converted into chyle, and its absorption from the surface of the intestines and transmission into the circulating current more rapid. That the blood so improved may be properly and quickly animalized in the laboratory of the lungs, respiration becomes deeper and more frequent, thus admitting a larger quantity of air and freer circulation through them than before; and the blood, in this way renewed and re-endowed with the pabulum of life, imparts fresh nutriment and vigour to all the organs of the body, and fits them for that active exertion which the proper discharge of his duties imperatively requires from every member of the human race.

Considered in this point of view, the hurried breathing and quickened circulation, of which we are so apt to complain when engaged in muscular exercise, instead of being evils, are, in fact, the beneficent means

by which we become fitted to continue the exertion. Without a more than usually rapid flow of blood to the part in use, the necessary stimulus to its vessels and nerves could not take place, and its action could not be sustained. But were the bloodvessels not so situated among the muscles as to have their contents propelled more quickly by the compression to which every muscular contraction necessarily subjects them, it is obvious that no increase of circulation could take place. And if respiration, on the other hand, were not to be accelerated, so as to oxygenate the venous blood more quickly as it arrived at the lungs, it is obvious that the requisite stimulus must again have failed; as, in that case, the blood must either have accumulated in the lungs and caused death, or have passed through them imperfectly prepared, and extinguished life more slowly, but not less certainly.

It is from this effect of muscular compression in promoting the flow of blood through the arteries and veins, that *shampooing*, which consists in a kind of kneading of the flesh, is so successfully resorted to in the warm climates of the east, and among the richer class of invalids in our own country, as a substitute for active exercise. Shampooing furnishes from without that impulse to the circulation which the Creator has destined it to receive from active muscular exertion; and the principle of its action being the same, we cannot wonder that it should prove indisputably useful in promoting circulation, strength, and nutrition, in cases where active exercise cannot be enjoyed. Hence also its utility in dispersing indolent swellings, in restoring tone to weakened joints, and in the cure of rheumatism.

It is a common observation, that sedentary persons are habitually subject to costiveness and its attendant evils. The reason is the same. In the natural state, the contents of the bowels are propelled partly by the successive contractions of the muscles, which form the walls of the belly and separate that cavity from the chest, and partly by the contraction of the muscular fibres, which constitute an important part of

the structure of the intestines themselves. If, however, exercise be refrained from, and the same position be preserved for many hours a day, as in sitting at a desk, the bowels are necessarily deprived of one important source of power; and, thus weakened, they are unable to act upon and propel their contents with the same regularity as when assisted by exercise. A slowness of action ensues, which no course of medicine, and scarcely any modification of diet, can overcome, so long as sedentary habits are indulged in; but which also may often be relieved by daily pressing over the region of the abdomen with a kind of kneading motion, imitating, though feebly, the effects of muscular action. Females suffer much from intestinal debility caused by sedentary habits.

The evils arising from *deficiency* of exercise to all the functions of the mind and body will now be equally evident and intelligible, for they are the converse of what we have seen to be the advantages of adequate exercise. The circulation, from want of stimulus, becomes languid, especially in the extreme vessels; the feebleness of action occasions little waste of materials, and little demand for a new supply; the appetite and digestion consequently become weak, respiration heavy and imperfect, and the blood so ill conditioned, that, when distributed through the body, it proves inadequate to communicate the stimulus requisite for healthy and vigorous action. The concatenation of causes and consequences thus exhibited, cannot fail, when the principle connecting them is perceived, to interest and instruct every thinking mind.

The time at which exercise ought to be taken is of some consequence in obtaining from it beneficial results. Those who are in perfect health may engage in it at almost any hour, except immediately after a full meal; but those who are not robust ought to confine their hours of exercise within narrower limits. To a person in full vigour, a good walk in the country before breakfast may be highly beneficial and exhilarating; while to an invalid or delicate person, it

will prove more detrimental than useful, and will induce a sense of weariness which will spoil the pleasure of the whole day. Many are deceived by the current poetical praises of the freshness of morning, and hurt themselves in summer by seeking health in untimely promenades.

In order to prove beneficial, exercise must be resorted to only when the system is sufficiently vigorous to be able to meet it. This is the case after a lapse of from two to four or five hours after a moderate meal, and, consequently, the forenoon is the best time. If exercise be delayed till some degree of exhaustion from the want of food has occurred, it speedily dissipates instead of increases the strength which remains, and impairs rather than promotes digestion. The result is quite natural; for exercise of every kind causes increased action and waste in the organ, and if there be not materials and vigour enough in the general system to keep up that action and supply the waste, nothing but increased debility can reasonably be expected.

For the same reason, exercise *immediately before meals*, unless of a very gentle description, is injurious, and an interval of rest ought always to intervene. Muscular action causes an afflux of blood and nervous energy to the surface and extremities; and if food be swallowed whenever the activity ceases, and before time has been allowed for a different distribution of the vital powers to take place, the stomach is taken at disadvantage, and, from want of the necessary action in its vessels and nerves, is unable to carry on digestion with success. This is very obviously the case where the exercise has been severe or protracted; and the consequence is so well known, that it is an invariable rule in the management of horses, never to feed them immediately after work, but always to allow them an interval of rest proportioned to the previous labour. "*Eat not*," therefore, "until you be fully reduced to that temper and *moderate heat* as when you began, and when the spirits are retired to their

proper stations."* Even instinct would lead to this conduct, for appetite revives after repose.

Active exercise ought to be equally avoided immediately *after* a heavy meal. In such circumstances, the functions of the digestive organs are in the highest state of activity; and if the muscular system be then called into considerable action, the withdrawal of the vital stimuli of the blood and nervous influence from the stomach to the extremities, is sufficient almost to stop the digestive process. This is no supposition, but demonstrated fact; and, accordingly, there is a natural and marked aversion to active pursuits after a full meal. In a dog, which had hunted for an hour or two directly after eating, digestion was found, on dissection, to have scarcely begun; while in another dog, fed at the same time and left at home, digestion was nearly completed.

A mere stroll, which requires no exertion and does not fatigue, will not be injurious before or after eating; but exercise beyond this limit is at such times hurtful. All, therefore, whose object is to improve or preserve health, and whose occupations are in their own power, ought to arrange these so as to observe faithfully this important law, for they will otherwise deprive themselves of most of the benefits resulting from exercise.

When we know that we shall be forced to exertion soon after eating, we ought to make a very moderate meal, in order to avoid setting the stomach and muscles at variance with each other, and exciting feverish disturbance. In travelling by a stagecoach, where no repose is allowed, this precaution is invaluable. If we eat heartily as appetite suggests, and then enter the coach, restlessness, flushing, and fatigue are inevitable; whereas, by eating sparingly, the journey may be continued for two or three days and nights with less weariness than is felt during one fourth of the time under full feeding I observed this when travelling as an invalid on rather low diet, and

* Maynwaringe, p. 141.

was surprised to find myself less fatigued at the end of seventy-two hours, than I had previously been, when in health and living fully, with half the journey; and I have heard the same remark made by others, also from experience.

It is the custom in many families and schools, apparently for the purpose of saving time, to take young people out to walk about the close of the day, because there is not light enough to do anything in the house. Nothing can be more injudicious than this plan; for, in the first place, exercise once a day is very insufficient for the young; and even supposing that it were enough, the air is then more loaded with moisture, colder, and proportionably more unhealthy, than at any other time; and, secondly, the absence of the beneficial stimulus of the solar light diminishes not a little its invigorating influence. For those, consequently, who are so little out of doors, as the inmates of boarding-schools and children living in towns, and who are all at the period of growth, the very best times of the day ought to be chosen for exercise, particularly as in-door occupations are, after nightfall, more in accordance with the order of nature.

By devoting part of the forenoon to exercise, another obvious advantage is gained. If the weather prove unfavourable at an early hour, it may clear up in time to admit of going out later in the day; whereas, if the afternoon alone be allotted to exercise, and the weather then proves bad, the day is altogether lost. In winter, indeed, it is not unusual for girls to be thus confined from Sunday to Sunday, simply because the weather is rainy at the regular hour of going out. When the muscular system is duly exercised in the open air early in the day, the power of mental application is considerably increased; while, by delaying till late, the efficiency of the whole previous mental labour is diminished by the restless craving for motion which is evinced by the young of all animals, and which, when unsatisfied, distracts attention, and leads to idleness in school. It would be well to copy in this respect the practice adopted in the in-

fant schools, where the children are turned out to play for a few minutes as soon as the wandering of mind and restlessness of body indicate that the one has been too much and the other too little exerted. After such an interval, work goes on briskly again, and every one is alive.

To render exercise as beneficial as possible, particularly in educating the young, it ought always to be taken in the open air, and to be of a nature to occupy the mind as well as the body. Gardening, hoeing, social play, and active sports of every kind, cricket, bowls, shuttlecock, the ball, archery, quoits, hide-and-seek, and similar occupations and recreations well known to the young, are infinitely preferable to regular and unmeaning walks, and tend in a much higher degree to develop and strengthen the bodily frame, and to secure a straight spine, and an erect and firm, but easy and graceful, carriage. A formal walk is odious and useless to many girls, who would be delighted and benefited by spending three or four hours a day in spirited exercise and useful employment.

Let those mothers who are afraid to trust to Nature for strengthening and developing the limbs and spines of their daughters, attend to FACTS, and their fears will vanish. It is notorious that a majority of those girls who, in opposition to the laws of Nature, are encased in stays, and get insufficient exercise, become deformed; an occurrence which is, on the other hand, comparatively rare in boys, who are left, in conformity with the designs of Nature, to acquire strength and symmetry from free and unrestricted muscular action. In a seminary for young ladies, for example, containing forty pupils, it was discovered, on examination, by Dr. Forbes, that *only two* out of those who had been resident in it for two years had straight spines; while out of an equal number of boys, imperfect as their exercise often is, it would be difficult to discover as many whose spines were not straight. Here, then, is ample proof, that stays and absence of exercise, so far from contributing to an elegant carriage,

are directly opposed to its acquisition; and that the absence of stays and indulgence in exercise, even when not carried so far as the wants of the system require, instead of being hurtful to the spine, contribute powerfully to its strength and security. Yet such is the dominion of prejudice and habit, that, with these results meeting our observation in every quarter, we continue to make as great a distinction in the physical education of the two sexes in early life, as if they belonged to different orders of beings, and were constructed on such opposite principles that what was to benefit the one must necessarily hurt the other. It is true that there are cases *of disease* in which the use of stays may be beneficially resorted to; but, so far from sanctioning their general employment, such cases are sufficient to prove, that, like every other remedy, they ought to be used only under the direction of the medical attendant.

Were there any real difficulty in determining the best means of developing the body and preventing deformity, the comparison of savage with civilized man would at once remove it. Mr. Henry Marshall, in his late excellent work "*On the Enlisting, the Discharging, and the Pensioning of Soldiers*," states, that "lateral curvature of the spine is intimately connected with civilized life. In the male sex, it occurs more frequently among boys who study very closely, clerks, and persons who exercise sedentary trades. The agricultural peasant is seldom affected with it, and *the tribes of people commonly denominated savage perhaps never*. I have had good opportunities of observing the form of the natives of India and of the Malay islands, and I do not recollect having seen a single case of this deformity among them."—P. 21. Mr. Marshall's testimony is strongly supported by an intelligent old author, who, in describing the Caribs 170 years ago, says, in a tone of regret, "They do not swaddle their infants, but leave them to tumble about at liberty in their little hammocks, or on beds of leaves spread on the earth in a corner of their huts; and, NEVERTHELESS, *their limbs do not become crooked*,

and their whole body is perfectly well made!" And again, "ALTHOUGH *the little creatures are left to roll about on the ground in a state of nudity, they* NEVERTHELESS *grow marvellously well*, and most of them become so robust as to be able to walk without support at six months old."*

The naïveté of this expression of surprise at the little Caribs growing *marvellously well* with the assistance of Nature alone, and without the use of stays and bandages imported from Europe, is extremely amusing, and shows to what extent prejudice and custom, once established, will continue to prevail, even where we have before our eyes the strongest evidence of their being hurtful. Our excellent author seems never to have allowed the thought to enter his head, that the Europeans *produced* the deformity by means of swaddling and bandages, and that the Caribs *escaped* it simply by avoiding its causes, and giving liberty to both limbs and trunk of the body.

It is mentioned of the Araucanian Indians, also, in Stevenson's Narrative of Twenty Years' Residence in South America, that "the children are never swaddled, nor their bodies confined by any tight clothing." "They are allowed to crawl about nearly naked until they can walk." "To the loose clothing," adds Mr. Stevenson, "which the children wear from their infancy, may doubtless be attributed the total absence of deformity among the Indians."—Vol. i., p. 9, 10.

Different kinds of exercise suit different constitutions. The object, of course, is to employ all the muscles of the body, and to strengthen those especially which are too weak: and hence exercise ought to be often varied, and always adapted to the peculiarities of individuals. Speaking generally, *walking* agrees well with everybody; but as it brings into play chiefly the lower limbs and the muscles of the loins, and affords little scope for the play of the arms and muscles of the chest, it is insufficient of itself to con-

* Histoire Naturelle et Morale des Isles Antilles. Rotterdam, 1658.

stitute adequate exercise; and hence the advantage of combining with it movements performed by the upper half of the body, as in rowing a boat, fencing, shuttlecock, and many other useful sports. Such exercises have the additional advantage of animating the mind, and, by increasing the nervous stimulus, making exertion easy, pleasant, and invigorating. Nature, indeed, has shown her intention that the upper part of the body should always partake in the exercise of the lower, by rendering it impossible for us even to walk gracefully without the arms keeping time, as it were, with the movements of the legs.

Pedestrian excursions, in pursuit of mineralogical or botanical specimens, or in search of scenery, combine in their results all the advantages which well-conducted exercise is capable of yielding, and are much resorted to in the German seminaries, for the purpose of developing the mental and bodily powers. On the Continent generally, more attention is paid to health in the education of the young than with us; and in many institutions a regular system of useful manual occupation is substituted for mere play, and with decided advantage. For not only is the physical organization thereby strengthened and developed, but the mental energy and dignity of character are increased, and the mind becomes better fitted for independent action. Among the ancients the training and invigoration of the body formed a leading object in education; but physical strength having become of less importance in war since the invention of gunpowder, the moderns have too generally restricted their attention to the direct improvement of the mind.

In summer, walking excursions to the Highlands of Scotland are common among the youth of our cities; and, when proportioned in extent to the constitution and previous habits of the individual, nothing can be more advantageous and delightful. But not a season passes in which health is not sacrificed and life lost by young men imprudently exceeding their natural powers, and undertaking journeys for which they are totally unfit. It is no unusual thing for youths, still

weak from rapid growth, and perhaps accustomed to the desk, to set out in high spirits at the rate of twenty-five or thirty miles a day, on a walking excursion, and (in consequence of carrying exercise, for days in succession, to the third degree, or that in which *waste exceeds nutrition*) to come home so much worn out and debilitated that they never recover. Young soldiers, whose growth is scarcely finished, are well known to die in great numbers when exposed to long and heavy marches, particularly when food is at the same time scanty. Violent exercise is not less pernicious, and, as well remarked by Dr. Johnson, "it did great harm even when nations were more in a state of nature than they now are. Galen, in his discourse on Thrasibulus, inveighs against the athletic practices of the gymnasium. A smart walk of a mile is to a valetudinarian what a furious wrestle would be to an athletic. If we trace those dreadful aneurismal affections of the heart and arteries in early life, we shall find their origins in violent exercise or sudden over-exertion, in nine cases out of ten, where age and ossification are not concerned."* Even a single day of excessive fatigue will sometimes suffice to interrupt growth and produce permanent bad health; and I know one instance of a strong young man, who brought on a severe illness and permanent debility by sudden return to hard exercise for a single day, although some years before he had been accustomed to every species of muscular exertion in running, leaping, and swimming. Many young men hurry on the premature development of consumption by excessive fatigue during the shooting season, in cases where, by prudent management, they might have escaped it for years, if not altogether. The principle already laid down, of not exceeding the point at which *exercise promotes nutrition and increases strength*, will serve as a safe guide on all occasions, and indicate the rate at which it may be extended. Old sportsmen know the rule by experience, and generally prepare themselves

* Johnson on Derangement of the Liver, &c., p. 129.

for the moors by several weeks of previous training. The science and judgment which fox-hunters display in preparing their horses for their future exertions in coursing are well known, and might be still more usefully applied by their riders to the training of their own families.

Since the above remarks appeared in the third edition of this volume, I have had occasion to examine carefully two young gentlemen, who, during their attendance at Cambridge, were in the habit of using very violent and continued exertion in rowing. In the one the muscles of the arm and upper part of the chest were of an almost unnatural size and hardness from excess of nutrition, while the rest of the body was only moderately developed. In the other there was no such disproportion, but there was a liability to palpitations and severe pain in the region of the heart, which, he said, were first brought on by excessive exertion. On cautioning him against the probable consequences of continuing such trials of strength as occurred during their frequent boat-races, he told me that, in looking back to his own companions at college, he could name several dead within the last four years whose lives were distinctly ascertained to have been sacrificed in this way; a fact strikingly corroborating Dr. Johnson's testimony, and which certainly ought to make a salutary impression in the minds of those who, in the pursuit of pleasure, rush so thoughtlessly into danger.

As the subject is one of much practical importance, I may add another melancholy but instructive example, with which a friend has furnished me, of the operation of the principles just inculcated. He says, "A young gentleman whom I knew was employed as a clerk in one of the banks in Edinburgh. He was closely confined to his desk during the summer, and towards the end of July had become weak and emaciated from deficient exercise in the open air. His strength continued to decline till Friday the 12th of August, when he went to shoot on Falkirk Moor. On Friday and Saturday he was much fatigued by exces-

sive and unusual exertion, and on Sunday evening was feverish and heated, and perspired much during the night. In this condition, he rose about three or four o'clock on Monday morning, and returned to Edinburgh on the top of a coach. When he reached home he felt very unwell, but went to the bank. At two o'clock he became so sick as to be unable to sit at his desk. He was then bled by a medical gentleman, but without much effect; and after passing three months in a feverish and sleepless condition, he died in the beginning of November. He was previously of a healthy constitution." It is more than probable that this young man's life became a sacrifice to his ignorance of the structure and functions of the human body.

Riding is a most salubrious exercise, and, where the lungs are weak, possesses a great advantage over walking, as it does not hurry the breathing. It calls into more equal play all the muscles of the body, and, at the same time, engages the mind in the management of the animal, and exhilarates by the free contact of the air and more rapid change of scene. Even at a walking pace, a gentle but universal and constant action of the muscles is required to preserve the seat, and adapt the rider's position to the movements of the horse; and this kind of muscular action is extremely favourable to the proper and equal circulation of the blood through the extreme vessels, and to the prevention of its undue accumulation in the central organs. The gentleness of the action admits of its being kept up without accelerating respiration, and enables a delicate person to reap the combined advantages of the open air and proper exercise for a much longer period than would otherwise be possible.

From the tendency of riding to equalize the circulation, stimulate the skin, and promote the action of the bowels, it is also excellently adapted as an exercise for dyspeptic and nervous invalids.

Dancing is a cheerful and useful exercise, but has the disadvantage of being used within doors, in confined air, and often in dusty rooms and at most un-

seasonable hours. Practised in the open air and in the daytime, as is common in France, dancing is certainly an invigorating pastime; but in heated rooms and at late hours, it is the reverse, and often does more harm than good.

Gymnastic and callisthenic exercises have been in vogue for some years, for the purpose of promoting muscular and general growth and strength, but they are now rather sinking in public estimation; entirely, I believe, from overlooking the necessity of adapting the kind and extent of them not only to the individual constitution, but to the natural structure of the body; the consequence of which has been, that some of the more weakly pupils have been injured by exertions beyond their strength, and discredit has thus been brought upon the system. It is certain, indeed, that some of the common gymnastic exercises are altogether unnatural and at variance with the design of the bodily organization; and that others are fit only for robust and healthy boys, and not at all for improving those who are delicately constituted, and who stand most in need of a well-planned training. It is impossible to enter minutely into this subject at present; but the best guide we can have is to follow the footsteps of Nature, and, before adopting any exercise, to consider whether it is in harmony with the mode of action assigned by the Creator to the parts which are to perform it. If it be so, we may proceed with perfect confidence that it will not only improve the health, but add to the freedom, elegance, precision, and strength of our movements; whereas, if it be opposed to the obvious intention of the Creator, we may rest assured that no good can accrue from it.

If, for example, we examine the various attitudes and motions of the body which occur in fencing, dancing, swimming, shuttlecock-playing, and some of the better class of gymnastic exercises, we find that they are not less graceful and beneficial to the young who engage in them, than pleasing to those by whom they are witnessed; just because they are in perfect harmony with Nature, or, in other words, with the

structure and mode of action of the joints, ligaments, and muscles by which they are executed. But it is far otherwise with some of the anomalous exercises which were at one time so fashionable, and which are not yet extinct in schools and gymnasia, and which seem to have for their chief object the conversion of future men and women into foresters, firemen, or savages, rather than into beings who are to continue to have the use of stairs, ladders, carriages, steamboats, and the other conveniences of civilized life. It is no doubt a good thing for a boy to be able to climb up a perpendicular pole or a slippery rope, when no other means present themselves of attaining an important object at its upper end; and it is an equally good thing for a young lady to be able to sustain her own weight hanging by one or both hands, when there is no possibility of resting her feet on *terra firma;* and where boys and girls are strong enough to take pleasure in such amusements, there is no great reason to hinder them, provided they are impelled to them, not by emulation or any secondary motive which may lead to over-exertion, but by the pure love of the exercise itself. In all ordinary circumstances, those only who are vigorously constituted will attempt them, and, if left to themselves, will be sure to desist before any harm can be done. But the case is entirely altered when such extraordinary evolutions are not only encouraged, but taught to all indiscriminately, whether they be strong or weak, resolute or timid. We have only to reflect for a moment on the structure of the shoulder-joint, and on the sphere of action of the muscles surrounding it, to perceive at once that the position of the one and the strain upon the other, caused by the exercises alluded to, are so *forced* and *unnatural* as to exclude the possibility of the Creator having intended either to be practised except upon occasions of urgent necessity, and to discover how preposterous it is, therefore, to make them a subject of general instruction. Nay, the very violence of the effort required to sustain the body when hanging by the hands is far beyond that moderate exertion

which adds to nutrition and to strength; and in delicate subjects it may even induce relaxation and stretching of the ligaments and bloodvessels, and thus, as in the case of the young men at Cambridge, lay the foundation for future and fatal disease. The same remarks apply to a common practice of making the pupils slide down an inclined plane resting on the hands alone, by which unnatural effort the shoulders are pushed half way up the neck, and the wrists, arms, and chest severely tried. But in these and other similar evolutions, it requires only to look at the dragging and distortion which they produce, and which form such a painful contrast to the ease and grace of all natural motions and attitudes, to perceive that they are *out of the order of Nature*, and that neither health nor elegance can result from them.

I am aware that these exercises are said to stretch the spine and to remedy its deformities; but it would be quite as sound logic to maintain, that, because a *broken* leg requires to be tied up with splints and bandages, therefore the best way to strengthen a *sound* leg must be to bandage it also; as to infer, that, because a few *diseased* spines require to be stretched, therefore all *healthy* spines must also derive benefit from the same process; although, in the latter case, it is obvious to reason that the stretching will be much likelier to put the bones out of their places than to fix them more firmly in those which they already occupy. It is not by such extravagant means that a soldierlike carriage is obtained in the army, and yet there the uniformity of result, the erect and steady gait, is scarcely less remarkable than the discordant materials and variety of slouching and awkward attitudes out of which it is formed, by perseverance in a rational system of drilling.

In the selection of exercises for the young, then, we should not be misled by a vain desire of surmounting difficulties and performing feats at the serious risk of inducing aneurism or rupture, but rather endeavour to strengthen the body by active amusements, which shall call the social and moral feelings and intellect

into play at the same time, and by the practice of such gymnastic evolutions only as tend to improve and give tone to the *natural action* of the moving powers. And in endeavouring to attain this object, we should be always careful to avoid great fatigue, and to modify the kind, degree, and duration of the exercise, so as to produce the desired results of *increased nutrition and strength;* and to remember that the point at which these results are to be obtained is not the same in any two individuals, and can be discovered only by experience and careful observation.

For giving strength to the chest, *fencing* is a good exercise for boys, and what is called the *club exercise* for females; but the above limit ought never to be exceeded, as it often is, by measuring the length of a lesson by the hourhand of a clock, instead of its effects on the constitution. *Shuttlecock*, as an exercise which calls into play the muscles of the chest, trunk, and arms, is also very beneficial, and would be still more so were it transferred to the open air. After a little practice, it can be played with the left as easily as with the right hand, and is, therefore, very useful in preventing curvature and giving vigour to the spine in females. It is an excellent plan to play with a battledore in each hand, and to strike with them alternately. The play called the *graces* is also well adapted for expanding the chest, and giving strength to the muscles of the back, and has the advantage of being practicable in the open air.

Dumb-bells are less in repute than they were some years ago; but when they are not too heavy, and the various movements gone through are not too eccentric or difficult, they are very useful. They do harm occasionally from their weight being disproportioned to the weak frames which use them; in which case they pull down the shoulders by dint of mere dragging. When this or any other exercise is resorted to in the house, the windows ought to be thrown open, so as to make the nearest possible approach to the external air.

Reading aloud and recitation are more useful and in-

vigorating muscular exercises than is generally imagined, at least when managed with due regard to the natural powers of the individual, so as to avoid effort and fatigue. Both require the varied activity of most of the muscles of the trunk to a degree of which few are conscious till their attention is turned to it. In forming and undulating the voice, not only the chest, but also the diaphragm and abdominal muscles, are in constant action, and communicate to the stomach and bowels a healthy and agreeable stimulus; and, consequently, where the voice is raised and elocution rapid, as in many kinds of public speaking, the muscular effort comes to be even more fatiguing than the mental, especially to those who are unaccustomed to it, and hence the copious perspiration and bodily exhaustion of popular orators and preachers. When care is taken, however, not to carry reading aloud or reciting so far at one time as to excite the least sensation of soreness or fatigue in the chest, and it is duly repeated, it is extremely useful in developing and giving tone to the organs of respiration and to the general system. To the invigorating effects of this kind of exercise, the celebrated and lamented CUVIER was in the habit of ascribing his own exemption from consumption, to which, at the time of his appointment to a professorship, it was believed he would otherwise have fallen a sacrifice. The exercise of lecturing gradually strengthened his lungs and improved his health so much that he was never afterward threatened with any serious pulmonary disease. But, of course, this happy result followed only because the exertion of lecturing was not too great for the then existing condition of his lungs. Had the delicacy of which he complained been farther advanced, the fatigue of lecturing would only have accelerated his fate; and this must never be lost sight of in practically applying the rules of exercise.

It appears, then, from the foregoing remarks, that the most perfect of all exercises are those sports which combine free play of all the muscles of the body, mental excitement, and the unrestrained use of the

voice; and to such sports, accordingly, are the young so instinctively addicted, that nothing but the strictest vigilance and fear of punishment can deter them from engaging in them the moment the restraint of school is at an end. Many parents, absorbed in their own pursuits, forgetful of their own former experience, and ignorant that such are the benevolent dictates of Nature, abhor these wholesome outpourings of the juvenile voice, and lay restrictions upon their children, which, by preventing the full development of the lungs and muscles, inflict permanent injury upon them in the very point where, in this climate, parents are most anxious to protect them. In accordance with this, we find that what are called wild romping boys or girls, or those who break through all such restrictions, often turn out the strongest and healthiest; while those who submit generally become more delicate as they grow older.

Enough has, I trust, been said to enable any rational parent or teacher to determine the fitness of the different kinds of muscular exercise, and to adapt the time, manner, and degree of each to every individual under his care; but, before taking leave of the subject, and with a view to impress the more deeply upon the mind of the reader the practical importance of the principles inculcated in the preceding pages, I cannot refrain from subjoining a case which affords an extremely apposite illustration of almost every one of them. The particulars were furnished to me by a young friend who was allowed to peruse the manuscript of these pages, and who, as himself the subject of the case, was struck with the perfect accordance between his own experience and the doctrines here expounded. It is proper to keep in view, that, at the time of his experiment, my friend was about seventeen years of age, and growing rapidly. I shall use nearly his own words.

After having passed the winter, closely engaged in a sedentary profession, and accustomed to much exercise, he was induced, by the beauty of returning spring, to dedicate a day to seeking enjoyment in a country excursion; and for that purpose set off one

morning in the month of May, without previous preparation, to walk to Haddington by way of North Berwick, a distance of thirty-four miles. Being at the time entirely unacquainted with the principles of physiology, he was not aware that the power of exerting the muscles depended in any degree upon the previous mode of life, but thought that, if a man were once able to walk thirty miles, he must necessarily continue to possess the same power, under all circumstances, while youth and health remained. The nervous stimulus arising from his escape from the desk, and from the expected delights of the excursion, carried him briskly and pleasantly over the ground for the first twelve miles, but then naturally began to decrease. Unfortunately, the next part of the road lay through a dull, monotonous, and sandy tract, presenting no object of interest to the mind, and no variety of any description; so that the mental stimulus, already greatly impaired in intensity, became still weaker. Being *alone*, his intellect and feelings could not be excited by the pleasure of companionship and conversation; weariness consequently increased at every step; and long before his arrival at North Berwick (twenty-five miles), "every vestige of enjoyment had disappeared, time seemed to move at a marvellously tardy pace, and every mile appeared doubled in length."

Not being aware that excessive exercise, without a succeeding period of repose, is unfavourable to digestion, and having a lively recollection of the pleasure and refreshment consequent upon eating a good dinner with an appetite whetted by a *proper* degree of bodily labour in the open air, he looked forward with confidence to some recompense and consolation for his toils when dinner should make its appearance. In this, however, he was doubly disappointed; for, from having started with too light a breakfast, and walked so far, his digestive organs were, in common with every part of his system, so much impaired, that he looked upon the viands placed before him almost without appetite; and as they were in themselves not remarkably nutritive or digestible, he infringed still

further that condition of muscular action which consists in a full supply of nourishing arterial blood, made from plenty of nutritious food; a condition which I have stated to be essential, especially in youth and during growth.

After a rest of two hours, and taking a moderate allowance of wine, which, however, he says, "seemed to have lost its ancient virtue of imparting cheerfulness to the human heart," he set out to complete the remaining nine miles to Haddington. The country was more beautiful and varied, but the charms of Nature had, by this time, lost all attractions, for our pedestrian was "now wholly occupied in counting the tedious miles yet to be traversed, and in making a pious vow that this *pleasure excursion*, though not the first, should certainly be the *last* in his life." Being reduced to the utmost degree of exhaustion, it required an extraordinary effort to persevere; but at last he arrived at Haddington, in a state of exquisite misery. Unable to read from fatigue, and having nobody to converse with, he sought refuge in bed at an early hour, in the expectation that "tired Nature's sweet restorer, balmy sleep," would visit his couch and bring him relief. But, in accordance with what is mentioned on page 128, he tossed and tumbled incessantly till four in the morning, a period of seven hours, after which sleep came on. Next day my youthful friend returned home in the stagecoach, wiser at least, if not happier, for his pleasure excursion; and now makes the observation, that if he had been instructed in the least degree in the nature of the human constitution, he would never, for a moment, have entertained an expectation of enjoyment from a proceeding so utterly in defiance of all the laws of exercise, as that of which he reaped the unpalatable fruits. He adds justly, that the number of young men who suffer in a similar way is by no means small, and that he has reason to be thankful that he has not, like some of his companions, carried his transgressions so far as permanently to injure health, or even sacrifice life.

My aim being practical utility, I have said nothing in this place on the subject of what are called the *Involuntary* Muscles, or those over which the will has no power, in contradistinction to the *Voluntary*, or those which obey the direction of the will. Most of the involuntary muscles are the agents of important vital functions, which are carried on by them unconsciously to ourselves, and which it would have been dangerous to leave under our control. The chief of them is the heart, which goes on in one unvarying round of alternate contraction and relaxation, from the commencement till the close of existence. The next in importance are those connected with respiration, which, like the heart, continue to act by night and by day for the whole period of a long life, without weariness and without interruption. The muscular fibres of the stomach, bowels, and other viscera, are excellent examples of the same class; and the beneficence of Providence in withdrawing them from our control cannot be sufficiently admired. Had the action of the heart and respiratory muscles depended on the will, as that of the muscles of locomotion does, the circulation of the blood and the process of breathing would both have ceased whenever sleep or any other cause overcame the power of attention, and life would, in consequence, have been extinguished.

From the different constitution of the voluntary and involuntary muscles, it is clear that the former were designed for alternate activity and repose. Had it so pleased the Creator, he could as easily have rendered the one set of muscles incapable of fatigue, as he has actually rendered the other; but then the powers of man would not have been in harmony with the purpose of his existence. Incessant muscular activity would not only have been incompatible with the highest human enjoyment, that arising from the gratification of the moral and intellectual faculties, but it would have lacked objects on which to expend itself usefully, and, unguided by intellect, would only have served to overturn and destroy the best provisions of Nature for our happiness.

CHAPTER VI.

THE BONES, THEIR STRUCTURE, USES, AND CONDITIONS OF HEALTH.

The Bones essential to Motion, and to the security of the Vital Organs.—The Skeleton.—Bones are composed of Animal and of Earthy Matter.—The Animal Part the Seat of their Vitality.—The Proportions between these vary at different Periods of Life.—Vessels, Nerves, Life, Growth, and Decay of Bones.—Advantages of their Vitality and Insensibility.—Their adaptation to contained Parts.—Conditions of Health.—Necessity of Exercise.

The hardness, strength, and insensibility which form the distinguishing properties of healthy bones, fit them in a remarkable degree for serving as a basis of support to the softer and more active textures of the body. By their means, the human frame is enabled to unite the most finished symmetry of form with the most perfect freedom of motion and security to life.

Some of the bones, such as those which compose the scull and the socket for the eye, are designed exclusively for the protection of important organs contained within them. But by far the greater number are constructed with a direct reference to voluntary motion, and serve only incidentally the purposes of protection.

In proportion to the variety of movements which any piece of mechanism is required to perform, its component parts must be numerous and varied. Considered in this light, the animal frame is the most wonderful of all combinations of machinery. No production of art can be compared with it for the multiplicity and nicety of its evolutions; and yet all these are executed simply by muscular power, acting upon the bones or other parts, and changing their relative positions.

The incalculable variety of movements required from man, is the reason why the bones composing the skeleton are so numerous, and each so admirably connected with the others by articulations, constructed so as to admit of precisely that kind of motion which the animal requires of it, and of no other. The advantages of this arrangement are not less obvious than admirable. Had the osseous framework consisted of one entire piece, not only would man and animals have been incapable of motion, but every external shock would have been communicated undiminished to the whole system. Whereas, by the division of its parts, and by the interposition of elastic cartilages and ligaments at the joints, free and extensive motion is secured, and the impetus of every external shock is deadened in its force and diffused over the body, in the same way as, to a person riding in a carriage, the jolt of the wheel passing over a stone is diminished by being equally diffused over the whole vehicle, in consequence of the elasticity of the springs. The safety imparted by this arrangement to the delicate and important vital organs, is apt to be lost sight of from the very smoothness with which it enables us to move along; but it will be perceived if we reflect on the shock given to the whole system by taking a single false step in going up or down stairs. The parts have then no time to adapt themselves to the exigencies of the moment, and to put the proper springs in play for the equal distribution of the impetus. Death has been occasioned by accidents of this kind.

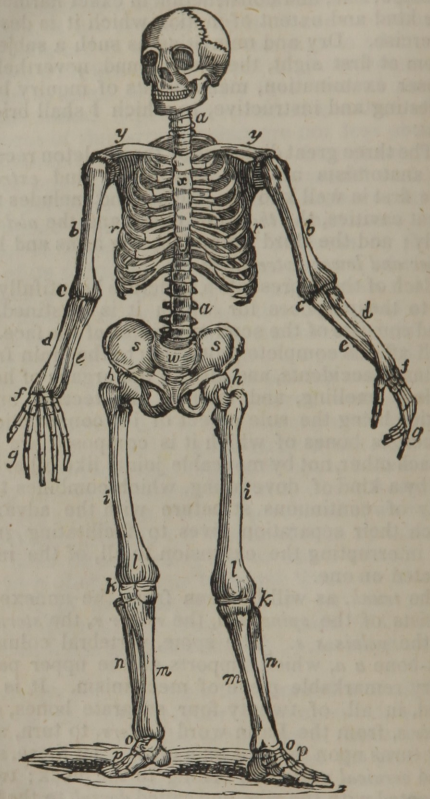
The fabric resulting from the connexion of all these pieces, in their natural order of arrangement, is called the *Skeleton*. When the connexion is maintained by means of the ligaments which bound the pieces together during life, the whole is called a *natural* skeleton; but if the place of the ligaments be supplied by wires, the skeleton is then said to be *artificial*. The bones entering into the composition of the human skeleton exceed 200 in number. Each is separated from, but intimately connected with, the rest; and of

a shape, size, and construction in exact harmony with the kind and extent of motion which it is destined to exercise. Dry and uninviting as such a subject may seem at first sight, there are found, nevertheless, on closer examination, many points of inquiry both interesting and instructive, to which I shall briefly advert.

The three great divisions of the skeleton recognised by anatomists are the *head*, *trunk*, and *extremities*. The first is well known; the second includes the two great cavities, the *thorax* or chest, and the *abdomen* or belly; and the third comprises the arms and legs, or *upper and lower extremities*.

Each of these presents a structure beautifully adapted to the purposes for which it is destined. The head consists of the scull and bones of the face. The scull affords complete protection to the brain from all ordinary accidents, and also to the organs of hearing, seeing, smelling, and tasting. Protection and not motion being the sole object of its construction, the numerous bones of which it is composed are joined to each other, not by moveable joints like other bones, but by a kind of dovetailing, which combines the solidity of continuous structure with the advantages which their separation gives to facilitating growth, and interrupting the extension to all, of the injuries inflicted on one.

The *trunk*, as will be seen from the annexed cut, consists of the *spine a a*, the *ribs r r*, the *sternum x*, and the *pelvis s s*. The spine, vertebral column, or back-bone *a a*, which supports all the upper parts, is a very remarkable piece of mechanism. It is composed, in all, of twenty-four separate bones, called *vertebræ*, from the Latin word *vertere*, to turn, as the body turns upon them as on a pivot. Of these, seven, called *cervical* vertebræ, belong to the neck; twelve, connected with the ribs, and called *dorsal*, to the back; and five, called *lumbar*, to the loins. The base of the column rests on the *sacrum w*, which is closely compacted between the bones of the pelvis *s s*. The vertebræ are firmly bound to each other in such a way as



to admit of flexion and extension, and a certain degree of rotation, while, by their solidity and firm attachment to each other, great strength is secured. Some conception of this strength may be formed when we

consider the enormous loads which some athletic men are able to carry on their shoulders, or raise in their hands; the whole weight of which is necessarily borne by the vertebræ of the loins. As the space occupied by the abdomen gives large outward dimensions to this region of the body, it is only upon reflection that we perceive that the whole force exerted by the human frame in its most strenuous efforts centres in the bony column we are now examining.

While the smooth or rounded forepart or *body* of the vertebræ affords support to the superincumbent parts, the projecting ridge behind and rugged processes at the sides combine with it to form a large tube or canal, extending from the top to the bottom of the column, and in which the spinal marrow is contained and protected. Between each of the vertebræ a thick compressible cushion of cartilage and ligament is interposed, which serves the triple purpose of uniting the bones to each other, of diminishing and diffusing shocks received in walking or leaping, and of admitting a greater extent of motion than if the bones were in more immediate contact.

The ribs *r r*, twelve in number on each side, are attached by their heads to the spine, and by their other (cartilaginous) extremities to the *sternum* or breast-bone *x*. The seven uppermost are called true ribs, because each of them is connected directly with the sternum by means of a separate cartilage. The five lower ribs are called *false*, because one or two of them are loose at one end, and the cartilages of the rest run into each other instead of being separately prolonged to the breast-bone. The use of the ribs is to form the cavity of the chest for the reception and protection of the lungs, heart, and great bloodvessels, and to assist in respiration by their alternate rising and falling. This action enlarges and diminishes by turns the size of the chest and the capacity of the lungs.

The *pelvis s s*, is formed by the broad, flat bones which support the bowels, and serve for the articulation of the thigh. A general notion of their appear-

ance and uses may be obtained from inspection of the cut, which, however, does not represent with perfect accuracy the minuter structure.

The bones of the *upper extremities* are, the *scapula* or shoulder-blade; the *clavicle* or collar-bone *y;* the *humerus* or arm-bone *b;* the *radius d*, and *ulna e*, or bones of the forearm; and the small *carpal* and *metacarpal* bones *f* and *phalanges g*, forming the wrist, hand, and fingers.

The *scapula* is the broad flat bone lying at the upper part of the back, familiarly known as the shoulder-blade, and so troublesome to many young ladies by its unseemly projection. It serves to connect the arm with the trunk of the body, and gives origin to many of the muscles by which the former is put in motion. The *collar-bone y* extends from the breast-bone outward to the scapula. Its chief use is to prevent the arms from falling forward in front of the body; and hence it is wanting in the lower animals, whose superior extremities are much closer to each other than those of man.

The *humerus*, or arm-bone *b*, is adapted by a kind of ball and socket joint to a corresponding surface in the scapula, and hence enjoys great latitude of motion, and, from the shallowness of the receptacle, is somewhat liable to dislocation. The *radius* and *ulna d e* constituting the forearm, are connected with the humerus by a hinge-like joint, which admits readily of flexion and extension, but not of rotation; and as the articulation is of a peculiar construction, it is rarely dislocated. The movements of pronation and supination, or turning round the hand, are effected, not by the elbow-joint, but by the radius *d* moving upon the ulna *e*, by means of joints formed for this purpose. The wrist and finger-joints are too complicated to admit of explanation here.

The lower extremities consist of the *os femoris* or thigh-bone *i;* the *patella* or knee-pan *l;* the *tibia m*, and *fibula n*, or leg bones; and the *tarsal and metatarsal* bones *o*, and *phalanges p*, composing the ankle, foot, and toes.

The thigh-bone *i* is articulated by means of a large round head deeply sunk into a corresponding hollow in the pelvis at *h*; freedom of motion being thus combined with greater security. The thigh may be moved backward and forward, as in walking; and also outward and inward, as when sitting on horseback, or with the legs crossed. The socket being much deeper than that of the shoulder-joint, the thigh-bone has not the same range of motion as the humerus, but it has proportionally greater security.

The *patella*, or kneepan *l*, is well known. It is a small bone constituting the projection of the knee. It increases the power of the muscles which extend the leg, and protects the front of the knee-joint. The *tibia m* is the principal bone of the leg, and is the only one articulated with that of the thigh. Its lower end forms the projection at the inner ankle. The *fibula n* is the long slender bone at the outer side of the leg, the lower end of which forms the outer ankle. The *tibia* and *fibula* both contribute to the formation of the ankle-joint, which, like that of the knee, is almost limited to flexion and extension.

The tarsal bones constituting the foot display an admirable mechanism, but without plates any description of them would be unintelligible. My present aim being practical utility, I shall, therefore, pass over these details, and rather lay before the reader several considerations of a more general and directly useful nature.

Bones consist of two kinds of substances, viz., those of an animal and those of an earthy nature. To the former belongs everything connected with the life and growth of bones, and to the latter the hardness and power of resistance by which they are characterized.

The animal portion of bones constitutes, according to the analysis of Berzelius, about 32.17 per cent. of their substance, and consists chiefly of albumen, gelatine, cellular membrane, bloodvessels, nerves, and absorbents. Of the remaining 67 per cent. of earthy

matter, nearly 52 parts consist of phosphate, and 11 of carbonate, of lime. The relative proportions of the animal and earthy constituents vary, however, according to the period of life. In infancy, the animal portion greatly predominates, and, consequently, the bones are at that age comparatively soft, yielding, and elastic. In middle life, the portions are more equally balanced, and while the bones thereby acquire great hardness and solidity, they still preserve some elasticity. In old age, on the contrary, when the earthy constituents predominate, they become dry, brittle, and comparatively lifeless.

If a bone be subjected for a time to the action of muriatic acid, the earthy portion is gradually decomposed, and a cartilaginous-looking substance of the exact shape and size of the bone is procured, which is in reality its animal constituent. If, on the other hand, the bone be subjected to the action of fire, which decomposes and dissipates the animal elements, but scarcely affects the earths, a white, light, easily crumbled mass, of the shape and appearance of the original bone, is procured, which is simply the earthy part of bone, deprived of its connecting membrane. The latter is called the *animal* constituent of the bone, because it is the product of animal life, and does not exist in nature, except in the system of animals; and the former is called the *earthy* constituent, because it may and does exist in nature, without relation to life.

A very important purpose is served by the different proportions which the animal elements of bone bear to the earthy at different ages. In early youth, when much strength is not wanted, as the body is never exposed to severe efforts, but when a great *growth* of bone is required to complete the development of the human frame, the animal or living part of the bone is observed to preponderate. But in middle life, when growth is finished, and the powers of resistance are at their maximum, and when nutrition is required only to repair waste, a larger proportion of the solid or earthy, and a smaller proportion of the vital constituents, become necessary. In old age,

again, when the wants of the system are reversed, and when positive diminution of existing masses is required to put the frame into harmony with the shrunk muscles and feebler powers of life, the absorbent vessels carry away more of the vital matter, leaving chiefly the earthy, which, being less susceptible of change, requires scarcely any support from within; and hence the brittle and compact hardness of the bones, and their little capability of uniting when fracture happens at an advanced period of life.

At birth many of the bones are, properly speaking, of a cartilaginous nature. As ossification advances, the cartilage is removed by the absorbents, and its place supplied by a kind of cellular membrane, in the interstices of which the earthy particles are deposited; the two forming, by their union, the homogeneous whole called Bone. Although, therefore, it is to the softer material alone that vital properties essentially belong, it is usual to speak of the life, the vessels, and the nerves of bones, as if life belonged equally to the earthy and animal portions. This is correct enough in reality, because the union between the earthy and animal tissues is always the product of life; and the parts thus united are, to all intents and purposes, living parts.

To carry on the processes of waste and renovation, by which every living structure is distinguished, all parts of the body are provided, 1st, with arteries conveying to them red or nutritive blood; 2dly, with exhalants, by which the new matter is deposited, and which are believed to be the minute terminations of the arteries; 3dly, with veins, by which the blood is carried back to the heart; 4thly, with absorbent vessels, which take up and carry away the waste particles to be thrown out of the system; and, lastly, with nerves to supply all these vessels and the organs on which they are distributed, with that nervous energy which is essential to their vitality, and to their connexion with other parts of the system. The bones, insensible as they may seem, possess all these attributes of living and organized parts. They are all

provided with bloodvessels, with nerves, and with exhaling and absorbing vessels; and they are constantly undergoing the same process of decay and of renovation, to which all other living parts are subjected.

That bones are provided with bloodvessels, is shown by the fact, that anatomists are able to trace these vessels into their substance, and to inject those of a young subject with wax, so minutely as to make the bones appear of a lively red colour. That they are provided also with nerves, is evident, both from dissection and from the effects of injuries and disease. A healthy bone may be cut or sawed across without causing pain; but when the same bone becomes inflamed, the most excruciating torture is felt. And, as sensation is the exclusive attribute of the nervous system, this fact alone would authorize us to assume their existence, even although nervous fibres could not be traced entering the osseous substance.

That the substance of the bones is continually undergoing a change, and that, while the old particles are withdrawn by absorbents, new particles are constantly deposited by the nutrient or exhalant vessels, is abundantly proved by the often-repeated experiments of Duhamel. If madder be mixed with the food of fowls for a few days, and the fowls be then killed, the colouring matter deposited by the nutrient vessels will invariably be found to have died the bones of a deep red; and if the madder be withdrawn, the bones will then be found to be less and less red in proportion to the length of time which has been allowed to elapse—evidently showing that waste and renovation are constantly going on.

It may be thought that bones are, in their very essence, so hard and durable, as to render any such supply of nourishment and change of parts altogether unnecessary. But if we look for a moment to the advantages consequent upon this order of things, we shall see abundant cause to reject such an opinion.

It is only by means of the processes of growth and renewal that the bones can adapt themselves to the

wants and state of the system. If the bones were not endowed with the principle of life, the stature of the infant must have been that of the future man. Or even supposing the osseous system to have grown to maturity, and then remain unchanged, the withered form of old age would necessarily have been oppressed and overcome by the large and massive bones which the vigorous muscles of manhood alone can easily put in motion. Had the bones been created unsusceptible of internal change and unendowed with life, it is obvious that, when broken by accident, they must have remained for ever disunited, and therefore an encumbrance instead of an assistance to the animal. But, from possessing bloodvessels of their own to supply them with nourishment, and nerves to give power of action to those bloodvessels, the very irritation of the broken end is made to serve the purpose of increasing the vital powers of the injured parts, and producing that excitement which is necessary for the formation of a new bond of union, and for filling up the gap that would otherwise have remained.

In a state of health, the bones are insensible to pain; and here also the more provident benevolence appears. For, surrounded as they are by the softer and more sensitive parts, these afford them ample protection, while their insensibility enables them to act, for any length of time, without weariness or pain. But when a severe accident occurs to break them asunder or destroy their texture, pain then becomes their kindest guardian, and the surest promoter of their recovery. In such circumstances, indeed, nothing can be more truly benevolent than pain. It accompanies that inflammation and vascular activity, without which the work of reunion of the broken part cannot be accomplished; and is the means of securing the repose and quietude which are essential to the exact adaptation of the parts to each other, and which can be effected only by causing great pain to follow even the slightest motion. Of such utility is inflammation on these occasions, that when, as sometimes happens, the requisite degree of it, from want of ner-

vous sensibility in the part, does not take place, and the bone remains ununited for many weeks, surgeons are in the habit of using violence to produce the necessary stimulus. In this case, they either rub the broken ends rudely against each other, or introduce an instrument between them, by which pain and irritation may be excited, and then reunion is accomplished. On the other hand, if pain did not guard the limb from motion when the process of recovery is going on, the union would be incessantly disturbed by every heedless and unavoidable start altering the relative position of the parts. This, also, is occasionally exemplified in practice. Looking at these facts, it is impossible not to admire the wisdom and the benevolence manifested in the adaptation of the structure of bones in every particular to the circumstances and occurrences of life.

Another advantage arising from the vitality of bones, is their susceptibility of change without injury to life. Thus it frequently happens, that, in infancy, water collects within the head in considerable quantity; but, in consequence of the law that the form of the scull accommodates itself to the form and dimensions of its soft contents, the bones yield to the pressure from within, become larger, and, by forming a larger cavity, permit the brain to execute its functions, and life to go on; whereas, had the scull been incapable of undergoing change, death would have to a certainty ensued. The scull owes this power of adaptation entirely to its possessing vessels and nerves, and to its undergoing a constant decay and renewal, like the other parts of the system.

The same phenomena are exhibited by the bones of the chest. When tumours arise, or collections of fluid take place within that cavity, there is a constant effort on the part of nature to take advantage of this constitution of the bones, and to cause them so to expand as to save the lungs and heart from hurtful pressure, and allow respiration and circulation to go on unimpaired.

In the opposite circumstances of diminished volume

of the soft contents of the cavities, the same law enables the bone to decrease in a corresponding proportion, and, consequently, to continue the protection which it affords to its contained organs. Thus, were the bone to remain unaltered, when, in cases of disease and in old age, the brain diminishes in size, the cavity of the scull would be only partially filled, and the brain, so far from being protected, would be jolted backward and forward, upward and downward, by every motion of the head or body, till its structure should be utterly destroyed, and life itself extinguished.

To those who are unacquainted with the laws of nutrition of organized bodies, and who are accustomed to notice the hard and unyielding nature of bone, without having any adequate perception of the particular uses of the adaptation of the hard to the soft parts, this adaptation may seem strange and improbable; but a little consideration will satisfy every one that it could not have been otherwise.

In infancy, when the lungs are imperfectly developed, the chest is narrow, flat, and confined, and the ribs almost in close juxtaposition. In youth and in middle age, when force and activity require fulness and vigour of respiration, the lungs enlarge, and to give them scope, the chest becomes full, broad, and capacious. In old age, again, when the season of active exertion is over, and the strength decays, the broad shoulders and capacious chest of manhood gradually disappear, and a totally different form occupies its place. Now, at all these periods, the *bones* are the parts which, by their alteration, serve as an index of the changes going on within; and, on this large scale, the difference in their form is so great that it must be obvious to all.

Where the whole of the soft contents of a bony cavity increase in size, as happens in the case of water in the head, the result is, as already mentioned, an expansion from interstitial growth of the osseous covering. But where the tumour or pressure is limited to a small part, a process of a different kind often

takes place, which also has the preservation of life for its object, and which is accomplished by another of the natural actions—absorption. When a bone, say of four inches square, is required gradually to expand itself so as to protect a surface of six inches, or of double the extent, this is accomplished by the gradual removal of the old, and the deposition of new and additional particles, on, as it were, a new and enlarged mould. But in the other case, where the pressure is very limited—where, for instance, a small tumour develops itself on the surface of the brain, which, if allowed to grow within unyielding walls, would soon cause death by pressure on the brain—the ordinary process of absorption becomes greatly excited, and gradually eats away the whole thickness of the bone over the tumour, which then protrudes externally, and relieves the brain within from pressure, which would have been fatal to it.

I have already stated, that, besides a large proportion of earthy matter, which gives to them dryness and hardness, bones contain a large quantity of animal matter, which is essential to their constitution. In early life, this cartilaginous matter preponderates, and the bones are consequently less heavy, more pliable and elastic, and possessed of greater vitality. In old age, again, the earthy parts predominate, and with them fragility, insensibility, and a lower degree of life. It is from this difference that bones broken in youth reunite in one third of the time necessary for their reunion in advanced life.

In some unhealthy states of the system, the proportion of earthy matter is greatly diminished, and in some parts it is even altogether removed. The bones become soft, compressible, and incapable of affording protection or support to the other parts, to such a degree that instances have occurred in which the lower extremities could be twisted behind, as if made of wire. A slighter degree of the same affection is common in weak, rickety children; and hence the deformity of limbs, so often occurring from absolute

insufficiency of the bones to support the weight of the body.

The practical application to be made of our knowledge of the constitution of the bones, as parts of our animal frame, and as governed by the ordinary organic laws, will now be obvious. Their health we have seen to depend on the regular supply of nourishment by the bloodvessels, on a due supply of nervous energy by the nerves, and on a due balance between the action of the nutrient and absorbent or removing vessels. To the steady fulfilment of these conditions, therefore, we are bound to attend.

It is a common fault to consider the study of an organ or function complete, when we have viewed it on all sides as an isolated part, without regarding its external relations as constituting an essential portion of its history. Thus, although we examine the structure and functions of the heart, and see that it is a muscle, and that its office is to contract, our knowledge is incomplete if we do not go still further, and see that *blood* is the stimulant which causes the contractile power to act. And in like manner with the eye, whose relations to light are as essential a part of its constitution as the transparency of its membranes or the convexity of its lens. Now, in the case of the bones, we are apt to describe their hardness, their mobility, and other qualities, without sufficiently adverting to the fact that, being organs of support and resistance, the frequent and regular performance of a full but not excessive amount of their duties is as essential to their wellbeing as blood is to the heart, air to the lungs, or light to the eyes. And, accordingly, when that condition is not fulfilled, the bones become feeble, diseased, and unfit for their functions, just as the softer parts of the body do. In practice, it is of the utmost importance to be fully aware of this fact.

It is familiar to the professional mind, that a part deprived of that exercise or action which nature destined it to fulfil, becomes weakened, diminishes in size, and at last shrivels and alters so much in appearance as not to be recognisable. Thus, if an ar-

tery—the large artery which supplies the arm with blood, for example—be tied, and the flow of blood obstructed, a change of structure immediately begins, and goes on progressively, till, at the end of a few weeks, what was formerly a hollow elastic tube presents the appearance of a ligamentous inelastic cord. A muscle condemned to inaction is speedily reduced to half its original bulk; and, if long unexercised, at last loses entirely its power of contraction and muscular appearance. The same rule holds with all other parts of the system, and, in an especial manner, even with the hard and apparently unalterable fabric of the bones. It is ascertained by extensive experience, that complete inaction, besides diminishing the size of bone, injures its structure so much as to deprive it of hardness, and render it susceptible of being cut with a knife. Now, what is strongly marked in the extreme case is not less active, although it may be less palpably apparent, in cases where there is great, though not total, deprivation of exercise; and here is seen one cause of the bad health, crooked spines, and deformed figures, of which the habitual restraint and condemnation to attitude in modern education lay so wide-spreading and so deep a foundation; evils which could never stand for a moment before knowledge or reason. The bones are the solid framework of the body; and unless they are duly exercised in actual motion, they, like the muscles which move them, suffer and decay in virtue of that universal law which requires the exercise of voluntary organs as the condition of their wellbeing—as the stimulus necessary to their efficient existence.

One great requisite, then, for the development and health of the osseous system, is adequate exercise. But wherever matter is the subject, *action* implies waste of materials, and unless this waste be made up by proportionate supplies, exercise leads to speedy decay, such as we see take place where the exertion has been carried beyond the proper limits, and occasioned a waste beyond what any supply can compensate. A second requisite for the proper state of the

bones, therefore, is a sufficient amount of nourishment to counteract the waste now alluded to.

In early youth, in particular, when every part teems with life and activity, and is almost hourly acquiring an increase of dimensions, the nutrient system is in a state of unceasing and powerful action, and a rich and abundant supply of food is indispensable to health. Nature points out this fact in the keen and vigorous appetite and strong powers of digestion which every healthy child uniformly manifests. To put ourselves in accordance with the intention of Nature at this period of life, it is therefore absolutely necessary to supply in abundance wholesome and nourishing food. The non-fulfilment of this condition, so often seen in times of distress among the labouring classes, gives rise to that tumid softness and consequent weakness of the bones and soft parts, which is known by the name of rickets; and which, if it continue till maturity, *i. e.*, during the years of active nutrition and growth, invariably leads to distortion and deformity.

The effect of exercise in causing the waste of the active organs, is well illustrated by the comparative absence of waste when they are unemployed. *Inaction* implies almost *stagnation*, and is always attended by diminution of the vital functions; as is exemplified in the extreme degree in hybernating animals, which pass months in sleep without food, and almost without breathing; and also in frogs found alive in stones and trees, where they must have been dormant for a great number of years. Inactive parts, then, require little nutrition, because there is little expenditure; and they require little force or energy, because it would be not only useless, but detrimental to them.

By a law of the constitution, manifestly arranged with relation to this principle, when any part of the system is active, it attracts to itself, by the simple stimulus of that activity, an increased supply of blood and nervous energy. The former repairs the waste of substance which action produces, and the latter gives an increased tone in harmony with the greater call made on its powers. If the exercise is moment-

ary and is not repeated, the extraordinary flow of blood soon disappears, and the nervous power falls to the usual standard: but if it is continued for a time, and is recurred to at regular intervals, a more active nutrition is established; a permanently greater supply of blood enters the vessels, even during the intervals of inaction; and an increase of development takes place, attended with increased facility and vigour of function.

If, again, any part is not duly exercised, there is no local stimulus to attract a large supply of blood or abundant flow of the nervous fluid; there is no activity of nutrition, no perfection of development, and no vigour of function. And hence, in partial exercise, there is always predominance of some parts over others; the one too strong, the other too feeble. In the muscular system, the arms of a blacksmith contrasted with those of a dancing-master are a sufficient illustration.

This law of increased afflux of fluids and increased nutrition to exercised parts, and of diminished afflux and nutrition to inactive parts, is not only highly important in its practical consequences, but in exact and obvious accordance with the plainest principles of reason. By this benevolent arrangement, parts acting strongly receive large supplies, and parts doing nothing are left in the state of weakness befitting the demands made upon them. To every one who sees the principle, it must appear the height of folly to expect great nutrition and great energy to follow inaction, and *vice versa;* and yet this is what is, in ignorance, daily looked for by mankind at large.

This law of exercise, as influencing nutrition and function, is universal in its application, and applies to the osseous as much as to any other system. If the bones are duly exercised, then active nutrition goes on, and they acquire dimension, strength, and solidity. If they are not exercised, the stimulus required for the supply of blood to them becomes insufficient; imperfect nutrition takes place; and debility, softness, and unfitness for duty follow in the train. This cause

of defective formation is most active and most commonly seen in the bones of the spine in growing girls, who are denied free exercise in that part; and the consequent weakness in the bones and cartilages, as well as in the muscles, is a very frequent cause of the swollen joints and curvature in the bones of the limbs in young people, which no subsequent care can ever remove.

The beneficial effects of exercise and diet in imparting solidity to the bones, have not escaped the observation of trainers and veterinary surgeons. Sir John Sinclair expressly mentions that the bones of persons trained become, in a remarkable degree, *harder* and *tougher*, and less liable to be injured by blows or accidents.* Delabere Blaine, also, in speaking of the deposite of earthy matter, and the consequent consolidation of the bones of the horse being hastened by anything that permanently quickens the circulation through them, adds, that Nature gives to young animals a playful disposition for the purpose of "increasing the flow of blood, and occasioning a more free deposite of the earthy particles." "The earthy deposite," he continues, "is usually proportioned to the wants of the animal; it is thus most perfect in those whose exertions are most considerable; in the full-bred horse, therefore, the bones will be found more solid than in the bulky lower-bred varieties." But from this very circumstance, when the animal is subjected to premature exertion, the consolidation of the bones becomes complete before their softer portion has increased to its full dimensions, and hence "horses early and hard worked never arrive at their full size."† Testimony of this kind ought to be of great weight, as based, not on theory, but on the broad and well-marked experience of practical men.

It must be observed, however, that defective nutrition may arise from other causes than inadequate exercise; but even then, the consequences attending it are analogous in their nature. Among the poor it

* Code of Health, 5th edition. Appendix, p. 35.

† Blaine's Outlines of the Veterinary Art. Third edition, p. 93.

often arises from deficiency of wholesome food, and from damp dark habitations; among the rich, from feeble digestive and assimilating powers, and pampering in diet; and also from errors in clothing, and neglect of sufficient ventilation, and due exposure to the open air. Rickets, softness of the bones, and white swelling, are accordingly observed to be almost confined to children belonging to one or other of these classes.

To understand more clearly the relative uses of bones and muscles, we may be allowed to use a comparison, although, like all other comparisons, it presents many points of difference. The bones are to the body what the masts and spars are to a ship; they give support and the power of resistance: and the muscles are to the bones what the ropes are to the masts and spars. It is to the muscles that the bones are indebted for the preservation or change of their relative position. If the bones or masts are too feeble in proportion to the weight which they are required to sustain, then a deviation from their shape or position takes place; and, on the other hand, if the muscles or ropes are not sufficiently strong and well braced, then insufficiency of support must necessarily result. Early infancy affords an instance of both imperfections; the bones being infirm, and the muscles small and destitute of true fleshy fibres. The diseased state, called *mollities ossium*, or softness of the bones, is an instance of what may be called a weak mast of the body, which must yield if its muscles be strongly drawn. The state of muscular debility consequent on fever and many acute diseases, or even on sudden fright, is, on the other hand, an instance of the inability of the bones alone to preserve an attitude, or execute motion, when the muscular system is weakened by disease. These differences merit attention.

In the regular order of Nature, the maturity and perfection of all organs and functions are attained at the precise time at which each is required. The bones of the infant are soft, vascular, cartilaginous,

full of life, and vigorous in growth; but, having no energetic motions to perform, they possess little power of solid resistance. In accordance with this condition of the bones, the muscles which move them are small, gelatinous, imperfectly fibrous, and incapable of powerful contraction. If the bones had been made solid and heavy from the beginning, they would not only have been inert and cumbrous masses, destitute of muscles to put them in motion, but, from being less vascular and less alive, could not have grown with the rapidity necessary to adapt themselves to the growth of the other parts of the system. If, on the other hand, powerful muscles had existed from the first, they would have served only to twist the soft and yielding bones into fantastic shapes. Or, if both solid bones and strong muscles had been given from birth, then a complete power of locomotion would have been the result, which, from the absence of intellect and of knowledge of the external world to direct it, would have led to incessant evils, if not to speedy destruction. But as things are arranged, the most profound wisdom and the purest benevolence show themselves in the beautiful adaptation of all the parts and functions to each other and to one common end.

Knowledge of the condition of the bones at different periods of life is not without its practical uses, particularly in regulating our treatment of children. Some fond parents, disregarding the fact that the bones are comparatively soft and pliable in infancy, and in their haste to see the little objects walk without support, are continually soliciting attempts at standing or walking, long before the bones have acquired sufficient power of resistance, and the muscles sufficient power of contraction, to cope with the laws of gravitation. The natural consequence is a curvature of the bone, which yields just like an elastic stick bending under a weight. The two ends approach nearer to each other than they ought to do; and, to accommodate themselves to the change, the muscles become shorter on one side, and perhaps long-

er on the other, each losing part of its efficiency in the unnatural change which it undergoes.

From this view, it will be seen how hurtful leading-strings must be. In the first place, by their mechanical force, they compress the chest and impede respiration; and, in the second, by preventing the body from falling to the ground, or, rather, by preserving an upright position, they cause more of the weight to fall on the bones of the spine and lower extremities than these parts are fitted to carry. From this noxious practice, flatness of the chest, confined lungs, distorted spine, and deformed legs, too often originate.

The impropriety of the indiscriminate use of dumb-bells in early life will also be easily understood. If the weight of these be disproportioned to the strength of the *bones*, it is obvious that we must produce the same kind of evil as by premature attempts to walk, viz., yielding of the bones, and stretching and relaxation of their connecting ligaments. If, again, they be disproportionate to the *muscular* power, their effect will be to exhaust instead of increasing the strength of the body.

From the exposition I have given of the laws of exercise, as affecting the muscular and osseous systems, the absurdity of expecting to *strengthen* either the one or the other by the use of stays, or by lying for hours on a horizontal or inclined plane, will be abundantly manifest. There is no royal road to health and strength, and no method by which, while exercise is dispensed with, its advantages can be obtained. *In the intervals between exercise*, reclining on a plane is very useful in delicate, fast-growing girls; but it should be resorted to only when the feeling of fatigue exists, either from previous exercise or from mere sitting up. As soon, however, as this feeling is entirely recovered from, it ought to be discontinued, and never employed for hours and days in succession, without reference to previous weariness, as it often is, on the false notion of its being conducive to strength.

In this chapter, as well as that on the muscles, I have dwelt perhaps too long on the principles by which exercise ought to be regulated; but as the subject is little understood by those who have the direction of youth, and is of paramount importance, I am inclined to hope that the tediousness of repetition may be forgiven, if clearness and conviction are obtained.

CHAPTER VII.

THE LUNGS—THEIR FUNCTIONS—AND HEALTH.

Arterial and Venous Blood.—Circulation of the Blood.—Respiration.—Situation and Structure of the Lungs—their Air-cells and Bloodvessels.—Pulmonary Exhalation and Absorption.—Conditions of healthy Action in the Lungs.—Influence of hereditary Predisposition—of wholesome Food and good Digestion—of the free Expansion of the Lungs—of Exercise of the Muscles and Voice—of Cheerfulness and of Depression of Mind—of pure Air and Ventilation.—Vitiation of the Air by Breathing—Extent and Nature of the Vitiation.—Examples of Death produced by great Impurity—its Influence in destroying Health—Illustrations.—Want of Ventilation in Public Halls, Churches, Schools, and Houses—Necessity for the Scientific Regulation of Ventilation—Disease from ill-regulated Ventilation—Means of Ventilation—Effects of vitiated Air on the Animal Economy.—Respiration the Source of Animal Heat—Causes of deficient Generation of Heat.—Means of Strengthening the Lungs and Chest.—Direct and Indirect Exercise of the Lungs—Beneficial Effects of, and Rules for, Pulmonary Exercise.—Precautions to be observed in Diseases of the Lungs, and in persons predisposed to Consumption, particularly at Puberty.

We come next to treat of the lungs and of the function which they perform; but, in order to be clearly understood, I must premise a few observations on the circulation of the blood.

The blood circulating through the body is of two different kinds; the one *red* or *arterial*, and the other *dark* or *venous* blood. The former alone is capable of affording nourishment and of supporting life. It is distributed from the *left* side of the heart all over the body, by means of a great *artery* or bloodvessel called the *aorta*, which subdivides in its course, and ultimately terminates in myriads of very minute ramifications closely interwoven with, and, in reality, constituting a part of, the texture of every living part. On reaching this extreme point of its course, the blood passes into

equally minute ramifications of the veins, which, in their turn, gradually coalesce and form larger and larger trunks, till they at last terminate in two large veins, by which the whole current of the venous blood is brought back in a direction contrary to that of the blood in the arteries, and poured into the *right* side of the heart. On examining the quality of the blood in these two systems of vessels, it is found to have undergone a great change in its passage from the one to the other. The florid hue which distinguished it in the arteries has disappeared, and given place to the dark colour characteristic of venous blood. Its properties, too, have changed, and it is now no longer capable of sustaining life.

Two conditions are essential to the reconversion of venous into arterial blood, and to the restoration of its vital properties. The first is *an adequate provision of new materials from the food*, to supply the place of those which have been expended in nutrition; and the second is *the free exposure of the nervous blood to the atmospheric air*.

The first condition is fulfilled by the chyle or nutrient principle of the food being regularly poured into the venous blood just before it reaches the right side of the heart; and the second, by the very important process of RESPIRATION, which takes place in the air-cells of the lungs, and which it is our present object to explain.

The venous blood, having arrived at the right side of the heart, is propelled by the contraction of that organ into a large artery, leading directly, by separate branches, to the two lungs, and hence called the *pulmonary* artery.* In the innumerable branches of this artery expanding themselves throughout the substance

* Taking the nature of the blood for our guide, the pulmonary *artery* ought to be named the pulmonary *vein*, for it contains venous blood. But, from its structure and office in regard to the right side of the heart resembling those of the arteries, it has been called an artery. The pulmonary *veins*, or vessels which return the blood from the lungs to the left side of the heart, on the other hand contain *arterial* blood, although named veins. To prevent confusion, it is necessary to advert to this source of ambiguity.

of the lungs, the dark blood is subjected to the contact of the air inhaled in breathing; and a change in the composition both of the blood and of the inhaled air takes place, in consequence of which the former is found to have reassumed its florid or arterial hue, and to have regained its power of supporting life. The blood then enters minute venous ramifications, which gradually coalesce into larger branches, and at last terminate in four large trunks in the left side of the heart; whence the blood, in its arterial form, is again distributed over the body, to pursue the same course and undergo the same changes as before.

There are thus two distinct circulations, each carried on by its own system of vessels: The one, from the left side of the heart to every part of the body, and back to the right side; and the other, from the right side of the heart to the two lungs, and back to the left. The former has for its object nutrition and the maintenance of life; and the latter the restoration of the deteriorated blood, and the *animalization* or *assimilation* of the chyle from which that fluid is formed.

As the food cannot become a part of the living animal, or the venous blood regain its lost properties, until they have undergone the requisite changes in the air-cells of the lungs, the function of respiration, by which these are effected, is one of pre-eminent importance in the animal economy, and well deserves the most careful examination. The term respiration is frequently restricted to the mere inhalation and expiration of air from the lungs; but more generally it is employed to designate the whole series of phenomena which occurs in these organs. The words *sanguification* and *aëration of the blood* are other forms of expression occasionally used to denote that part of the process in which the blood, by exposure to the action of the air, passes from the venous to the arterial state; and, as the chyle does not become assimilated to the blood until it has passed through the lungs, the term sanguification or *bloodmaking* is not unaptly applied.

The *quantity* and *quality* of the blood have a most direct and material influence upon the condition of every part of the body. If the *quantity* sent to the arm, for example, be diminished by tying the artery through which it is conveyed, the arm, being then imperfectly nourished, wastes away, and does not regain its plumpness till the full supply of blood be restored. In like manner, when the *quality* of that fluid is impaired by deficiency of food, bad digestion, impure air, or imperfect sanguification in the lungs, the body and all its functions become more or less disordered. Thus, in consumption, death takes place chiefly in consequence of respiration not being sufficiently perfect to admit of the formation of proper blood in the lungs.

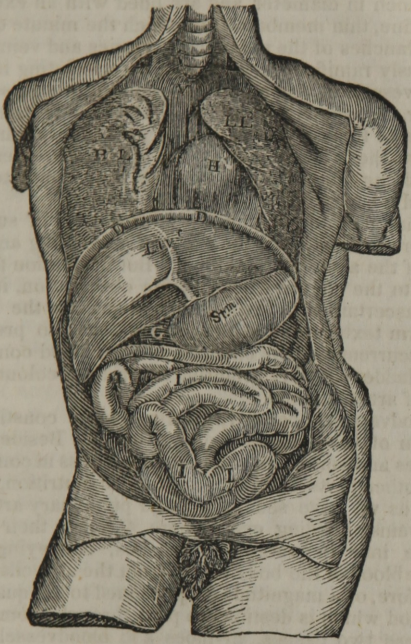
A knowledge of the structure and functions of the lungs, and of the conditions favourable to their healthy action, is therefore very important; for on their welfare depends that of every organ of the body. And when we recollect that, in the British Isles alone, above fifty thousand persons fall victims annually to pulmonary consumption, and that these are chiefly among the young and most gifted, we cannot but feel deeply interested in obtaining some acquaintance with the organization which is the seat of that affection, and with the conditions most conducive to the due performance of its functions and the preservation of its health.

The exposure of the blood to the action of the air seems to be indispensable to every variety of animated creatures. In man and the more perfect of the lower animals, it is carried on in the lungs, the structure of which is admirably adapted for the purpose. In many animals, however, the requisite action is effected without the intervention of lungs. In fishes, for example, which live in a dense medium, and do not breathe, the blood circulates through the gills, which, from being constantly and directly in contact with the water, are more accessible than lungs would be to the action of the air which the water contains, and much better adapted to the medium in which fishes

live. In worms and many similar animals, on the other hand, no distinct organ is set apart for the purpose, but the aëration of the blood takes place at the surface of the body, by means of pores in the skin, called *spiracula*, specially adapted to this end, and which cannot be shut up or obstructed, any more than the lungs or gills, without inducing death. So necessary, indeed, is atmospheric air to the vitality of the blood in all cases of animals, that its abstraction inevitably proves fatal; and a fish can no more live in water deprived of air, than a man could do in an atmosphere devoid of oxygen. And thus the fish requires a renewal of air, and perishes when it is denied, exactly as man does in similar circumstances.

In man the lungs are those large, light, spongy bodies, which, along with the heart, completely fill the cavity of the chest. They vary much in size in different persons; and as the chest is formed for their protection, we find it either large and capacious, or the reverse, according to the size of the lungs. Their position relatively to the other viscera may be understood on reference to the subjoined woodcut, which represents the various organs of the chest and belly, as they appear on removing the integuments, breast-bone, and part of the ribs. The sketch is rather rude, but it will serve the purpose. The letters R L and L L mark the right and left lungs, with the heart H lying between them, but chiefly on the left side. V is a not very accurate representation of the large blood-vessels going to the head, neck, and superior extremities. Liv^{r}. is the liver, lying in the abdomen, or belly, and separated from the chest by the arched fleshy partition D D, called the diaphragm or midriff. The stomach appears on the other side marked St^{m}., but both it and the liver are removed a little from their natural situation. G is the gall-bladder. I I I are the various parts of the intestinal canal, through which the food is passed on its way from the stomach, by means of what is called the *peristaltic* or *vermicular* motion of the bowel, one circle of fibres narrowing after another, so as to propel its contents slowly but

steadily, and resembling, in some degree, the contraction of a common worm.



The substance of the lungs consists of bronchial tubes, air-cells, bloodvessels, nerves, and cellular membrane or *parenchyma*. The first are merely continuations and subdivisions of the windpipe, and serve to convey the external air to the air-cells of the lungs. The air-cells constitute the chief part of the pulmonary tissue, and are, in one sense, the terminations of the smaller branches of the bronchial tubes. When fully distended, they are so numerous as in appear-

ance to constitute almost the whole lung. They are of various sizes, from the twentieth to the hundredth of an inch in diameter, and are lined with an exceedingly fine, thin membrane, on which the minute capillary branches of the pulmonary arteries and veins are copiously ramified; and it is while circulating in the small vessels of this membrane, and there exposed to the air, that the blood undergoes the change from the venous to the arterial state. So prodigiously numerous are these air-cells, that the aggregate extent of their lining membrane in man has been computed to exceed a surface of 20,000 square inches.

It may be thought that the interposition of such a membrane must have the effect of preventing any action of the air upon the blood. But in addition to the proof to the contrary drawn from observation, it has been ascertained by experiment, that even the thick and firm texture of bladder is insufficient to prevent the occurrence of the change; venous blood confined in a bladder speedily acquiring a florid red colour, like that of arterial blood.

Bloodvessels necessarily form a large constituent portion of the substance of the lungs. Besides the arteries and veins which the lungs possess in common with other parts for the purposes of nutrition, they have, as we have seen, the large pulmonary arteries and veins, dividing everywhere through their substance into innumerable branches, conveying the whole blood of the body to and from the air-cells, and, therefore, of a magnitude proportioned to the quantity of blood which is destined to pass through them.

These two tissues, air-tubes and bloodvessels, together with the loose cellular texture or network which binds them together, called parenchyma, form the principal part of the structure of the lungs. But the latter, like all other organs, are provided also with nerves, without the active co-operation of which, in supplying the requisite nervous stimulus, their special functions, and, consequently, life itself, would speedily cease.

Every one must have remarked the copious *exhala-*

tion of moisture which takes place in breathing, and which presents a striking analogy to the exhalation from the surface of the skin. In the former, as in the latter instance, the exhalation is carried on by the innumerable minute capillary vessels, in which the small arterial branches terminate in the air-cells. Pulmonary exhalation is, in fact, one of the chief outlets of waste matter from the system; and the air which we breathe is thus vitiated, not only by the subtraction of its oxygen and the addition of carbonic acid, but also by animal effluvia, with which it is loaded when returned from the lungs. In some individuals, this last source of impurity is so powerful as to render their vicinity offensive and even insupportable to the by-standers, and it is its presence which gives the disagreeable, sickening smell to crowded rooms.

Absorption, in like manner, takes place from the lining membrane of the lungs, as we have seen it do in the skin. When a person breathes an atmosphere loaded with fumes of spirits, of tobacco, of turpentine, or of any other volatile substance, a portion of the fumes is taken up by the absorbing vessels of the lungs, and carried into the system, and there produces precisely the same effects as if introduced into the stomach; dogs, for example, have been killed by being made to inhale the fumes of prussic acid for a few minutes. The lungs thus become a ready inlet to contagion, miasmata, and other poisonous influences diffused through the air which we breathe.

From this general explanation of the structure and uses of the lungs, it will be obvious that several conditions, which it is our interest specially to know and observe, are essential to the healthy performance of the important function of respiration. First among these we may rank a healthy original formation of the lungs. No fact in medicine is better established than that which proves the hereditary transmission from parents to children of a constitutional liability to pulmonary disease, and especially to consumption; yet no condition is less attended to in forming matrimonial engagements. The children of scrofulous

and consumptive parents are generally precocious, and their minds being early matured, they engage early in the business of life, and often enter the married state before their bodily frame has had time to consolidate. For a few years, everything seems to go on prosperously, and a numerous family gathers around them. All at once, however, even while youth remains, their physical powers begin to give way, and they drop prematurely into the grave, exhausted by consumption, and leaving children behind them destined, in all probability, either to be cut off as they approach maturity, or to run through the same delusive but fatal career as that of the parents from whom they derived their existence.

Many examples of this kind might be pointed out among the higher classes of society, who are not restrained from following their predominant inclinations by any necessity of seeking subsistence in professional pursuits. And many instances might be referred to, in which no regard was shown to the manifest existence of the same disposition in the family of either parent, and in which, consequently, the married state was imbittered either by barrenness, which is then the most favourable result, or by the prevalence of disease and delicacy in the progeny. It may not be easy to enforce upon the young and inexperienced the requisite degree of attention to these circumstances; but surely education, especially when backed by example, might do much, if the young were properly instructed at an early period in the leading facts and principles of the human constitution. Where there are hereditary precocity and delicacy of frame, marriage, instead of being hastened, ought invariably to be delayed, at least, till the fullest maturity and consolidation of the system; otherwise the consequences will be equally unhappy for the individual and for his progeny. During growth, and for a considerable time afterward, the constitution is still imperfect even in healthy subjects, and wants the enduring strength which it acquires in mature age, and the possession of which marks the period which nature

has fixed for the exercise of the functions of production. Many young people of both sexes fall sacrifices to early marriages, who might have withstood the ordinary risks of life, and lived together in happiness, if they had delayed their union for a few years, and allowed time for the consolidation of their constitutions.

I have urged this point strongly, because hereditary predisposition is, avowedly and beyond all doubt, the most frequent source of the more serious forms of pulmonary disease, and it would be worse than folly to allow past and painful experience to go for nothing. Medical men have much in their power in preventing such violations of the laws of the Creator, at least where they are regarded, as they always ought to be, as the friends not less than the professional advisers of the family.

As connected with this subject, I may mention that Dr. Clark has the merit of having drawn attention to the important fact, that a state of impaired health in the parent, *whether constitutional or acquired*, and particularly if caused by imperfect digestion and assimilation, is as productive of a tendency to scrofula and consumption in the children as if it had descended by hereditary transmission. If parents in general were duly impressed with the truth and bearing of this fact, many of them might be induced, on account of their children, to take that rational care of their own health which they seem to be incapable of doing for its own sake.

The Second requisite to the wellbeing of the lungs, and to the free and salutary exercise of respiration, is a due supply of rich and healthy blood. When, from defective food or impaired digestion, the blood is impoverished in quality, and rendered unfit for adequate nutrition, the lungs speedily suffer, and that often to a fatal extent. So certain is this fact, that, in the lower animals, *tubercles* (the cause of incurable consumption) *can be produced in the lungs to almost any extent, by withholding a sufficiency of nourishing food.* The same circumstances operate to a lamentable ex-

tent among the poorly-fed population of our manufacturing towns; whereas it is proverbial that butchers—a class of men who eat animal food twice or thrice a day, and live much in the open air—are almost exempt from pulmonary consumption. Among the higher classes, again, the blood is impoverished, and the lungs are injured, not from want of food, but *from want of the power of adequately digesting it;* and hence we find, in every treatise on consumption, a section devoted specially to "*dyspeptic phthisis*," as it is called, or simply "consumption from bad digestion." The late hours, heavy meals, and deficient exercise, which are so generally complained of, but still so regularly adhered to in society, are the chief sources of the evils to which we are now alluding.

THIRDLY.—The free and easy expansion of the chest is obviously indispensable to the full play and dilatation of the lungs: whatever impedes it, either in dress or in position, is prejudicial to health; and, on the other hand, whatever favours the free expansion of the chest, equally promotes the healthy fulfilment of the respiratory functions. Stays, corsets, and tight waistbands operate most injuriously, by compressing the thoracic cavity, and impeding the due dilatation of the lungs; and, in many instances, they give rise to consumption. I have seen one case, in which the liver was actually indented by the excessive pressure, and long-continued bad health and ultimately death were the results. In allusion to this subject, Mr. Thackrah mentions, that men can exhale at one effort from six to ten pints of air; whereas in women the average is only from two to four pints. In ten females, about 18 1-2 years of age, belonging to a flax-mill, and "who were labouring under no disease," Mr. Thackrah found the average to be only 3 1-2 pints, while in young men of the same age it amounted to 6 pints. Some allowance is to be made for the naturally smaller capacity of the lungs in females than in males, but Mr. Thackrah is satisfied that the above remarkable difference "is attributable

chiefly to the lacing of the chest."* Having, however, discussed this matter when treating of the muscular system, it is unnecessary to enlarge on it again, further than to remark, that the constrained motionless attitudes enforced upon young females in the course of education, are very unfavourable to the play of the lungs and to the full development of the chest.

The admirable harmony established by the Creator between the various constituent parts of the animal frame, renders it impossible to pay regard to, or infringe the conditions required for, the health of any one, without all the rest participating in the benefit or injury. Thus, while cheerful exercise in the open air and in the society of equals is directly and eminently conducive to the wellbeing of the muscular system, the advantage does not stop there, the beneficent Creator having kindly so ordered it that the same exercise shall be scarcely less advantageous to the important function of respiration. Active exercise calls the lungs into play, favours their expansion, promotes the circulation of the blood through their substance, and leads to their complete and healthy development. The same end is greatly facilitated by that free and vigorous exercise of the voice, which so uniformly accompanies and enlivens the sports of the young, and which doubles the benefits derived from them considered as exercise. The excitement of the social and moral feelings which children experience while engaged in play, is another powerful tonic, the influence of which on the general health ought not to be overlooked; for the nervous influence is as indispensable to the right performance of respiration, as it is to the action of the muscles or to the digestion of food.

This latter principle explains the reason why the depressing passions predispose to pulmonary consumption, a fact which has been remarked from a

* Thackrah on Employments as affecting Health and Longevity, p. 95.

very early period. When the mind is in a state of depression, the whole nervous system becomes enfeebled; the stimulus to the other organs, on which so much of their vital power depends, is impaired; and a general want of tone pervades the system, rendering the principal organs of the body, and the lungs among the rest, unusually susceptible of disease. Here, again, we may perceive the beautiful adaptation of all the functions to each other, and the exquisite harmony of design existing between the different parts of the body.

It is curious indeed to trace the relations in which the animal functions stand to each other. Grief, sorrow, fear, and other depressing passions of the mind, diminish the activity of the circulation, impair respiration, lower vitality, and, consequently, render the organization more than usually susceptible of diseases arising from diminished action. Anger, joy, and the other exhilarating passions, on the other hand, stimulate the circulation, quicken respiration, increase the vital powers, and create a proneness to inflammatory or excited action. At first sight, it may seem strange that such should be the results of different kinds of mental emotion. On examination, however, we perceive evident design in the arrangement. The tendency of grief, despondency, and sorrow, is to produce meditative *inaction*. These emotions require no exercise of the bodily powers, and no unusual expenditure of vital energy; but rather the reverse. This, it will be observed, is a condition incompatible with a quick supply of blood or a high degree of respiration; for if these were conjoined, they would only give rise to an amount of bodily activity at variance with the absorbed and concentrated state of the mind. The nature of the exciting passions, again, is to impel us vigorously to action; but action cannot be sustained without a full supply of highly oxygenated blood, and hence a very manifest reason for the quick respiration and accelerated circulation which attend mental excitement. Great depression of mind thus leads naturally to imperfect

respiration, a more sluggish flow of blood, and the various diseases of diminished vitality; while great excitement induces full respiration, quickened circulation, and the various diseases of exalted vitality. These principles show the paramount importance, in the treatment of disease, of carefully regulating the mental state of the patient, according to the object we have in view.

A FOURTH essential condition of healthy respiration remains to be noticed, viz.: *a regular supply of pure fresh air*, without which the requisite changes in the constitution of the blood, as it passes through the lungs, cannot be effected. To enable the reader to appreciate this condition, we must premise some remarks on the nature of the changes alluded to.

Atmospheric air consists of about 78 per cent. of nitrogen or azotic gas, 21 per cent. of oxygen, and not quite 1 per cent. of carbonic acid or fixed air; and such is its constitution when taken into the lungs in the act of breathing. When it is expelled from them, however, its composition is found to be greatly altered. The quantity of nitrogen remains nearly the same, but 8 or 8 1-2 per cent. of the ogygen or vital air have disappeared, and been replaced by an equal amount of carbonic acid. In addition to these changes, the expired air is loaded with moisture. Simultaneously with these occurrences, the blood collected from the veins, which enters the lungs of a dark colour and unfit for the support of life, assumes a florid red hue, and acquires the power of supporting life.

It is not easy to offer a satisfactory explanation of the processes by which these changes are effected in the lungs. According to one view, the carbonic acid contained in expired air is formed by the secretion of carbon from the venous blood in its passage through the lungs, this immediately uniting with the oxygen of the air, and forming carbonic acid, in which shape it is then thrown out in expiration. According to the other view, the carbonic acid exists in, and is separated from, the venous blood in the state of acid, and the oxygen which disappears is absorbed into the cir-

culating current. The former explanation was long almost universally received, but Dr. Edwards has lately advanced very strong grounds for adopting the latter. Whatever may be the true theory, all physiologists are agreed as to the fact that the arterialization of the blood in the lungs is essentially dependant on the supply of oxygen contained in the air which we breathe, and that air is fit or unfit for respiration in exact proportion as its quantity of oxygen approaches to, or differs from, that contained in pure air. If, consequently, we attempt to breathe nitrogen, hydrogen, or any other gas not containing oxygen, the result will be speedy suffocation; while, if we breathe air containing a too high proportion of oxygen, the vital powers will speedily suffer from excess of stimulus. From oxygen being thus essential to life and respiration, it is often called *vital* air, in contradistinction to those gases which are incapable of supporting life.

We can now appreciate the importance of a due supply of fresh air wherever living beings are congregated. In man, the rate of vitiation produced by breathing, and the relative importance of ventilation, may easily be estimated. An individual is ascertained to breathe, on an average, from 14 to 20 times in a minute, and to inhale from 15 to 40 cubic inches of air at each inspiration. Sir H. Davy and others rate the quantity so low as from 13 to 17 inches: but most observers agree with Dr. Menzies, who experimented with great care, in estimating it at 40 inches. The quantity, however, varies much in different individuals.

Even taking the consumpt of air at 20 inches, as a very low estimation, and rating the number of inspirations at 15, it appears that, in the space of one minute, no less than 300 cubic inches of air are required for the respiration of a single person. In the same space of time, 24 cubic inches of oxygen disappear, and are replaced by an equal amount of carbonic acid; so that, in the course of an hour, one pair of lungs will, at a low estimate, vitiate the air by the subtrac-

tion of no less than 1440 cubic inches of oxygen, and the addition of an equal number of carbonic acid, thus constituting a source of impurity which cannot be safely overlooked.

The fatal effects of breathing highly vitiated air may easily be made the subject of experiment. When a mouse is confined in a large and tight glass jar full of air, it seems for a short time to experience no inconvenience; but in proportion as the consumption of oxygen and the exhalation of carbonic acid proceed, it begins to show symptoms of uneasiness, and to pant in its breathing, as if struggling for air; and in a few hours it dies, convulsed exactly as if drowned or strangulated. The same results follow the deprivation or vitiation of air in man and in all animated beings; and in hanging, death results, not from dislocation of the neck, as is often supposed, but simply because the interruption of the breathing prevents the necessary changes from taking place in the constitution of the blood.

The horrible fate of the 146 Englishmen who were shut up in the Black Hole of Calcutta in 1756, is strikingly illustrative of the destructive consequences of an inadequate supply of air. The whole of them were thrust into a confined place 18 feet square. There were only two very small windows by which air could be admitted, and as both of these were on the same side, ventilation was utterly impossible. Scarcely was the door shut upon the prisoners, when their sufferings commenced, and in a short time a delirious and mortal struggle ensued to get near the windows. Within four hours, those who survived lay in the silence of apoplectic stupor; and at the end of six hours, *ninety-six* were relieved by death! In the morning, when the door was opened, 23 only were found alive, many of whom were subsequently cut off by putrid fever, caused by the dreadful effluvia and corruption of the air.

But, it may be said, such a catastrophe as the above could happen only among a barbarous and ignorant people. One would think so, and yet such is the ig-

norance prevailing among ourselves, that more than one parallel to it can be pointed out even in our own history. Of two instances to which I shall allude, one has lately been published in the Life of Crabbe, the poet. When ten or eleven years of age, Crabbe was sent to a school at Bungay. "Soon after his arrival he had a very narrow escape. He and several of his schoolfellows were punished for playing at soldiers, by being put into a large dog-kennel, known by the terrible name of the 'Black Hole;' George was the first that entered; and the place being crammed full with offenders, the atmosphere soon became pestilentially close. The poor boy in vain shrieked that he was about to be suffocated. At last, in despair, he bit the lad next to him violently in the hand; 'Crabbe is dying, Crabbe is dying,' roared the sufferer; and the sentinel at length opened the door, and allowed the boys to rush out into the air. My father said, 'A minute more and I must have died.'"*

The other instance is recorded in Walpole's Letters, and is the more memorable, because it was the pure result of brutal ignorance, and not at all of cruelty or design. "There has been lately," says Walpole, "the most shocking scene of murder imaginable; a parcel of *drunken* constables took it into their heads to put the laws in execution against *disorderly* persons, and so took up every person they met, till they had collected five or six-and-twenty, all of whom they thrust into St. Martin's roundhouse, where they kept them all night with doors and windows closed. The poor creatures, who could not stir or breathe, screamed as long as they had any breath left, begging at least for water; one poor wretch said she was worth eighteen pence, and would gladly give it for a draught of water, but in vain! So well did they keep them there, that in the morning four were found stifled to death; two died soon after, and a dozen more are in a shocking way. In short, it is horrid to think what the poor creatures suffered; several of them were beggars,

* Crabbe's Life by his Son, p. 17.

who, from having no lodging, were necessarily found on the street, and others honest labouring women. One of the dead was a poor washerwoman, big with child, who was returning home late from washing. One of the constables is taken, and others absconded; but I question if any of them will suffer death: though the greatest criminals in this town are the officers of justice, there is no tyranny they do not exercise, no villany of which they do not partake. These same men, the same night, broke into a bagnio in Covent Garden, and took up Jack Spencer, Mr. Stewart, and Lord George Graham, and would have put them into the roundhouse with the poor women if they had not been *worth more than eighteen pence*."*

These melancholy examples ought not to be lost upon us. If the results arising from extreme vitiation of the air be so appalling, we may rest assured that those arising from every minor degree, although they may be less obvious, are not less certain in their operation. It is, indeed, readily admitted in the abstract, that a constant supply of pure air is indispensable to the healthy performance of respiration; but if we inquire how far this condition is attended to by mankind at large, we shall have no reason to think the present warning unnecessary. I have already noticed (at p. 26) the case of Captain Ganson, who was suffocated in the cabin of the Magnus Troil, in Leith Harbour, on 1st March, 1833, and whose brother was recovered with great difficulty from a state of stupor, induced apparently by an insufficient supply of respirable air. To these instances another may be added from the *Globe* newspaper of 1st April, in which it is mentioned that the captain and mate of the French Chasse-marée *Royaliste* lost their lives from suffocation, in the harbour of Jersey, in a precisely similar way. In both vessels the cabin was very small, and the door having been carefully shut, the access of fresh air was completely prevented. It has been said that cases like these are of rare occurrence, and arise

* Walpole's Letters, 1833.

only from extremely vitiated air; but there is, as we have seen, reason to believe that they occur more frequently than has been supposed; and if they have happened already, where is the security that they will not occur again, if we do not bestir ourselves to remove the ignorance in which they originated?

I do not mean to say, that in all of the above instances the fatal results were attributable *exclusively* to vitiation of the air by breathing. Fixed air may have been disengaged also from some other source; but the deteriorating influence of respiration, where no ventilation is possible, cannot be doubted. According to Dr. Bostock's estimate, an average sized man consumes about 45,000 cubic inches of oxygen, and gives out about 40,000 of carbonic acid in twenty-four hours, or 18,750 of oxygen, and 16,666 of carbonic acid in ten hours, which was nearly the time during which the sufferers had remained in the cabin before they were found. As they were two in number, the quantity of oxygen which would have been required for their consumption was of course equal to 37.500 cubic inches, while the carbonic acid given out would amount to upward of 32,000 inches; a source of impurity which, added to the constant exhalation of waste matter and animal effluvia from the lungs, was manifestly quite equal to the production of the serious consequences which ensued from it, and which no one, properly acquainted with the conditions essential to healthy respiration, would ever have willingly encountered. Even supposing that the cause of death was some disengagement of gas within the vessel, it is still certain that, had the means of ventilation been adequately provided, this gas would have been so much diluted, and so quickly dispersed, that it would have been comparatively innocuous.

The best and most experienced medical officers of the army and navy, are always the most earnest in insisting on thorough ventilation as a chief preservative of health, and as indispensable for the recovery of the sick. Sir George Ballingall recurs to it frequently, and shows the importance attached to it by

Sir John Pringle, Dr. Jackson, Sir Gilbert Blane, and others of equally high authority. Sir John Pringle speaks of hospitals being, in his day, the causes of much sickness and of frequent deaths, "*on account of the bad air* and other inconveniences attending them;" and Dr. Jackson, in insisting on "height of roof as a property of great importance in a house appropriated to the reception of the sick of armies," adds as the reason, that "the air being contaminated by the breathings of a crowd of people in a confined space, disease is originated, and mortality is multiplied to an extraordinary extent. It was often proved in the history of the late war, that *more human life was destroyed by accumulating sick men in low and ill-ventilated apartments, than by leaving them exposed, in severe and inclement weather, at the side of a hedge or common dike.*"*

In the same volume (p. 114), the reader will find another example not less painful than instructive of the evils arising, first, from crowding together a greater number of human beings than the air of the apartment can sustain, and, secondly, from the total neglect of scientific rules in effecting ventilation. In the summer of 1811, a low typhoid fever broke out in the 4th battalion of the Royals, then quartered in Stirling Castle. In many instances, violent inflammation of the lungs supervened, and the result of the two diseases was generally fatal. On investigating the circumstances of this fever, it was found that rooms of 21 feet by 18 were occupied by SIXTY men, and that others of 31 feet by 21 were occupied by SEVENTY-TWO men! To prevent suffocation, the windows were kept open all night, so that the men were exposed at once to strong currents of cold air and to "the heated and concentrated animal effluvia necessarily existing in such crowded apartments; thus subjecting them to the combined effects of *typhus fever* and of *pneumonic inflammation*. In the less crowded apartments of the same barrack, no instance of fever occurred." The men who were directly in the way of

* Ballingall's Letters, p. 178.

the current of cold air, were, of course, those who suffered from inflammation.

Mr. Carmichael justly regards impure air as one of the most powerful causes of scrofula, and accounts for the extreme prevalence of the disease in the Dublin House of Industry at the time he wrote (1809), by mentioning, that, in one ward of moderate height, sixty feet by eighteen, there were *thirty-eight* beds, each containing *three* children, or more than one hundred in all! The matron told Mr. Carmichael, that "there is no enduring the air of this apartment when the doors are first thrown open in the morning; and that it is in vain to raise any of the windows, as those children who happen to be inconvenienced by the cold close them as soon as they have an opportunity. The air they breathe in the day is little better; many are confined to the apartments they sleep in, or crowded to the number of several hundreds in the schoolroom."* Can any one read this account, and wonder at the prevalence of scrofula under such circumstances?

In the preface to the present work, I have expressed an opinion that the attention of the professional student is by far too little directed to the acquisition of an accurate acquaintance with the laws and conditions of health, as in reality one of the most directly useful branches of knowledge which he can attain. A stronger proof of the truth of this proposition cannot be desired, than the simple statement of the above facts. If the medical officers then in charge of the sick at Stirling Castle had been as intimately conversant with the conditions required for the healthy performance of the living functions, and as deeply impressed with the importance of *preventing* disease, as they were qualified to conduct its treatment when once excited, it is impossible that such causes could have been allowed to come into play, or to remain a single hour undetected and unremoved. When the Professorship of Military Surgery was first established in

* Carmichael's Essay on the Nature of Scrofula. Dublin, 1810.

the University of Edinburgh, it was contended by many that attendance on its lectures would be a hardship on the student rather than a benefit, as the information to be obtained from them was already communicated in the ordinary courses on surgery. But when I state that one of the main purposes of the professorship is to teach the means of preserving the health and efficiency of soldiers under every vicissitude of garrison, tent, and field, the reader, instead of thinking its establishment superfluous, will rather be disposed to agree with me in regretting that no analogous course of instruction, having a reference to the exigences of civil life, is provided for those who are destined for the not less important duties of private practice. Many would gladly avail themselves of such an opportunity, if it once existed.

That the due renovation of the air which we breathe is really influential in protecting us against the inroads of disease, may be inferred also from instances of an opposite kind, those in which health has been preserved apparently through its agency, even in the midst of pestilence. In preventing contagion from fever, a constant circulation of air is known to be the most effectual means; and Sir Walter Scott, in describing the old Tolbooth or prison of Edinburgh, or "Heart of Mid-Lothian," mentions that, "gloomy and dismal as it was, the situation in the centre of the High-street rendered it *so particularly well aired, that, when the plague laid waste the city in* 1645, *it affected none within these melancholy precincts*;"* and yet, in other respects, a jail was precisely the place where it might have been expected to prevail with the greatest virulence. An equally striking example of the beneficial influence of fresh air is mentioned in a memoir by the late Dr. Joseph Clarke, of Dublin, read before one of the meetings of the British Association, at Edinburgh, in September, 1834. The memoir consisted of an abstract of a Registry kept in the Lying-in Hospital, Dublin, from 1758 to the end of 1833; from which it appeared

* Heart of Mid-Lothian, vol. i., chap. vi. Note.

"that, in 1781, every sixth child died, within nine days after birth, of convulsive disease; and that, after means of thorough ventilation had been adopted, the mortality of infants, in five succeeding years, was reduced to nearly *one* in *twenty*."* Facts like these are very conclusive.

Many writers have been at pains to point out the actual occurrence of the evils which sound physiology would lead us to anticipate from frequently breathing impure air. Among others, Mr. Thackrah, in his excellent little work on the effects of trades and professions on health, expresses himself very strongly, and specially notices that dyspeptic symptoms are often the first indications of the commencing disease, and that the lungs suffer only after the digestive system has been for a time disordered. It may not be easy to explain why the stomach and bowels should suffer even sooner than the lungs themselves, from a cause which seems exclusively directed to the latter; but observation substantiates the fact, and it is one of much interest in enabling us to trace to their true sources many of the forms of bad health prevalent in the middle ranks of life.

Although, however, the *first* effects are so often referable to the stomach, the lungs and general system sooner or later become implicated. An individual possessing a strong constitution may indeed withstand the bad consequences of occasionally breathing an impure atmosphere, but even he will suffer for a time. He will not experience the same amount of mischief from it as the invalid, but will be perfectly conscious of a temporary feeling of discomfort, the very purpose of which is, like pain from a burn, to impel him to shun the danger, and seek relief in a purer air. The comparative harmlessness of a single exposure is the circumstance which blinds us to the magnitude of the ultimate result, and makes us fancy ourselves safe and prudent, when every day is surely, though imperceptibly, adding to the sum of the mischief. But let

* Report of Proceedings of the British Association, in Edin. Phil. Jour. for Oct., 1834, p. 416.

any one who doubts the importance of this condition of health watch the dyspeptic, the pulmonary, or the nervous invalid, through a season devoted to attendance on crowded parties and public amusements, and he will find the frequency of headaches, colds, and other fits of illness, increase in exact proportion to the accumulated exposure, till, at the end of spring, a general debility has been induced, which imperatively demands a cessation of festivity, and a change of scene and air. This debility is often erroneously ascribed to the unwholesome influence of spring—a season extolled by the poets, not as a cause of relaxation and feebleness, but as the dispenser of renovated life and vigour to all created beings.

It is in vain to warn such persons beforehand, that Nature is always consistent, and that, if bad air be really unfit for healthy respiration, it must be detrimental *to them*, and to all who breathe it; and that its ill effects are not less real, because at first gradual and unperceived in their approach. They know too little of the animal economy and of Nature's laws, and are too much devoted to their own object, to be impressed by cautions of this kind; and, in looking forward to the ballroom or crowded evening party, few of them will believe that any possible connexion can exist between breathing its vitiated atmosphere, and the headaches, indigestion, and cutaneous eruptions which so frequently follow, and to be delivered from which they would sacrifice almost every other enjoyment.

If it be said that nobody will be troubled with all this trifling care, and that thousands who expose themselves in every way nevertheless enjoy good health and a long life, I can only answer that this is true; but that an infinitely greater proportion pass through life as habitual invalids, and scarcely know, from experience, what a day of good health really is. The late discussions on the Factory Bill have demonstrated, by an unassailable mass of evidence, that many circumstances, rarely considered as injurious, because they have no immediate effect in suddenly

destroying life by acute diseases, have, nevertheless, a marked influence in slowly undermining health and shortening human existence. There are trades, for example, at which workmen may labour for fifteen or twenty years, without having been a month confined by disease during all that time, and which are, therefore, said to be healthy trades; and yet, when the investigation is pursued a little farther, it is found that the general health is so steadily, although imperceptibly, encroached upon, that scarcely a single workman survives his fortieth or fiftieth year.

It is this insidious influence of impure air to which I am anxious to direct attention. So long as delicacy is the rule, and robust health the exception, especially among females, and so long as nearly one fourth of the annual deaths in Great Britain are caused by consumption alone, it will be difficult to persuade any rational and instructed mind that every cause of disease is already removed, and that farther care is superfluous. My own conviction, on the contrary, is that, by proper care and a stricter observance of the laws of the animal economy on the part of the parents and guardians of the young, the development of the disease might be prevented in a large proportion of the number, and that even the robust would enjoy health in a higher degree and with increased security. It is an instructive proof of this, that those who have directed their chief attention to *training* either man or animals for athletic exercises or the racecourse, have been led by observation to attach the utmost importance to pure air. The late Sir John Sinclair was at pains to collect the rules followed by Jackson, the celebrated trainer, and others of the same profession, and he tells us that, *by all of them*, the necessity of pure air is uniformly insisted upon. Sir John adds, that the same condition was deemed so essential by the ancients, that the Roman Athletæ established their principal schools at Capua and Ravenna, as enjoying the most pure and healthy air in all Italy; and that, in the training of racehorses, and even of gamecocks, the most sedulous attention is paid to the purity of the air in which they live.

The necessity for adequate ventilation is nowhere more urgent than in many of our manufactories, where, from the length of time (varying from 10 to 17 hours a day) during which the operatives are exposed to the evils of impure air, a great sacrifice of health and happiness is constantly going on. In reference to this cause, Dr. Clarke mentions the striking fact, that among the forkgrinders of Sheffield, those resident in the country, and subjected to a more free circulation of air, live, on an average, eight years longer than those resident in towns. In both, the irritating cause and the habits of life are the same, but the rooms in which the country workmen carry on their labours are larger and much better ventilated. The latter live, on an average, forty years, while their town companions are cut off between the ages of *twenty-eight* and *thirty-two*.* I may add, that the dust floating in the air in cotton manufactories and spinning mills, and produced in many trades, is a very serious aggravation of the evil, as all foreign bodies thus inhaled into the lungs produce irritation in their structure, and sooner or later lead to the development of fatal pulmonary disease.

Striking, however, as these and innumerable other facts of a similar nature are, we still remain so blind to the instructions of experience, until we acquire a knowledge of the principles which give it value, that we go on, especially in towns, constructing our houses in utter defiance of scientific rules. The public rooms, which can be easily ventilated at any time—which are, in fact, ventilated by the constant opening and shutting of the door, and by the draught of the chimney—and in which, therefore, large dimensions are less necessary for salubrity, are always the most spacious and airy. The bedrooms, on the other hand, in which, from the doors being shut, and from there being no current of air in the whole seven or eight hours during which they are occupied, the vitiation of the air is the greatest, and in which, consequently,

* Cyclopædia of Practical Medicine, Part xxii., p. 312.

size is most required, are uniformly the smallest and most confined; and, as if this source of impurity were not sufficient, we still farther reduce the already too limited space by surrounding the bed closely with curtains, for the express purpose of preventing ventilation and keeping us enveloped in the same heated atmosphere. Can anything be imagined more directly at variance than this with the fundamental laws of respiration? Or could such practices ever have been resorted to, had the nature of the human constitution been regarded before they were adopted? In this respect, we are more humane towards the lower animals than towards our own species; for, notwithstanding all the refinements of civilization, we have not yet aggravated the want of ventilation in the stable or the cowhouse, by adding curtains to the individual stalls of the inmates.

So little, indeed, are we taught to think of the nature and wants of the human constitution, that in Edinburgh, and almost every large town, we have instances of large public rooms, capable of holding from 800 to 1000 persons, built within these few years, without any means of adequate ventilation being provided, and apparently without the subject having ever cost the architect a thought! When these rooms are crowded and the meeting lasts for some hours, especially if it be in winter, the consequences are sufficiently marked. Either such a multitude must be subjected to all the evils of a contaminated and unwholesome atmosphere, or they must be partially relieved by opening the windows, and allowing a continued stream of cold air to pour down upon the heated bodies of those who are near them, till the latter are thoroughly chilled, and perhaps fatal illness is induced: and unfortunately, even at such a price, the relief is only partial; for the windows being all on one side of the room, and not extending much above half way to the ceiling, complete ventilation is impracticable. This neglect is glaringly the result of ignorance, and could never have happened had either the architects or their employers known the laws of

the human constitution; and yet it is still doubted whether it be prudent or right to teach the intelligent portion of the community any knowledge of the structure and uses of their own organs!

These remarks have been fully verified since they were first printed. During the last winter an unusual number of courses of popular lectures were given in Edinburgh, many of which were very fully attended. From the utter impossibility of *safe* ventilation, those courses which were most crowded, were accessible only at such an expense of health and suffering on the part of their less robust auditors, as served to neutralize, in a great measure, the advantages which might otherwise have been derived from them. Several of my own friends were compelled to discontinue their attendance, while others persevered, although at the certain cost of a severe headache. This nuisance is the more to be regretted, as it has arisen solely from the architects and the public not having been sufficiently alive to the importance of that prime necessary of life, pure air; and not at all from any difficulty of obtaining it which could not, at the first, have been easily overcome.

Nowhere, perhaps, have the evils arising from deficient ventilation been experienced in greater intensity than in the two Houses of Parliament, and more particularly in the House of Commons, where, from the great number of both members and strangers generally in attendance, the length of the sittings, the small size of the apartment, and the vitiating effects of the lights, the air is rendered so impure, that few, indeed, are able to withstand its poisonous influence for many weeks. The effects of this vitiation gave rise to loud complaints during the busy and memorable session of 1835, when the importance of the interests at stake, and the equal balancing of parties, occasioned an unusually close attendance and very lengthened sittings. The lives of several of the members were sacrificed in consequence of it, and the health of many more, even the most robust among them, was very seriously impaired. The evil, how-

ever, at last attracted the attention of Parliament so forcibly, that there is every reason to hope that special care will be taken to guard against its occurrence in the construction of the new edifices. It will, in truth, be a disgrace to the country, and to the scientific talent with which it abounds, if so vital a defect be not entirely and permanently remedied.

In dwelling houses lighted by gas, the frequent renewal of the air acquires increased importance. A single gas-burner will consume more oxygen, and produce more carbonic acid to deteriorate the atmosphere of a room, than six or eight candles. If, therefore, where several burners are used, no provision be made for the escape of the corrupted air, and for the introduction of pure air from without, the health will necessarily suffer. A ventilator placed over the burners, like an inverted funnel, and opening into the chimney, is an efficient and easy remedy for the former evil; and a small tube, forming a communication between the external air and the room, would supply fresh air where necessary. The tube might be made to pass, like a distiller's worm, through a vessel containing hot water, by which means the air might be heated in very cold weather before being thrown into the room, and thus the danger arising from cold draughts and inequalities of temperature be avoided.

Many of our churches and schools are extremely ill ventilated; and accordingly it is observed, that fainting and hysterics occur in churches much more frequently in the afternoon than in the forenoon, because the air is then in its maximum of vitiation. Indeed, it is impossible to look around us in a crowded church, towards the close of the service, without perceiving the effects of deficient air in the expression of the features of every one present. Either a relaxed sallow paleness of the surface, or the hectic flush of fever is observable; and, as the necessary accompaniment, a sensation of mental and bodily lassitude is felt, which is immediately relieved by getting into the open air.

I have seen churches frequented by upward of a

thousand people, in which, during winter, not only no means of ventilation are employed during service, but even during the interval between the forenoon and afternoon services, the windows are kept as carefully closed as if deadly contagion lay outside, watching for an opportunity to enter by the first open chink; and where, consequently, the congregation must inhale, for two or three hours in the afternoon, an exceedingly corrupted air, and suffer the penalty in headaches, colds, and bilious and nervous attacks.

Few of our schools are well regulated in this respect. It is now several years since, on the occasion of a visit to one of the classes of a great public seminary, my attention was first strongly attracted to the injury resulting to the mental and bodily functions from the inhalation of impure air. About 150 boys were assembled in one large room, where they had been already confined nearly an hour and a half when I entered. The windows were partly open; but, notwithstanding this, the change from the fresh atmosphere outside to the close contaminated air within, was exceedingly obvious, and most certainly was not without its effect on the mind itself, accompanied as it was with a sensation of fulness in the forehead and slight headache. The boys, with every motive to activity that an excellent system and an enthusiastic teacher could bestow, presented an aspect of weariness and fatigue which the mental stimulus they were under could not overcome, and which recalled forcibly sensations long by-gone, which I had experienced to a woful extent when seated on the benches of the same school.

These observations stirred up a train of reflections; and when I called to mind the freshness and alacrity with which, when at school, our morning operations were carried on, the gradual approach to languor and yawning which took place as the day advanced, and the almost instant resuscitation of the whole energies of mind and body that ensued on our dismissal, I could not help thinking that, even after making every necessary deduction for the mental fatigue of the les-

sons and the inaction of body, a great deal of the comparative listlessness and indifference was owing to the continued inhalation of an air too much vitiated to be able to afford the requisite stimulus to the blood, on which last condition the efficiency of the brain so essentially depends. This became the more probable, on recollecting the pleasing excitement occasionally experienced for a few moments, from the rush of fresh air which took place when the door was opened to admit some casual visiter.* Indeed, on referring to the symptoms induced by breathing carbonic acid gas or fixed air, it is impossible not to perceive that the headache, languor, and debility consequent on confinement in an ill-ventilated apartment, or in air vitiated by many people, are nothing but minor degrees of the same process of poisoning which ensues on immersion in fixed air. Of this latter state, "*great heaviness in the head, tingling in the ears, troubled sight, a great inclination to sleep, diminution of strength, and falling down*," are stated by Orfila as the chief symptoms,† and every one knows how closely these resemble what is felt in crowded halls.

Another instance of the noxious influence of vitiated air, which made a very strong impression on my mind, was during a three hours' service in a crowded country church, in a warm Sunday of July. The windows were all shut, and, in consequence, the open door was

* The accuracy of the above remarks has been strikingly confirmed, since the appearance of the first edition, by an intelligent teacher in Edinburgh, who, in compliance with my advice, pays much attention to ventilation, and turns out his pupils to play in the open air for ten minutes at the end of the first hour. During this time the doors and windows are thrown open, and the air completely renewed. The effect of this proceeding was a marked increase in the mental activity and attention of the pupils, greater pleasure and success in the exercises, and a striking diminution in the number of absentees from sickness. The latter effect was so marked, that some of the parents observed the improved health of their children, without being aware to what it was due. Since the publication of the second edition, an almost identical instance has been published in a very favourable review of the present volume in the Quarterly Journal of Education for October, 1834.

† Toxicologie, ii., 422.

of little use in purifying the atmosphere, which was unusually contaminated, not only by the respiration and animal effluvia proceeding from so many people, but by their very abundant perspiration excited by the heat and confinement. Few of the lower classes, either in town or country, extend their cleanliness beyond the washing of the hands and face. Hence the cutaneous exudation, in such persons, is characterized by a strong and nauseous smell, which, when concentrated, as it was on this occasion, becomes absolutely overpowering. Accordingly, at the conclusion of the service, there was heard one general buzz of complaint of headache, sickness, and oppression; and the reality of the suffering was amply testified by the pale and wearied appearance even of the most robust.

One of the evils of ignorance is, that we often sin and suffer the punishment without being aware that we are sinning, and that it is in our power to escape the suffering by avoiding the sin. For many generations, mankind have experienced the evil results of deficient ventilation, especially in towns, and suffered the penalty of delicate health, headaches, fevers, consumptions, and cutaneous and nervous diseases; and yet, from ignorance of the true nature and importance of the function of respiration, and of the great consumption of air in its performance, architects have gone on planning and constructing edifices, without bestowing a thought on the means of supplying them with fresh air, although animal life cannot be carried on without it; and, while ingenuity and science have been taxed to the uttermost to secure a proper supply of water, the admission of pure air, though far more essential, has been left to steal in like a thief in the night, through any hole by which it can find an entrance. In constructing hospitals, indeed, ventilation has been thought of, because a notion is prevalent that the *sick* require fresh air, and cannot recover without it; but it seems not to have been perceived, that what is indispensable for the recovery of the sick, may be not less advantageous in *preserving* from sick-

ness those who are well. Were a general knowledge of the structure of man to constitute a regular part of a liberal education, such inconsistencies as this would soon disappear, and the scientific architect would speedily devise the best means for supplying our houses with pure air, as the engineer has already supplied them with pure water.

The truth of the preceding remarks is strongly confirmed by the recent experience of the highly respectable establishment by which this volume is printed. For years the workmen employed in it were exposed to the full influence of the vitiated air arising in printing-houses from the nature of the materials, the presence of many persons in the same room, and the numerous lights required, especially in winter, the whole of which, combined, formed an atmosphere sickening and oppressive to those unaccustomed to it, but of the true nature of which, those habitually exposed to it received a much fainter impression. On the attention of the partners being drawn to the importance of pure air to bodily health and mental activity, they became anxious to effect a thorough ventilation of their own premises. The plan resorted to was very simple, viz., opening a hole of six or eight inches square into a disused chimney at each end of the principal apartments, the upper edge of it being on a level with the ceiling. The warm vitiated air naturally ascends, and having the benefit of the draught through the chimney, is readily carried up, and a good ventilation thus established. The consequent improvement in the comfort and working power of the men is, I understand, not less remarkable than the difference in comfort and freshness to a stranger entering from the open air. The same simple plan has been adopted in the printing-office of the *Scotsman* newspaper, and I have been told by one of the proprietors, that there the workmen are now as little exhausted by two or three hours of extra labour, as they were before with their ordinary exertion. But in admitting an abundant supply of fresh air, especially into hospitals, care must be taken that it do not form currents

which may be prejudicial to the persons within. A writer in the Lancet, of 29th December, 1832, after narrating a case of a patient who was carried off by pleurisy, while under treatment by Dr. Elliotson, in St. Thomas's Hospital, for disease of the pylorus, gives his opinion, that the pleurisy "was most likely occasioned *by the extreme draughts of this ward.* There is a great current of air in the ward, and I have seen many persons in it suffer very much indeed." In a note, it is added, "*The number of patients who are thus carried off yearly, forms a startling list to be laid before the eyes of the governors of this institution. Such results are shamefully frequent.*" I have already noticed the occurrence of pneumonic inflammation from the same causes in the garrison at Stirling Castle, and it is to be feared that there are still many hospitals as much in need of improvement in this respect as St. Thomas's.

As a contrast to the above case, it is gratifying to observe the care which has been taken to effect a thorough and safe ventilation in fitting up the new surgical wards of the Edinburgh Infirmary, which may serve as a model of what ought to be done, not only with all public edifices, but, I may add, with all private dwellings. In these wards, fresh air is introduced by large circular openings in the floor, and the vitiated air escapes by similar openings in the roof. The apparatus is so constructed as to admit of the air being heated in winter before it enters the ward, by which means all danger from cold currents is prevented.

Since the first publication of these pages, my attention has been kindly drawn, by Mr. Robert Cadell, bookseller in this city, to the still more efficient and wholesome method of warming and ventilating houses and buildings, at present in use in his own extensive establishment, and which was first invented by Mr. Perkins. The apparatus consists simply of a furnace in the lowest part of the building, and of a continuous iron pipe, about an inch in diameter, filled with water and of a length sufficient to make it extend through

all the apartments in which heat is wanted, and return to the point from which it started. The pipe is thus properly a circle, and has no end. The portion of it surrounded by the fire of the furnace becomes first heated, the water in it expands, and this, being specifically lighter than the colder water in the descending branch, begins to ascend, and continues to do so as its temperature rises. A regular current of ascending hot water and descending cooler water is thus established; and all that is required to heat any apartment is to have a quantity of the ascending pipe in it proportioned in length to the space to be heated. In ordinary rooms, this is done by having part of it coiled up in the usual fireplace; but in large halls the pipe is carried round the edge of the floor, so as to diffuse the heat more equally over its most distant parts.

From the small size of the pipe, and the distance to which it is carried in large establishments, like that of Mr. Cadell, there may seem at first sight an impossibility that it should be able to furnish an adequate supply of heat. But experience shows that it is greatly more than adequate to this purpose. When I visited Mr. Cadell's premises, I was struck with the genial and pleasant heat which pervaded every part of them, although there was only one furnace for the whole five stories. I was not less struck with the total absence of the empyreumatic odour and parched dryness so generally characteristic of heated air.

By Mr. Perkins's apparatus, ventilation can be carried, with safety, to any extent which may be required. All that is necessary is to have the cold air from without conveyed into the lower part of the ornamental metal box or stove, in which the coils of pipe are contained, and to have proper apertures at the top of the box to allow the warm air to escape into the room. To permit the vitiated air to get out, openings are left in the ceiling of the room or hall; and, by having stopcocks placed on both, the entrance of warm external air, and the issue of vitiated air, or, in other words, ventilation, can be regulated at pleas-

ure, without any risk either from draughts or from the entrance of cold damp air, such as prevails in this climate during the winter months.

The efficacy, economy, safety, and agreeableness of warming by the above plan can scarcely be overrated, particularly in large buildings, hospitals, and places liable to fire. The pipes may be conveyed through rooms full of paper or other inflammable materials without the possibility of accident; and the apparatus being once fitted up, lobbies and every part of a house can be comfortably heated with as little trouble as a single room. This, too, is of much consequence, because numerous colds are caused by passing frequently from warm rooms to cool lobbies and bedrooms, without any additional clothing. The Russians and other northern nations owe their comparative exemption from consumption partly to the whole interior of their houses being of a comfortable and uniform temperature, and partly to their warm clothing; and, so long as our modes of heating and ventilation remain so imperfect, and diseases of the chest continue so prevalent among us, we ought never to lose sight of the relation of cause and effect subsisting between the two circumstances, or relax in our endeavours to obviate the latter by the rectification of the former.

In the third chapter, I pointed out the necessity of protecting the skin by suitable clothing, and mentioned the intimate relation which subsists between its functions and those of the lungs. We have now to consider this subject a little farther, as regards the origin and regulation of the *animal heat*.

The true sources of animal heat are still imperfectly known, and any discussion concerning them would be too abstract for the present volume. Its regular production, however, is an essential condition of life. If the human body did not possess within itself the power of generating heat, so as to maintain nearly an equality of temperature in all climates, it could not long exist. In winter, and especially in the northern regions, the blood would speedily be converted

into a solid mass, and life be extinguished, if no provision existed for replacing the caloric withdrawn from the system by the cold air surrounding it. In most parts of the globe, the heat of the atmosphere is, even in summer, inferior to that of the human body, and, consequently, a loss of caloric is always going on, which must be made up in some way, otherwise disease and death would speedily ensue. In cholera a very remarkable diminution of heat occurs, and return to the natural temperature is an indispensable step towards recovery.

The relation between the production of animal heat and the condition of the respiratory functions is the most direct and remarkable. In general, other conditions being alike, the quantity of heat generated is in proportion to the size and vigour of the lungs; and, when these are impaired, its production is diminished. Hence many persons, with imperfectly developed lungs and a predisposition to consumption, complain habitually of coldness of the surface and feet; and many who were previously in good health, become more and more sensible to cold, in proportion as the approach of disease weakens the functions of the lungs. I have noticed this increased sensibility to cold, as a precursor of chronic pulmonary disease, both in myself and in others, before any other very obvious symptom had appeared, and think I have seen its farther progress arrested by the timely use of proper means, where much greater difficulty would have been experienced had the warning not been attended to.

The generation of heat in the living system being so immediately connected with the lungs, we find the temperature highest in those animals which possess them in the greatest perfection, namely, birds. In many species, the internal heat exceeds that of man by twenty or thirty degrees; while that of man exceeds, to as great an extent, the heat of such of the inferior animals as are remarkable for imperfect organs of respiration.

The next condition affecting the production of ani-

mal heat, is *the co-operation of the nervous system.* If the mind be depressed by grief, tormented by anxiety, or absorbed in sedentary meditation, all the bodily functions become weakened, the circulation languishes, the breathing becomes slow and scarcely perceptible, digestion is ill performed, and coldness of the extremities ensues. If, on the other hand, the mind and nervous system be stimulated by cheerful and agreeable emotions, a pleasant glow pervades the frame, and external cold is much more easily resisted.

The *quantity and quality of the food, and state of the digestive functions*, are also important conditions. The enormous quantity of stimulating animal food, such as fat and oil, required for the support of life under exposure to the intense cold of the polar regions, as mentioned by Franklin, Parry, and Richardson, is an appropriate example. The proposition will, indeed, be readily assented to, when the reader considers that a due supply of well-formed chyle is necessary to restore the nourishing properties of the blood, and that if, in consequence either of insufficient food or of a weak digestion, this be rendered impossible, all the animal functions, among others the production of heat, must unavoidably be impaired. This is the reason why cold is felt most severely in the morning before breakfast, and why coldness of the feet and chillness of the surface are so generally complained of in indigestion and bilious complaints.

Everybody knows that exercise favours and indolence obstructs the development of animal heat. Exercise produces its effects by the general stimulus which it gives directly to the respiratory and circulating systems, and indirectly to the nervous and digestive functions.

In attempting, therefore, to increase the power of resistance to cold in the human body, we ought to take into account all the conditions which favour the generation of heat. Observation proves that the degree of cold required to overcome the internal generating power and to extinguish life, varies in the

same individual at different times; and, therefore, our protecting measures also ought to be varied according to the state of the constitution, the vigour of the respiratory and digestive functions, the kind and quantity of food, and the amount of exercise. When the food is inadequate and the mind depressed, the system resists the impression of cold with great difficulty; and even in Scotland, where the temperature is rarely very low, scarcely a winter passes without several instances of death from exposure occuring in ill-fed and ill-clothed individuals, even when the thermometer is above the freezing point. This happens usually when a high wind aids the rapid abstraction of heat. Well-fed guards of coaches, on the other hand, are remarkable examples of the power of withstanding low temperatures in very exposed situations, where the animal functions are in a state of vigour. The recent Arctic expeditions under Parry, Lyon, and Ross, afford similar instances.

Having already, when treating of the skin, sufficiently explained the principles on which clothing ought to be adjusted, it is unnecessary to recur to its utility as a means of regulating the temperature of the human body. If the use of suitable clothing is found insufficient to keep the body warm, we may infer with certainty, although no other sign of bad health has appeared, that some internal cause exists, affecting and impairing one or other of the sources of animal heat already mentioned, and that, till the special cause be discovered and removed, the evil itself will continue undiminished. A not unfrequent cause of suffering from cold during the day in delicate persons is the common practice of sleeping on very soft feather beds, in which the body sinks so deep as to be almost surrounded by feathers. The undue warmth thence arising relaxes the surface of the body, weakens the action of the skin, and thus renders the individual unusually susceptible of the impression of cold when exposed out of doors. When a feather bed is used, it ought to be so well stuffed as to afford ample resistance to the weight of the body.

In winter, young people often suffer from being daily confined, for many hours in succession, without exercise, in rooms insufficiently heated. This is a constant subject of complaint in large academies and boarding-schools, where economy in fuel is carried to its utmost limits. Nothing tends more than this to lower the general standard of health, and prepare the individual for the future inroads of insidious diseases. In scrofulous children especially, in whom the evolution of heat is rarely energetic, the evil is one of great magnitude; for the chilblains, colds, and headaches more immediately complained of, are often its least important consequences. It is far from my wish to recommend that the young of either sex should be brought up in the relaxing atmosphere of overheated rooms. On the contrary, comfortable warmth ought, in every instance, to be drawn chiefly from its legitimate sources, free respiration in a pure air, abundant exercise out of doors, vigorous digestion, and an actively employed mind. If these conditions be observed, little fire will be required to supply warmth to the young. But if, as often happens, these be neglected, and the generation of animal heat be thereby reduced too low, we must either allow the mischief to go on increasing, or afford adequate warmth from without. It is in vain to think of rendering young creatures hardy by subjecting them to the continued influence of a low and chilling temperature. A few may escape, but the majority will certainly suffer.

In the heating of rooms and public halls, it is proper to be on our guard against rendering the air *too dry*, a condition which is hurtful in causing too rapid evaporation from the whole line of the air-passages, as well as from the surface of the body, and which is apt to produce considerable irritability in the system at large. On the Continent, where stoves are much in use, a vessel containing water is commonly placed in a sand-bath on the top, that moisture may be generated quickly or slowly, according to the degree of heat, and diffused through the top atmosphere. In such of our halls as are warmed by

heated air or stoves, some plan of this sort ought to be adopted.

Having thus examined the chief conditions required for healthy respiration, it only remains for me to throw out a few practical hints in regard to what may be called the *education* of the lungs, or the means by which their development may be favoured, and their functions improved in tone and extent. Most of these means have been already noticed at some length, and the only important one which still claims our attention is the *exercise of the lungs*.

Judicious exercise of the lungs is one of the most efficacious means which we can employ for promoting their development and warding off their diseases. In this respect the organs of respiration closely resemble the muscles and all other organized parts. They are made to be used, and if they are left in habitual inactivity, their strength and health are unavoidably impaired; while, if their exercise be ill-timed or excessive, disease will as certainly follow.

The lungs may be exercised *indirectly* by such kinds of bodily or muscular exertion as require quicker and deeper breathing; and *directly* by the employment of the voice in speaking, reading aloud, crying, or singing. In general, both ought to be conjoined. But where the chief object is to improve the lungs, those kinds which have a tendency to expand the chest, and call the organs of respiration into play, ought to be especially preferred. Rowing a boat, fencing, quoits, shuttlecock, and the proper use of the skipping-rope, dumb-bells, and gymnastics, are of this description. All of them employ actively the muscles of the chest and trunk, and excite the lungs themselves to freer and fuller expansion. Climbing up hill is, for the same reason, an exercise of high utility in giving tone and freedom to the pulmonary functions.

Where, either from hereditary predisposition or accidental causes, the chest is unusually weak, every effort should be made, from infancy upward, to favour the growth and strength of the lungs, by the habitual

use of such of the above-mentioned exercises as can most easily be practised. The earlier they are resorted to and the more steadily they are pursued, the more certainly will their beneficial results be experienced. In their employment, the principles explained in the chapter on the Muscles ought to be adhered to.

Habitual exercise in a hilly country, and the frequent ascent of acclivities, especially in pursuit of an object, are well known to have a powerful effect in *improving the wind* and strengthening the lungs; which is just another way of saying that they increase the capacity of the chest, promote free circulation through the pulmonary vessels, and lead to the more complete oxygenation of the blood. Hence the vigorous appetite, the increased muscular power, and the cheerfulness of mind so commonly felt by the invalid on his removal to the mountains, are not to be wondered at. I was myself sensible of advantage from this kind of exercise during a Highland excursion. The necessity of frequent and deep inspirations, and the stimulus thus given to the general and pulmonary circulation, had an obvious effect in increasing the capacity of the lungs and the power of bearing exertion without fatigue. Even when I was wearied, the fatigue went off much sooner than after a walk of equal length on a level road, and was unattended with the languor which generally accompanied the latter. In fact, the most agreeable feeling which I experienced during the whole time was while resting after undergoing, in the ascent of a hill, a degree of exertion sufficient to accelerate the breathing, and bring out a considerable quantity of perspiration. A lightness and activity of mind, and freedom about the chest, which I never felt to the same extent at any other time, followed such excursions, and made the fatigue comparatively light.

Before such practices, however, can be resorted to with advantage, or even with safety, there must be nothing in the shape of active disease existing. If there be, the adoption of such exercise will, in all probability, occasion the most serious injury. This

also I experienced in my own case, as, for many months at an earlier stage of convalescence, going up a stair, ascending the most gentle acclivity, or speaking aloud for a few minutes, was equally fatiguing and hurtful, and often brought on cough, and occasionally a slight spitting of blood. All that time, riding on horseback, which exercises the body without hurrying the breathing, was especially useful. The advantage of these exercises in giving tone and capacity to the lungs, where debility rather than disease is complained of, is shown in their being uniformly resorted to in preparing for the racecourse and for the field. The true sportsman puts himself in training as well as his dog or his horse, and fits himself for the moors by regular excursions previous to the 12th of August. By so doing he improves his wind and increases his muscular strength to a remarkable extent in a very short time.

When no active pulmonary disease exists, these exercises may, with the best effects, be frequently carried so far as to induce free perspiration; only great care ought to be taken immediately after, to rub the surface of the body thoroughly dry, and to change the dress. It is quite ascertained that, with these precautions, perspiration from exercise is the reverse of debilitating. It equalizes and gently stimulates the circulation, relieves the internal organs, improves digestion, and invigorates the skin. Jackson testifies strongly to these results, when he declares that the severe exercise undergone in training not only improves the lungs, but always renders the skin "quite clear, *even though formerly subject to eruptions.*"* These assertions are, of course, to be received as the statements of a man partial to his own art; but they are in accordance with experience, and with the laws of the animal functions, so far as these are known. They therefore merit the consideration of professional men, and of those whose features are often disfigured by

* Sir John Sinclair's Code of Health, 5th Edition. Appendix, p. 37.

eruptions which they find it difficult to remove by any kind of medicine.

I need hardly say, that, when wishing to favour the development of the lungs, we ought to be scrupulous in avoiding such positions of the body as hinder their full expansion. Tailors, shoemakers, clerks at a writing desk, and the like, are unfavourably situated in this respect, as their bent position constrains the chest, and impedes the breathing and circulation.

Direct exercise of the lungs in practising deep inspiration, speaking, reciting, singing, and playing on wind instruments, is very influential for good or for evil, according as it is indulged in with or without reference to the constitution of the individual. If it is properly managed and persevered in, particularly before the frame has become consolidated, nothing tends more to expand the chest, and give tone and health to the important organs contained in it; but if either ill-timed or carried to excess, nothing can be more detrimental. As a preventive measure, Dr. Clark is in the habit of recommending the full expansion of the chest in the following manner: "We desire the young person, while standing, to throw his arms and shoulders back, and, while in this position, to inhale slowly as much air as he can, and repeat this exercise at short intervals, several times in succession; when this can be done in the open air, it is most desirable, a double advantage being thus obtained from the practice. Some exercise of this kind should be adopted daily by all young persons, more especially by those whose chests are narrow or deformed, and should be slowly and gradually increased."* In this recommendation I heartily concur.

For the same reason, even the crying and sobbing of children contribute to their future health, unless they are caused by disease, and carried to a very unusual extent. The loud laugh and noisy exclamations attending the sports of the young, have an evident relation to the same beneficial end; and ought, there-

* Clark on Consumption and Scrofula, p. 298.

fore, to be encouraged instead of being repressed, as they are often sought to be by those who, forgetting that they themselves were once young, seek in childhood the gravity and decorum of more advanced age. I have already noticed, at page 117, an instance on a large scale, in which the inmates of an institution were, for the purpose of preserving their health, shut up within the limits of their hall for six months, and not allowed to indulge in any noisy and romping sports. The aim of the directors was undoubtedly the purest benevolence, but, from their want of knowledge, their object was defeated, and the arrangement itself became the instrument of evil.

Beneficial as the direct exercise of the lungs is thus shown to be in strengthening the chest, its influence extends still farther. If we examine the position of the lungs as represented in the figure on page 183, we shall see that, when fully inflated, they must necessarily push downward and flatten the moveable arch of the diaphragm D D, by which they are separated from the belly or abdomen. This alteration, however, cannot take place without the diaphragm in its turn pushing down the liver, stomach, and bowels, which it accordingly does, causing them to project forward and outward. But no sooner are the lungs fully inflated, than the contained air is again thrown out. The lungs diminish in size, the diaphragm rises, and with it all the contents of the abdomen return to their former position. The whole digestive apparatus is thus subjected to a continual pressure and change of place; and the stimulus thence arising is in truth essential to the healthy performance of the digestive functions, and is one of the means arranged by the Creator for the purpose. Consequently, if the lungs be rarely called into active exercise, not only do *they* suffer, but an important aid to digestion being withdrawn, the *stomach* and *bowels* also become weakened, and indigestion and costiveness make their appearance. I have already alluded to this subject in the chapter on muscular exercise; but the principle will now be better understood with the aid of the figure.

After this exposition I need hardly say that the loud and distinct speaking enforced in many public schools is productive of much good to the young, and that the occasional songs in which all are required to join in the infant schools and other institutions are much to be commended. Let any one who doubts their efficacy as exercises of the lungs, attend to what passes in his own body on reading aloud a single paragraph, and he will find that not only deep inspirations and full expirations are encouraged, but that a considerable impulse is communicated to the bowels, affording a marked contrast to the slight breathing and quiescent posture of those whose voices never rise above a whisper.

Reading aloud, public speaking, and lecturing, are excellent exercises for developing the lungs and the chest. But, as they require some exertion, they ought to be indulged in with prudence, and with constant reference to the constitution and health of the individual. The reviewer of a former edition of the present volume (himself a lecturer), in noticing this part of the book, adds the following testimony: "We know ourselves, from personal experience, that often, when preparing to go to lecture, a languor has crept upon us, inducing an unwillingness to exert ourselves. We have gone—the lecture has commenced—the mind was called into action—a perspiration broke forth on the brow—the circulation was equalized—and, at the conclusion of the lecture, the languor was gone." Hence he recommends "reading to one's family in the evening" as "an excellent practice, and one tending much to sweeten social life."* When early resorted to and steadily persevered in, such exercises are very useful in warding off disease and communicating strength to an important function. But when begun suddenly, and carried to excess by persons with weak lungs, they are more directly injurious than almost any other cause. It is not uncommon for young divines to devote themselves to preach-

* London Medical and Surgical Journal, No. 134, p. 107.

ing, without any preparation for the effort which it requires, and to experience, in consequence, pains in the chest, spitting of blood, and other dangerous forms of disease, which often extinguish their brightest prospects in the morning of life. Sacrifices of this kind are the more to be lamented, because it is probable that, by a well-planned system of gradual preparation, many who fall victims might find in their profession even a source of safety.

The late illustrious Cuvier, as was mentioned at page 150, is considered to have been saved from an early death by his appointment to a professorship leading him to the moderate and regular exercise of his lungs in teaching; a practice which soon removed the delicacy of chest to which he was subject, and enabled him to pass uninjured through a long life of active business. Other examples of the same kind might be mentioned. But it is important to observe, that in all of them the exercise was, at all times, accurately proportioned to the existing state of the lungs. Had active disease existed, or the exertion required been beyond what the lungs were fully able to bear, the effect would have been, not to improve health, but to destroy life; and this condition of accurate relation between the amount of exercise and the state of the organization must never for a moment be overlooked. With a little care, however, the point at which direct exercise of the lungs ought to stop may easily be determined by observing its effects.

The same principle leads to another obvious rule: When disease of any kind exists in the chest, exercise of the lungs in speaking, reading, and singing, and also in ordinary muscular exertion, ought either to be entirely refrained from or strictly regulated by professional advice. When a joint is sore or inflamed, we know that motion impedes its recovery. When the eye is affected, we, for a similar reason, shut out the light; and when the stomach is disordered, we have respect to its condition, and become more careful about diet. The lungs demand a treatment founded on the same general principle. If they are infla-

med, they must be exercised as little as possible, otherwise mischief will ensue. Hence, in a common cold of any severity, silence, which is the absence of direct pulmonary exercise, ought to be preserved, and will, in truth, be its own reward. In severe cases, and in acute inflammations of the chest, this rule is of the greatest importance. It is common to meet with patients who cannot speak three words without exciting a fit of coughing, and who, notwithstanding, cannot be persuaded that speaking retards their recovery. In like manner, in spitting of blood, and in the early stage of tubercular consumption, when the breathing cannot be excited without direct mischief, it is often difficult to convince the patient of the necessity of silence. He perhaps does not feel pain on attempting to speak, and says that "it merely raises a short tickling cough, which is nothing." But if he persists, dearly-bought experience will teach him his error, and dispose him to regret, as did a lamented friend of the author, that a few weeks out of the years which he had dedicated to the study of the classics had not been devoted to the acquisition of some little knowledge of the structure and functions of his own body. In the instance alluded to, after spitting of blood had been induced by severe bodily labour, the patient continued talking almost the whole day to the visiters and inmates of a large public establishment, and believed himself all the time to be very careful, as he said he was no longer exerting his body. When the error was pointed out, and the mechanism of the lungs explained to him, he deeply bewailed the ignorance which had allowed him to act in a manner so pernicious.

All violent exercise ought, for similar reasons, to be refrained from, during at least the active stages of cold. Everything which hurries the breathing, whether walking fast, ascending an acclivity, or reading aloud, has the same effect on the diseased lungs that motion of the bone has on an inflamed joint. It seems to me, that many people hurt themselves much more by the active exercise they take during a severe cold

than by the mere exposure to the weather. It is well known, that a person, when suffering from cold, may go out for a short time even in an open carriage more safely than on foot; and there is much reason to believe, that it is the absence of active exertion of the lungs in the former case which makes the exposure less hurtful.

After all active disease has been subdued, or when nothing but delicacy remains, the adequate exercise of the lungs is one of the best means of promoting effectual recovery. Those parents, therefore, act most erroneously who, in their apprehensive anxiety for the protection of their delicate children, scrupulously prohibit them from every kind of exercise which requires the least effort, and shut them up from the open air during winter, with the false hope of thereby warding off colds and protecting their lungs. I have seen the greatest delicacy of constitution thus engendered, especially where an undue quantity of warm clothing was at the same time employed. When tested by the principles above explained, such conduct is found to be as ill adapted as possible to the end in view, and utterly at variance with the laws of the animal economy.

Considering the delicacy and extent of the lining membrane of the lungs, and the ready access to it which the external air has, it cannot be a matter of surprise that sudden or great changes in its temperature or constitution should often operate injuriously on the lungs, and be the means of inducing not only colds, but more serious disease. Hence, especially in delicate subjects, the obvious propriety of diminishing the risk of sudden transitions, by breathing through several folds of woollen fabric or silk when obliged to pass from a warm room to the cold external air, or to breathe a cold or damp air for a length of time. The cold air becomes partially heated and deprived of its moisture in passing through such a medium, and the protection thus afforded is so marked, that few who have tried the precaution will ever afterward neglect it.

Perhaps the most important time in the life of a person born with a predisposition to consumption is that of puberty, comprising from the commencement of rapid growth to the full consolidation of the system about or after the twenty-fourth year. In most young people, the transition from adolescence to maturity is so rapid, that for two or three years all the animal powers are tasked to enable nutrition to keep pace with growth, and a corresponding debility of both body and mind is often observed to co-exist, indicating in the clearest manner the necessity of a temporary remission from such studies and occupations as require much mental exertion or confinement within doors. The development and health of the physical system ought then to be almost exclusively attended to; and when the body has acquired its solidity, the mental faculties will again become active. I have seen instances where a knowledge of the latter fact afforded substantial consolation to young men who, while their bodies were growing rapidly, were apt to become despondent, on account of the unusual sluggishness and inefficiency of their intellectual powers. In the course of a few years, when growth and consolidation were completed, the brain vigorously resumed its functions.

In such circumstances, relaxation from study, residence in the country, exercise in the open air, plenty of food, and freedom from care, will often do immense good, if sufficiently persisted in, and go far to protect the careful patient against the future invasion of consumption. Whereas, if, under the mistaken notion that such precautionary measures are a waste of time, a delicate growing youth is allowed to continue at his studies or his desk till disease has actually commenced, the disappointed parent may discover that it is too late to take alarm when health is gone.

A good deal of observation has satisfied me, that too little attention is paid to the *preservation* of health at this critical period of life, and that, by proper management during the transition from adolescence to maturity, many might be saved who now fall victims.

Dr. Clark, in the excellent treatise already referred to, strongly advocates the same view, and his remarks cannot be too earnestly recommended to both professional and general notice.

Mr. Marshall has taken some pains to point out the disadvantages laboured under by very young recruits from their being neglectful of health, and ignorant how to take care of themselves. In common life the same disadvantages result from the same causes. The young being left in entire ignorance of the structure and uses of the different organs of their own bodies, and without experience of the evils of exposure, heedlessly give way to their predominant inclinations, and rashly subject themselves to the operation of morbid causes, which, had they been instructed, they might easily have avoided. The consequence is, that the body being weak at that age from the rapidity of growth and want of consolidation, external causes act with double energy, and lay the foundation of consumption, or other forms of disease, without any means being used to counteract their influence; and that a greater mortality takes place during the few years of adolescence, than at an earlier or more advanced period of life.

A late writer, who has bestowed infinite pains on the investigation of the laws of mortality, describes the period between seventeen and twenty-four years of age in the male sex, as "one of restlessness, toil, and danger; the human faculties are then exercised to the utmost, and life is more freely expended than at any other season. Inflammatory diseases, often of fatal termination, are most prevalent for both sexes during this period."* The accuracy of these statements is incontrovertibly established by a reference to the bills of mortality. It appears, for example, from the Count Chabrol's Statistical Researches of the City of Paris and Department of the Seine, that, in 1819, the total mortality was 22,445, of whom 10,865

* On the Natural and Mathematical Laws concerning Population, Vitality, and Mortality. By Francis Corbaux. P. 92.

were males, and 11,580 were females. Of this number there died—

	Males.	Females.
Between the ages of 10 and 15,	298	238
" " 15 20,	420	391
" " 20 25,	815	650
" " 25 30,	374	567

Showing a remarkable increase in the number of deaths between 15 and 20 over those between 10 and 15, and again another increase of nearly double in those between 20 and 25 over those between 25 and 30. In the females, from circumstances not now to be explained, the period of increased mortality extends to nearly 30 years of age.

Similar results appear for other years. In 1820, the total deaths were 22,218, of whom 10,584 were males, and 11,634 females. Of this number there died—

	Males.	Females.
Between the ages of 10 and 15,	172	223
" " 15 20,	396	303
" " 20 25,	749	590
" " 25 30,	381	524

And in 1821 we have a total of 22,648, of whom 11,167 were males, and 11,481 females. Of this number there died—

	Males.	Females.
Between the ages of 10 and 15,	209	236
" " 15 20,	367	337
" " 20 25,	776	556
" " 25 30,	405	560

These tables, confirmed by others drawn up with equal accuracy, place in a striking point of view the dangers of the state of transition from youth to manhood, and the necessity of attempting, by early influence and timely prudence, to protect the young against the numerous causes of disease which then come into active and fatal operation. They ought also to serve as a warning to those who, in the spring-time of life, are inclined to trust implicitly for their safety to the strength of a good constitution, and to

despise the prudence which dictates the avoidance of unnecessary exposure. The experience derived from the limited observation of one man may be set aside as undeserving of trust; but when the unvarying results exhibited to us are deduced from the changes in nearly a million of people, it is impossible to ascribe them to chance, or to deny their bearing on ourselves. Many invaluable practical truths will, ere long, be furnished to the world by the statistical researches now in progress.

The earlier maximum of mortality in the male sex, especially in cities, is explicable by the fact, that it is at the approach of manhood, when both mind and body are in a state of transition, that dissipation is most indulged in, and presses with its deadliest force. Many delicate youths are carried off, who would have escaped without injury if they could have been persuaded to act with prudence during these two or three critical years. Many, I am constrained to say, first learn the means of their destruction in boarding-schools and places of public resort, and that often when no mischief is suspected by their respectable teachers. On this topic, however, the non-professional character of the present work precludes me from entering into details.

Before quitting this important subject, I may add another word of advice in regard to those who are predisposed to consumption or weakness of chest. As soon as active growth commences, permanent benefit may be derived from removal, for a few years, to a milder and less variable climate. Many who are sent abroad only to die painfully in a foreign land, in the noonday of life, might have lived for years, in the enjoyment of health and usefulness, had they been sent abroad *before* the appearance of disease, instead of after its unequivocal commencement. The previous delicacy, whence the susceptibility to colds and pulmonary affections arises, ought to attract the earliest attention, and excite the most persevering efforts for its removal. If it be allowed to make progress till consumption has commenced, medicine may come

armed with its most powerful remedies, and directed by the most consummate skill; but it will too often come in vain. The rage which now prevails for mere intellectual education, and the utter neglect of the bodily health to which it leads, is too often carried so far as to be a curse rather than a blessing; and till its fury be moderated by an increase of good sense in the parents, great mischief must, I fear, continue to ensue.

I cannot dismiss this subject without again referring the reader to Dr. Clark's work on Consumption and Scrofula, as affording, I may almost say for the first time, a comprehensive, philosophical, and practical view of the causes, nature, and treatment of consumption. The able author has not, it is true, greatly extended our power over that fatal disease in its most advanced periods, but he has done more to throw light upon its causes, to obviate its development, and to arrest it in its incipient stages, than any writer with whose works I am acquainted.

CHAPTER VIII.

NERVOUS SYSTEM AND MENTAL FACULTIES.

Nervous System.—Structure of the Brain.—The Brain the Organ of Mind and Seat of Sensation.—Connexion between the Mind and Brain.—Conditions of Health in the Brain.—Influence of hereditary Constitution—of the Blood.—Effects of imperfectly oxygenated Blood.—Exercise of the Brain and Mind.—Effects of mental Inactivity—exemplified in the Deaf and Dumb.—Mental Inactivity a Cause of nervous Disease.—Exemplified in retired Officers, Merchants, and Others—in Females of the middle and higher Ranks.—Effects of mental Activity on the Brain.—Effects of excessive mental Activity—Exemplified in precocious Children—in Youth—in hard Students—in early and middle Life, Case of Sir Humphrey Davy—in advanced Life, Case of Sir Walter Scott—a Cause of Insanity.—Effects of over Activity of Mind on Health, Cases of Gretry, Weber, and others.

In man and the higher orders of animals, the nervous system is composed of, 1st, the brain; 2d, the spinal marrow; and, 3d, the nerves. But, on the present occasion, it will be necessary to confine our remarks chiefly to the brain; and, even regarding it, to offer observations only on such points as all are agreed upon, and the general reader can easily comprehend.

The brain is that large organized mass which, along with its enveloping membranes, completely fills the cavity of the scull. It is the seat of thought, of feeling, and of consciousness, and the centre towards which all impressions made on the nerves distributed over the body are conveyed, and from which the commands of the will are transmitted, to put the various parts in motion.

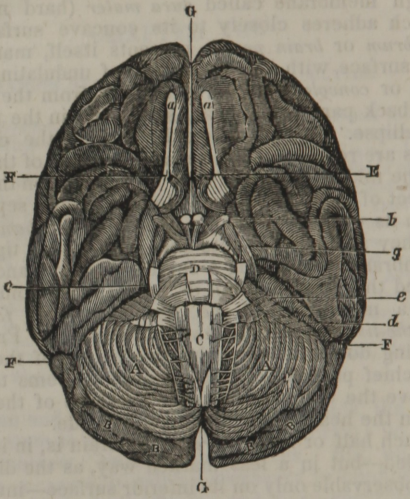
The structure of the brain is so complicated, that less is known of its true nature than of that of almost any other organ. It would, therefore, be entirely out

of place to attempt to describe it here, farther than by stating generally its principal divisions. On sawing off the top of the scull, and removing the firm, tough membrane called *dura mater* (hard mother), which adheres closely to its concave surface, the *cerebrum* or *brain proper* presents itself, marked on the surface with a great variety of undulating windings or *convolutions*, and extending from the fore to the back part of the head, somewhat in the form of an ellipse. In the annexed woodcut, the convolutions are represented as seen on the base of the brain. In the middle line from G to G, there is, on the upper aspect of the brain, a deep cleft or fissure, separating it, in its whole length, into two halves, or *hemispheres* as they are called. Into this cleft dips a tight stiff membrane, resembling a scythe in shape, and hence called the *falx* (scythe), or, sometimes, from its being a mere fold of the *dura mater*, the *falciform* (*scythe-like*) *process* of the *dura mater*. From its dipping down between the two halves of the brain, the chief purpose of this membrane seems to be to relieve the one side from the pressure of the other, when the head is reclining to either side.

Each half or *hemisphere* of the brain is, in its turn, divided—but in a less marked way, as the divisions are observable only on its inferior surface—into three portions, called, from their situations, the *anterior*, *middle*, and *posterior lobes*, each occupying nearly a third of the whole length of the brain. The anterior lobe, being the portion lying above the dotted line E E, occupies the forehead; the middle is all the portion lying between the two transverse lines E E and F F, above and a little in front of the ears; and the posterior lobe is that portion lying below the transverse line F F, and corresponding to the back part of the head.

Beneath the posterior lobe, a strong fold of the dura mater, called the *tentorium*, is extended horizontally to support and separate it from the *cerebellum* A A, or little brain, lying below it. The cerebellum forms the last great division of the contents of the

scull. Its surface is marked by convolutions, differing, however, in size and appearance from those observed in the brain.



Adhering to the surface of the convolutions, and, consequently, dipping down into and lining the *sulci* or furrows between them, another membrane of a finer texture and greater vascularity, called *pia mater*, is found. The bloodvessels going to the brain branch out so extensively on the pia mater, that, when a little inflamed, it seems to constitute a perfect vascular network. This minute subdivision is probably of use in preventing the blood from being impelled with too great force against the delicate tissue of the brain.

A third covering, called the *arachnoid* membrane, from its fineness resembling that of a spider's web, is interposed between the other two, and is frequently the seat of disease.

On examining the convolutions in different brains,

they are found to vary a good deal in size, depth, and general appearance. In the various regions of the same brain they are also different, but preserve the same general aspect. Thus they are always small and numerous in the anterior lobe, larger and deeper in the middle, and still larger in the posterior. The thick cord or root C, springing from the base of the brain, is named the *medulla oblongata*, or oblong portion of the spinal marrow, which is continued downward, and fills the cavity of the spine or backbone. At one time the brain has been regarded as proceeding from, and at another as giving rise to, the spinal marrow; but, in reality, the two are merely connected, and neither grows from the other. The false analogy of a stem growing from a root has led to this abuse of language.

The small round filaments or cords seen to proceed from the sides of the medulla oblongata, and from near the base of the brain, are various *nerves* of sensation and motion, some of them going to the organs of sense, and others to the skin and muscles of the face, head, and other more distant parts. The long, flat-looking nerve *a a*, lying on the lower surface of the anterior lobe, is the *olfactory nerve*, or nerve of smell, going to the nose. The round, thick nerve 4 4, near the roots of the former, is the *optic nerve*, or nerve of vision, going to the eye. That marked *b* is the *motor* nerve, which supplies the muscles of the eyeball. A little farther back, the fifth pair *C*, is seen to issue apparently from the arch D, called *Pons Varolii*, or *bridge of Varolius*. It is a large compound nerve, and divides into three branches, which are ramified on almost all the parts connected with the head and face, and the upper and under jaw. It comprehends nerves both of sensation and motion, and one branch of it, ramified on the tongue, is the nerve of taste. Other branches supply and give sensibility to the teeth, glands, and skin. The seventh or *auditory* nerve *e*, is distributed on the internal ear, and serves for hearing. The eighth or *pneumogastric* nerve *d*, sends filaments to the windpipe, lungs, heart,

and stomach, and is one of great importance in the production of the voice and respiration. It also influences the action of the heart and the process of digestion.

Such are the principal nerves more immediately connected with the brain, but which it is impossible to describe more minutely here. Those which supply the trunk of the body and the extremities, issue chiefly from the spinal marrow; but they also must, for the present, be passed over in silence, that we may return to the consideration of the brain.

The brain receives an unusually large supply of blood, in comparison with the rest of the body; but the nature of its circulation, although a very interesting object of study, being only indirectly connected with our present purpose, cannot now be discussed.

Most physiologists are agreed that the different parts of the brain perform distinct functions, and that these functions are the highest and most important in the animal economy; but there is great discrepancy of opinion as to what the function of each part is, and as to the best mode of removing the obscurity in which the subject is involved. It would be useless to examine here the merits of the respective theories and modes of inquiry, as the attempt would lead us too far from the practical aim of the work. Suffice it to say, that all physiologists and philosophers regard the brain as the organ of mind; that most of them consider it as an aggregate of parts, each charged with a specific function; and that a large majority regard the anterior lobe as more immediately the seat of the *intellectual* faculties.* Farther, by nearly universal consent, the brain is held to be also the seat of the passions and moral feelings of our nature, as well as of consciousness and every other mental act, and to

* In speaking of the cerebral lobes being the place "where all the sensations take a distinct form and leave durable impressions," Cuvier adds, "L'anatomie comparée en offre une autre confirmation *dans la proportion constante du volume de ces lobes avec le degré d'intelligence des Animaux.*"—Vide Report to the Institute on Flourens's Experiments in 1822.

be the chief source of that nervous influence which is indispensable to the vitality and action of every organ of the body. There are so few exceptions to the general belief of these propositions, that I consider myself fairly entitled to hold them as established.

Many animals possess individual senses or instincts in greater perfection than man, but there is not one which can be compared with him in the number and range of its faculties; and, as a necessary consequence, there is not one which approaches him in the development and perfection of its nervous system. No organ can execute more than a single function; and, accordingly, even the Edinburgh Review (which has evinced great hostility to some of the above views) admits, that, exactly in proportion as we ascend in the scale of creation, and the animal acquires a sense, a power, or an instinct, do its nerves multiply, and "its brain improve in structure and augment in volume; *each addition being marked by some addition or amplification of the powers of the animal, until in man we behold it possessing some parts of which animals are destitute, and wanting none which they possess*," so that "*we are enabled to associate every faculty which gives superiority, with some addition to the nervous mass, even from the smallest indications of sensation and will, up to the highest degree of sensibility, judgment, and expression.*"*

It is extremely important to bear in mind this constant relation between mental power and development of brain. It not only explains why capacities and dispositions are so different, but shows incontrovertibly that the cultivation of the moral and intellectual faculties can be successfully carried on only by acting in obedience to the laws of organization, and associating together those faculties, the organs of which are simultaneously progressive in their growth. When, in infancy, for example, the intellectual powers are feeble and inactive, this arises solely from the inaptitude of a still imperfect brain; but, in proportion as

* Edinburgh Review, No. xciv., p. 442-3.

the latter advances towards its mature state, the mental faculties also become vigorous and active. In like manner, when we engage in intense thought so long as to induce confusion of mind and headache, these results follow solely because the *brain* has been overtasked, and its action carried beyond the limits of health. Every mental operation, in fact, takes place in subjection to the laws of organization; and it is worse than useless for us to attempt to disjoin that which an all-wise Creator has connected together. It is a law, for instance, that alternate periods of activity and repose conduce to the strength and development of every organ, and to the easy performance of its function, and that excess in either direction is alike hurtful in its consequences. If, therefore, in our anxiety for the advancement of a child in a favourite pursuit, we urge it to incessant and unvaried exertion of the same kind for many hours a day, we violate this law in neglecting the necessary intervals of rest, and thus run the risk of injuring the health of the brain, and entirely defeating our object. And, on the contrary, if we withdraw the child altogether from the pursuit, for weeks or months at a time, as happens during the vacation of a school, we violate the organic law again, in depriving the faculties of their necessary exercise, and thus run the risk of sacrificing the improvement already gained, and of diminishing the mental power. In neither case is the brain exercised in conformity with the organic laws, and, consequently, we look in vain for the same amount of improvement which would have followed their fulfilment; and yet, so far is the physiology of the brain from being considered as the only sound basis on which the science of education can rest, that very few teachers or moralists are aware that the organic laws have any connexion with the operations of mind, and still fewer have ever thought of adapting their practice to the dictates of these laws; although no truth in education or philosophy can be more clearly proved or more beneficially applied than that on which I am now insisting.

It has been said, in answer to the above proposition, that a month's vacation and idleness in the country, after ten or eleven months spent at schools in town, is beneficial in increasing the aptitude for mental exertion. This is true, but it is, in reality, no exception to what I have stated. According to the present system of education, intellectual cultivation and school tasks are pushed so far as to impair health and injure the constitution; and after ten months of this unwholesome discipline, the vigour of mind and readiness of application are so much diminished, that the school is regarded with loathing, and the vacation is longed for with all the ardour of an exile panting for his home. If a young person, *in this unnatural situation*, be sent to the country to enjoy exercise and play in the open air for two months without opening a book, there cannot be a doubt that he will return better disposed for his lessons, and more able to keep pace with his companions, than if he had continued to receive daily instruction at school during all that time. This result, however, will follow simply because his health, which had been impaired by confinement and overtasking, will now be restored by country air, idleness, and exercise; and his brain will have regained its lost tone, and be able to manifest the mental faculties with greater vigour.

But it does not by any means follow from this circumstance, that, if the brain and mind be *always* duly exercised according to their strength and the laws of Nature, a month or two of idleness will then be advantageous. As well might we say that because two or three weeks of bodily inaction may be relished after many months of exhaustion from hard labour, therefore a long interval of inactivity will be equally agreeable to a person who is getting daily no more exercise than enough. In the one case as in the other, the absence of exertion, so far from being desirable, would be not less hurtful than irksome to the individual; and if a healthy young person were so situated, idleness would be so unpleasant to him, that he would devise active occupation of some kind or other for

himself. This distinction must not be lost sight of.

In thus treating of the brain as the indispensable instrument or organ of the mental faculties, I must not be understood as representing mind and brain to be one and the same thing. I mean only that the brain is necessarily engaged in every intellectual and moral operation, exactly as the eye is in every act of vision; and that, as the mind cannot see without the intervention of the eye, so neither can it think or feel, during life, except through the instrumentality of the brain. Consequently, it would be as reasonable and logical to infer from the former proposition that the eye is the mind or the mind the eye, as to infer from the latter, that the brain is the mind or the mind the brain.

It requires, however, to be distinctly understood, that activity of mind and activity of brain are not only inseparable, but that, so long as life remains, the mental operations are directly influenced by the condition of the brain. If, by the excessive use of stimulants, the *brain* be highly excited, the mind will be disturbed in an equal degree, as is exemplified every day in the phenomena of intoxication; and if, on the other hand, the *mind* be suddenly roused by violent passions, the vessels of the brain will instantly take on increased action, redness will suffuse the face, and the cerebral excitement will show itself in characters as legible as if produced by a physical cause.

The mind and brain being thus so closely associated during life that the former acts in strict obedience to the laws which regulate the latter, it becomes an object of primary importance in education to discover what these laws are, that we may yield them willing obedience, and escape the numerous evils consequent on their violation. To this inquiry the following pages shall be devoted.

The brain being a part of the animal system, and subject to the same general laws as the other organs, the reader will not be surprised that I should, as in the case of the lungs, state a *sound original constitution* as the FIRST condition of its healthy action. If the

brain possess from birth a freedom from all hereditary taints and imperfections, and have acquired no unusual susceptibility from injudicious treatment in infancy, it will withstand a great deal in after-life, before its health will give way. But if, on the other hand, either it inherit deficiencies, or early mismanagement have subsequently detailed upon it an unusual proneness to morbid action, it will give way under circumstances which would otherwise have been perfectly innocuous; and, accordingly, it may be truly said that the most powerful of all the causes which *predispose* to nervous and mental disease, is the transmission of a *hereditary* tendency from parents to children, producing in the latter an unusual liability to the maladies under which the parents have laboured.

Even where the defect in the parent is merely some peculiarity of disposition or temper, amounting, perhaps, to eccentricity, it is astonishing how clearly its influence on some one or other of the progeny may often be traced, and how completely a constitutional bias of this description may interfere with a man's happiness or success in life. I have seen instances in which it pervaded every member of a family, and others in which it affected only one or two. When the original eccentricity is on the mother's side, and she is gifted with much force of character, the evil extends more widely among the children than when it is on the father's side. Where both parents are descended from tainted families, the progeny is, of course, more deeply affected than where one of them is from a pure stock; and seemingly for this reason, hereditary predisposition is a more usual cause of nervous disease in the higher classes, who intermarry much with each other, than in the lower, who have a wider choice.

Unhappily, it is not merely as a cause of disease that hereditary predisposition is to be dreaded. The obstacles which it throws in the way of permanent recovery are even more formidable, and can never be entirely removed. Safety is to be found only in avoiding the perpetuation of the mischief; and, there-

fore, if two persons, each naturally of an excitable and delicate nervous temperament, choose to unite for life, they have themselves to blame for the concentrated influence of similar tendencies in destroying the health of their offspring, and subjecting them to all the miseries of nervous disease, madness, or melancholy.

Even where no hereditary defect exists, the state of the mother during pregnancy has an influence on the mental character and health of the offspring of which few parents have any adequate conception. In my work on Mental Derangement, I referred, in proof of this fact, to the testimony of M. Esquirol, whose talent, general accuracy, and extensive experience, give great weight to all his well-considered opinions. It is often, he says, in the maternal womb that we are to look for the true cause, not only of imbecility, but also of the different kinds of mania. During the agitated periods of the French revolution, many ladies then pregnant, and whose minds were kept constantly on the stretch by the anxiety and alarm inseparable from the epoch in which they lived, and whose nervous systems were thereby rendered irritable in the highest degree compatible with sanity, were afterward delivered of infants whose brains and nervous systems had been affected to such a degree by the state of their parent, that, in future life, as children they were subject to spasms, convulsions, and other nervous affections, and in youth to imbecility or dementia almost without any exciting cause. The extent to which the temporary state of the mother during gestation may influence the whole future life of the child, may be conceived from a single fact recorded by the same author. A pregnant woman, otherwise healthy, was greatly alarmed and terrified by the threats of her husband when in a state of intoxication. She was afterward delivered, at the usual time, of a very delicate child. The child had, however, been so much affected by its mother's agitation, that, up to the age of eighteen, it continued subject to panic terrors, and then became completely maniacal.

The nervous timidity of James VI., so ludicrously exhibited by Sir Walter Scott in the Fortunes of Nigel, is said to have had a similar origin. I have myself seen several instances of the same kind, and, among others, one of a young lady, whose extreme nervous sensibility was partly attributable to prolonged excitement and alarm in her mother, who, when pregnant with her, spent several days half immersed in water during a storm at sea, and in the hourly expectation of shipwreck and death.

Dr. Caldwell, too, the able and philanthropic advocate of an improved system of physical, moral, and intellectual education in America, is very urgent in enforcing rational care during the period of gestation on the part of every mother who values the future health and happiness of her progeny. Among other things, he insists on the necessity of mothers taking more exercise in the open air than they usually do; and cautions them against allowing a feeling of false delicacy to keep them confined in their rooms for weeks or months.* For the same reason, the mind ought to be kept free from gloom or anxiety, and in that state of cheerful activity which results from the proper exercise of the moral and social feelings and intellect. But if seclusion and depression be hurtful to the unborn progeny, thoughtless dissipation, late hours, dancing, waltzing, and rough exercise on horseback, irritability of temper and peevishness of disposition, are not less injurious. Hence the Margravine of Anspach most justly remarks, that "when a female is likely to become a mother, she ought to be doubly careful of her temper, and, in particular, to indulge no ideas that are not cheerful and no sentiments that are not kind. Such is the connexion between the mind and body, that the features of the face are moulded commonly into an expression of the internal disposition; and is it not natural to think that an infant, before it is born, may be affected by the temper of its mother?"—*Memoirs*, vol. ii., chap. viii.

* Thoughts on Physical Education, by Charles Caldwell, M.D. Boston, 1833.

The SECOND condition required for the health of the brain is a due supply of properly oxygenated blood. The effects of slight differences in the quality of the blood are not easily recognised, but, when extreme, they are too obvious to be overlooked. If the stimulus of arterial blood be altogether withdrawn, the brain ceases to act, and sensibility and consciousness become extinct. Thus, when fixed air is inhaled, the blood circulating through the lungs does not undergo that process of oxygenation which is essential to life; and as it is in this state unfit to excite or support the action of the brain, the mental functions become impaired, and death speedily closes the scene. If, on the other hand, the blood be too highly oxygenated, as by breathing oxygen gas instead of common air, the brain is too much stimulated, and an intensity of action, bordering on inflammation, takes place, which also soon terminates in death.

Such are the consequences of the two extremes; but the slighter variations in the state of the blood have equally sure, although less palpable effects. If its vitality be impaired by breathing an atmosphere so much vitiated as to be insufficient to produce the proper degree of oxygenation, the blood then affords an imperfect stimulus to the brain; and, as a necessary consequence, languor and inactivity of the mental and nervous functions ensue, and a tendency to headache, syncope, or hysteria, makes its appearance. This is seen every day in the listlessness and apathy prevalent in crowded and ill-ventilated schools; and in the headaches and liability to fainting which are so sure to attack persons of a delicate habit in the contaminated atmospheres of crowded theatres, churches, and assemblies. It is seen less strikingly, but more permanently, in the irritable and sensitive condition of the inmates of cotton manufactories and public hospitals. In these instances, the operation of the principle cannot be disputed, for the languor and nervous debility consequent on confinement in ill-ventilated apartments, or in air vitiated by the breath of many people, are neither more nor less than minor

degrees of the same process of poisoning to which I have formerly alluded. It is not real debility which produces them; for egress to the open air almost instantly restores activity and vigour to both mind and body, unless the exposure has been very long, in which case more time is required to re-establish the exhausted powers of the brain. A good deal of observation has convinced me, that the transmission of imperfectly oxygenated blood to the brain is greatly more influential in the production of nervous disease and delicacy of constitution, than is commonly imagined; and I am delighted to see the same truth so powerfully insisted on by Mr. Thackrah, from extensive experience in the manufacturing district about Leeds. Having, however, dwelt on this subject in the preceding chapter, I need not repeat the observations already made.*

Although, in delicate constitutions, the health of the brain and nervous system is often impaired by inadequate nutrition, and a due supply of nourishing food is therefore indispensable to their wellbeing; yet, as this condition is implied in the preceding, and its separate consideration would lead us too far from our main object, I shall not dwell upon it here. I shall merely state, that starvation often affects the brain so much as to produce ferocious delirium, and that in the Milanese, a species of insanity arising from defective nourishment is very prevalent, and is easily cured by the nourishing diet provided in the hospitals to which the patients are sent. I have seen the mental functions weakened, and the brain disordered, by the same cause—inadequate nutrition—at

* The intelligent teacher to whom I have already alluded as acting on the above views, by turning his pupils out to play, and throwing open the door and windows for ten minutes at the end of the first hour's confinement, assures me that the difference between the languor and little power of sustained attention exhibited under the old system, and the activity shown under the new, is very marked, and that the interval of relaxation is most profitably spent time both to his pupils and to himself, as they return to work with *new life*. Its influence on the health of his pupils has been already noticed.

the period of rapid growth. This defective nutrition, however, it must be observed, does not always depend on want of proper food. On the contrary, it is often the result, among the higher classes, of too much or too stimulating food over-exciting and ultimately impairing the digestive powers. The proneness to morbid excitement in the brain, induced by insufficient food, is one cause why, in times of public distress, the lower orders are so apt to resort to violence to remove the sources of their discontent.

The THIRD condition of health in the brain and nervous system, and that to which it is my chief object in the present chapter to direct attention, is the regular exercise of their respective functions, according to the laws already so frequently referred to, and so fully explained in a preceding part of this work.*

The brain, being an organized part, is subject, in so far as regards its exercise, to precisely the same laws as the other organs of the body. If it be doomed to inactivity, its health decays, and the mental operations and feelings, as a necessary consequence, become dull, feeble, and slow. If it be duly exercised, after regular intervals of repose, the mind acquires readiness and strength; and, lastly, if it be overtasked, in either the force or the duration of its activity, its functions become impaired, and irritability and disease take the place of health and vigour.

The consequence of *inadequate* exercise may be first explained.

We have seen that, by disuse, muscles become emaciated, bone softens, bloodvessels are obliterated, and nerves lose their characteristic structure. The brain is no exception to this general rule. Of it also the tone is impaired by permanent inactivity, and it becomes less fit to manifest the mental powers with readiness and energy. Nor will this surprise any reflecting person, who considers that the brain, as a part of the same animal system, is nourished by the same

* See Chapter iv., p. 127, and also p. 171.

blood, and regulated by the same vital laws, as the muscles, bones, and nerves.

It is the weakening and depressing effect upon the brain of the withdrawal of the stimulus necessary for its healthy exercise, which renders solitary confinement so severe a punishment even to the most daring minds; and it is a lower degree of the same cause which renders continuous seclusion from society so injurious to both mental and bodily soundness, and which often renders the situation of governesses one of misery and bad health, even where every kindness is meant to be shown towards them. In many families, especially in the higher ranks, the governess lives so secluded, that she is as much out of society as if she were placed in solitary confinement. She is too much above the domestics to make companions of them, and too much below her employers to be treated by them either with confidence or as their equal. With feelings as acute, interests as dear to her, and a judgment as sound as those of any of the persons who scarcely notice her existence, she is denied every opportunity of gratifying the first or expressing the last, merely because she is "only the governess;" as if governesses were not made of the same flesh and blood, and sent into the world by the same Creator, as their more fortunate employers. It is, I believe, beyond question, that much unhappiness, and, not unfrequently, madness itself, are unintentionally caused by this cold and inconsiderate treatment. For the same reason, those who are cut off from social converse by any bodily infirmity, often become discontented and morose in spite of every resolution to the contrary. The feelings and faculties of the mind, which had formerly full play in their intercourse with their fellow-creatures, have no longer scope for sufficient exercise, and the almost inevitable result is irritability and weakness in the corresponding parts of the brain.

This fact is particularly observed among the deaf and blind, in whom, from their being precluded from a full participation in the same sources of interest as

their more favoured brethren, irritability, weakness of mind, and idiocy, are known to be much more prevalent than among other classes of people. In the *Dictionnaire de Médecine* (vol. xx., p. 87), Andral gives a description of the deaf and dumb, every word of which bears a direct reference to the above principle; and a nearly similar account has been lately given of the blind by an equally intelligent observer. "The deaf and dumb," says Andral, "presents, in intelligence, character, and the development of his passions, certain modifications which depend on his state of isolation in the midst of society. He remains habitually in a state of half childishness, is very credulous, but, like the savage, remains free from many of the prejudices acquired in society. In him the tender feelings are not deep; he appears susceptible neither of strong attachment nor of lively gratitude; pity moves him feebly; he has little emulation, few enjoyments, and few desires. This is what is commonly observed in the deaf and dumb, but the picture is far from being of universal application; some, more happily endowed, are remarkable for the great development of their intellectual and moral nature; but others, on the contrary, remain immersed in complete idiocy." Andral adds, that we must not infer from this that the deaf and dumb are therefore constitutionally inferior in mind to other men. "*Their powers are not developed, because they live isolated from society: place them, by some means or other, in relation with their fellow-men, and they will become their equals.*" This is the cause of the rapid brightening up of both mind and features, which is so often observed in blind or deaf children, when transferred from home to public institutions, and there taught the means of converse with their fellows. In these instructive instances, the whole change is from a state of inactivity of the mind and brain to that of their wholesome and regular exercise. The truth of these remarks has since been confirmed by an admirable letter on deafness, from the pen of Miss H. Martineau, which appeared in Tait's Magazine for April, 1834. Miss

Martineau cautions her fellow-sufferers against indulging in seclusion from society, for the very reason I have just stated. The letter is full of sound practical observations, and does infinite credit to the moral courage and talent of its author.

Keeping the above principle in view, we shall not be surprised to find that *non-exercise* of the brain and nervous system, or, in other words, inactivity of intellect and of feeling, is a very frequent predisposing cause of every form of nervous disease. For demonstrative evidence of this position, we have only to look at the numerous victims to be found among females of the middle and higher ranks, who have no call to exertion in gaining the means of subsistence, and no objects of interest on which to exercise their mental faculties, and who consequently sink into a state of mental sloth and nervous weakness, which not only deprives them of much enjoyment, but lays them open to suffering, both of mind and body, from the slightest causes.

If we look abroad upon society, we shall find innumerable examples of mental and nervous debility from this cause. When a person of some mental capacity is confined for a long time to an unvarying round of employment, which affords neither scope nor stimulus for one half of his faculties, and, from want of education or society, has no external resources, his mental powers, for want of exercise to keep up due vitality in their cerebral organs, become blunted, and his perceptions slow and dull; and he feels any unusual subjects of thought as disagreeable and painful intrusions. The intellect and feelings not being provided with interests external to themselves, must either become inactive and weak, or work upon themselves and become diseased. In the former case the mind becomes apathetic, and possesses no ground of sympathy with its fellow-creatures; in the latter, it becomes unduly sensitive, and shrinks within itself and its own limited circle, as its only protection against every trifling intrusion. A desire to continue an unvaried round of life takes strong

possession of the mind; because to come forth into society requires an exertion of faculties which have been long dormant, and cannot be awakened without pain, and which are felt to be feeble when called into action. In such a state, home and its immediate interests become not only the centre, which they ought to be, but also the boundary of life; and the mind, originally constituted to embrace a much wider sphere, is thus shorn of its powers, and the tone of mental and bodily health is lowered, till a total inaptitude for the business of life and the ordinary intercourse of society comes on, and often increases till it becomes a positive malady. Such are the effects of inactivity on the tone of the brain.

But let the situation of such persons be changed; bring them, for instance, from the listlessness of retirement to the business and bustle of a town; give them a variety of imperative employments, and place them in society so as to supply to their cerebral organs that extent of exercise which gives health and vivacity of action; and, in a few months, the change produced will be surprising. Health, animation, and acuteness will take the place of former inspidity and dulness. In such instances it would be absurd to suppose that it is the mind itself which becomes heavy and feeble, and again revives into energy by these changes in external circumstances; the effects arise entirely from changes in the state of the brain; and the mental manifestations and the bodily health have been improved solely by the improvement of its condition.

Examples of this kind are not rare among retired officers, annuitants, merchants, and other persons living on certain incomes, without fixed occupations to interest them; and a curious enough instance occurred lately in a young military officer, who spent three years in Canada, commanding a small detachment in a remote station, where he was completely separated from all society of his own rank. During all that period he spent his time in sauntering, shooting, or fishing, without that excitement to his various facul-

ties which is afforded by the society of equals. The consequence of this compulsory mental apathy, and the corresponding inactivity of brain, was that, on returning to England, his nervous system had become so weak and irritable, that, although by nature fond of society, he feared to meet even with the members of his own family, and for many weeks would never venture to walk out to take necessary exercise except in the dark. And it was only at the end of several months that the renewed stimulus of society and employment restored the tone of his nervous system so far as to allow him to regain his natural character of mind and to return to his former habits of life. In this predisposed state of the system, a very slight cause would obviously have sufficed to convert the depression into absolute derangement.

But, as mentioned above, the most frequent victims of this kind of predisposition are females of the middle and higher ranks, especially those of a nervous constitution and good natural abilities; but who, from ill-directed education, possess nothing more solid than mere accomplishments, and have no materials of thought, and no regular or imperative occupations to excite interest or *demand* attention. Such persons have literally nothing on which to expend half the nervous energy which nature has bestowed on them for better purposes. They have nothing to excite and exercise the brain, nothing to elicit activity; their own feelings and personal interests necessarily constitute the grand objects of their contemplation; these are brooded over till the mental energies become impaired, false ideas of existence and of Providence spring up in the mind, the fancy is haunted by strange impressions, and every trifle which relates to self is exaggerated into an object of immense importance. The brain, having almost no employment, becomes weak, and the mental manifestations are enfeebled in proportion; so that a person of good endowments thus treated, will often not only exhibit somewhat of the imbecility of a fool, but gradually become irritable, peevish, and discontented, and

open to the attack of every form of nervous disease and of derangement from causes which, under different circumstances, would never have disturbed her for a moment. Persons so situated too often fly for relief to opium or drinking.

That the liability of such persons to melancholy, hysteria, hypochondriasis, and other varieties of mental disease, really depends on a state of irritability of brain, induced by imperfect exercise, is proved by the vast and rapid improvement we often witness in consequence of the sudden supervention of occurrences which excite and employ the mental powers and their cerebral organs. Nothing is more usual than to see a nervous young lady, who for years had been unfit for anything while ease and indolence were her portion, deriving the utmost advantage from apparent misfortunes, which throw her upon her own resources, and force her to exert her utmost energies to maintain a respectable station in society. Where, as in such circumstances, the mental faculties and brain, the intellect and moral and social feelings, are blessed with a stimulus to act, the weakness, the tremours, and the apprehensions which formerly seemed an inborn part of herself, disappear as if by enchantment, and strength, vigour, and happiness take their place; solely because now God's law is fulfilled, and the brain, with which he has connected the mind, is supplied with that healthful stimulus and exercise which he ordained to be indispensable to its healthy existence. The same principle explains the conversion which often occurs of a timid, sensitive, and nervous young lady, into a firm-minded and healthy matron.

An additional illustration, and I venture upon it because the principle is an important one in the production of many distressing forms of disease, will be found in the case of a man of mature age and of active habits, who has devoted his life to the toils of business, and whose hours of enjoyment have been few and short. Suppose such a person to retire to the country in search of repose, and to have no deep moral, religious, or philosophical pursuits to oc-

cupy his attention and keep up the active exercise of his brain, this organ will lose its health, and the inevitable result will be ennui, weariness of life, despondency, or some other variety of nervous disease.*

One great evil attending the absence of some imperative employment or object of interest to exercise the mind and brain, is the tendency which it generates to waste the mental energies on every trifling occurrence which presents itself, and to seek relief in the momentary excitement of any sensation, however unworthy. Not only does painful instability of purpose and interest arise from this cause, especially among females, but, by degrees, enjoyment is sought for more from the indulgence of the sensual appetites of eating and drinking than from any higher occupation; till at last the habit of gormandizing is established, and quantities of food and wine are daily swallowed, which add disease to indolence, and oppress both mind and body. Patients labouring under this form of indisposition complain much of debility, and of the exhaustion left by every effort. It is common to hear them defending the excesses which they commit, by affirming, that with less support they would die of weakness; but the plea, though plausible, is utterly groundless. No doubt they may feel stronger after a good dinner and a few glasses of wine, but the strength is that of feverish excitement, and the subsequent languor is proportionally great. Ere long, too, the power of mental application gives way; the digestive organs fail under the task imposed upon them, and headache, flushing, sickness, and bilious attacks ensue in such rapid succession, that life at last becomes a state of habitual indisposition.

The best remedy for these evils is to create occupation to interest the mind, and give that wholesome exercise to the brain which its constitution requires.

* It may be proper to state, that several of the preceding pages have been taken, with little alteration, from my "*Observations on Mental Derangement*," published some time ago. But as that work is designed more for the profession than for the general reader, I have thought it necessary to repeat them here.

Unless this can be done, the services of the physician will be available only so long as their novelty continues a source of excitement; and then, in all probability, he will be discharged to make way for another, who will, in his turn, be dismissed to give place to a third. The principle on which this is done is perfectly sound, and, in such cases, no sensible physician will take it amiss that his assistance is declined. The error lies in the patient seeking the necessary mental stimulus in a change of attendance, instead of in salutary occupation. But there cannot be a doubt, that where the patient is either unable or unwilling to seek recovery from engaging in proper employment, the mere change of physician is often of temporary service.

The evils arising from EXCESSIVE or ill-timed exercise of the brain or any of its parts, are numerous and equally in accordance with the ordinary laws of physiology. When we use the eye too long or in too bright a light, it becomes bloodshot, and the increased action of its vessels and nerves gives rise to a sensation of fatigue and pain requiring us to desist. If we turn away the eye, the irritation gradually subsides, and the healthy state returns; but if we continue to look intently, or resume our employment before the eye has regained its natural state by repose, the irritation at last becomes permanent, and disease, followed by weakness of sight or even blindness, may ensue; as often happens to glass-blowers, smiths, and others, who are obliged to work in an intense light.

Precisely analogous phenomena occur when, from intense mental excitement, the brain is kept long in a state of excessive activity. The only difference is, that we can always see what happens in the eye, but rarely what takes place in the brain. Occasionally, however, cases of fracture of the scull occur, in which, from part of the bone being removed, we *can see* the quickened circulation in the vessels of the brain as easily as in those of the eye. Sir Astley Cooper had a young gentleman brought to him who had lost a portion of his scull just above the eyebrow. "On

examining the head," says Sir Astley, "I distinctly saw the pulsation of the brain was regular and slow; but at this time he was agitated by some opposition to his wishes, and directly *the blood was sent with increased force to the brain, the pulsation became frequent and violent; if, therefore*," continued Sir Astley, "*you omit to keep the mind free from agitation, your other means will be unavailing*" in the treatment of injuries of the brain.* A still more remarkable case is mentioned by Dr. Caldwell, as having occurred to Dr. Pierquin, in the hospital of Montpelier, in 1821. "The subject of it was a female at the age of 26, who had lost a large portion of her scalp, scull-bone, and dura mater, in a neglected attack of lues venerea. A corresponding portion of her brain was consequently bare, and subject to inspection. When she was in a *dreamless sleep*, her brain was *motionless*, and *lay within* the cranium. When her sleep was *imperfect* and she was agitated by dreams, her brain *moved* and *protruded without* the cranium, forming *cerebral hernia*. In *vivid* dreams, reported as such by herself, the protrusion was considerable; and when she was perfectly awake, especially if engaged in active thought or sprightly conversation, it was still greater."† This protrusion arose, of course, from the greater quantity of blood sent to the brain during its activity than when it was quiet; and, if the case be accurately reported, it is certainly one of the most interesting on record.

In alluding to this subject, Dr. Caldwell remarks, that, if it were "possible, without doing an injury to other parts, to augment the constant afflux of healthy arterial blood to the brain, the mental operations would be invigorated by it. I state this opinion confidently, because we often witness its verification. When a public speaker is flushed and heated in debate, his mind works more freely and powerfully than at any other time. Why? Because his brain is in better tune. What has thus suddenly improved its

* See Sir A. Cooper's Lect. on Surg., by Tyrrel, vol. i., p. 279.
† Annals of Phrenology, No. i., p. 37. Boston, 1833.

condition? An increased current of blood into it, produced by the excitement of its own increased action. That the blood does, on such occasions, flow more copiously into the brain, no one can doubt who is at all acquainted with the cerebral sensations which the orator himself experiences at the time, or who witnesses the unusual fulness and flush of his countenance, the dewiness, flashing, and protrusion of his eye, and the throbbing of his temporal and carotid arteries. It is well known, that, while intensely engaged in a memorable debate last winter in Washington, a distinguished senator became so giddy, by the inordinate rushing of blood into his brain, that he was obliged to sit down, and the Senate adjourned to give him time to recover. And, more recently, a new member of the House of Representatives fell while speaking, and suddenly expired from the same cause. A member of the law class of Transylvania, moreover, experienced, a few weeks ago, a convulsive affection from a congestion of blood in the head, induced by excessive excitement of the brain in the ardour of debate."* In many instances, indeed, the increased circulation in the brain attendant on high mental excitement, reveals itself by its effects when least expected, and leaves traces after death which are but too legible. How many public men, like Whitbread, Romilly, Castlereagh, and Canning, urged on by ambition or natural eagerness of mind, have been suddenly arrested in their career by the inordinate action of the brain induced by incessant toil! And how many more have had their mental power for ever impaired by similar excess! When tasked beyond its strength, the eye becomes insensible to light, and no longer conveys any impressions to the mind. In like manner, the brain, when much exhausted, becomes incapable of thought, and consciousness is almost lost in a feeling of utter confusion.

At any time of life, excessive and continued mental exertion is hurtful; but in infancy and early youth,

* Caldwell's Thoughts on Physical Education, p. 114.

when the structure of the brain is still immature and delicate, permanent mischief is more easily inflicted by injudicious treatment than at any subsequent period; and, in this respect, the analogy is complete between the brain and the other parts of the body, as we have already seen exemplified in the injurious effects of premature exercise of the bones and muscles. Scrofulous and rickety children are the most usual sufferers in this way. They are generally remarkable for large heads, great precocity of understanding, and small, delicate bodies. But, in such instances, the great size of the brain and the acuteness of mind are the results of morbid growth; and, even with the best management, the child passes the first years of its life constantly on the brink of active disease. Instead, however, of trying to repress its mental activity, the fond parents, misled by the early promise of genius, too often excite it still farther, by unceasing cultivation and the never-failing stimulus of praise; and finding its progress, for a time, equal to their warmest wishes, they look forward with ecstasy to the day when its talents will break forth and shed a lustre on its name. But in exact proportion as the picture becomes brighter to their fancy, the probability of its being realized becomes less; for the brain, worn out by premature exertion, either becomes diseased or loses its tone, leaving the mental powers slow and depressed for the remainder of life. The expected prodigy is thus utimately and easily outstripped in the social race by many whose dull outset promised him an easy victory.

Taking for our guide the necessities of the constitution, it will be obvious that the modes of treatment commonly resorted to ought to be reversed, and that, instead of straining to the uttermost the already irritable powers of the precocious child, and leaving his dull competitor to ripen at leisure, a systematic attempt ought to be made, from early infancy, to rouse to action the languid faculties of the latter, while no pains ought to be spared to moderate and give tone to the activity of the former. Instead of this, how-

ever, the prematurely intelligent child is generally sent to school, and tasked with lessons at an unusually early age; while the healthy, but more backward boy, who requires to be stimulated, is kept at home in idleness, perhaps for two or three years longer, merely on account of his backwardness. A double error is here committed, and the consequences to the clever boy are frequently the permanent loss both of health and of his envied superiority of intellect.

In speaking of children of this description, Dr. Brigham, in an excellent little work on the influence of mental excitement on health, lately published in America, says, "Dangerous forms of scrofulous disease among children have repeatedly fallen under my observation, for which I could not account in any other way than by supposing that the brain had been exercised at the expense of other parts of the system, and at a time of life when nature is endeavouring to perfect all the organs of the body; and after the disease commenced, I have seen with grief the influence of the same cause in retarding or preventing recovery. I have seen several affecting and melancholy instances of children five or six years of age, lingering a while with diseases from which those less gifted readily recover, and at last dying, notwithstanding the utmost efforts to restore them. During their sickness, they constantly manifested a passion for books and mental excitement, and were admired for the maturity of their minds. The chance for the recovery of such precocious children is, in my opinion, small, when attacked by disease; and several medical men have informed me, that their own observations had led them to form the same opinion, and have remarked, that in two cases of sickness, if one of the patients was a child of superior and highly cultivated mental powers, and the other one equally sick, but whose mind had not been excited by study, they should feel less confident of the recovery of the former than of the latter. This mental precocity results from an unnatural development of one or-

gan of the body at the expense of the constitution" (p. 45).*

Dr. Brigham justly remarks, that it is ignorance in the parents which leads to the too early and excessive cultivation of the minds of children, especially those who are precocious and delicate; but from the examples which he gives, and the general bearing of his admonitions, the error of commencing systematic education too soon, and stimulating the infant mind too highly, seems to be decidedly more prevalent in the United States than in this country. Among the "children's books" in the United States, many are announced as purposely prepared "for children from *two* to *three* years old!" and among others are "INFANT Manuals" for Botany, Geometry, and Astronomy!! That mode of teaching is considered the best which forces on the infant mind at the most rapid rate, without regard to health or any other consideration.

Dr. Brigham adds from personal observation, that, in many families, children *under three years* of age are not only required to commit to memory many verses, texts of Scripture and stories, but are often sent to the ordinary schools for six hours a day. Few children are kept back later than the age of *four*. At home, too, they are induced by all sorts of excitement to learn additional tasks or peruse juvenile books and magazines, till the nervous system becomes enfeebled and the health broken. "I have myself," he continues, "seen many children who are supposed to possess almost miraculous mental powers, experiencing these effects and sinking under them. Some of them died early, when but six or eight years of age, but manifested to the last a maturity of understanding which only increased the agony of separation. Their minds, like some of the fairest flowers, were 'no sooner blown than blasted;' others have

* Remarks on the Influence of Mental Cultivation and Mental Excitement upon Health. By Amariah Brigham, M.D., Boston, 1833.

grown up to manhood, but with feeble bodies and disordered nervous system, which subjected them to hypochondriasis, dyspepsy, and all the protean forms of nervous disease;" "others of the class of early prodigies exhibit in manhood but small mental powers, and are the mere passive instruments of those who, in early life, were accounted far their inferiors" (lib. cit., p. 59). In well-conducted infant schools, these evils are carefully guarded against.

In this country children are not generally sent to school so early; but education is still too much restricted to the exclusive exercise of the mental powers, to the neglect of the physical, and, in the instance of delicate children, is pushed on too rapidly. I lately witnessed the fate of one of these early prodigies, and the circumstances were exactly such as those above described. The prematurely developed intellect was admired, and constantly stimulated by injudicious praise, and by daily exhibition to every visiter who chanced to call. Entertaining books were thrown in the way; reading by the fireside encouraged; play and exercise neglected; the diet allowed to be full and heating, and the appetite pampered by every delicacy. The results were the speedy deterioration of a weak constitution, a high degree of nervous sensibility, deranged digestion, disordered bowels, defective nutrition, and, lastly, *death*, at the very time when the interest excited by the mental precocity was at its height.

Such, however, is the ignorance of parents on all physiological subjects, that when one of these infant prodigies dies from erroneous treatment, it is not unusual to publish a memoir of his life, that other parents may see by what means such transcendent qualities were called forth. Dr. Brigham refers to a memoir of this kind, in which the history of John Mooney Mead, aged four years and eleven months, is narrated as approved of by "several judicious persons, ministers and others, all of whom united in the request that it might be published, and all agreed in the opinion that *a knowledge of the manner in which the*

child was treated, together with the results, would be profitable both to parents and children, and a benefit to the cause of education." This infantine philosopher was "taught hymns before he could speak plainly;" "reasoned with" and constantly instructed until his last illness, which, "*without any assignable cause,*" put on a violent and unexpected form, and carried him off. As a WARNING not to force education too soon or too fast, this case may be truly "profitable both to parents and children;" but, as an example to be followed, it assuredly cannot be too strongly or loudly condemned. Infant schools, however, in which physical health and moral training are duly attended to, are excellent institutions. Such are those established and regulated on the plan of the benevolent Wilderspin, whose exertions have gone so far to demonstrate the importance of early infant training. But I regret to say that many schools lately opened under the same name have scarcely one sound principle in action, and threaten to do more injury to the children by forced and injudicious intellectual cultivation and close confinement than will be easily remedied even by the best management in after life. I know some schools, consisting of a single small apartment, without any playground, and with very imperfect means of ventilation, where upward of 150 children are crowded together for four or five hours a day, with no free access to the open air, no adequate muscular or pulmonary exercise, no mental recreation worthy of the name, no systematic cultivation of the moral and social feelings in actual intercourse with each other; and where, with a few intervals of rest, an occasional march round the room, and a frequent change of subject, the time is consumed in intellectual tasks, to the almost complete exclusion of everything else. Schools of this description cannot be too strongly denounced as fraught with mischief to the young, and as flagrant abuses of a most valuable principle. But in thus censuring what is radically wrong, we must be careful not to go to the other extreme, and, like Cobbett, condemn as bad that which is so only in its abuses.

A well-regulated infant school is an instrument of great power in improving and humanizing mankind.*

In youth, too, much mischief is done by the long daily periods of attendance at school, and the continued application of mind which the ordinary system of education requires. The law of exercise, that long-sustained action exhausts the vital powers of an organ, applies, I cannot too often repeat, as well to the brain as to the muscles; and hence the necessity of varying the occupations of the young, and allowing frequent intervals of active exercise in the open air, instead of enforcing the continued confinement now so common. This exclusive attention to mental culture fails, as might be expected, even in its essential object; for experience shows that, with a rational distribution of employment and exercise, a child will make greater progress than in double the time employed in continuous mental exertion. If the human being were made up of nothing but a brain and nervous system, it would be very well to content ourselves with sedentary pursuits, and to confine ourselves entirely to the mind. But when observation tells us that we have numerous other important organs of motion, sanguification, digestion, circulation, and nutrition, all demanding exercise in the open air as essential both to their own health and to that of the nervous system, it is worse than folly to shut our eyes to the truth, and to act as if we could, by denying it, alter the constitution of nature, and thereby escape the consequences of our misconduct.

Reason and experience being thus set at naught by both parents and teachers in the management of children, young people naturally grow up with the notion

* Many of my readers will be glad to learn that Dr. Brigham's little work has lately been reprinted in this country in a very cheap form, under the care of Dr. Macnish, of Glasgow, who is already well known as a very able and successful writer, and who has enriched his edition with a number of excellent notes. Dr. Caldwell's "Thoughts on Physical Education" are also in the course of republication. Both works contain facts and principles of great interest to every parent and teacher, and are calculated to be highly useful in advancing the cause of rational education.

that no such influences as the laws of organization exist, and that they may follow any course of life which inclination leads them to prefer, without injury to health, provided they avoid what is called dissipation. It is owing to this ignorance that we find young men of a studious or literary habit enter heedlessly upon an amount of mental exertion, unalleviated by bodily exercise or intervals of repose, which is quite incompatible with the continued enjoyment of a sound mind in a sound body. Such, however, is the effect of the total neglect of all instruction in the laws of the organic frame during early education, that it becomes almost impossible to warn an ardent student against the dangers to which he is exposing himself, and nothing but actual experience will convince him of the truth. I have seen several instances of almost total incapacity for future useful exertion brought on by long-protracted and severe study in subjects whose talents, under a better system of cultivation, would have raised them to that eminence, the injudicious pursuit of which had defeated their own object and ruined their general health. Two of these persons made the remark, that early instruction in the structure and laws of the animal economy, such as that which I am now attempting to communicate, might have saved them. Both meant well, and erred from ignorance more than headstrong zeal.

In the first number of the "American Annals of Education," the reader will find an instructive article on the necessity of combining bodily with mental exercise. "For twenty years and more," says the writer, in reference to what had taken place in an American seminary, "the unnatural union of sedentary with studious habits, contracted by the monastic system, has been killing in the middle age. The Register of Education shows in one year 120 deaths. Examine into the particular cases, and these will be found the undoubted effects of sedentary habits. Look at one name there. He had valuable gifts, perfected by two years' academic, four years' collegiate, and three years' theological studies. *He preached, gave much*

promise, and then died of a stomach disease. He contracted it when a student. He did not alternate bodily with mental labour, or he had lived and been a blessing to the church. *When he entered on his studies, he was growing into full size and strength. He sat down till his muscles dwindled, his digestion became disordered, his chest contracted, his lungs congested, and his head liable to periodical pains.* He sat four years in college, and three years in theological application. *Look at him now.* He has gained much useful knowledge and has improved his talents; he has lost his health. The duties of his mind and heart were done, and faithfully so; but those of his body were left undone. *Three hundred and seventy-five muscles, organs of motion, have been robbed of their appropriate action for nine or ten years, and now they have become, alike with the rest of his frame, the prey of near one hundred and fifty diseased and irritable nerves.*"—"Look at another case. Exposure incident to the parson or missionary has developed the disease in his chest, planted there while fitting himself for usefulness. He contracted a sedentary, while he was gaining a studious habit. That which he sows that also shall he reap. The east winds gave him colds; a pulpit effort causes hoarseness and cough, oppression and pain. He becomes alarmed and nervous. His views of usefulness begin to be limited. *He must now go by direction, and not so much to labour where otherwise he would have been most wanted, as to nurse his broken constitution.* He soon adds to the number of *mysterious providences;* to the number of innocent victims, rather, of cultivating the mind and heart, at the unnecessary and sinful expense of the body; to the number of loud calls to alternate mental and corporeal action daily, for the reciprocal sanity and vigour of both body and mind."

To remedy these evils and introduce a better system of training, so as to make bodily health and mental and rational education go hand in hand, an establishment called the Manual Labour Academy was opened near Philadelphia in 1829, and has already proved the soundness of its principles by the success of its

results. The usual branches of study in classical schools, with the addition of the Bible, are pursued; and the "hours of recreation are employed in useful bodily labour, such as will exercise their skill, make them dexterous, establish their health and strength, enable each to defray his own expenses, and fit him for the vicissitudes of life." From this systematic union of bodily labour in gardening, farming, carpentry, and other work, with the usual academic studies, many comforts are said to have arisen. The health of the inmates has been uninterrupted, except in a few who were ill when received; and, at the date of the report, in 1830, "*every invalid remaining there had been restored to health.*" Young men thus trained to practical obedience to the organic laws are much less likely to run into excess in after life, than those who have been left in ignorance of the constitution of their own bodies. "*When thought shall need no brain,*" the Report continues, "*and nearly four hundred organs of motion shall cease to constitute the principal portion of the human body, then may the student dispense with muscular exertion;*" but, till then, let him beware what he does, and, looking to the laws which the Creator has established for his guidance, seek his happiness, not in denying their existence, but in yielding them willing and cheerful obedience. De Fellenberg has done much at his agricultural school near Berne, to adapt the physical and mental education of the lower orders to their situation in society, and it would be well were his methods better known and more practised in this country.

In early and middle life, fever, with an unusual degree of cerebral disorder, is a common consequence of the excessive and continued excitement of the brain, which is brought on by severe study, unremitted mental exertion, anxiety, and watching. Some very marked cases of this kind have come under my observation; but that of Sir Humphrey Davy is so strikingly illustrative of the dangers alluded to, that I cannot do better than lay it before the reader. In November, 1807, Sir Humphrey Davy was seized with

very severe fever, in consequence of the excitement and fatigue which he underwent when engaged in the researches which led to his splendid discovery of the alkaline metals. "The laboratory of the institution was crowded with persons of every rank and description; and Davy, as may be readily supposed, was kept in a continued state of excitement throughout the day. This circumstance co-operating with the effects of the fatigue he had previously undergone, produced a most severe fit of illness, which, for a time, caused an awful pause in his researches, broke the thread of his pursuits, and turned his reflections into different channels." Davy ascribed his illness to contagion caught in experimenting on the fumigation of hospitals. "Upon conversing, however, with Dr. Babbington, who, with Dr. Frank, attended Davy throughout this illness, he assured me that there was not the slightest ground for this opinion, and that the fever was evidently the effect of *fatigue and an over-excited brain.* The reader will not feel much hesitation in believing this statement, when he is made acquainted with the habits of Davy at this period. *His intellectual exertions were of the most injurious kind,* and yet, unlike the philosophers of old, he sought not to fortify himself by habits of temperance." "Such was his great celebrity at this period of his career, that persons of the highest rank contended for the honour of his company at dinner, and he did not possess sufficient resolution to resist the gratification thus afforded, although it generally happened that *his pursuits in the laboratory were not suspended until the appointed dinner hour had passed. On his return in the evening, he resumed his chymical labours, and commonly continued them till three or four o'clock in the morning, and yet the servants of the establishment not unfrequently found that he had risen before them.*" Such was the alarming state of his health, that for many weeks his physician regularly visited him four times in the day; and the housekeeper, Mrs. Greenwood, never retired to bed, except one night, during eleven weeks. In the latter part of his illness "he was reduced to the ex-

treme of weakness, and his mind participated in the debility of his body."*

Instances sometimes occur of persons, exhausted by anxiety and long attendance on others, being themselves attacked by fever, and dying, more from the unfavourable state to which previous exhaustion had reduced them, than from the intensity of the fever itself.

Nervous disease from excessive mental labour and exaltation of feeling sometimes shows itself in another form. From the want of proper intervals of rest, the vascular excitement of the brain, which always accompanies activity of mind, has never time to subside, and a restless irritability of temper and disposition comes on, attended with sleeplessness and anxiety, for which no external cause can be assigned. The symptoms gradually become aggravated, the digestive functions give way, nutrition is impaired, and a sense of wretchedness is constantly present, which often leads to attempts at suicide. While all this is going on, however, the patient will talk or transact business with perfect propriety and accuracy, and no stranger could tell that anything ails him. But in his intercourse with his intimate friends or physician, the havoc made upon the mind becomes apparent; and, if not speedily arrested, it soon terminates according to the constitution and circumstances of the individual case, in derangement, palsy, apoplexy, fever, suicide, or permanent weakness.

As age advances, moderation in mental exertion becomes still more necessary than in early or mature years. Scipion Pinel, in adverting to the evil consequences of excessive moral or intellectual excitement, acutely remarks, that although in youth and manhood the wear of the brain thus induced may be repaired, no such salutary result follows over-exertion in the decline of life; "*what is lost then, is lost for ever.* At that period, we must learn to wait for what the brain is willing to give, and allow it to work at its own

* Paris's Life of Sir H. Davy, p. 183.

time: *to attempt to force it is to weaken it to no purpose;* it becomes excited and quickly exhausted when forced to vigorous thinking." "Men of exalted intellect perish by their brains, and such is the noble end of those whose genius procures for them that immortality which so many ardently desire."*

Who can peruse these lines without the fate of Scott instantly occurring to his mind as a practical illustration of their truth? In the vigour of manhood, few ever wrote so much or with greater ease. But when, on the verge of old age, adversity forced him to unparalleled exertion, the organic waste could no longer be repaired, and perseverance only "weakened the brain to no purpose," till morbid irritability became the substitute of healthy power, and he perished by that brain which had served him so faithfully and so efficiently, but which could no longer perform with safety the gigantic efforts which he continued to demand from it.

Where a predisposition to insanity exists, the cerebral excitement induced by excessive activity of mind often leads to disease. Examples of this kind abound in the works of authors. Pinel mentions several. One of them is the case of a young man distinguished for his talents and his profound knowledge of chymistry, who was occupied with a discovery which he hoped would lead him to fortune and distinction. To effect it the sooner, he resolved to shut himself up in his laboratory for several successive days; and, the better to banish sleep and to raise himself to the level of his labours, he prepared a variety of stimulants. A singing girl shared his retreat; he drank spirits, smelled frequently odoriferous substances, and sprinkled the room with eau de Cologne. The combined action of all these means, added to the heat of his furnace, caused such a degree of cerebral excitement, that, at the end of eight days, the most furious delirium took place, followed by a regular attack of mania. If anything can demon-

* Physiologie de l'Homme Aliéné, p. 177.

strate the mutual influence of mind and brain, it is surely a case like this; a case which it is impossible to read without perceiving how easily the cerebral affection might have been of the violent inflammatory character, which terminates after a few days, in life or in death: or of the febrile character, that lasts for one or two months, and leaves the mind for ever reduced in tone and vigour.

It is well remarked by Tissot, that the disorders produced by efforts of the mind fall soonest upon such as are incessantly engaged in the contemplation of the same object. In this case, he adds, there is *only one part of the sensorium* (brain) *acted upon, and that is kept always on the stretch: it is not relieved by the action of the other parts, and, therefore, is sooner fatigued and injured;* the same rule holding with the brain as with the muscles, that the exercise, which, if divided among the different parts of which it is composed, will strengthen them, will, if confined to a few, exhaust and impair them. Boerhaave himself, after a long period of intense thinking, suffered for six weeks from excitement of the brain, bordering on madness, and characterized by that want of sleep, irritability, and indifference to ordinary interests which so often appear as the harbingers of insanity.

The number of literary and public men, students and persons in business, who do themselves irreparable injury in this way, is so great, that few of my readers who have had experience of the world will be at a loss for examples even among their own acquaintances. In addition to Davy, Scott, and others already mentioned, Sir Isaac Newton may be referred to, as it is now certain that his mind was for a time disordered by excessive application, and there is much reason to believe that he never altogether recovered from the shock. The more limited the sphere of talent, the greater the danger of the brain being over-exercised, particularly where the temperament is quick and irritable; and hence the frequency of nervous affections in musicians and others of sus-

ceptible minds, who dedicate their lives to the exclusive cultivation of their arts. It is said that Gretry not only ruined his own health, but lost three highly-gifted and beautiful daughters in succession from over-excitement of the nervous system thus induced; and there can be no doubt that the melancholy fate of Weber was greatly hastened by intense application. He continued deeply engaged in musical composition long after his health was undermined; and, even when the hand of death was almost upon him, his avocations pressed so heavily that he could not help exclaiming, "*Would that I were a tailor, for then I should have a Sunday's holyday!*" The philanthropic physician will rather be inclined to exclaim, "Would that mankind would study their bodily structure and functions, and thus learn to preserve longer the health and existence of those whose genius is the source of so many pleasures to the world at large!"

So little, however, is this close connexion of the mind with the brain generally understood, even among educated people, that instances are constantly occurring of the health of the nervous system being ruined by excessive application of mind, without the sufferer in the least suspecting the true cause of his ailments. This fact is well exemplified in the pages of a very sound and able American writer, who says, "I once knew a young Christian, who resolved that he would pass the whole day in prayer. But very soon he became exhausted and weary. He, however, persevered through the whole day, with the exception of a few necessary interruptions; and, when night came, *he felt a deadness and exhaustion of feeling, which he unhappily mistook for spiritual desertion.*"* I need scarcely add, that no one at all acquainted with the laws under which God has placed the functions of the human body, could ever have expected his blessing to attend so flagrant a violation of his designs, or have felt surprise at the apparent

* Jacob's Young Christian, 2d Edinburgh edition, p. 230.

spiritual desertion increasing in exact proportion to the excess of the bodily fatigue. Cases like that of the young Christian show, in a strong light, the evils arising from confining ourselves too exclusively to the *word*, and neglecting the study of the *works*, of God, as if the latter were quite of a secondary character, and did not proceed from the same infallible source; whereas it is only by duly investigating the laws of God, as operating in the varied works of creation, that we become enabled rightly to interpret and to apply to our conduct what is revealed in His word.

CHAPTER IX.

RULES FOR MENTAL EXERCISE.

Rules for the proper Exercise of the Mind and Brain.—Mind not to be tasked immediately after a Meal.—Best Time for Mental Exertion.—Importance of Regularity in Mental Employment.—Repetition of Mental Act indispensable to Improvement of Mind.—Effects of Repetition illustrated in Moral and Intellectual Training.—Every Faculty to be employed directly on its own Objects.—Illustrations.—Direct Exercise of the Moral Faculties.—Best Means of exciting the Moral Sentiments.—Errors in ordinary Moral Education, and in Boarding-schools.—Use of Philosophy of Mind in conducting Education.—Influence of the Brain and Nervous System on the general Health.—Exemplified in ordinary Life, and in the Army.—The depressing Emotions destructive of Health.—Influence of the cheerful Emotions in preserving and restoring Health.—Sir H. Davy's Cure of Palsy by the application of a Thermometer explained.—Examples at the Siege of Breda—in the Army and Navy, and on the Northern Expedition.

HAVING thus pointed out the evils arising both from inadequate and from excessive mental exertion, it remains for me to direct attention to some of the rules which ought to guide us in the proper exercise of the brain.

It seems to be a law of the animal economy, that two classes of functions cannot be called into vigorous action at the same time, without one or other, or both, sooner or later sustaining injury. Hence the important rule, never to enter upon continued mental exertion, or to rouse deep feeling, immediately after a full meal, as the activity of the brain is sure to interfere with that of the stomach, and disorder its functions. Even in a perfectly healthy person, unwelcome news, sudden anxiety, or mental excitement, occurring after eating, will put an entire stop to digestion, and cause the stomach to loathe at the sight of food. In accordance with this, we learn by experi-

ence, that the worst forms of indigestion and nervous depression are those which arise from excessive application of mind or turmoil of feeling, conjoined with unrestrained indulgence in the pleasures of the table. In such circumstances, the stomach and brain react upon and disturb each other, till all the horrors of nervous disease make their unwelcome appearance, and render life miserable. Literary men and hard students know this fact from sad experience; but as they are not aware of the incompatibility of the two processes of active thinking and active digestion going on at the same time, it is extremely difficult to give them a sense of their danger, and to convince them that an hour or an hour and a half after a meal is more profitably spent in easy relaxation than in the labour of composition. As regards the lower animals, indeed, we are careful enough to observe this organic law; for we do not allow our horses or dogs to be actively exercised till digestion is in some degree completed.

It may be said that mechanics, labourers, and others, hurry away to work immediately after meals without any apparent injury; and that, in the United States, the practice of hastily swallowing dinner and instantly returning to business is almost universal. My answer to this objection is simply that experience proves the fact that digestion goes on better when exertion is refrained from and repose is enjoyed; and that the tendency to sleep and inactivity which besets most animals after a full meal, shows repose to be, in such circumstances, the intention of Nature. It must be observed, also, that the bad effects of immediate exertion are not among those which ensue instantly, or are felt from day to day. They may show themselves only at the end of months and years, when the influence has, as it were, accumulated by repetition. Although, therefore, the system possesses a certain power of resistance, and many persons seem to escape even for years, it cannot be doubted that opposition to the law of Nature will eventually [illegible] rious. The extreme prevalence of dys-

peptic complaints and of insanity among Americans is doubtless partly owing to the very practice which is supposed by some to be harmless to them. Dr. Caldwell, of Lexington, who has devoted much time and talent to the diffusion of sound knowledge and the improvement of the race, and whose opportunities of observation have been very extensive, expressly states, that "dyspepsy and madness prevail more extensively in the United States than among the people of any other nation. Of the amount of our dyspeptics," he says, "no estimate can be formed; but IT IS IMMENSE. Whether we inquire in cities, towns, villages, or country places, among the rich, the poor, or those in moderate circumstances, we find dyspepsy more or less prevalent throughout the land."* It is clear, from this testimony, that the people of the United States form no exception to the general law of Nature.

The time best adapted for mental exertion falls next to be considered. Nature has allotted the darkness of night for repose, and for the restoration, by sleep, of the exhausted energies of mind and body. If study or composition be ardently engaged in towards that period of the day, the increased action in the brain which always accompanies activity of mind requires a long time to subside; and, if the individual be at all of an irritable habit of body, he will be sleepless for hours after going to bed, or perhaps be tormented by unpleasant dreams. If, notwithstanding, the practice be continued, the want of refreshing repose will ultimately induce a state of morbid irritability of the nervous system, not far distant from insanity. It is, therefore, of great advantage to engage in severer studies early in the day, and devote two or three of the hours which precede bedtime to lighter reading, music, or amusing conversation. The vascular excitement previously induced in the head by study has then time to subside, and sound refreshing sleep is much more certainly obtained. This rule is of great

* Caldwell's Discourse on Physical Education, p. 87.

consequence to those who are obliged to undergo much mental labour, and it will be found that many of our most prolific writers—of those especially who write much and yet preserve their health—are among those who have, either from knowledge or from inclination, devoted their mornings to study and their evenings to relaxation. Such was Sir Walter Scott's distribution of his time, and such I know to be that of one of our ablest living writers.

There are, no doubt, individuals so happily constituted, and whose natural sphere is so essentially that of activity, that they are able to think and work, early and late, for years in succession, with very little sleep, and with little regard to diet and regimen; but they are so obviously exceptions to the general rule, that we cannot for a moment hold them up as models for imitation; and even they would enjoy their astonishing gifts with greater security, were they to conform more completely to the laws of their organization.

Periodicity, or the tendency to resume the same mode of action at stated times, is peculiarly the characteristic of the nervous system; and, on this account, *regularity* is of great consequence in exercising the moral and intellectual powers. All nervous diseases have a marked tendency to observe regular periods, and the natural inclination to sleep at the approach of night is but another instance of the same fact. It is this principle of our nature which promotes the formation of what are called habits. If we repeat any kind of mental effort every day at the same hour, we at last find ourselves entering upon it, without premeditation, when the time approaches; and in like manner, if we arrange our studies in accordance with this law, and take up each regularly in the same order, a natural aptitude is soon produced, which renders application more easy than by taking up the subjects as accident may direct. Nay, the tendency to periodical and associated activity occasionally becomes in the course of time so great, that the faculties seem to go through their operations almost without conscious effort, while their facility of action becomes so

prodigiously increased as to give unerring certainty where at first great difficulty was experienced.*

In thus acquiring readiness and forming habits, we merely turn to account that organic law which associates increased aptitude, animation, and vigour, with regular exercise. It is not the soul or abstract principle of mind which is thus changed, but simply the organic medium through which it is destined to act: and when we compare the rapid and easy eloquence of the practised orator with the slow and embarrassed utterance which distinguished him at the outset of his career, we have merely a counterpart in the organ of mind, of what is effected in the organs of motion, when the easy and graceful movements of the practised dancer, writer, or piano-forte player take the place of his earliest and rudest attempts.

The necessity of judicious *repetition* in mental and moral education is, in fact, too little adverted to, because the principle on which it is effectual has not been understood. To induce facility of action in the organs of the mind, *practice* is as essential as it is in the organs of motion. The idea or feeling must not only be communicated, but it must be reproduced and represented in different forms, till all the faculties concerned in understanding it come to work efficiently together in the conception of it, and till a sufficient impression be made upon the organ of mind for the latter to retain it. We often blame servants for not doing a thing every day because they were *once* told to do so. The organic laws, however, teach us that we are presumptuous in expecting the formation of a habit from a single act, and that we must reproduce the associated activity of the requisite faculties many

* These remarks are curiously confirmed by an anecdote of Silvio Pellico, which I read in the Foreign Quarterly Review (No. xxii., p. 478), when this sheet was passing through the press. When first imprisoned, Pellico was "allowed the use of a copy of Dante and the Bible. Of the former, he used to commit a canto to memory every day, till at last the exercise *became so mechanical that it ceased to afford any interruption to the train of melancholy thought.*" I need scarcely point out the coincidence between this and the remarks in the text.

times before the result will certainly follow, just as we must repeat the movement in dancing or skating many times before we become master of it. In like manner, we find, on turning to a new subject, that, however well we may understand it by one perusal, we do not fully master it except by dwelling upon it again and again.

Repetition is thus necessary to make a durable impression on the brain; and, according to this principle, it follows, that, in learning a language or science, six successive months of application will be more effectual in fixing it in the mind, and making it a part of its furniture, than double or triple the time, if the lessons are interrupted by long intervals. Hence it is a great error to begin and study, and then break off to *finish* at a later period. The *ennui* is thus doubled and the success greatly diminished. The best way is to begin at the proper age, and to persevere till the end is attained. This accustoms the mind to sound exertion, and not to *fits* of attention. Hence the mischief of long vacations, and hence the evil of beginning studies before the age at which they can be understood, as in teaching the abstract rules of grammar to children; to succeed in which implies in them a power of thinking and an amount of general knowledge which they cannot possess.

In physical education, we are quite alive to the advantages of repetition and practice. We know that if practice in dancing, fencing, skating, and riding be persevered in for a sufficient length of time to give the muscles the requisite promptitude and harmony of action, the power will be ever afterward retained, although little called into use; whereas, if we stop short of this point, we may reiterate practice by fits and starts, without any proportional advancement. The same principle applies equally to the moral and intellectual powers because these operate by means of material organs.

The necessity of being in private what we wish to appear in public, springs from the same rule. If we wish to be polite, just, kind, and sociable, we must

habitually act under the influence of the corresponding sentiments in the domestic circle and in everyday life, as well as in the company of strangers and on great occasions. It is the daily practice which gives ready activity to the sentiments and marks the character. If we indulge in vulgarities of speech and behaviour at home, and put on politeness merely for the reception of strangers, the former will shine through the mask which is intended to hide them; because the habitual association to which the organs and faculties have been accustomed cannot thus be controlled. As well may we hope to excel in elegant and graceful dancing by the daily practice of every awkward attitude. In the one case as in the other, the organs must not only be associated in action by the command of the will, but also be habituated to the association by the frequency of the practice; a fact which exposes the ignorant folly of those parents who habitually act with rudeness and caprice towards their children, and then chide the latter for unpolite behaviour towards strangers.

The same principle of repetition being necessary to make a durable impression on the brain and constitute a mental habit, also explains the manner in which natural endowments are modified by external situation. Taking the average of mankind, the limits to which this modification may be carried are not narrow. Place a child, for example, of *average* propensities, sentiments, and intellect, among a class of people—thieves—in whom the selfish faculties are exclusively exercised; by whom gain is worshipped as the end of life, and cunning and cheating as the means; and among whom is never heard one word of disapprobation or moral indignation against either crime or selfishness, and its lower faculties will be exclusively exercised and increased in strength, while the higher will be left unemployed and become weak. A child so situated will, consequently, not only act as those around him do, but insensibly grow up resembling them in disposition and character; because, by the law of repetition, the organs of the selfish qualities

will have acquired proportionally greater aptitude and vigour, just as do the muscles of the fencer or dancer. But suppose the same individual placed *from infancy* in the society of a superiorly endowed moral and intellectual people; the moral faculties will then be habitually excited, and their organs invigorated by repetition, till a greater aptitude, or, in other words, a higher moral character, will be formed. There are, of course, limits set to this modification by the natural endowments of the individual; but where the original dispositions are not strongly marked, the range is still a wide one.

From this source arise many differences not only of individual but of national character, and such differences as we observe take place from changes of fortune and condition. The negro free in Africa differs widely from the negro subjected to the scourge of the colonist.

The same principle is well illustrated by M. Arago in his account of Freycinet's Voyage round the World in 1818, 19, 20. In speaking of the different results of education in the Isle of France and in the mother country, he observes, that the professors, the methods, and the subjects taught, are quite on a par with those of Paris; but that, nevertheless, from the very early maturity of the human being in that climate, the pupils are removed from school so soon that the impression made on their minds is speedily obliterated; on which account, he adds, the only really educated and well-informed men to be met with are those who have been sent to France very young, and retained there till a later age and more thorough grounding have been attained, after which the risk of losing their acquirements is greatly diminished.

The next rule to be observed in the cultivation of the brain and mental faculties, is founded on that law of our constitution which directs *each organ to be exercised directly upon its own objects*, and not merely roused or addressed through the medium of another organ. We have said that when we wish, for exam-

ple, to teach the graceful and rapid evolutions of fencing, we do not content ourselves with merely giving directions, but our chief attention is employed in making the muscles themselves go through the evolutions, till, by frequent repetition and correction, they acquire the requisite quickness and precision of action: and when we wish to teach music, we do not merely address the understanding and explain the qualities of sounds, but we train the ear to their attentive discrimination, and the hand to the reproduction of the motions which call them into existence. We follow this plan, because the laws of organization require direct practice, and we feel instinctively that we can succeed only by obeying them. Now, the purely mental faculties, being connected during life with material organs, are subjected to precisely the same law; and, therefore, if we wish to improve the reasoning powers, we must exercise them regularly in tracing the causes and relations of things. And, in like manner, if our aim is to develop the sentiments of attachment, benevolence, justice, or respect, we must exercise each of them directly and for its own sake, otherwise neither it nor its organ will ever acquire promptitude or strength.

It ought never to be forgotten, that in education it is the brain, or organ of the mind, and not the abstract immaterial principle, which requires cultivation, and that hence *education operates invariably in subjection to the laws of organization.* In improving the *external* senses, we admit this principle readily enough; but whenever we come to the *internal* faculties of thought and feeling, it is either denied or neglected. With gross inconsistency, we admit that the superior quickness of touch, sight, and hearing consequent upon judicious exercise, is always referable to increased facility of action in their appropriate organs; but when we explain, on the same principle, the superior development of the reasoning powers, or the greater warmth of feeling produced by similar exercise in these and other internal faculties, few are inclined to listen to our proposition, or allow to it half the weight

or attention which its importance requires, although every fact in philosophy and experience concurs in supporting it. We see the mental powers of feeling and of thought unfolding themselves in infancy and youth, in exact accordance with the progress of the organization; we see them perverted or suspended by the sudden inroad of disease, and as suddenly restored; nay, we sometimes observe every previous acquirement obliterated from the adult mind by fever or by accident, leaving education to be commenced anew, as if it had never been; and yet, with all these evidences of the organic influence, it is still a novelty in education to propose that the established laws of physiology, as applied to the brain, should be considered as our best and surest guide; and scarcely a volume can be pointed out in which it is even hinted that these laws have the slightest influence over mental or moral improvement.

Were a general acquaintance with the laws of organization to be held as an indispensable part of a liberal education, we would then be able to inculcate, with tenfold force and success, the necessity of actively exercising every faculty, whether of thought, feeling, or motion, directly *on its own objects*, and at once to explode the mistake of supposing that any organ or function may be efficiently exercised through the medium of another, and that, to produce high moral feeling, it is sufficient to address ourselves to the intellect alone. The merest savage, following the footsteps of Nature, would pity the philosopher who should seriously assure him that, to cultivate acuteness of hearing or of vision, it was sufficient to be told how to listen or to look. The savage goes more directly and surely to work. If he wants physical strength, agility, and swiftness of foot, he sets himself to develop the muscular system of his child by ample muscular exercise, by constant repetition of the movements and acts he wishes him to perform, and by causing him to run, to leap, or to swim; and he rests in well-founded hope of accomplishing his purpose. Following the same rule when he seeks acute-

ness of hearing, he does not merely tell his child how to listen, but he lays him with his ear to the ground, and teaches him, by practice, to distinguish the qualities of sounds. If he wishes him to excel in hunting, in fishing, in lying in ambush, or in scenting the approach of an enemy, he expects to be successful only in proportion as he finds occasion to employ him in the practice of these pursuits. If he wishes to inculcate courage in battle, contempt of pain, endurance of fatigue, obedience to chiefs, or revenge upon enemies, he chooses the sure way, and cultivates each of these qualities by calling it into direct action on its own objects; and we all know the success which the savage meets with in the education thus bestowed.

With this experience before our eyes, then, let us, who pretend to superior wisdom and civilization, show ourselves also consistent, and ready to receive instruction from whatever quarter it may come. As God has given us bones and muscles, and bloodvessels and nerves, for the purpose of being used, let us not despise the gift, but consent at once to turn them to account, and to reap health and vigour as the reward which he has associated with moderate labour. As he has given us lungs to breathe with and blood to circulate, let us abandon the folly of shutting ourselves up with so little intermission, engaged in motionless study and sedentary occupations, and consent to inhale copiously and freely that wholesome atmosphere which his benevolence has spread around us. As he has given us appetites and organs of digestion, let us profit by his bounty, and earn their enjoyment by healthful exercise. As he has given us a moral and a social nature, which is invigorated by activity, and impaired by solitude and restraint, let us cultivate good feeling, and act towards each other on principles of kindness, justice, forbearance, and mutual assistance; and, as he has given us intellect, let us exercise it in seeking a knowledge of his works and of his laws, and in tracing out the relation in which we stand towards him, towards our fellow-men,

and towards the various objects of the external world: and, in perfect faith and sincerity, let us rely upon his promise that, in so doing, we shall have a rich reward; a reward a thousand times more pure, more permanent, and more delightful, than we can ever hope to experience in following our own blind devices, regardless of his will and intentions towards us.*

Shortly after the third edition of this work was published, I had occasion, in the course of conversation with a very intelligent friend, to express the gratification which I felt on learning that in two excellent educational establishments just opened in Edinburgh, by associations of the ablest teachers of the city, physiology was not only included as an important branch of study, but had proved attractive and interesting even to young ladies, who constituted a large proportion of the audience, although, by their previous education, they were as little prepared for the favourable reception of its doctrines as it was possible to conceive any one to be. On being asked why I attached so much importance to physiology as a practical science, I stated briefly some of the reasons mentioned in these pages. My friend was struck with their force, and wishing to be put in possession of them in a tangible form for a special purpose, requested me to write them out in the form of a letter. I complied with the request, and as an explanation arising out of an individual case often possesses more

* Those of my readers who wish to pursue the inquiry, and to trace the relations in which Man stands to his Creator, to his fellow-creatures, to himself, and to the external world, will find a clear and comprehensive guide in a small volume entitled "The Constitution of Man considered in relation to External Objects. By George Combe." In this work, of which upward of 15,000 copies have got into circulation within the last year, a general view is taken of the human constitution, and of the laws which regulate the organic, moral, and intellectual nature of man. The sources of most of the evils which afflict the human family are successfully traced to violations of those laws, and shown to be, to a great extent, within our own control; so that practical usefulness, and not mere speculation, is the characteristic of the volume.

point and applicability than a more general argument, and the subject is one of immense importance, I shall subjoin the letter entire, although it necessarily involves some repetition of statements already given.

EDINBURGH, 9*th April*, 1835.

"MY DEAR ——,

"When we last met, I said that I was much gratified to see the recently-formed Association of Teachers ranking physiology first among the subjects which it was important for them, as professional men, to be acquainted with; and the reason I gave was the simple fact, that all the moral and intellectual functions stand in the same relation to one part of our organized structure, viz., the brain, as the physical power of motion or exercise does to another, viz., the muscles; that, consequently, to educate the moral or intellectual faculties successfully, we must have the same constant reference to the laws under which organization acts, as we have in educating the muscles and training them to any of the ordinary exercises of walking, dancing, fencing, or riding; and that hitherto this grand principle had been overlooked, and many modes of training the intellect and feelings resorted to, which, being contrary to the laws of organization, *could not* succeed.

"I gave the muscular system as an example, and stated it as a law of organization, that, to keep a part in health and vigour, it must be *duly* and *regularly* exercised. If it be too little, the blood flows languidly through it, the nervous energy in it is enfeebled, and the part becomes *weakened* and INDISPOSED TO ACT *without some strong stimulus*. If it be too much exercised, its vessels and nerves become feeble and irritable *from exhaustion*, and INABILITY to act with vigour ensues. If it be exercised to a proper extent, the circulation through it becomes animated, it receives more blood, and, consequently, more nourishment; its nerves act with more tone, and IT BECOMES STRONGER, READIER FOR ACTION, and after a time fitted for repose. If, however, the exercise be not resumed after sufficient repose, then weakness of necessity follows as above.

"To apply this principle to the exercise of a bodily power. Suppose that A B walks ten or fifteen miles every Monday morning, and during the other six days of the week not at all, and that, finding himself greatly fatigued by the exertion, he roundly asserts that exercise is hurtful—what answer would be made? He would be told that as he sowed so had he reaped; that, as he had infringed all the laws of exercise, so had he suffered the punishment due to the infringement: 1*st*, By walking much farther than his constitution was fit for, he had induced *debility from exhaustion;* 2*dly*, By remaining inactive the other six days, he had induced *debility*, *with indisposition to action*, dependant on a sluggish circulation and low tone of vitality. Had he wished to strengthen his muscular system, the laws of exercise required that he should employ his muscles to a sufficient degree to increase their tone, and regularly resume the exercise after adequate repose. The very gradual and regular way in which horses are prepared for the race-course or hunting-field, is an excellent illustration of the importance attached to the observance of the law of Nature in training animals.

"In training the mental powers, precisely the same principle ought to guide our efforts, because God has made the mind as dependant on the brain for its action during life, as he has done the power of motion in the muscles; and, therefore, we are doubly bound to follow the law which he has given us for our guidance. According to this principle, then, every mental power may be weakened by *too little*, and also by *too much* exercise; because the brain, through which it acts, may be left sluggish or be exhausted by excess of exertion. In the first case, the mental faculty becomes *indisposed* to act; and, in the second, it becomes *incapable* of acting vigorously and steadily. It *may* be excited to action, but the action will be irritable, and unsteady, and unprofitable; not permanent, enduring, and available, such as attends the medium or right degree of exercise.

"To apply this to moral education. It is evident

that, granting the truth of the principle (which can be demonstrated), every *moral* feeling which we wish to strengthen and cultivate must be duly, regularly, and systematically exercised before full success can be attained, just as we see done with the intellectual faculties of music, painting, language, and memory of facts. We have no choice in the matter. Either we must obey the law which God has imposed on our constitution, or we must fail in attaining the moral excellence of which he has made us capable. He has connected mind and feeling with organization to fit us for our residence in a material world, and we must either act under its laws or suffer.

"Here, then, is the use of teachers being taught this fact. Love of approbation is a strong and active feeling of the human mind, and it is one to which food is easily administered, and the gratification of which is attended with much pleasure to those who are largely endowed with it. Being a very prominent feeling in society, it is, perhaps, the most regularly and sedulously educated which we have. Before an infant can walk, or speak, or understand, we begin by praising its beauty, its shoes, its rattle, or its dress: when it cries, we flatter it to silence; when it speaks, reads, sings, or dances, every one is in an ecstasy of admiration at its achievement. At school, its vanity is cultivated by places, and prizes, and public exhibitions. At college, emulation ill directed is often its bane. In the world, 'fame' is its grand prize. With females, emulation, prizes, flattering, and compliment are still more effective. The result of this careful education and systematic exercise of an inferior feeling is manifest in every age and in every rank of life. It predominates everywhere. How much of character and conduct in public and in private circles springs from the single principle of love of approbation in its various modifications of emulation, vanity, desire of renown, love of praise, notoriety, or fame! There is, in truth, scarcely an act of any note in which it does not come in as a primary element.

"Is it equally so with the sense of justice or reli-

gion? Are *they* called systematically into play in every act which intervenes between the cradle and the grave? And do we find them constantly referred to as rules of conduct, as we do emulation, fame, glory, and honour? And do we find them exercising even a tithe of the influence over human conduct which the other does? Far from it: conscience, indeed, is a "still small voice," for its cry is rarely heard, and its voice is easily drowned by less noble sounds. Why is it so? The reason is obvious: not being recognised as a primitive faculty connected with an organ of its own, no one thinks that it requires regular and systematic exercise to give it strength. Being viewed as an offshoot from intellect, it is said, 'Cultivate intellect, and the sense of justice will shift for itself.' From this error, parents and teachers not only neglect to educate conscience, or the sentiment of justice, but too often violate its dictates, in the belief that the child has not sense enough to see the violation. Instead of being made a ruling principle in every-day life, it is rarely heard of; and hence, *from inactivity*, IT BECOMES INDISPOSED TO ACT, because such is the law of its organization.

"It is the same with the religious feelings. If these be actively cherished and made to regulate every-day life, their organs acquire readiness and vigour of action, and the feelings become sources of happiness and right conduct. But if their exercise be reserved for the seventh day, and they be laid aside in the intervening six, the law of organization decreed by God is again broken, and from sluggishness *indisposition to activity is induced!* The separation of belief from practice, which some inculcate, has misled many and done infinite harm.

"From the same principle which requires the regular exercise of *all* the moral and intellectual faculties, it necessarily happens, that, if one or several be greatly cultivated to the exclusion of the rest, all are apt to suffer. Those which are too constantly in action, are apt to pass into that irritable state of excitement which constitutes an almost morbid craving, and is

hurt by indulgence; while those which are not sufficiently exercised become sluggish and INDISPOSED to act. This is, in truth, one of the reasons why persons remarkably gifted with partial talent, are rarely equally remarkable for sound general sense or feeling, or for being proportionably happy. Continual activity in the one direction exalts their irritability, diminishes the healthy tone of the system, and leaves in abeyance all the other faculties of the mind, whether moral or intellectual. Hence, in some degree, the proverbial irritability of poets, artists, musicians, and authors, whose minds are exercised on one set of objects, and whose moral feelings are not brought sufficiently into play in the ordinary duties of life. And hence, I may add, the danger of deterioration of character in young people from excessive addiction to one line of pursuit, and the neglect of their other and higher faculties.

"In short, in attempting to produce moral excellence in the young, we have no royal road to stride over with seven-league boots. We must just submit to cultivate the sense of justice, and the sentiments of veneration and benevolence, on the same principle as we do musical talent or muscular power; and we may be very thankful in having the guarantee of Omnipotence to assure us of success when we do so. It is a fact which I can explain only by the prevailing neglect of moral education, that, as a general rule, the sense of conscientiousness is more active in childhood than in mature age. If the sentiment were properly cultivated, I think it would become proportionably stronger instead of weaker."

So little, however, are even educated men familiar with the influence and laws of the organization, that, even in our best-directed establishments, as well as in private families, cultivation is still in a great measure confined to intellect alone; and the *direct* exercise and training of the moral and religious sentiments and affections are rarely thought of as essential to their full and vigorous development. Moral

precepts are, no doubt, offered in abundance; but these address themselves chiefly to the intellect. We must not be satisfied with merely exclaiming, "be kind, just, and affectionate," when perhaps, at the very moment, we are counteracting the effect of the advice by our own opposite conduct. "*She told me not to lie*," said Guy Rivers in speaking of his mother, "*and she set me the example herself by frequently deceiving my father, and teaching me to disobey and deceive him.*" Conduct like this is more common in real life than is supposed, although generally less flagrant in degree. Parents and teachers, indeed, too often forget that the sentiments *feel* and *do not reason*, and that, consequently, even a stupid child may, by the instinctive operation of its moral nature, at once detect and revolt at the immorality of practices, the true character of which its *reason* is unable to penetrate or expose. It is one of the most effectual methods of cultivating and exciting the moral sentiments in children, to set before them the manifestations of these in our habitual conduct. What kind of moral education is that, for instance, which, while the instructress vilifies the physical appetites of hunger and thirst, and preaches disregard of their cravings and of the gratifications of taste, leads her to set down a meal to her boarders, from partaking in which she betrays the strongest desire to escape, on account of its inferiority to that which is provided for herself and the few at the head of the establishment? What advances in morality and religion can be expected under the charge of one who says, "*Do unto others as you would be done by*," and then leaves his dependants to suffer pain, chilblains, and disease, from want of a fire to warm the room in which they sit, he himself coming into it with features flushed by the heat of the blazing fire, which, for weeks, has been provided for his comfort in his own apartment? What generosity of feeling can arise from the superintendence of a teacher, who, though liberally paid for the food of her pupils, and with moral precepts on her lips, satisfies the cravings of nature in the long interval between

meals only at the expense of the pence constituting the pocket-money of the scholar? the food in this case being denied, not because it is considered improper—for, were that the case, it would be a dereliction of duty to give it on any terms—but from sheer meanness and cupidity. What kind of moral duties does the parent encourage, who, recommending kindness, openness, and justice, *tricks* the child into the confession of faults, and then basely punishes it, having previously promised forgiveness? And how is openness best encouraged—by practising it in conduct, or by neglecting it in practice but praising it in words? Is it to be cultivated by thrusting suspicions in the face of honest intentions? And how is justice to be cultivated by a guardian who *speaks* about it, recommends it, and *in practice* charges each of four pupils the whole fare of a hackney-coach? Or what kind of moral education is that which says, *Do as I bid you, and I will give you sweetmeats or money, or I will tell your mamma how good you were;* holding out the lowest and most selfish propensities as the motives to moral conduct! Did space permit, I might indeed pursue the whole round of moral and religious duties, and ask similar questions at each. But it is needless. These examples will suffice; and I give them, not as applicable generally either to parents or teachers, but simply as individual instances from among both, which have come within the sphere of my own knowledge, and which bear directly upon the principle under discussion.

If I have here or elsewhere spoken too harshly of the errors of teachers and conducters of boarding-schools, it has been quite unconsciously, for my sole anxiety is to see them, as a class, elevated to that high moral and intellectual position in the scale of society, which those intrusted with so responsible a charge as the education of the young ought unquestionably to occupy. But I have too deep a sense of the mischief done by incompetent persons assuming the duties and responsibilities of instructers, without possessing a single preparatory qualification, and with no higher motive than that of having been unfortunate

in another calling, to hesitate about condemning practices which I believe to be wrong. For those among them who have fitted themselves in earnest for the duties of their profession, and whose energies are devoted to the welfare of their pupils—and there are many such—I entertain the highest respect, and to them none of the censure is meant to apply.

Such were the remarks which, in the former editions, I felt it necessary to make on the want of harmony between precept and practice in the moral training of the young in boarding-schools. Since then, my attention has been called to other practices, which are still more reprehensible than those already noticed. One of these is the custom which prevails in many seminaries of retaining, when the pupil leaves the school, the towels, sheets, and even the silver fork and spoon which each is required to bring along with her at entry. So far, indeed, was this paltry spirit of appropriation carried in one instance, that even a pianoforte belonging to one of the young ladies was retained, without leave being either asked or given. In another instance the pupil brought along with her a new wardrobe, in which she and her friends intended that she should keep her own clothes and property. But, to her great mortification, it was taken from her the very first day, set up as an ornament in another room, and a single drawer in an old chest given in its place! It also was left behind as the property of the family.

Those who have been long familiar with the existence of the above practice in boarding-schools, or who have themselves acted upon it from habit, without being conscious of any censurable meanness, may think I go too far in thus stigmatizing it. But I have never met with any one who, on hearing of it for the first time, hesitated a moment to denounce it as repugnant to all the higher feelings of our nature, and as peculiarly unbecoming in those whose conduct so directly influences the moral and religious training of the youth confided to their charge. The only excuse which I have ever heard alleged in its favour, even by those who defend it, is that *such is the custom*, and that

as parents are aware of the practice before they send their children to school, there is, therefore, no immorality involved in its continuance. This mode of reasoning, however, is as false and oblique as the proceeding which it is used to sanction; and does not touch the real merits of the question, Whether the retention of the property of the pupil be an open and honourable way of increasing their own gains or not? If it is, then it need not be concealed, but should be plainly and broadly stated in the list of terms. If it is not, but the thing is done merely from long custom, then the sooner it is given up the better: for although indulgence in that which is wrong may blunt the acuteness of the moral perceptions, it can never so far alter the true relation of things as to render that right and virtuous which was at first wrong and unjust; and, to the essential merits of the question, it signifies little whether the property be detained by the express order of the conductors of the school, or by the attachment of ridicule to the pupil who would otherwise take it away. To every delicate mind, the one motive to the sacrifice is evidently as compulsory as the other.

Another immoral and disgraceful practice in many seminaries is that of exacting from the private teachers employed in them a heavy *per-centage* (amounting in some instances within my knowledge to ONE HALF) on the fees which they receive from the pupils. If these fees be fair and reasonable, gross injustice is obviously done to the teacher by this underhand system of pillage. If, on the other hand, the teacher be compelled to increase his demand on the pupil beyond the point of a fair remuneration, on purpose to meet the *per-centage* required of him, then he is made the instrument of a dishonest exaction from others. On either supposition, the practice is immoral; and that it is felt to be so, even by the parties themselves, is proved by the very concealment with which it is attended. It has also the farther drawback of exposing the conductors to the temptation of employing, not the teachers who are best qualified, but those who will give up the largest allowances out of their own gains.

It is no excuse whatever to allege, as is sometimes

done, in justification, that without these additions the rate of board received would afford an inadequate remuneration to the conductors of the boarding-school. This would be an exceedingly good reason for increasing the amount payable by each pupil, but it is none whatever for the perpetration of a gross immorality. The education, and moral and religious training of the young, ought to be liberally and gratefully paid for. If, therefore, an erroneous calculation has been made at the outset, the board ought clearly to be increased; but the necessity for such increase ought to be openly and honestly stated, and not allowed to stand for ever after as an apology for the continued infliction of a miserable and degrading injustice; an injustice calculated to set at naught all the moral and religious instruction for which chiefly the remuneration is bestowed. To the pocket of the pupil or parent it matters little under what heads the amount is claimed; but to their feelings and character it is of great importance that no outrage to the common feelings of honesty should be mixed up with the conduct of education.*

* As the observations in the text are strongly expressed, I think it right to subjoin a few specimens of the charges made in a most respectable school, of which the prospectus is now before me, and which, I think, will amply justify all that I have said. The sums received by the teachers are given on what I believe to be a trustworthy authority.

For	The pupil is charged per quarter,	The teacher receives,	And, consequently, the *annual* surcharge amounted to,
Dancing, . .	*l.* 2 2 0	*l.* 1 1 0	*l.* 4 4 0
Drawing, . .	3 3 0	2 2 0	4 4 0
Singing, . .	4 4 0	3 3 0	4 4 0
Harp, . .	4 4 0	3 3 0	4 4 0
Guitar, . .	4 4 0	3 3 0	4 4 0
German, . .	3 3 0	2 2 0	4 4 0
French, . .	2 2 0	1 11 6	2 2 0
Writing, &c. . .	1 1 0	0 10 6	2 2 0
Geography, . .	1 1 0	0 10 6	2 2 0
Elocution, . .	1 1 0	0 10 6	2 2 0
Annual total of surcharge on the above branches,			*l.* 33 12 0

There are persons who, when proved to be in the wrong, find great comfort to their wounded feelings in the fact of their neighbours or censors being as bad as themselves. To such of my readers as require consolation of this description, I am ready to admit, that men of my own profession are also fallible, and that, not very many years ago, physicians participated largely in the profits of their apothecaries, on the very same principle as that on which conductors of schools participate in the gains of the private teachers. But I am happy to say that this practice has been long discontinued, as not less degrading to the parties concerned in it than injurious to the public; and all that I wish, in the present instance, is to see their example followed for good as well as for evil.

Not to be misunderstood, however, I must add that the parents and public are fully as much to blame for these delinquencies as those who more immediately commit them. If, in society, the teachers and guardians of youth were treated generally with the respect and consideration to which those really qualified for the trust are so amply entitled, and a liberal remuneration were afforded them in the same spirit of confidence and equality, a higher class of minds would dedicate themselves to the profession, and qualify themselves by previous preparation for its duties. Whereas, under the existing system, there is no inducement whatever for any person of superior talent and character to enter upon a profession which places him in an inferior grade in society to that which the same talents and character, differently employed, would enable him to reach with ease: and hence, with a few honourable exceptions, those only embark in it who are compelled by the narrowness of their circumstances or the impossibility of finding any other career left open to them. Both parties are thus to blame, and both suffer the consequences of their own errors; the one in being treated with disrespect, and the other in disappointment at the miserable results of the expensive education which their children receive.

Before leaving this subject, I am anxious to repeat, that I am far from including all boarding-schools in the above censure. There are some in which the practices commented upon are stigmatized and discountenanced; and in alluding to such defects as *I know* to be still in existence in many of them, my sole object has been to increase their usefulness, by hastening the introduction of such improvements as are essential not less to their own moral respectability and ultimate prosperity than to the lasting advantage of their pupils.

In the practical training of the young, it is of consequence to keep in mind that the moral sentiments, in common with the intellect, are dependant on organization for their means of activity during life, and, consequently, are more successfully cultivated by being habitually employed in regulating the every-day affairs of life, than by waiting for great occasions on which they may be exercised with unusual vigour. Benevolence, no doubt, is vividly excited by the aspect of great misery and unhappiness, and impels strongly to the relief of the suffering object; but this is not its most common or its most useful field. In ordinary life, it finds ample scope in charity to our neighbours, and in contributing to the happiness of our family circle, and of our associates and dependants. Benevolence is much better occupied in adding a gleam of enjoyment, in removing little sources of irritation, in promoting concord among relatives, and in other kind offices of a similar nature, than in giving alms indiscriminately to all who demand them, or even in relieving occasional distress, where this is held, as it too often is, to dispense with all obligation to habitual forbearance and Christian good-will in the private relations of life. But how little is this most important faculty directly attended to or cultivated, in the way we see done with the faculties necessary for the practice of drawing or music, which, by incessant exercise, procured at a great sacrifice of time, money, and labour, are brought into such a state of

activity as ever after to enable their possessors to derive delight from their exercise, where the talents are possessed in any considerable degree! And what might we not expect from the systematic training of the higher sentiments on a similar plan, in improving society and exalting the happiness of the race! But it is evident that the objects of benevolence are our fellow-creatures; and, consequently, if we restrict our intercourse and our sympathies to the limits of our own drawing-rooms, and take no interest in the progress of the race or of the individuals composing it, we leave our best faculties in abeyance, and reap the reward of bodily debility, and weakness and monotony of mind.

Conscientiousness is another moral principle that requires direct cultivation, and that rarely receives it. It holds the balance between man and man, and is excited by the presentment of any difference of right between individuals, of any injustice, or of any temptation offered by the other faculties, which may lead us to encroach on the rights of other men. It gives a strong sense of duty, with which it is agreeable to act in conformity, but which it is painful and injurious to oppose. It gives weight and force to the impulses of the other sentiments, and, joined with intellect and the feeling of devotion, gives that faith in the beneficence and equity of the Deity, and in the immutability of all his laws, that forms the strongest encouragement to virtuous conduct and temporary self-denial. And here again, living in society, engaged in the active duties of life, and acting justly amid the conflicting interests of others—and not seclusion and privacy—are manifestly intended by the Creator as our proper sphere.

I need not follow out this exposition in detail. The preceding illustrations will suffice to explain the *principle;* and to exceed this limit would withdraw attention too much from the matters more directly before us.

For the same reason that every faculty ought to be exercised directly upon its own objects, the exclusive

use of book-education as a means of conveying instruction is manifestly unnatural as well as inefficient. If allowed to handle and examine a new object, a child will pursue the investigation with pleasure, and in five minutes will acquire more correct knowledge than by a whole hour's reading about its qualities without seeing it. In the one instance, its perceptive powers are stimulated by the direct presence of the qualities of which they are destined to take cognizance; while, in the other, they are roused only through the imperfect medium of artificial language, and the child has to *create* the object in his own mind before he can take notice of its qualities. When we recollect the different ideas which the same written language suggests to different *mature* minds, we may form some conception of the impossibility of a child making progress in this way, and of the weariness and ennui which the thankless effort must always induce; and yet, at the present day, in nineteen out of twenty schools, all the knowledge that is offered is through the medium of books and language alone!

It is well remarked by M. Duppa, in his excellent little work on the education of the peasantry in England, that "it is the habit of accurately observing the actual nature of objects, as perceivable by the senses, and distinctly marking their differences, which in after life renders a man intelligent and judicious. There are few whose natural faculties are so dull as to be unable to perceive a distinction when pointed out to them or when their notice is directed towards it; for instance, that one thing is long, another short; that one is round, another flat; one green, and another black. But how few are there who, when minutely questioned, can give a clear or circumstantial description of any object they have been conversant with, or in what particular that object differs from another. And why is this? Because they have not the habit of accurate observation of things; and they have not that habit, *because, in modern education, a child's observation, at the moment when all is new and observation most active, is wilfully drawn away from things to the*

signs of things; and the boy who might easily have been made to distinguish the nature and properties of the different objects around him, has only learned to distinguish one letter from another." (P. 27.)

It is but another proof of the harmony of design in all the works of the Creator, that this method of directly cultivating the observing powers cannot be adequately fulfilled without a certain amount of muscular exertion and of daily exposure to the open air, in going about to collect and examine the varied objects of interest with which creation abounds. In other words, we cannot benefit the perceptive faculties, without at the same time benefiting the muscular system and the organs of respiration, circulation, and digestion; and this grand recommendation in the eye of reason, viz., pursuing study in the field of nature instead of in books alone, is actually, though not avowedly, the circumstance which retards its adoption in ordinary education. To take the scholar out of the schoolroom to look at the works of God, is thought to be encouraging idleness and a love of pleasure, and therefore it is denied!

What, therefore, is wanted is a system of education in harmony with the constitution of the human mind, and a mode of life and of occupation which shall give not only full play to the intellectual powers, but also *healthy excitement and activity, and a right direction to the moral, religious, and affective feelings.*

The details of such a system do not fall under the scope of a treatise like this; and I must, for the present, content myself with the exposition of the general principle.* A serious obstacle to entering upon

* Mr. Simpson, in his recent work on "The Necessity of Popular Education as a National Object," and in his admirable evidence before the Irish Education Committee of the House of Commons, in August, 1835, has filled up the above outline, and very ably shown *how* the different faculties of the mind may be best called into play. His clear, consistent, and eloquent exposition of what is still wanted to render education effective and available for all classes of society, produced a strong impression on the Committee, and richly deserves the attentive consideration of every one who takes an interest in the improvement of the race.

the regular exertion here recommended requires to be noticed, as it arises from a feeling in the patient against which he cannot be too much on his guard. Where the nervous system is weak, and where it, of course, requires most to be strengthened, there is often a retiring sensitiveness of disposition, leading its possessor rather to avoid than to seek intercourse with society. Feeling the irksomeness of present exertion, the nervous invalid is apt to form the secret resolution to live in solitude *till the mind shall become stronger*, and then to seek society when it will no longer be a burden. Unhappily, however, this feeling leads only to delusion, and the wished-for result becomes every day more distant, the longer retirement and indolence are persevered in. It is by activity, and not by repose, that strength is to be acquired. We do not expect to increase bodily strength by lying in bed, but by stirring about; and, in like manner, we shall never succeed in strengthening the nervous system by indulging in mental indolence. Many are led astray by the false expectation of acquiring strength without using the natural means from which alone strength can be procured.

It may be remarked, that in the preceding pages I have made no allusion to the doctrines of Phrenology. My reasons are simply, that, for the object I had in view, a special reference to them was not necessary; and that, in a work written for the general reader and for practical purposes, I was naturally anxious to avoid every contested point. Accordingly, in limiting myself to the statement that different parts of the brain perform different functions, without specifying those connected with any particular part, farther than that they are all concerned in the mental operations, I am not venturing beyond what most eminent anatomists and physiologists, in the past or present times, have taught before me. My own sentiments on the subject are already before the public;* and I am

* *Vide* Observations on Mental Derangement; being an application of the Principles of Phrenology to the elucidation of the Causes, Symptoms, Nature, and Treatment of Insanity. 1 vol. post 8vo., 1831.

bound to say that every day's experience increases my conviction of the truth of Phrenology, and deepens my sense of its practical value. Those who desire to prosecute the inquiry will find ample assistance in the numerous works already published, both in this country and in France. The splendid work of Vimont would do honour to any age or country.

I have already had frequent occasion to notice the direct influence exercised by the mind and brain over all the bodily functions and over the general health. As the subject is an important one, and has not received all the attention which it deserves, it may be proper, before concluding, to offer a few remarks on it.

The nervous fluid or influence presents many phenomena allied to those of electricity, but its real nature is not yet known. All that can be said is, that it is an influence of a peculiar kind, originating in the brain and nervous system; and that, like the blood, it is essential to the vital action of every animal organ. When I move the hand in writing, the muscles of the arm are called into play by an influence transmitted to them from the brain, by means of the soft white cords called nerves. This stimulus is so indispensable, that, if the communication between the brain and the muscles be cut off, by dividing or tying the nerve, no effort of the mind will longer suffice to excite them to action. In like manner, if the nerves of the lungs and stomach be cut through, so as to interrupt the flow of nervous influence, respiration and digestion will cease, although in every other respect their respective organs remain uninjured.

Changes in the quality or amount of the nervous influence transmitted from the brain to any organ, have thus a direct power of modifying its function. If, from a peculiar state of the brain, the nervous influence sent to the stomach be impaired, the tone of that organ will be also impaired, and digestion become imperfect; whereas if, in consequence of pleasing excitement, the nervous stimulus be increased, a corresponding activity will be communicated to the

stomach, and digestion will be facilitated, as is experienced after a dinner in pleasant society. But if, by a violent burst of passion or grief, the brain be inordinately and disagreeably excited, so as to send forth a stimulus vitiated in quality, the stomach which receives it will partake in the disorder. Hence the sudden loathing and sickness so often induced by unexpected bad news, vexation, or alarm.

Something analogous to this is still more visibly exhibited in the case of the muscles. If the mind be active and decided, the muscles, receiving a strong stimulus, move with readiness and force; but if the cerebral activity be impaired by bilious depression, muscular action becomes slow, infirm, and indolent; whereas, if the brain be excited by strong passion, and the stimulus be impetuous, the movements instantly become energetic and decided; and, if the excitement be carried still farther, the regulated muscular contraction passes the limits of health, and becomes involuntary and convulsive.

As the quality of the nervous influence depends on the condition of the brain, that which springs from a brain of which all the parts are in sound and vigorous action is the best. Mental indolence and high mental excitement are alike inimical to bodily health; and, consequently, our great aim ought to be to secure for every mental power, moral as well as intellectual, that equal and regular exercise from which alone the proper nervous stimulus can spring.

It is indeed interesting to observe the various efforts of the nervous influence, according to the faculties in predominant action at the time it is produced. If the higher feelings have the ascendency, and the more selfish propensities be merely active enough to give force to the character, without setting the mind at war with itself, the nervous influence is the most grateful and efficient which can be imagined for sustaining the healthy co-operation of the whole body. This result follows, because the Creator evidently designed such a state of mind to be the best and happiest for man himself, and therefore took care to sur-

round him with every motive to induce him to enter into it.

If, however, the lower feelings be in great activity, and filled with designs and emotions repulsive to the moral sentiments, so that the faculties are ranked in opposition to each other; or, if the mind be oppressed with grief, anxiety, or remorse, the stimulus which it communicates is far from beneficial, being no longer in accordance with the conditions designed by the Creator. It is in such circumstances, accordingly, that bad health is so often seen to arise from the state of the mind, and that suffering is produced which no art can relieve till the primary cause has ceased to exist.

The same result follows over-exercise of intellect and inactivity of the feelings. From the concentration of vital action in the brain, the stomach and other organs are unprovided with the requisite nervous stimulus, and become impaired in their functions; and hence the dyspeptic and hypochondriacal symptoms which so often render life a burden to literary men. Persons so situated, when advised to attend to diet, often answer that it is in vain, and that, while at some times nothing can be digested, at other times, perhaps within a few hours or days, nothing comes amiss—the power of digestion varying thus quickly, according to their mental condition. Whereas, when indigestion arises from a primary affection of the stomach, the least deviation in the way of indulgence proves injurious. In both instances, attention to diet is beneficial; but in the one it is less rigidly important than in the other.

The influence of the brain on the digestive organs is so direct, that sickness and vomiting are among the earliest symptoms of many affections of the head, and of wounds and injuries of the brain; while violent emotions, intense grief, or sudden bad news, sometimes arrest at once the process of digestion, and produce squeamishness or loathing of food, although, an instant before, the appetite was keen. Narcotics, the

direct action of which is on the brain, have a similar effect on the stomach.

The influence of the mind and brain over the action of the heart and lungs is familiar to every one. The sighing, palpitation, and fainting, so often witnessed as consequences of emotions of the mind, are evidences which nobody can resist. Death itself is not a rare result of such excitement in delicately-organized persons.

This law of our constitution, whereby the regulated activity of both intellect and feeling is made essential to sound bodily health, seems to me one of the most beautiful arrangements of an all-wise and beneficent Creator.

If we shun the society of our fellow-creatures, and shrink from taking a share in the active duties of life, mental indolence and physical debility beset our path. But if, by engaging in the business of life, and taking an active interest in the advancement of society, we duly exercise our various powers of perception, thought, and feeling, we promote the health of the whole corporeal system, invigorate the mind itself, and, at the same time, experience the highest mental gratification of which a human being is susceptible—that of having fulfilled the end and object of our being, in the active discharge of our duties to God, to our fellow-men, and to ourselves. If we neglect our faculties or deprive them of their objects, we weaken the organization, give rise to distressing diseases, and, at the same time, experience the bitterest feelings that can afflict human nature, ennui and melancholy. The harmony thus shown to exist between the moral and physical world is but another example of the numerous inducements to that right conduct and activity in pursuing which the Creator has evidently destined us to find terrestrial happiness.

The reader will now understand why the state of the mind is so influential in the production and progress of disease. In the army, this principle has often been exemplified in a very striking manner, and

on so large a scale as to put its influence beyond a doubt. Sir George Ballingall mentions, in his lectures on Military Surgery, that the proportion of sick in garrison in a healthy country and under favourable circumstances, is about five per cent.; but that, during a campaign, the usual average is never ten per cent. So marked, however, are the preservative effects of cheerfulness and the excitement of success, that, according to Vaidy, the French army cantoned in Bavaria after the battle of Austerlitz, had only 100 sick in a division of 8000 men, being little more than *one* in the hundred. When, on the other hand, an army is subjected to privations, or "*is discouraged by defeat or want of confidence in its chiefs*," the proportion of sick is "*often fearfully increased.*"*

The same principle explains why it is so important for the physician to carry the feelings of the patient along with him in his curative measures. It is well known, for example, that those who live in constant apprehension of fever, cholera, or other ailment, are generally among its first victims when exposed to its causes. The reason is obvious. The depressing nervous influence resulting from the painful activity of the selfish feelings, affects all the organs of the body, and places them on the brink of disease, even before any external cause is in operation; and hence the easy inroad which the latter makes when it comes into play.

The influence of the state of the mind on health is well exemplified in recruits for the army. According to Mr. Henry Marshall, regret for having enlisted and separation from friends make them brood over the inconveniences attending their new mode of life, and their health suffers in consequence. These causes, combined with the fatigue of drill and the restraints of discipline, have so much influence, that "growing lads" frequently fall victims to them. The recruit, if not very robust, "loses that active fortitude which is required to fit him to bear up against

* Medico-Chirurgical Review, No. xxxvi., p. 430.

difficulties, and falls into a gloomy state of mind that is soon followed by deteriorated bodily health; he loses his appetite, becomes emaciated, a slight cough supervenes, and, after frequent admission into hospitals, he at last dies of diseased lungs. This is an outline of the history of many a young lad who enlists in the army."* In France, where the conscription is compulsory, and many are, of course, serving against their will, the agency of depression of mind is still more marked and fatal. In the seven years extending from 1820 to 1826, both inclusive, it appears from the returns that the French army lost ninety-seven men from pure nostalgia or home-sickness, an affection which is rarely fatal in this country.

So efficacious, on the other hand, is a more cheerful state of mind, from the more healthful nervous influence which it diffuses through the frame, that surprising recoveries occasionally happen which can be ascribed to no other cause but this. A singular but instructive instance fell under the observation of Sir Humphrey Davy, when, early in life, he was assisting Dr. Beddoes in his experiments on the inhalation of nitrous oxyde. Dr. Beddoes having inferred that the oxyde must be a specific for palsy, a patient was selected for trial and placed under the care of Davy. Previously to administering the gas, Davy inserted a small thermometer under the tongue of the patient to ascertain the temperature. The paralytic man, wholly ignorant of the process to which he was to submit, but deeply impressed by Dr. Beddoes with the certainty of its success, no sooner felt the thermometer between his teeth than he concluded the talisman was in operation, and, in a burst of enthusiasm, declared that he already experienced the effects of its benign influence throughout his whole body. The opportunity was too tempting to be lost. Davy did nothing more, but desired his patient to return on the following day. The same ceremony was repeated; the same result followed; and at *the end*

* Marshall on Enlisting and Discharging Soldiers, p. 5.

of a fortnight he was dismissed cured, no remedy of any kind except the thermometer having ever been used.* Quacks profit largely by taking advantage of this principle of our nature: and regular practitioners would do well to bestow more pains than they do in assisting their treatment by well-directed moral influence. Baglivi was deeply impressed with this sentiment when he said, "I can scarcely express how much the conversation of the physician influences even the life of his patient, and modifies his complaints. For a physician powerful in speech and skilled in addressing the feelings of a patient, adds so much to the power of his remedies, and excites so much confidence in his treatment, as frequently to overcome dangerous diseases with very feeble remedies, which more learned doctors, languid and indifferent in speech, could not have cured with the best remedies that man could produce."

Another remarkable instance occurred during the siege of Breda in 1625. When the garrison was on the point of surrendering from the ravages of scurvy, a few vials of sham-medicine, introduced by the Prince of Orange's orders as the most valuable and infallible specific, and given in drops as such, produced astonishing effects: "*such as had not moved their limbs for months before were seen walking in the streets sound, straight, and whole;* and many who declared they had been rendered worse by all former remedies, recovered in a few days, to their inexpressible joy."†

Every one, indeed, who has either attended invalids or been an invalid himself, must often have remarked that the visit of a kind and intelligent friend is highly useful in dispelling uneasy sensations, and in promoting recovery by increased cheerfulness and hope. The true reason of this is simply that such intercourse interests the feelings, and affords an

* Paris's Life of Davy, p. 51.

† F. V. Mye, De Morbis et Symptomatibus, &c., quoted by Dr. Johnston in his Treatise on Derangements of the Liver, &c., p. 206.

agreeable stimulus to several of the largest organs in the brain, and thereby conduces to the diffusion of a healthier and more abundant nervous energy over the whole system. The extent of good which a man of kindly feelings and a ready command of his ideas and language may do in this way, is much beyond what is generally believed; and if this holds in debility arising from general causes, in which the nervous system is affected not exclusively, but only as part of the body, it must hold infinitely more in nervous debility and in nervous disease; for then the moral management is truly the medical remedy, and differs from the latter only in this, that its administration depends on the physician, and not on the apothecary; on the friend, and not on the indifferent attendant.

In his excellent little treatise on physical education, Dr. Caldwell justly remarks, that the influence of a regulated and well-balanced activity in the moral and intellectual faculties on the general health, compared with that of active and boisterous passions, is like the salutary effect of mild and wholesome nourishment contrasted with the fiery potency of alcohol. The former is eminently conducive to life, health, and enjoyment, while the latter is eminently opposed to them all. Of this truth Dr. Caldwell gives an interesting example from the history of his own country. Of the fifty-six delegates who signed the Declaration of Independence, almost all were men of well-regulated and active minds, not marked by any excess of passion. Two of them died early from accidents. The aggregate years of the remaining fifty-four were 3609, giving to each an average of sixty-six years and nine months; thus affording a striking evidence of the salutary influence of the mind on health. From the same absence of active passion in mathematicians, the average duration of life in twenty of them, taken promiscuously by Dr. Caldwell, extended to seventy-five years, while, in an equal number of *poets*, whose vocation greatly depends on excitability of feeling, the average was so low as fifty-seven.*

* Caldwell on Physical Education, p. 84–86.

The powerfully stimulating effect of healthy mental excitement on the bodily functions is familiar to every one, and is duly noticed in the works of the novelist and poet. In nine cases out of ten, a visit to a watering-place, or a journey through an interesting country, does more good by the beneficial excitement which it gives to the mind and brain, than by all the other circumstances put together. It is, indeed, greatly to the credit of the medical departments of both army and navy, that the influence of the mind in preserving and restoring health is more correctly appreciated and provided for than it is even in private practice. In the late expeditions of discovery to the Northern Regions, the utmost attention was bestowed by the enlightened commanders to keep up a healthful vivacity of intellect and feeling among their men, by constant occupation, intellectual instruction, the representation of plays, masquerades, and other amusing and exciting exertions; and there cannot be a doubt that their remarkable immunity from disease was in no small degree owing to these admirable arrangements. From this is obvious the immense importance which attaches to the selection of a humane and considerate, as well as scientific commander. In the second volume of Captain Basil Hall's first series of Fragments of Voyages and Travels, some of the principles just explained are very amusingly illustrated.

CHAPTER X.

APPLICATION OF THE PRECEDING PRINCIPLES.

Causes of bad Health.—Not always the Result of Moral or Immoral Conduct—nor of Accident—but of the Infringement of the Laws of Organization.—Proofs from past History.—Diminished Mortality from increase of Knowledge, and better fulfilment of the Conditions of Health.—The Expeditions of Anson and Cook contrasted.—Gratifying Results of the Sanatory Arrangements of Ross, Parry, and Franklin.—Pulmonary Diseases in the Channel Fleet, from ignorance of Physiology.—Rates of Mortality in different Ages and Countries.—Causes of late Improvement.—Conditions of wealthier and poorer Classes compared.—Good done by the apprehension of Cholera.—Influence of Habit.—Neglect of Organic Laws in Recruiting Service.—Examples.

The reader will now be prepared to take a correct view of a question on which it especially interests us to have true and precise notions. I allude to *the real origin of bad health*. On this point very vague and contradictory opinions are prevalent; and, as our conduct in life must necessarily be closely dependant on our views in regard to this subject, I cannot do better, before concluding, than devote a chapter to its consideration.

Setting aside, for the present, hereditary tendencies to disease (which must have begun at first with some progenitor, from ordinary causes, and which, therefore, are not really unconnected with the inquiry), bad health may be regarded in one of three different lights. First, As having no necessary connexion with our conduct, but as being the result of circumstances entirely beyond our knowledge and control, and sent by a superintending Providence, not to urge us to more rational care, but to soften our hearts and warn us from sin; Secondly, As the result of accident alone or of external influences which we

can appreciate, but from which it is impossible to withdraw ourselves; or, THIRDLY, As, in every instance, the result of the direct infringement of one or more of the laws or conditions decreed by the Creator to be essential to the well-being and activity of every bodily organ, and the knowledge and observance of which are, to a great extent, within our power.

According as one or other of these views shall be adopted, the most opposite practical results will follow. If the *first* be received as the truth, and health and sickness be viewed as dispensed without reference to our bodily conduct, but solely as a means of reclaiming us from sin, attention to moral and religious improvement alone will be our best protection, and any attempt to avert bad health, by studying and obeying the laws which regulate the bodily functions, will be entirely useless. If, again, the *second* principle be correct, and disease arise from accident and from influences beyond our control, then neither our moral nor our bodily conduct will avail us as a protection, and our only resource will be humble resighation to the will of God. But if the *third* be true, and the human frame be constructed by the Creator on principles calculated to carry on life for seventy years, and if, *de facto*, a large portion of the race perish before attaining ten years of age, chiefly from infringing the conditions on which the due performance of the various vital functions depends, it then becomes an object of great interest to us to study the structure of our organs, to discover the laws which regulate their functions, and to yield to those laws that implicit obedience from which alone health can spring.

That the strictest observance of the moral laws, and the purest devotion of which human nature is capable, are insufficient to secure health to the body without a simultaneous observance of the organic laws, is too clearly proved by the instances already adduced, and by the history of mankind, to require any demonstration here. The biographies of the pious and excellent furnish abundant examples to the con-

trary; while the annals of crime afford numerous instances of men of the most depraved characters enjoying unbroken health. If, indeed, the organic conditions be fulfilled, the upright man will enjoy a serenity of health which the criminal can never know; but the moral observance alone will not avail him, if he at the same time neglect the organic laws.*

In regard to the second proposition, a little reflection will satisfy every intelligent mind that it is equally untenable, and that disease is not always the result of accident or of circumstances which cannot be modified. There are causes of bad health against which even the most stupid and prejudiced take some precautions, and with success; and the whole art of medicine would be a grosser delusion than ever romancer believed it to be, if health were not influenced by circumstances within our control. All our remedies, and all our attention to diet, clothing, and regimen, are indications of the contrary persuasion. There are, indeed, agencies from which we shall probably never be able entirely to protect ourselves. Such are variations in the state of the atmosphere, epidemic and contagious causes, and necessary exposure, in pursuance of higher duties, to known unhealthy influences; but, allowing for all these, ample scope remains within which man may, by an extension of his knowledge and industry, provide himself with safeguards far beyond what he has ever yet made use of or has ever dreamed of discovering.

The third view, or that which ascribes bad health to the infringement of some one or more of the organic laws, thus presents itself as the only one in accordance with observation and past experience; and, after the full exposition I have already given of the conditions of health of various important organs, I trust that little farther proof of this will be required. At the same time, as the principle is full of practical

* I may again refer to "The Constitution of Man" for a consistent and intelligible view of the relation subsisting between the organic and the moral and intellectual laws.

value, I will take a short review of some facts which go far to establish its accuracy.

Considering that the human frame is constructed to endure, in many cases, for sixty, seventy, or eighty years, it must seem extraordinary to a reflecting mind, that, in some situations, one half of all who are born should die before attaining maturity; and that, of 1000 infants born and reared in London, 650 die before the age of ten years. It is impossible to suppose that such a rate of mortality was designed by the Creator as the unavoidable fate of man; for, by the gradual improvement of society and a closer observance of the organic laws, the proportion of deaths in early life has already been greatly reduced. A hundred years ago, when the pauper infants of London were received and brought up in the workhouses, amid impure air, crowding, and want of proper food, not above one in twenty-four lived to be a year old; so that out of 2800 annually received into them, 2690 died. But when the conditions of health came to be a little better understood, and an act of Parliament was obtained obliging the parish officers to send the infants to nurse in the country, this frightful mortality was reduced to 450 instead of upward of 2600! Can evidence stronger than this be required to prove that bad health frequently arises from causes which man may often be able to discover and remove, and which, therefore, it is his bounden duty to investigate and avoid by every means which Providence has placed within his reach?

The different rates of mortality in crowded cities and country villages equally demonstrate the influence of bad air, crowding, and imperfect food in abridging life. Even in the best managed communities, the number not only of the sick of all ages, but of those who are cut off in early youth, is so prodigious as to show that we are far from having arrived at the maximum of health of which the race is susceptible; while the advances we have already made give us every reason to hope that, by perseverance

and the extension of our knowledge, we may continue to improve for many centuries to come.

The progress of knowledge and the increasing ascendency of reason have already delivered us from many scourges which were regarded by our forefathers as unavoidable dispensations of an inscrutable Providence. In the days of the ancient Romans, their capital and territories were frequently almost depopulated by visitations of plague and pestilence, from which the present generation is, by a stricter observance of the conditions of health, entirely exempted. In London, in like manner, the same contempt of cleanliness, ventilation, and comfort, which was so fatal to the Romans, produced similar results, and swept off its thousands and tens of thousands, till a fortunate disaster—the great fire—came in the place of knowledge, and, by destroying the crowded lanes and other sources of impurity, which man had shown himself so little solicitous to remove, procured for its inhabitants a perfect and permanent immunity from one of the deadliest forms of disease, and taught them the grand practical truth, that such awful visitations are not wanton inflictions of a vengeful Providence, but the direct consequences of neglect of those conditions by which the various vital functions are regulated, and by conforming to which alone health can be preserved. Accordingly, by greater attention to proper food, cleanliness, and pure air, London, with its gigantic population, now flourishes in comparative security, and scarcely feels the ravages of an epidemic which has inflicted a blow on some less fortunate cities, the effects of which will be long remembered.

Smallpox is another scourge which annually carried off its thousands, and from which modern science bids fair to protect us; although, half a century ago, any one who might have ventured to express such an expectation would have been ridiculed for his credulity. Even before Jenner's immortal discovery of vaccination, the improvement of medical science consequent on increased knowledge of the structure and functions of the human body had greatly mitigated the fatality

of smallpox. Formerly the patients were shut up, loaded with bedclothes, in heated rooms, from which every particle of fresh air was excluded; and stimulants were administered, as if on purpose to hasten the fate of the sick. But sounder views of the wants of the animal economy at last prevailed; and, by the admission of fresh air, the removal of everything heating or stimulating, and the administration of cooling drinks and other appropriate remedies, thousands were preserved whose lives would have been lost under the mistaken guidance of the older physicians.

So lately as the middle of last century, ague was so prevalent in many parts of Britain where it is now never seen, that our ancestors looked upon an attack of it as a kind of necessary evil, from which they could never hope to be delivered. In this instance also, farther experience has shown that Providence was not in fault. By draining the land, removing dunghills, building better houses in better situations, and obtaining better food and warmer clothing, it appears that generations now succeed each other, living on the very same soil, without a single case of ague ever occurring where, a century ago, every man, woman, and child were almost sure to suffer from it at one time or other of their lives; thus again showing how much man may do for the preservation of his health and the improvement of his condition, when his conduct is directed by knowledge and sound principles.

If we wish for a still more admirable proof of the same practical truth, we have only to compare the condition of our seamen in maritime expeditions undertaken a century ago, with their lot in the present day; the expedition against Carthagena, or that of Anson, for instance, with those of Cook, Parry, and Ross, or the health enjoyed by the crew of the Valorous with that of the seamen in the other vessels lying in the same harbour.*

Anson set sail from England on 13th September, 1740, in the Centurion, of 60 guns and 400 men, ac-

* Vide p. 80.

companied by the Gloucester, of 50 guns and 300 men; the Pearl, of 40 guns and 250 men; the Wager, of 28 guns and 160 men; the Tryal sloop, of 8 guns and 100 men, and two victuallers, one of 400, and the other of 200 tuns. They had a long run to Madeira, and thence to the coast of Brazil, where they arrived on the 18th December; but by this time the crews were remarkably sickly, so that many died, and great numbers were confined to their hammocks. The commodore now ordered "six air-scuttles to be cut in each ship, to admit *more air between the decks*," and took other measures to correct the "noisome stench on board" and destroy the vermin, which nuisances had become "very loathsome;" "and, besides being *most intolerably offensive*, they were doubtless, *in some sort*, productive of the sickness under which we had laboured." Such is the mild language used by the chaplain Mr. Walter, in communicating these frightful truths! On anchoring at St. Catharine's, 80 patients were sent on shore from the Centurion alone, of whom 28 soon died, and the number of sick increased to 96. Although this was nothing compared to what took place afterward, it is nevertheless worthy of remark; for as yet they had suffered no privations or unusual hardships, except from contrary winds. The causes of disease lay entirely within themselves.

After a stormy and tedious navigation of three months round Cape Horn, scurvy carried off 43 more in the month of April, and double that number in May, 1741. Those who remained alive now became more dispirited and melancholy than ever; which "*general dejection added to the virulence of the disease, and the mortality increased to a frightful degree.*" On 9th June, when in sight of Juan Fernandez, the debility of the people was so great, that, 200 being already dead, the lieutenant could muster only two quartermasters and six foremast-men able for duty in the middle watch; so that, had it not been for the assistance of the officers, servants, &c., they would have been unable to reach the island; to such a condition was the crew of 400 men reduced in the course of a few months!

I have noticed the cutting of holes for the admission of air between decks, and the dejection of the men. The narrative proceeds to say that the commodore's principal attention was now devoted to getting the sick on shore, as they were dying fast on board, "the distemper being, doubtless, considerably augmented *by the stench and filthiness in which they lay; for few could be spared to look after them, which rendered the ship extremely loathsome between decks.*" The officers suffered least, as being the best fed and best lodged. Within a year, out of upward of 1200 men composing the crews of the squadron who had sailed from England, only 335 remained.

The fate of the Spanish squadron, which sailed nearly at the same time, was still more horrible. The Esperanza, of 50 guns, lost 392 out of 450 men, and the other ships almost as large a proportion. It is true that, in doubling Cape Horn, they encountered the severest weather and the greatest privations, and that their deplorable fate was aggravated by these causes. But when we look to the conduct of later navigators in circumstances equally trying, it is impossible to resist the gratifying conviction, that mortality like this forms no part of the designs of a beneficient Providence; and that, for the best of purposes, our safety is placed, to a great extent, within the limits of our own power. The late memorable expeditions of Parry, of Franklin, and more especially of Ross, who, with few resources, spent upward of four years in the desolate regions of the north with scarcely any loss of life, are examples pregnant with meaning to all who are interested in the future progress of man.

It may be said that the climate and situation of the two parties were dissimilar. In some respects the objection is well founded: but Cook's second voyage round the world in 1772 affords a parallel presenting so many points of resemblance to that of Anson, that no one can reasonably object to their comparison. On this occasion, the vessels selected were the Resolution, carrying 112 men, and the Adventure, with a

crew of 81. Enlightened by former experience, Cook spared no pains to effect his equipment in the completest manner, and to lay in such stores of clothing and provisions as he knew to be useful in preserving the health of those under his command. Among these were malt, sourkrout, portable broth, sugar, and wheat. Care was taken to expose the men to wet as little as possible, to make them shift themselves after being wet, and to *keep their persons, hammocks, bedding, and clothes, perfectly clean and dry.* Equal attention was paid to keeping the ship clean and dry between decks: once or twice a week it was aired with fires; and a fire was also frequently made at the bottom of the well, which was of great use in purifying the air in the lower parts of the ship. To the last precaution too great attention cannot be paid; as the least neglect occasions a putrid and disagreeable smell below, which nothing but fires can remove. Fresh water, vegetables, and fresh provisions, were also eagerly sought for at every opportunity, and these it was Captain Cook's practice to oblige his people, by his own example and authority, to make use of. The results of these measures we shall now see.

The two ships sailed on 13th July, 1772. Towards the end of August, when they were advancing towards the south, the rain "poured down, not in drops, but in streams; and the wind at the same time being variable and rough, the people were obliged to attend so constantly upon the deck, that few of them escaped being completely soaked;" but although rain is a great promoter of sickness in warm climates, the airing by fires between decks, and the other precautions, were so effectual, that, on arriving at the Cape of Good Hope, *only one man was on the sick list;* whereas we have seen that, after a similar voyage, the Centurion arrived on the coast of Brazil with 80 sick, of whom 28 soon died. As we proceed, the contrast becomes still more striking. On 22d November, Cook sailed from the Cape in search of a southern continent. On the 29th, a violent storm, attended with hail and rain, came on, and caused the loss of most of the live

stock on board; and a sudden transition took place from warm and mild to extremely cold and wet weather, which was severely felt by the people. On 10th December they met with islands of ice; and, from that time till the middle of March, continued their search for land with unremitting diligence, amid cold, hardships, and dangers, such as landsmen can form a very imperfect idea of; and at last, on 26th March, *after being* 124 *days at sea*, during which they had sailed 3660 leagues, they came to anchor in Dusky Bay, New Zealand. "After so long a voyage," says Dr. Kippis, from whose Life of Cook these particulars are taken, "in a high southern latitude, it might certainly have been expected that many of Captain Cook's people would be ill of scurvy. This, however, was not the case. So salutary were the effects of the sweetwort and several articles of provision, and *especially of the frequent airings and sweetening of the ship*, that there was only one man on board who could be said to be much afflicted with the disease; and even in that man it was chiefly occasioned by a bad habit of body, and a complication of other disorders."

Can anything be conceived more demonstrative of the advantages to be derived from investigating and obeying the laws of health, than those splendid results, when contrasted with those on board of the Centurion! In the Resolution, cheerful activity, cleanliness, dry pure air, adequate clothing, and a suitable regimen, were found to carry man unscathed through hardships, and exposure which, in the Centurion, were, from neglect of the same protective means, severe enough to sweep off a large proportion of her crew. And, as if on purpose to place the efficacy of these measures beyond a doubt, and to remove any objection which might be started on the ground of the inferior health of the Centurion's crew originally, it appears that, in the month of July, 1773, the Adventure had many sick, and twenty of her best men incapable of duty from scurvy and flux, when the Resolution, with a larger crew, had but three men sick, and only one of them from scurvy. This difference in

the state of health of the two ships was distinctly traced to the crew of the Adventure having eaten few or no vegetables when in Queen Charlotte's Sound, while, on board of the Resolution, Cook was most particular in enforcing attention to this part of their dietetic regimen.

By this admirable care and unwearied watchfulness on the part of Cook and his officers, the Resolution performed a voyage of THREE YEARS and eighteen days, *through all climates*, from 52° north to 71° south, with the loss of only ONE man by disease out of 112! And in his last voyage, so efficaciously were the same means put in practice, that his ship was brought home after an absence of FOUR YEARS, without the loss of a single man by disease! Lord Nelson is said to have been equally successful, and to have spent three years on the West India station without one life having been lost by disease.*

Similar results were obtained by the able commanders of our more recent expeditions to the Northern Regions. The Fury and Hecla were, at one time, no less than *twenty-seven months entirely dependant on their own resources*, before scurvy began to make its appearance; and at the end of 28 1-2 months both ships returned home (in September, 1823,) with the loss of only five men; a result which, a century ago, could hardly have occurred, and which, even at the present day, is a remarkable indication of the talent and humanity of the officers by whom it was effected.

Nothing, in fact, could have been better devised than the means practised in these expeditions to preserve the health of the people; and, did my limits permit it, I might illustrate almost every principle in this volume by a reference to its actual efficacy as displayed in these voyages. Not only were the conditions of health attended to as regarded the skin, the muscles, the bones, the lungs, and the digestive organs; but the health of the all-important nervous system was sedulously provided for by the constant

* Sir George Ballingall's Lectures on Military Surgery, p. 73.

and cheerful occupation of the people in their various duties and amusements; and so judiciously were these planned, that a spirit of life and activity extremely favourable to the preservation of health was constantly kept up, and had, no doubt, great influence in producing that concord and unity of feeling among them, which were so conspicuous amid all their privations.

If, from these bright examples, we turn to the extraordinary prevalence of disease at the penitentiary of Milbank in 1823–4, we shall find little reason to congratulate ourselves on the successful application of scientific principles to the preservation of health in our civil institutions. At the time spoken of, intractable affections of the bowels and other insidious forms of disease were so general in the penitentiary that few of the prisoners escaped, and parliamentary inquiry into their causes was ordered. Great discrepance of opinion prevailed, as usual, among the witnesses, from each giving utterance rather to his own impressions than to opinions founded on any philosophical examination of the circumstances. But evidence enough was brought forward to show that several great errors had been committed. In the *first* place, the penitentiary itself was built, at an enormous expense, in a *low*, *damp situation*, rather under than above the level of the highest tides in the river, so that ventilation or the supply of dry pure air is always imperfect, and the atmosphere at night is often heavy and damp, as on all low grounds in the neighbourhood of rivers and half-covered mud. To this great and permanent source of debility were added, *secondly*, a very low and inadequate diet; and, *thirdly*, the influence of constant mental depression, arising partly from the local situation of the prisoners, and partly from the monotonous confinement and labour under too scanty a supply of food. In such circumstances, it was certainly not wonderful that a low state of health, and, latterly, scurvy and bowel complaints, should make such general havoc.

That much of the sickness was justly attributable to these causes, is shown by the perfect immunity enjoyed for some years both by the officers of the penitentiary and by about thirty of the prisoners, who, from being employed in the kitchen and offices of the establishment, were less subjected than the rest to the debilitating influence ; and also by the rapid convalescence of almost every one out of 635, on being removed to Woolwich and to the Regent's Park, and supplied with a more nourishing diet. On more minute inquiry, indeed, it appeared that, instead of the bad health having begun all at once in 1823, as at first supposed, bowel complaints had been extremely prevalent from the first opening of the penitentiary in 1816, and had continued to be so, though in rather a less degree, down to that time ; so that the causes, instead of being altogether of sudden origin, must have been inherent in it from the beginning, and only became aggravated by the farther reduction of diet, which took place some months previously, and by the inclemency of the weather.

Dr. Latham gives striking evidence of the state of the mind exerting a powerful effect on the health of the prisoners. Speaking of the women who were sent on board of one of the hulks at Woolwich, he says that individuals were pardoned from time to time for good conduct, and that recently pardons had become very numerous, as a kind of atonement for the bad health to which they had been subjected. But, as all had nearly an equal claim, "every one pleased herself with believing that she would be the next who would be set at liberty. Whenever, therefore, an individual was pardoned, all the rest *were thrown into an agony of the bitterest disappointment, and were, at the same time, overtaken by disease.* It was not a mere nervous or hysterical ailment, but *some actual form of real disease, such as they had before suffered*, and requiring the strictest medical treatment for its relief."* Examples like these, let it be again

* Account of the disease lately prevalent at the General Penitentiary, by Dr. Latham, p. 192.

and again repeated, show the extent to which health is in our power when we choose to fulfil the conditions on which alone it can be obtained.

In looking forward to a still greater diminution of disease in the human family, it is cheering to fix attention on what has been already accomplished by the hand of authority. Had the same individuals who circumnavigated the globe with Cook, or braved the northern winters with Ross and Parry, been left for an equal number of years to undergo the ordinary vicissitudes of life at home, unrestrained in their inclinations and conduct by the constantly operating and beneficent influence of a superior mind, it is morally certain that disease and death would have made greater havoc among them than actually occurred amid physical privations and suffering much greater than they were likely to have ever encountered at home. This renders obvious the pressing necessity of diffusing widely among society that species of knowledge which has proved beneficial in the hands of those who were fortunate enough to possess it. If human health and happiness be thus effectually promoted by increased attention to the conditions which regulate the vital and animal functions, nothing can be more useful than to communicate to every intelligent being such a measure of knowledge as will enable him to do for his own safety and improvement that which government now does for those whose services it requires.

With these successful and cheering results of knowledge, it will be instructive to contrast another instance of the fatal effects of ignorance in a situation where knowledge might have been effectual in preserving life and sparing suffering. I shall take the example from an early publication of Dr. James Johnson,* who has devoted no small attention to the subject of health and the causes by which it is affected, and whose work contains much valuable matter connected with hygiène, as well as with the history and cure of dis-

* On the influence of the Atmosphere on the Health and Functions of the Human Frame, &c., 8vo, 2d edition, p. 193.

ease. In treating of exercise and the evils of its excess, Dr. Johnson says, "I shall exemplify this reasoning by an instructive lesson. During the late war, it was observed that, in its earlier periods, fever, fluxes, and scurvy made the greatest havoc; while, in its middle and ulterior periods, these diseases almost disappeared, and pneumonia (inflammation of the lungs), with its too frequent consequence, PHTHISIS, became infinitely more prevalent and fatal. The facts were apparent to all, but the causes few could divine. Some of our chymical wiseacres attributed the pneumonic diathesis to the lime-juice served out; but this hypothesis need not detain us, for I think a more rational explanation can be offered. As the period of warfare was lengthened out, discipline gradually became more perfect, and at length attained its acmé. Every evolution was now performed with a rapidity and precision that seemed the effect almost of magic. All machinery and apparatus were not only so arranged as to give human power its greatest force and facility of application, but human strength was put to its ultimatum of exertion, and every muscular fibre of the frame called into furious action during each manœuvre of navigation or war. Thus, in exercising the great guns, the heaviest pieces of artillery were made to fly out and in, or wheel round, with almost the celerity of a musket in the hands of a fugleman. The most ponderous anchors were torn from their beds with astonishing velocity, while the men were often seen lying about the decks breathless and exhausted after such ultra-human exertions!

"But reefing and furling sails were still worse. Here, as in all other operations, there was a constant struggle against time. The instant that the word '*aloft*' was given, the men flew up the shrouds with such agility, that, by the time they were on the yards, the respirations were then nearer fifty than fifteen in a minute! In this state of anhelation they bent across the yards, and exerted every atom of muscular energy in dragging up the sails and securing the reef-lines, while the thorax was strained and compressed

up against the unyielding wood! What were the consequences? The air-cells were frequently torn; blood extravasated, and the origins of cough and hemoptoës continually laid. The lungs were now in a proper state for receiving the impression of aërial vicissitudes; and constant exposure to night air, to rain, and every inclemency of the season, soon *evolved the long black catalogue of pulmonic and phthisical maladies, which swept off our men in vast numbers, to the no small surprise of the officers, who could not divine the cause of this new and destructive enemy.*

"But it was not the lungs alone that suffered here. The central organ of circulation bore a part of the onus, and a host of anomalous and otherwise inexplicable symptoms were produced, which completely puzzled the naval practitioners, who rarely suspected any lesion of the heart. These last affections both aggravated, and were in their turn aggravated by, the depressing passions engendered during the long confinement on shipboard and separation from friends and native home."

I need hardly stop to point out to what extent the fatal results above mentioned might have been prevented, had the officers been possessed even of superficial acquaintance with the laws of respiration and of muscular action. A perusal of the chapters on these subjects will enable the reader to judge for himself, and to determine whether the cause of the destruction was really difficult to be divined. Dr. Johnson, it may be mentioned, has the Channel and North Sea fleets chiefly in view in his remarks.

Increased attention to the organic laws has greatly reduced the annual rate of mortality in Europe, even within the last forty years, and it cannot be supposed that farther improvement is impracticable. Dr. Hawkins, in his Medical Statistics, states, that in 1780 the annual mortality in England and Wales was 1 in 40; in 1790 it was 1 in 45; in 1801 it was 1 in 47; in 1811 1 in 50; and in 1822 it had sunk so low as 1 in 58. In cities the diminution is still more remarkable. In London 80 years ago, the annual mortality was 1 in

20; it is now 1 in 40. In Manchester, Glasgow, and other places, a similar improvement has taken place; but, in some instances, the decrement in the rate of mortality has been so much exaggerated, that the deaths are stated at only 1 in 74; a proportion which is altogether incredible as occurring in any community.

In France the average mortality is 1 in 40; in Austria, 1 in 38; in Russia, 1 in 41; and in the United States, 1 in 40; while it is rated by Humboldt at 1 in 30 in South America. In Paris it is rated at 1 in 32.

From the greater accuracy with which statistical returns are obtained and preserved in France and on the Continent, and the inadequate means which we have in this country of procuring correct tables, as well as the great disparity between the results obtained here and abroad, there is every reason to suspect that, in England, sources of error have been overlooked, and that the rates are consequently too favourable. It is difficult to believe, for example, that with us the rate of mortality can be so low as 1 in 58, when in France, Russia, and Austria, it is ascertained to be so high as 1 in 40, 1 in 41, and 1 in 38. Still, however, the returns, such as they are, show a manifest improvement in the value of life within the last forty years, which can be ascribed only to a greater degree of comfort among the people, and a more skilful treatment of their diseases.

The principle which I am advocating is established even by many of the continental returns, which are more trustworthy than our own. In France, the annual deaths in 1781 were 1 in 29; in 1802, 1 in 30; and in 1823, 1 in 40; and in Paris the mortality has diminished, in seventy years, from 1 in 25 to 1 in 32: so that, though we neglect altogether the more than doubtful statements as to Manchester and other places, with an annual mortality of only 1 in 60 or 70, evidence enough exists to prove the proposition that health is intimately connected with, and dependant on, man's own conduct; and that, when the conditions of health

shall be better understood, we may reasonably look for still brighter results.

It was very common at one time to eulogize the simple food and hardy habits of the poor and labouring classes as eminently conducive to health, when contrasted with the debilitating effects of the cares and luxuries of the rich. Experience unfortunately reverses the picture, and shows, by arithmetical arguments, that the excess of work and the privations to which the poor are habitually exposed, produce a much higher rate of mortality among them, especially in seasons of scarcity or commercial depression, than among the richer classes of society; and the same thing is further proved by the fact that, in the army and navy, the officers almost invariably suffer less than the men from changes of climate, and from the fatigues and calamities of war. In France, the mortality among the infants of the poorer classes is said to be nearly double that occurring among those in more affluent circumstances; while, in the wealthier departments, the average of life is twelve years greater than in those which are poor. In London, according to Dr. Granville's tables, only 542 infants out of every 1000 births among the *poor* survive their second year; and in Paris, also, the mortality in the quarter inhabited by the working classes is nearly double that which occurs among the more wealthy. The influence of impoverished diet, defective clothing, and an unfavourable moral position, is strikingly exhibited among the children of soldiers, of whom, according to Mr. Marshall, only a very small proportion reach the age of manhood; most of them being stinted in their growth, scrofulous in constitution, and bad in morals.*

If, as seems to be the case, a corresponding disproportion occurs between the rates of mortality in the different classes of society in Great Britain, it suggests some most important considerations, the first of which is the simple question, Whether that condi-

* Marshall on Enlisting, &c., p. 16.

tion of the lower orders can be regarded as eminently prosperous or natural which subjects them to be cut off by death so many years before the term allotted to those by whom they are employed? It also illustrates strikingly what I have said about bad health being more frequently *the result of gradual causes long in unperceived operation*, than of any sudden or accidental exposure; and proves that a mode of life or degree of labour is not to be rashly pronounced harmless, merely because its injurious effects are not immediately seen, and because years may elapse before it breaks down the constitution. It is blindness to the existence of this principle which still misleads mankind, and renders them insensible to the agency of numerous hurtful influences, from which, by a little exertion, they might easily be relieved.

Much angry discussion took place a few years ago as to the reality of the mischief inflicted by the protracted and unremitted exertion required in our factories and spinning-mills, where an unerring test might easily have been found. If those who contended that the times of labour were not too long for either the children or the adults, could have produced evidence to show that, among operatives, the average of life was equally high as among the apparently more favoured classes, there would have been at once and for ever an end of the argument; while, had the result proved different, the system of labour might justly have been deemed oppressive, in the precise ratio in which the mortality among the operatives exceeded that among their wealthier countrymen. No criterion could be so infallible as the one now proposed; and if government possessed the means of obtaining accurate returns, it seems to me that the expense of procuring them would be well bestowed, as, whatever might be the result, it could not fail to produce greater harmony of views and purpose than now unhappily prevails between the different classes of society.

Everything which tends strongly to call attention

to the conditions which influence public and individual health, is calculated to do great good to the community. In this point of view I am disposed to consider the visitation of cholera to the British Isles rather as one of those remarkable instances in which a beneficent Providence brings good out of evil, and converts an apparent calamity into a positive blessing, than as the public scourge which it has been generally proclaimed. True it is that many individuals have perished, and others suffered by it in their affections and in their worldly circumstances; but I question if anything short of the dread which cholera produced could have combined all classes so efficiently and ardently in their efforts to discover and remove everything in the condition of the poor and labouring portions of the community which could prove detrimental to health. In the season of apparent danger, not only did the importance of cleanliness, ventilation, warmth, clothing, and nourishment, as preservatives of health, become manifest to minds on which nothing else could have made an impression; but their experienced efficacy became an impetus to the exertions of the lower orders in their own behalf, which will continue to be productive of good long after the cause from which it sprung shall be forgotten.

The comparative exemption of the wealthier classes from cholera is itself sufficient to show how much it is in the power of man, by the proper exercise of reason in the application of his knowledge, to obviate the dangers to which his health is exposed; how closely his bodily welfare is dependant on his own conduct and external situation; and how very little, comparatively, it is the result of circumstances which he cannot control or modify. In fact, every one who has investigated the subject with attention will readily testify that, but for the establishment of soup-kitchens, the supplies of warm clothing, and the whitewashing, cleaning, and ventilating of the houses of the poor before and during the epidemic, a much greater number would have

fallen victims to its ravages. And it is consoling to know, that even those who regard such visitations as direct inflictions of a vengeful Providence, and as nowise connected with mere neglect of the laws of health, were, nevertheless, not the least active in enforcing and superintending the removal of every external cause of disease, and promoting the comforts and supplying the wants of the needy and destitute; so that, whatever differences in mere belief there might be, all parties were content to act as if the Creator had intended the health of the race to depend, in a very high degree, on the care which was taken to fulfil the conditions which he has decreed to be essential to the due action and preservation of the various bodily organs.

Many individuals exist who, from hereditary deficiencies, can scarcely attain tolerable health, even with the best care; and many more are to be met with who are exposed to bad health from the hurtful nature of the professions in which they are engaged. Many suffer, also, from vicissitudes of the weather, and other causes which we may never be able entirely to guard against. But all these united are few, when compared to the number of those whose health is ruined by causes capable of removal or of modification, and to which they are now exposed from ignorance of their nature, from apathy, or from the want of the comforts and necessaries of life. If I have succeeded in calling attention to this important truth, one great object of these pages will be accomplished; and here I cannot help repeating the remark already made more than once, that *health is more frequently undermined by the gradual operation of constant though disregarded causes, than by any great and marked exposures of an accidental kind*, and is, consequently, more effectually to be preserved by a judicious and steady observance of the organic laws in daily life, than by exclusive attention to any particular function, to the neglect of all the rest.

It may be said that I allow nothing for the influence of habit in rendering situations and causes compara-

tively innocuous which were dangerous at first. It is quite true that the human constitution possesses a power of adapting itself within certain limits to a change of circumstances; but it is not less true that sudden and extreme changes often destroy health and life before the system can adapt itself to the exigency; and that, after making the most ample allowance for this sort of safety, the protection which it affords against the active causes of disease is comparatively trifling.

Where the change is sudden, as in passing from a temperate to a tropical climate, or even from very fine to very inconstant weather, the consequences to health are well known to be highly injurious. But where it is gradual and not extreme in degree, as in passing from winter to summer, health is not much endangered, because the system has time to accommodate itself to its new circumstances. Different organs predominate in activity in different climates and seasons, and time is thus required to admit of the necessary changes taking place without disturbing the general balance of the circulation. In hot countries, for example, the skin predominates greatly in activity in comparison with the kidneys; whereas, in a cold country, the case is precisely reversed. If, therefore, a sudden transition be made from the one to the other without due preparation, the rapid change in the distribution of the blood from the surface to the internal organs, or from these to the surface, consequent on such change, is likely to be attended with danger; although the same change, gradually effected, would be unattended with any injurious results.

If, again, the change be from a healthy situation to one only a little less favourable, the consequences to the system will be also gradual and progressive. No immediate injury to health may be apparent, and the body may be said to adapt itself to the circumstances; but, in reality, health will be lowered and life shortened in exact proportion to the amount of the injurious exposure and the state of the system at the time. Individuals of a peculiar constitution may live

long, but the average of health and life will be positively diminished; a fact which shows that the apparent exception is more a fallacy than a reality, and that, *cæteris paribus*, *the highest health and greatest vigour will always be on the side of those who make the nearest approach to the fulfilment of the organic laws.*

It is, therefore, a glaring perversion of logic and reason to infer that we may safely rest satisfied with a limited portion of evil, on the plea that the constitution will adapt itself to its presence. The argument ought to be turned in exactly the opposite direction. If the constitution possesses this power of adaptation to external circumstances, it becomes doubly incumbent on us to have it always surrounded with *beneficial* influences; seeing that, when the laws of health shall be fulfilled, the same tendency to adaptation will operate with equal force in permanently ameliorating the constitution. In every point of view, therefore, it is an object of much consequence to us to become acquainted with and to obey all the laws which regulate the functions of the human body.

It would be easy, were it consistent with the limits and purpose of the present volume, to show that, although great advances have been made of late years both in physiological knowledge and in its applications to the advancement of human happiness, many of the usages current in society, and many of the practices resorted to in education, are still far from being in harmony with the laws of the human constitution; and that much good may be done by diffusing among the reflecting portion of mankind, and especially among the young, more accurate notions of the structure and uses of the various bodily organs, and of the conditions required for their healthy action. Illustrations in proof this position, drawn from individual cases, may be cavilled at as incomplete, or regarded as accidental coincidences; but when the principle is exhibited in active operation on a large scale, minor qualifications fall into the shade, and leave the evidence absolutely unassailable. On this account I prefer selecting an example from the records of the

army, both as being striking in its features, and as being one in which the public interest is deeply involved.

A few years ago, young growing lads were uniformly selected for the army in preference to men of a mature age, on the supposition that, because their habits were not formed, they could be more easily converted into good soldiers, than if taken a few years later. Many officers still entertain and act upon this opinion; and the period at which, by law, liability to military service commences in this country, remains fixed at eighteen years of age, although it has been raised to twenty by most of the Continental governments.

Examined physiologically, the practice of enlisting juvenile recruits seems peculiarly irrational. During growth, the conditions required for the healthy development of the body are, moderate and healthy exercise, plenty of nourishing food, abundance of sleep, and a cheerful state of mind. In making the transition from boyhood to maturity, the equilibrium of action between the different parts of the system is so much disturbed, that, under the most favourable circumstances, an unusual susceptibility of disease prevails, which renders that period of life particularly dangerous. By consulting the statistical tables prepared by Mr. Finlayson, and those of the population of Paris by Count Chabrol, already referred to, it will be seen, that, in all classes of society, the rate of mortality suddenly increases from the age of fourteen, when rapid growth may be said to commence, to that of twenty-three, when it is nearly completed. In Paris, for example, the tables for the year 1820 exhibit only 395 deaths as occurring between the ages of 10 and 15; whereas those between 15 and 20 amount to no less than 703, being nearly double; while, in the five years immediately subsequent, they rise to 1339, and afterward begin to decrease.

Viewing these results in connexion with the laws of the animal economy, and bearing in mind that, even in peace, military service implies broken sleep,

separation from friends, and occasional exposure to fatigue and privation, we must consider it almost self-evident, that an army composed of young lads at this hazardous period of life must be sickly and inefficient, and that a large portion of the expense and trouble bestowed in enlisting and training them must be entirely thrown away. That such is actually the fact, has unfortunately been too often proved by fatal experience. Mr. Marshall, in the valuable work already quoted, adduces an irresistible mass of evidence to show that, till the growth is completed, it is impossible to form any correct estimate of the probable efficiency of a recruit; as numbers of apparently promising young men are cut off by affections of the chest, and other acute diseases, before attaining maturity, and before being exposed to any unusual privations or fatigue. So literally accurate is this statement, that Coche, a high French authority referred to by Mr. Marshall, mentions distinctly, that even in time of peace, when no great hardships are to be encountered, volunteers received into the army at the age of eighteen or twenty pass two, three, or four years of their period of service (eight years) in hospital, solely from inability to bear up against difficulties which scarcely affect those who are a few years older.

If such be the result during peace, I need hardly say that, in time of war, the practice of enlisting very young men must be not less fatal to the recruits than costly to the country. It appears, accordingly, that in the army in Spain, sickness and inefficiency prevailed almost in proportion to the youth and the recent arrival of the soldiers. Sir James MacGrigor cites the 7th regiment as an illustration, and adds, that between 9th August, 1811, and 20th May, 1812, it lost 246 men; of whom 169 were recruits landed in the preceding June, while only 77 were old soldiers. The original number of this detachment of recruits was 353, so that *more than one half died within the first eleven months.* The total number of old soldiers, on the other hand, was 1143, and of them only 77 perished in the same time! So convinced, indeed, is Sir

James of growing "lads being unequal to the harassing duties of the service," that in making calculations for measures in the field, he thinks that 300 men who had served five years would be more effective than 1000 newly arrived, not simply from their greater experience, but chiefly from the additional stamina proceeding from maturity.*

In a note subjoined to the preceding opinion of Sir James MacGrigor, Mr. Marshall says, "Numerous examples might be quoted to show that young lads are much less able to endure the fatigue of marching than men a little more advanced in life. During the winter of 1805, a French army, which was stationed on the coast in the neighbourhood of Boulogne, marched about 400 leagues to join the Grand Army before the battle of Austerlitz, which it effected *without leaving almost any sick in the hospitals on the route.* The men of this army had served two years, and *were not under twenty-two years of age.* The result of the march of this army may be compared with that of another under different circumstances. In the campaign of the summer of 1809, the troops cantoned in the north of Germany marched to Vienna, but, by the time they arrived at the place of their destination, *all the hospitals on the road were filled with sick. More than one half of the men* composing this army were *under twenty years of age,* the usual levy of conscripts having been anticipated. After the battle of Leipsic, Napoleon made great exertions to recruit his army, and called upon the legislative senate to give him their assistance, to which they showed some reluctance. 'Shame on you!' cried the emperor; * * * * 'I demand a levy of 300,000 men, but *I must have grown men;* BOYS SERVE ONLY TO ENCUMBER THE HOSPITALS AND ROADSIDES.'"

In similar defiance of the laws of physiology, half-grown lads were at one time preferred for the East India service, on the false supposition that their unconsolidated constitutions would more easily adapt

* Marshall on Enlisting, &c., p. 5.

themselves to the climate than those of men already arrived at maturity; a proposition very nearly equivalent to saying, that because a person is already enfeebled, exposure to the causes of disease will *therefore* have less effect on him than after his strength shall be restored! Palpably fallacious as this kind of logic now appears to be, it nevertheless reigned for years with undisputed sway, and still has a few stanch supporters. Sir George Ballingal is entitled to the credit of having early and earnestly raised his voice against it, in his work on Fever and Dysentery, published on his return from India in 1819. His evidence is very striking; but so slow is the march of reason, that it was only in December, 1829, that an order was issued from the Horse Guards that no recruits under *twenty* should be received for regiments serving in tropical climates; and so late as the year 1826, nearly 15 per cent. of the king's troops in Bengal were under that age.

Mr. Marshall also, in touching upon this question, supports his positions by reference to facts of a very conclusive kind, and to authors whose opinions ought to have great weight. Among other evidence, he quotes the register of a regiment employed in the Burmese territory in 1824, 5, from which it appears that, in 1824, the ratio of mortality among the young men who went out with the corps was 38 per cent., or 1 in every 2 1-3; while among the volunteers, who were considerably older, the mortality was 17 per cent., or only 1 in 6. In 1825, it was 30.5 per cent., or 1 in 3 1-3 among the younger class, and *only 6 per cent.*, or 1 in 16 *among the older.* P. 10.*

* In availing myself of Mr. Marshall's labours, I may be allowed to express my opinion of the benefit he is conferring by his statistical researches, not only on the service with which he has been so long and honourably connected, but also on the public at large. There are many practical questions deeply concerning public health, which can be fully elucidated only by such masses of facts being grouped together as shall destroy all minor inequalities, and place the operation of principles prominently in view. But to effect this object with due regard to accuracy, requires an acquaintance with details, an acuteness of observation, and a power of

Some other instances might be quoted in proof of the greatest mortality being always among the youngest men; and I might refer to a regiment mentioned by Dr. Davies, in which, when it was sent out to Bombay in 1808, there was not a single private above 22 years of age, and in which, out of 550 men, nearly 300 required medical assistance within six weeks after he joined it; but it is unnecessary, as, although individual officers still prefer young men, government is at least awakened to their unfitness. A vague notion that growing lads do not bear fatigue, is indeed prevalent enough; but I venture to say, that if those by whom the age of enlistment was first determined had been thoroughly acquainted with the laws of physiology, and had possessed a clear perception of the conditions of healthy growth, the practice of receiving recruits at 17 or 18 years of age would never have been sanctioned, and the country would have been saved the pain and the expense of sending thousands of young men to "encumber the hospitals and roadsides" of the Peninsula, or to perish under the exhausting influence of a tropical climate.

I have dwelt at some length on this subject, both because the practice which I condemn was lately in full operation, and is even yet not entirely exploded, and because, from the magnitude of its results, and the clearness with which they can be traced to the direct violation of a natural law of the constitution, it affords an instructive example of the evils arising from ignorance of the structure and functions of the human body, and of the aid which might be derived from a general acquaintance with physiology, in preserving health, and promoting the happiness of the race.

It was my intention to analyze, in the same way, various other practices in which public or private health is concerned; but I have already so far exceed-

successful generalization, which are rarely found in combination with adequate zeal and industry. It would be very useful if similar researches were instituted in regard to the occurrences in our public hospitals.

ed the limits originally proposed, that I must now draw to a conclusion, and judge, from the reception of the present volume, how far I am right in believing that information of the kind now communicated will be acceptable or useful to the public.

CHAPTER XI.

APPLICATION OF THE PRINCIPLES OF PHYSIOLOGY TO THE MORAL TREATMENT OF NERVOUS DISEASE AND INSANITY.

Condition of the Nervous and Insane too little known.—Necessity of improved Moral Treatment.—Use of Physiological Knowledge in effecting the required Improvements.—Principles on which the Nervous and Insane ought to be treated.—Necessity of providing the Means of Bodily and Mental Occupation, and humane and intelligent Attendants, in Asylums.—Admission of Visiters.—Middlesex and Edinburgh Pauper Asylums contrasted.—State of Private Asylums—M. Esquirol's Retreat at Ivry.—Conclusion.

Having given the reader some notion of the extent to which human health and happiness depend on the fulfilment of the conditions which the Creator has attached to the exercise of the bodily and mental functions, and shown that the direct design of suffering and pain is to lead to a stricter obedience to the Divine institutions, and to more perfect enjoyment of life, I might now, perhaps, leave the farther application of the doctrines to the consideration of the reader. But the reception which the first three editions of this volume have met with, gives me fresh confidence in the practical importance of the principles which I have been unfolding, and encourages me to add in the present edition a few remarks on the condition of the nervous and insane—a class of sufferers who have the strongest claims on our sympathy, and in regard to whom, notwithstanding the numerous channels in which public benevolence has of late been so generously flowing, an apathy is still displayed which is not less hurtful than melancholy, and which can proceed only from their real state and wants being too imperfectly known.

If the wretchedness of the *nervous* invalid has

been more frequently made the subject of mirth and ridicule than of friendly regard and rational curative treatment, a still greater sacrifice of health, feeling, and happiness has been occasioned to the *lunatic* by the extreme ignorance which prevails in society in regard to the disorders of the nervous system. In the case of the insane, the secluded life which most of them are obliged to lead, separated from kindred and from society, and the disgraceful prejudices against them which have descended to us almost unimpaired from amid the superstitions of the darker ages in which they originated, have, in no small degree, contributed to this result. Insanity has thus remained one of the few evils which mankind has never ventured to look fairly in the face, with a view to discover its nature, and the means of its prevention and cure. The consequences are, not only that it has been allowed to extend more and more widely, but that the waywardness of conduct, irritability of temper, and caprice of sentiment, which are the first indications of a disordered nervous system, are often resented by the friends as *voluntary*, and, therefore, *culpable* offences; and indignation or indifference is displayed where, perhaps, rational sympathy and an early perception of the true state of the patient might have led to the prevention of the disease. Similar maltreatment is far from uncommon in cases of what is called *nervous*—a term which some consider as equivalent to *imaginary*—disease, but in which, when used to denote a certain class of disorders having their seat in the nervous system, and not in the fancy, an amount of misery and wretchedness is often imbodied, of which few who have not either felt themselves, or witnessed it in some valued friend, can form any adequate conception. In the correction of these evils, little can be effected while the ignorance in which they arise remains undiminished; and, therefore, it becomes an imperative duty to allow no opportunity to escape of spreading abroad such information as may help to dissipate the prevailing indifference, and rouse attention to the magnitude of the existing evils.

If the state and management of public and private asylums for the reception of the insane be examined with reference to the conditions of health already explained in treating of the respiratory, muscular, and nervous systems, it cannot fail to strike the reflecting observer, that while in many institutions the most laudable zeal has been shown for the physical health and comfort of the patients, comparatively little has been accomplished, or even attempted, with the direct purpose of correcting the morbid action of the brain and restoring the mental functions. We have now, in most asylums, clean and well-ventilated apartments, baths of various descriptions, abundant supplies of nourishing food, and a better system of classification, the furious and the depressed being no longer subjected to each other's influence and society: and the result has been, that in so far as these important conditions are favourable to the general health, and to that of the nervous system in particular, recovery has been promoted and personal comfort secured. But in so far as regards the systematic employment of what is called active moral treatment and its adaptation to particular cases, a great deal more remains to be done than has hitherto been considered necessary. This will be apparent on reflecting how extremely influential the regular action of the various feelings, affections, and intellectual powers is on the health of the brain, and how few asylums possess any adequate provision for effecting this most desirable object. If want of occupation, and the absence of objects of interest, be, as we have seen, sufficient to destroy the health of a sound organ, the same causes must be not less influential in retarding the recovery of one already diseased. Hence it becomes an object of extreme importance in establishments for the insane, and in the social treatment of those suffering from nervous diseases, to provide the necessary means for encouraging the healthy and regular exercise of the various bodily and mental powers; and for drawing out, as it were, and directing to their proper objects, the various af-

fections, feelings, and intellectual faculties—this being a condition essential, in a higher degree than any other, to the success of our curative measures.

Those who have not attended to the subject may be disposed to think that the importance of mental and bodily occupation in cases of insanity and nervous disease is here exaggerated. But the physiologist who looks to the established law of the animal economy, which decrees regular action of every organic part to be essential to its health, no matter whether that part be bone, muscle, bloodvessel, nerve, or brain, will not fail to bear testimony to the truth of my remarks. The pathological observer, also, whose attention is daily called to the miseries and bad health resulting from the total absence of mental occupation in those whom fortune has condemned to a life of idleness, without having imparted to them that activity of constitution which seeks out objects of interest and makes occupation for itself, will at once acknowledge that a command of the means of healthy mental and bodily exercise would add more to his power over nervous and mental diseases than any other remedy which art has yet discovered. And yet, in the majority of our asylums, the patients are still merely placed in security and humanely treated, without the least effort made to afford them occupation of mind or body, or any of the more cheering comforts of sympathy and social intercourse; and this being the case, can we be surprised that only one third or one half recover their reason, or shall we rest contented in imagining that human means can go no farther to alleviate their calamities?

It is in the treatment of this unhappy class of patients, who are deprived of their dearest enjoyments and of the soothing intercourse and consolations of social and domestic life, that an acquaintance with the laws of health, and the structure and functions of the human body, becomes pre-eminently useful. When, for example, we contemplate the number of muscles, the importance of their functions, and their influence on the circulation and on the general sys-

tem, and understand the laws or conditions of their healthy action, we cannot fail to perceive that any mode of treatment which does not provide for their exercise in the nervous and the insane, must be radically defective, however kindly and judiciously it may be administered in other respects; and we have thus an unerring standard by which the efficacy of every contrivance used to rouse this class of patients from contemplative inaction to useful exertion may be at all times determined. Hence we have no hesitation in pronouncing as imperfect every asylum which does not provide for the regular active employment of its inmates, either in their former trades or in some kind of bodily, and, if possible, useful and imperative exertion. When we know the structure, uses, and relations of the skin, and are at the same time aware that, in disorders of the mind, its exhalations and nervous functions are almost always disordered, so much so as often to be accompanied with a smell peculiar to mental invalids, it becomes impossible for us longer to overlook the necessity of devoting attention to its condition, and taking steps for its restoration to health as a means of promoting the recovery of the brain. When we become acquainted, in like manner, with the functions of the lungs and the nature of respiration, we can scarcely fail to use every exertion to secure free ventilation, and such ample accommodation as shall prevent several lunatics from being placed together in a small apartment. And, lastly, when we become impressed with the fact that the human mind is endowed with affections, moral feelings, and intellectual powers, operating through the medium of bodily organs, and requiring for their health regular and free exercise on their respective objects—and that, without this gratified activity, they fall into debility and disease—we can no longer rest contented until every possible means of affording occupation to intellect, interest to the feelings, and employment to the body, shall have been resorted to. In fact, till adequate arrangements shall be made in every public and private asylum for effect-

ing these purposes, and till the same principles shall be acted upon in private society in regard to nervous diseases, it will be only deceiving ourselves and shutting our eyes to the truth to suppose that we have accomplished all that can be done for the recovery and relief of the nervous and insane; and too much pains cannot be taken to force attention to the defects which still impair the usefulness of many of our best institutions.

In making these comments I have no wish either to blame any one or to overlook the difficulties which stand in the way of such improvements as science and humanity will one day consider indispensable. Adequately trained and qualified moral agents will not be easily obtained in such numbers as will be required; nor will money be easily procured to meet the necessary expense. Still, however slow our progress may be, it will begin the sooner and proceed the faster if attention be now called to the urgency of the case, and to the leading principles by which farther ameliorations are to be effected.

It is a common but most deplorable mistake to suppose, that because a person is insane, he is insensible to the ordinary feelings and affections of humanity; that his reason is blind to the ordinary relations of life and of external nature; and that, consequently, it matters little in what language he is addressed or what demonstrations of feeling are offered to him; for, in the great majority of instances, the mind is only partially disordered, and is as much alive as ever to the perception of insult, kindness, common sense, and drivelling. And even in those rare instances in which all the faculties seem to be deranged, and in which much irritation and violence frequently exist, kindness, truth, and reason, although at the moment they seem without effect, rarely fail, when calmly persevered in, to produce a salutary impression and to sooth the patient. It therefore becomes of the utmost conceivable importance, in erecting asylums for the insane, to make also special provision for that systematic moral treatment, which is to the brain

and mind what medicine and dietetic regimen are to the stomach, the liver, and the bowels. It has been said, and I believe not without reason, that keepers of asylums who live, without any variety of intercourse and occupation, exclusively in the company of the insane, are themselves apt to become of unsound mind; and that of those who escape insanity there are comparatively few who do not ultimately acquire the peculiar expression of eye which is observable in lunatics. If, then, constant exposure to the society of lunatics be in any case sufficient to give rise to madness in a previously healthy mind, it is as clear as the light of day that the same influence must retard the recovery of those whose minds are already deranged; and that, on the same principle, it must be of importance to subject the lunatic continually to the restorative influence of the society of healthy and well-regulated minds. Every day brings fresh conviction with it, that *the more nearly we can approximate our treatment of the insane to that of reasonable beings, the more successful shall we be in effecting cures, and the more delightful will the duty become of ministering to the mind diseased.*

It is hardly necessary to remark, that in these observations on the importance of regulating the moral treatment of the insane, I have in view chiefly that numerous class of patients in whom the acute stage has been subdued, either by medical aid or by the mere lapse of time. At the very commencement of the disease, a cure may frequently be accomplished by the removal of the exciting causes, active medical treatment, and careful superintendence at home. But after this period, much more will be accomplished by judiciously regulating the exercise of the mental and bodily functions, than by strictly medical remedies; and it is consequently chiefly to this stage that I now refer. To the nervous invalid the rule is still more extensively applicable.

To secure regular and animating exercise of all the mental and bodily functions, as conducive equally to the preservation and restoration of mental health,

ought then to be our grand aim in the construction and management of public and private asylums, and in the treatment of nervous patients.

In planning the means of mental and bodily occupation for the insane, we should follow, as far as possible, the same rules and principles which are applicable to persons of sound mind. Thus, daily muscular exercise in the open air is essential equally to bodily health and to mental soundness, and is, therefore, indispensable to both sane and insane. It is more pleasant, more easily persevered in, and also more salubrious to the individual, when it is combined with an object calculated not only to occupy the mind, but to *impress the patient with the* UTILITY *of his labours*. This latter condition tends greatly to reconcile him to the world, and to sooth his feelings by the consciousness which it imparts to him of not being either a degraded or a forsaken being. Mere walking or riding, or employment resorted to merely *as* employment, generally becomes irksome, and is, consequently, either speedily given up, or pursued with a degree of languor which deprives it of its utility. On this account, mechanical and agricultural pursuits, which arrest attention and elicit activity, ought to be provided for in choosing a situation: for experience has demonstrated that, as remedies, such employments cannot be too highly estimated; and that, wherever the rank of the patient or the prejudices of his friends do not preclude him from engaging in them, they produce the happiest results in promoting quiet and sleep, subduing irritation, disposing to perfect subordination, and, above all, hastening the progress of recovery.

Ample extent of ground for the purposes of agriculture and gardening ought, therefore, never to be forgotten; and for those who either are fond of mechanics or have been trained to some manual employment, workshops become equally necessary, and have the advantage of contributing to the general expenses of the house. In several establishments where field-labour, gardening, and workshops have

been tried on an extensive scale, the results have been highly satisfactory, not only in the improved habits and comfort of the patients, and in their more speedy and numerous recoveries, but also in the important advantage of economy; as the labour of the patients has in some asylums gone far to defray their current expenses, while scarcely a single accident is on record as having arisen from an improper use of the liberty allowed them, or of the edged tools put into their hands.

Man is so much a social being, and depends so much on the sympathy, esteem, and co-operation of his fellows, that, as one of a body, he will submit cheerfully to tasks and duties against which, if proposed to him as an individual or as one of a few, he would unhesitatingly rebel. Disease may modify this tendency of the mind, but cannot destroy it; and the practical physician does not fail to avail himself of its power in the management of the insane. Many will at first refuse to work in the fields, in the garden, or in the workshop, particularly if unaccustomed to manual labour, who, seeing others do so with cordiality and pleasure, will gradually allow their resolution to give way, and, ere long, become as zealous as they were previously backward. One of the chief advantages of large establishments is the great facility they afford of turning out numbers to every kind of employment, so as to subject an individual who refuses to exert himself to all the disadvantages of singularity, which the insane dislike even more than persons of sound mind.

Where there is any difficulty in engaging patients of a higher class in the easier and more agreeable kinds of bodily labour, such as gardening, netting, and basket-making, much good may still be done by engaging them as much as possible in the employments to which they were formerly accustomed. Billiards, bowls, walking, reading, writing, and music, are then valuable resources, and may be made to constitute the business of the day; care being always taken to turn the talents of the patient to a useful

account whenever an opportunity occurs, so as to give him, as frequently as possible, the consciousness of filling his place as a member of society.

In the smaller, and especially in private asylums, dedicated to the middle and higher classes of society, the presence of A NUMEROUS BODY OF INTELLIGENT AND EDUCATED ATTENDANTS is a great desideratum. The patients are too few in number to operate on each other by example, and their habits are not in harmony with any manual employments. By placing numerous attendants among them, who would act systematically in endeavouring to engage them in useful labour, at first of a very light description, and to rouse them by example and cheerful encouragement, a good deal might be done; but as, in such retreats, the patients are generally persons of a more intelligent and refined description than in the larger asylums, the attendants, to be on a par with them, would require to possess proportionally higher moral and intellectual qualifications, so as to fit them for being companions and friends, as well as guardians, of the inmates. The expense of providing a sufficient number of qualified persons will long be an obstacle to their being obtained; but if the importance of the provision were once fully appreciated, and its success demonstrated, it can scarcely be doubted that this difficulty would be surmounted. Every year we hear of large legacies being left to lunatic asylums by the benevolent; and if one of these were bequeathed to the first public institution that should introduce such a system, we should not have to wait long to see the example generally followed. The wealthier classes are, indeed, directly interested in the experiment, as their ranks afford proportionally the greater number of victims; and if the diseases were once treated on such principles, there would be much less reluctance to seek early advice, and, consequently, much more success in combating its attacks. Since the former editions of this work appeared, a friend has communicated to me, as confirmatory of the truth of these remarks,

the cases of two patients who, after having been insane and violent for fourteen years, were placed some time ago in the society of a *family circle*, accustomed to the kind treatment of the insane. Even in these unpromising instances an improvement has taken place. "Every month," says my friend, "I perceive some strength gained by them in acquiring restraining power in the presence of the family. So long as any perceptive power remains, such patients soon discover the difference of being again with intelligent and agreeable companions, instead of being subjected to the caprice and authority of an ordinary keeper."

Pinel has said that thirty years' experience had taught him, that a striking analogy subsists between the art of educating and training the young and that of managing the insane, as the same principles are applicable to both. Natural activity, unwearied kindness, tact, and firmness, are eminently useful in both situations; but they are productive of their fullest advantages only when re-enforced by an accurate acquaintance with the laws which regulate the mutual influence of mind and body, with the nature and sphere of the primitive mental powers, and with the methods and objects by which each may be soothed into repose, or stimulated to activity; in other words, by an intimate knowledge of human nature and of the philosophy of mind.

But it will be asked, What fortunate establishment possesses attendants endowed with such excellent qualifications, and where are such persons to be found by any one who wishes to procure their assistance? The answer must be, Nowhere; but it may with equal truth be affirmed, that, as a necessary consequence, nowhere is the treatment of insanity so successful as it would be, were such assistants provided in sufficient numbers to mix with, and exert a constant and active influence on, the patients. In some retreats, an approximation to this desideratum is made in the frequent admission of visiters, who, actuated by kindness and intelligence, seek the society

of the insane, devote themselves to their relief and comfort, and, by gaining their confidence and showing a sympathy with their situation, succeed in dispelling morbid associations, and restoring health and tone to the disordered mind. In these asylums, the proportion of cures is greater than in others apparently as well regulated, but in which no effort is bestowed in active moral treatment. In the Connecticut Retreat this system has been carried as far as the present state of knowledge will permit, and with the best effects; the proportion of cures in recent cases being nine out of ten of all admitted. At present, indeed, no amount of funds could command the services of a sufficient number of properly qualified assistants; but, nevertheless, it is important that the deficiency be made known, that we may make provision for supplying it, and not proceed contented with our present means, as if they were already adequate. The tendency of the human mind is to become accustomed to existing defects, and never to think of remedying them till some accidental occurrence displays their magnitude, and turns attention to further improvements.

As matters now stand, the higher class of lunatics are in one sense the most unfortunate of all. Accustomed at home to the refinements of educated and intelligent society, to the enjoyments arising from change of scene, to horse and carriage exercise, and to the command of numerous sources of interest, they find themselves transported to an asylum where they may no doubt be treated with kindness, but where they are necessarily cut off from many of the comforts to which they have been accustomed, and must encounter prejudices, feelings, and modes of thinking and acting to which they are strangers, and with which they can have no sympathy. Being there restricted almost exclusively to the society of keepers, who, from their rank, education, and manners, cannot be considered qualified to gain their confidence or elicit friendly interchange of sentiment, the patients are, in a great measure, deprived of that beneficial intercourse with sound minds which is indis-

pensable to health, and of the numerous opportunities which such intercourse presents for gradually stirring up new interests and leading to new trains of thought. The medical attendant, indeed, is often the only being to whom patients of this class can freely unburden their minds, and from whom they can seek comfort; but unfortunately, in most establishments, his visits are so few and short, that they can scarcely be reckoned as part of an efficient moral regimen.

The poorer patients, on the other hand, although too much left to their own society, have still the advantage of being, to a certain extent, in daily communication with minds in harmony with their own both in feeling and in intelligence; as the keepers are always men of the same rank, education, and manners as themselves. They consequently are less sensible of the change in their situation, and feel less acutely any accidental indignities to which they may be exposed.

Experience has already shown that great benefit arises to the insane from the frequent association and sympathy of persons of tact, intelligence, and kindness, who feel a real interest in the happiness of the patients, and *visit them from a wish to sooth and comfort them*, and not from mere idle curiosity. Nothing tends so much as this to break down the formidable barrier which still separates the disordered in mind from the sympathies of society, and to dispel those sinful prejudices which brand insanity with the stigma of crime, and impel us to shroud its victims in obscurity and neglect.

It may be said, "This is all true, and very proper for medical men to know; but why introduce it into a book intended for the general reader?" My answer is, that I introduce it here purposely, because it is from among the public that the directors and managers of institutions for the reception of the insane are chosen; and so long as they remain unacquainted with the wants of the patients, little can be done to provide a remedy. Medical men may direct, but society must co-operate, and cheerfully and earnestly

take a part in the good work. Besides, there are thousands of warm-hearted beings who would delight in this very duty, if they only knew how to set about it; and these can be reached only by writings addressed to the general public.

That I may not be considered as either too severe in pointing out existing defects, or too visionary in conceptions of the improvements required, I shall give a brief outline of the condition of one or two establishments at present in full operation, and leave the reader to form his own conclusions.

In Edinburgh, for example, we have two institutions for the reception of pauper lunatics; one belonging to the city, and the other attached to the West Church Charity Workhouse. That belonging to the city is situated in a part of the town almost surrounded by high buildings and the old town-wall, which is of great height, and goes far to obstruct the free circulation of air. The buildings themselves were erected many years ago for a projected trading company, and are confined in extent, low in the ceilings, entirely cooped up, and not in any way adapted for the purpose. The usual number of patients is about seventy. From the scanty accommodation, there is little or no room for proper classification; none for workshops of any description, and very little for adequate ventilation or exercise. In the aspect of the place, there is nothing to cheer, to comfort, or to sooth; but, on the contrary, high walls, small windows, and iron bars appear on every hand. The same remarks apply essentially to the West Church Charity Asylum, with the single exception that it is more open to the air and the light of day.

As a contrast to these we may take the Middlesex County Asylum at Hanwell, which I had occasion to visit in May, 1834, and to which I refer in preference to the excellent institutions at Perth, Dundee, and Glasgow, because it is appropriated exclusively to pauper patients, which the others are not, and is, therefore, a fairer object of comparison. The Hanwell Asylum contains about 600 lunatics. The site

on which it is built is elevated, cheerful, dry, and airy, without being exposed, and commands an extensive and enlivening view. The various apartments are well laid out, admirably warmed and ventilated, clean, and comfortably furnished. The window-frames being of iron instead of wood, there is perfect safety without the appearance of restraint; and everywhere the apparatus of government is so little visible, that every one seems as if trusted entirely to his own discretion. Ample provision is also made for due classification, so that none are injured by being placed in contact with those whose state is likely to have a hurtful influence on their feelings.

In these respects, the superiority of Hanwell is incontestable. It fulfils almost every condition required for the purpose. Its moral advantages, however, are scarcely less remarkable. In its most humane, intelligent, and experienced resident superintendents, Sir William and Lady Ellis, Hanwell possesses a distinction which few other asylums, for either rich or poor, at present enjoy, but which is of immense importance as the mainspring of the whole moral machinery. Such, indeed, is the influence of their knowledge of human nature, undeviating kindness, and tact, in gaining the confidence and affection of the patients, that although the number of bad cases is unusually great (nearly five sixths being incurable before being sent to Hanwell), order, quiet, and comfort reign throughout; and even among the worst, namely, the idiotic, the furious, and the epileptic, there is an aspect of comparative cheerfulness and confidence, which is the strongest proof of the general system of treatment being active, kind, discriminating, and judicious. Such is the general appearance of the establishment, that I can scarcely imagine a more gratifying spectacle to a humane and intelligent mind than that which a visit to Hanwell affords. In this opinion I am powerfully supported by Miss Martineau, who, after repeated visits to the asylum, has given an eloquent testimony to the same effect in Tait's Edinburgh Magazine (June, 1834), in an article which is

full of interest, though it errs somewhat in assuming that asylums in general remain in the same deplorable condition which was so common about twenty years ago. In point of fact, a great advance has been made since then in both public and private establishments; and few indeed are now so bad as Miss Martineau describes. Hanwell ranks, justly, among the foremost; but to place it in its true position, it is not by any means necessary to depreciate the condition of all the rest. I have visited *one* public establishment since the publication of her letter, to which almost the worst of her description *was* applicable at the time of my visit. Even in the two great institutions of Bethlem and St. Luke's, the old system is still so far in full force that the patients wander about their courts in hopeless indolence, without an effort being made, so far as I know, to provide them with systematic employment.

The Edinburgh Pauper Asylum, also, is fortunate in having an excellent resident superintendent; but while I most willingly give him all the credit to which he is so justly entitled, I must be allowed to add, that an educated professional man, who is acquainted with the structure and functions of the human body, and has not only studied human nature as a physician and philosopher, but specially investigated the subject of insanity, possesses qualifications which experience alone can never impart; and it is therefore no disparagement to say, that, in regard to moral management, our asylum is less favourably circumstanced than that of Hanwell.

The almost entire absence of the means of active employment and healthful exercise in the Edinburgh Asylum, is another point which contrasts singularly with the ample provision of them at Hanwell, and with the aspect of industry by which the latter is characterized. On passing the outer gate, some of the patients are generally to be met with busily employed in keeping the grounds in order. Others are at work in their extensive garden, and others, again, in the adjoining fields. On entering the spacious

offices attached to the asylum, some are found plying their trades of baker, brewer, and dairyman; while in the workshops, numbers are seen engaged in rope-making, shoemaking, tailoring, and basket-making. Nor are the women idle. Many of them are employed in the kitchen, washing-house, and laundry; many in making and mending clothes; and many more in cleaning, knitting, sewing, and other household duties. No one is *forced* to work; whether he works or not, he is treated with kindness; but all are *requested* to work. If they obey, they are welcomed and encouraged. If they refuse, all their little extra comforts, such as tobacco, which are made to depend on their doing something as an equivalent, are withheld; and they soon find it to be more agreeable, and more for their own interest, to be industrious than to be idle.

In Edinburgh, on the other hand, there is neither sufficient ground for exercise, nor any means of useful bodily employment; and when it is considered that most of the patients are persons habituated to labour and to the open air, and unprovided with resources from which they can derive enjoyment within doors, the deprivations to which they are subjected by confinement assume increased importance. During the violence of the malady, when the patient requires to be confined, and is not composed enough for any quiet occupation, the want of room is less felt. But it is very different when the period of excitement is past, and both mind and body require to be roused to exertion on objects external to themselves. So far from idleness being then either necessary or natural, the bodily energies are often increased and craving for an outlet; and, even in the worst cases, several, at least, of the mental faculties remain unimpaired, and ready to act when their objects are presented to them. Idleness only aggravates the evil, by throwing the patient back upon his own morbid feelings; and the ennui to which it then gives rise renders the temper impatient and the confinement intolerable.

When a person in health is deprived of active exercise, he generally passes a restless night; or, if he sleeps, he is visited by distressing dreams. The same thing occurs among the insane. If their energies do not get scope by day, they become noisy and impatient during the night. At Hanwell and other similarly managed institutions, employment and exercise in the open air are found by experience to be of great value, even as soporifics, and, therefore, highly useful in promoting recovery.

In many private asylums, again, defects exist, which urgently demand improvement. The rooms are so small, low in the ceiling, and ill-ventilated, that, when the presence of an attendant is necessary during the night, the vitiation of the air becomes intolerable, does positive harm to the patient, and is often a source of complaint with the keeper. This is a very serious evil; for the exhalation from the skin and lungs is often extremely offensive in the insane, and its accumulation, from confinement in a small apartment, becomes not only a source of annoyance, but an obstacle to recovery. Cleanliness in person and in clothes, also, is too little enforced, and baths are too sparingly used. Little or no exertion is made to occupy or direct the mind, and no society or amusement of any kind is provided to cheer the tedious hours. Not unfrequently, moreover, patients, still possessed of the greatest acuteness, and the nicest sense of propriety, are habitually addressed as if they were incapable of thinking, and required to be moved or influenced like babies and idiots. I have known instances in which threats, such as are vulgarly held out to children, have been used towards lunatics whose powers of intellect and delicacy of feeling were far above the average of sound minds; and the effect was to induce a flood of tears, from a deep sense of the indignity to which they were so rudely subjected. It is a fatal mistake, I must again repeat, to suppose that, because a person is insane, he is, therefore, insensible to ordinary motives, and may be safely treated as if he could not appreciate

either reason or truth, kindness or severity. In general, the fact is the reverse, the sensitiveness to good or bad treatment being greatly increased.

The celebrated and benevolent ESQUIROL has been loud and eloquent in enforcing regard to the feelings, and attention to the real welfare, of the insane; and in his private establishment at Ivry, near Paris, which I had the gratification of visiting along with him in September, 1831, he exemplifies almost every principle on which such an asylum ought to be conducted. The asylum is placed in a beautiful and airy situation, with a pleasant exposure, and its general aspect is that of an inhabited and well-kept villa. Four distinct buildings, of ample size and elegant appearance, are conveniently distributed through a well laid out and ornamented park of twenty-five acres, part in garden, part in grass, and part in plantation, with neat walks bordered with flowers running in every direction; which, it will be observed, is a very handsome provision for thirty or thirty-five patients, to which number he restricts himself. For the troublesome or excited patients, there are two neat one-story buildings, one for males and the other for females, separate from each other, and far removed from those appropriated to the convalescent and tranquil. These one-story tenements open upon, and look into, spacious grassplots, surrounded on two sides by high walls, along which covered galleries are made for shelter from the rain and sun; so that the height of the walls seems as if intended to admit of galleries being made, rather than for the purpose of preventing escape. The third side is occupied by a plain, neat, high railing, like that of the Tuilleries garden. To these plots and galleries the patients have access at pleasure; and most of them prefer coming out at the window, from which they can easily step, no restraint being visible, and nothing of the *prison* being apparent. This degree of harmless freedom tranquillizes them amazingly. Each room (neatly and plainly furnished) has beside it a room for a servant—each patient having one—so that ample surveillance

is exercised. When a little confirmed in tranquillity, they are allowed to go out by a back door to a large ornamental walk, shrubbery, and garden, with a fine view over a lower wall, apparently opening upon the public fields, but, in reality, perfectly retired. The attendants are more refined and gentle in their manners, and better educated, as well as naturally more humane and intelligent, than the corresponding class of persons in this country. Their number, intelligence, and amiable disposition, are a great advantage both to themselves and to the patients. Being less exclusively confined to the society of the insane, they have not that peculiar expression of eye and general appearance which our keepers so often acquire, and which indicate a state in some degree allied to insanity. Esquirol says, that all his English visiters complain of the difficulty of getting any but coarse and ignorant men for keepers, and wonder how he succeeds; but the French of all classes are naturally more observant of the kindnesses of ordinary intercourse, especially with their inferiors, than we are, and are habitually more tolerant of the caprices and weaknesses of others. The different classes of society thus stand at all times in a more favourable position than with us for acquiring an interest in each other, and for becoming friends, or, in other words, for effecting a cure. The importance of this confidence was well illustrated by an expression of Esquirol's, in speaking of a patient: "At last," he said, "I succeeded in gaining his confidence; and after that," he added, with a significant look, "*on va vite à la guerison.*" This, of course, must be received as a *general* proposition only, but it shows the force of the principle.

When tranquillity is secured, the patient is removed to another building, and from that to a third, each bringing him nearer and nearer to ordinary life, till, in the third, convalescents meet, in the character of ladies and gentlemen, at meals, music, billiards, reading, &c., along with the family of Dr. Metivier, a nephew of Esquirol, who resides there with his wife

and children. There the patients receive their friends, and with them make excursions to the environs, or go to the theatre; or, if from the provinces, they go and see the wonders of the capital. They are thus gradually prepared to resume their station in society; and, from being treated throughout with most considerate kindness, they become attached to the family, and cease to repine at their temporary separation from friends and home. But, not to dwell too long on this most interesting subject, I shall conclude at once by remarking, that it is necessary only to see the different appearance and conduct of the patients in a well-contrived and properly-regulated asylum, as contrasted with one of an opposite character, to perceive at once how influential active moral treatment is in promoting recovery, and how necessary it is to devote more attention than hitherto to this and the other conditions of health in our treatment of the insane.

In commenting, as I have done, on the defects of the pauper asylum of Edinburgh, I must not be regarded as accusing the managers of neglect or indifference. I am quite aware of their anxiety to better the condition of the patients, and that they have already done more in the way of cure than could have been conceived possible with their imperfect means. But it is on this very account—that the public may be stirred up to provide the necessary funds—that I am so anxious to direct attention to the miserable accommodation; for I cannot help considering the asylum, in its present state, as a disgrace to the metropolis of the country.

QUESTIONS

ON THE

PRINCIPLES OF PHYSIOLOGY.

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CHAPTER I.

WHAT is the literal signification of the word *physiology?* How is the term *now* used? What are the branches of physiology called? What is *vegetable* physiology? *Comparative? Human?* In what respects are the objects of all these the same?

In what is the groundwork of distinction between *animate* and *inanimate* bodies to be found? Mention the different relations in which they stand to the ordinary laws of the material world.

Give some examples of these different relations.

What is the object of chymistry and natural philosophy? Can we infer anything of the qualities of living bodies from our knowledge of the elementary materials which compose them? How must we arrive at any just knowledge of the conditions by which life is characterized and under which it is carried on?

What branch of physiology is the subject of this treatise? In what do its importance and attraction consist? What is human physiology in its widest sense? In what respects is a true system of physiology eminently useful? What do you mean by *hygiène?* How are the mental and moral powers of man manifested? What would be the most successful plan for their cultivation?

Are living bodies possessed of any other distinctive properties besides the power of resisting the ordinary chymical and physical laws? What are these peculiar properties? How do they differ from inorganized matter with regard to origin and production? With regard to their preservation? With regard to their growth and decay? With regard to the term of their existence? To what classes are these properties common? What are the most remarkable which are peculiar to animals? What division of animated beings do these great marks of distinction warrant? In what respects is man far superior to other animals?

What renders any systematic arrangement of a treatise on human physiology very difficult or impossible? Why is not a systematic arrangement necessary in the present instance?

Why should this branch of science form an important part of a liberal education, and be familiar to the unprofessional reader? What evils result from popular ignorance on this subject?

What pernicious system was the Factories' Regulation Bill in England designed to amend? What prevented the legislative body from perceiving at once the evil tendency of the former system? What amelioration would an acquaintance with anatomy and physiology have led them immediately to adopt? What besides ignorance should not stand in the way of promoting the happiness of our fellow-creatures?

What was the case of Capt. Ganson's vessel, lying at Leith? To what was the accident attributed?

An acquaintance with what laws would have prevented this distressing occurrence? To what is a constant supply of pure air indispensable? What have been the evil effects resulting from want of proper ventilation in small rooms, in schools, jails, and hospitals?

What pernicious law, with regard to infants, exists, or *has* existed, in France? How is it at variance with the laws of the Creator? What are its destructive consequences? How came it to be enacted? And, if enacted knowingly, what would it legalize?

In what cases are the lungs called into action as powerfully as in running, or any other species of severe muscular exercise? Would an individual who had brought on spitting of blood by bodily labour at the spade, be deemed perfectly safe and cautious by relinquishing that occupation and confining himself to haranguing and discoursing? What would be the consequence? From what circumstance?

What are the constant practical anomalies in life with regard to health? What treatment takes place in the time of sickness? What are the reasons assigned? What inconsistency is observed upon the recovery of the patient? What inference are we to draw therefrom?

What is one cause of such anomalous conduct in regard to health? Give an illustration. Another. What is the ground insisted upon for such inconsistencies?

What would be beneficial to man in his so frequent breach of the laws of physiology? Why does he so often fail to trace the connexion between his conduct in life and his broken health? In what manner do the consequences of his aberrations come upon him?

To what is pure air essential, and how are its degrees of vitiation to be measured? In the case of a delicately-constituted female, who frequents heated rooms, crowded parties, theatres, &c., how is the plea, that the closeness and heat rarely injures *her*, to be understood? What is the real state of the case, and the genuine eventual consequence?

To what is the debility complained of in spring by invalids and persons of delicate constitution, more particularly owing? Detail the causes at length. In what cases does not the principle apply?

Is the hurtful cause derived from any positive quality of the spring season? From what then? Why is not this fact immediately perceived? What may be said in corroboration of this view of the case?

How are we to judge of the harm produced by any *single* excess in the human system? In what manner and by what kind of causes are the change and ruin of the human constitution generally effected? What, hence, is the character of the great mass of human ailments? How do those suddenly and violently induced differ from them? By what false inferences do we fail to trace diseased action to its true causes?

What is the rise and progress of the two kinds of casual influences to which man is liable?

What is the first called? What is the other? Why ought we not to wonder at the speedy termination of severe cases of the former, when the latter, as dyspeptic and nervous ailments, require months for their cure? What would have been the beneficial effect of a just knowledge on this subject? Detail at length in what the benevolence and wisdom of the arrangement are conspicuous.

How is the separation of the effect from the cause in *chronic* diseases to be estimated? Give an illustration in the case of *insanity*. How does this apply to other cases? And what may be the general deduction concerning them?

To what has the apparent but unreal separation of the effect from its cause given rise? What does this variety of opinions prove? Mention some of these discordant sentiments. What is the natural result of these apparent anomalies and contradictions?

What influence does this want of unanimity exert upon successive generations. From what two causes must this discrepance arise? Why can it arise from only one of them? How, then, are the differences of opinion with regard to the advantages or evils of exercise, food, and clothing, to be settled so as to obviate many difficulties?

Why should the intelligent classes of society become better acquainted with human physiology? What benefit would result to the physician and society in general therefrom?

What is the present state of medicine in its application to the physical and mental welfare of man? What are its prospects in these respects?

How has the practical importance of physiological knowledge been overlooked in the training of youth? What do the anatomist and physiologist respectively teach? Why should anatomy and physiology not be taught separately? In what do the anatomist and physiologist err? How far has the separation been carried? In what is the absurdity of this plan evident?

What is the result of this erroneous system to the young practitioner?

How are practitioners to be answered who object to unprofessional persons making themselves acquainted with the structure

or functions of the human body? Why is physiological knowledge desirable in the patient in the case of *chronic* diseases? Why also in *acute?*

How is the charge of selfishness to be repelled by those who are solicitous in yielding rational care to the preservation of their health? Who are the truly selfish? In what respects has the blessing of health been too foolishly underrated?

What is the better object of consideration with regard to the enjoyment of health?

How does Maynwaringe depict the advantages and blessings of health? How also does he describe the evils attendant on its loss?

What is the general inference to be deduced?

CHAPTER II.

On what principle are the following essays conducted? What have been hitherto the most prominent topics of disquisition in the animal economy? What other subjects of discussion are most worthy of notice?

What is the skin? Mention its different appearances in its different conditions in the human frame.

What is the structure and composition of the skin? How many layers of membrane has it? What are they? Are these distinctions of any importance? Why?

What is the *epidermis*, *cuticle*, or *scarfskin?* Describe it. From what is it supposed to originate? Is it porous? How is the objection to the contrary answered?

What is the use of the *cuticle*, and how is it adapted to its use? Give an illustration. Is the cuticle possessed of nerves? What benefit is conferred by their absence? Show the wisdom of this arrangement.

In what cases is a thicker cuticle provided? What reason have we to think this provision is intentional?

When does the cuticle become thicker than its original consistence, and for what purposes? Give some illustrations. What organization of the cuticle would have been less beneficial?

To which layer of the skin do the nails belong? Why? What are their use? What are their substitute in the lower animals?

How must the thickening of the cuticle be produced? Why? Give an illustration.

What is between the scarfskin and the true skin? Describe it accurately, and give its peculiarities in negroes and albinoes. What is the colouring matter?

What is known of the mucous network? What is its use? What in negroes? Is this theory correct? Why?

What place does the mucous coat occupy in fishes?

What is the third or inmost layer called? In what does it differ from the cuticle and mucous coat? Of what is it the seat and the instrument? Describe it. What appearance does its internal surface present? Describe the *areolæ* or cells. By what are they

traversed? What is the course and appearance of the nerves of the skin? What are they called? Where are they chiefly visible? What do they constitute? Where are they most thickly planted?

Of what, for practical purposes, may the true skin be said to be composed? What are proofs of the cellular nature of the skin? What proves the equal abundance of nervous filaments in the skin? What may be a general description of its character? Of the extent of its surface? Of its amount of nervous matter?

What may be considered as the four constituent functions of the true skin?

Explain how the skin is a *secreting* and *excreting* organ, and give the meanings of those words. What are extraordinary and ordinary exhalations of the skin? Prove the reality of the latter.

Does the amount of excreted matter admit of calculation? What was the estimate made by SANCTORIUS? What distinctions did LAVOISIER and M. SEGUIN introduce? What do you mean by cutaneous and pulmonary? How did SEGUIN calculate the cutaneous and pulmonary exhalations?

What was the *largest* quantity of pulmonary and cutaneous perspiration per minute, hour, and day, according to SEGUIN? The *smallest?* The *average?* What is the value of his estimate? What proportion does the cutaneous exhalation bear to the excretions of bowels and kidneys? What modification does the weather effect on the exhalations? What are other causes which affect them, and in what measure?

How does the *sensible* perspiration compare with the *insensible?* What consequence results from the former's being suddenly checked? Describe the condition of the skin when this takes place. The effects produced on its use. The results to other functions of the body. Are its ultimate consequences always sudden?

What is THENARD'S analysis of the cutaneous exhalation? What is BERZELIUS'S? How does the composition vary? Where does the blood enter most into the composition? What inference is to be deduced?

What is the lowest estimate of the cutaneous excretion made by LAVOISIER? What reasons have we, from considering the nervous system of the skin and its daily *insensible* exudations, to conclude that checked perspiration must prove so detrimental to health? What is the practical application of this fact?

Why do organs sympathize with each other? What organs sympathize with the skin? Why? What effect has checked perspiration on these organs? What is the result if any of them are in a diseased state? What if in a healthy condition?

Give an illustration of the reciprocity of action in the sympathetic organs allied to the skin.

What increases the secretion of the lungs when in a weak state? What great danger is obviated by the convulsive effort of coughing? How? What has the state of the skin to do with producing expectoration, and a cough?

What is one office of the lungs in conjunction with the skin? What is the consequence of this union? By what law does disease operate upon sympathizing organs? Illustrate. What ought a physician to make himself acquainted with? Is the same disease always produced by the same cause? Ought it to be treated always by the same remedy? Illustrate. To what class of persons does popular ignorance give currency?

What extraordinary sympathy exists between the skin and the stomach and bowels? Among the lower animals? How does the sympathetic concert between these two organs reciprocate?

How may the connexion between suppressed perspiration and internal disease be accounted for? Can an explanation of the mode of operation be always given? Why not?

What connexion have scalds and burns with the internal organs? How may this fatal connexion be accounted for? What is Baron DUPUYTREN'S opinion? What is the unquestionable inference?

Mention two or three remarkable instances of the sympathy between the skin and the bowels?

What is to be considered next to the exhalation of waste matter from the system? What is the temperature of the human body in various climates? What great principle in man subdues the external influences of his locality? In what does the benefit of this arrangement consist? What are the chief agents employed in adapting man to his external situation? What may be observed of Capt. Parry, Blagden, and Sir Joseph Banks?

What is known of animal heat? What is the law of its generation and expenditure? Illustrate. What connexion has thirst with the temperature of the body?

What is the process by which extraordinary heat is carried off from the system? What did the experiments of Edwards and Franklin tend to show upon the subject? How may superfluous animal heat be easily carried off on the evaporating principle? Is the skin the only agent?

How does the case of the dog bear upon the question?

What is Dr. Davy's observation on the standard heat produced in a European's body on his first landing in a tropical climate? How does it affect the nervous system? The skin? How is the skin affected on his passing from a dry to a humid region?

Why is *hot*, when connected with *moist*, weather unwholesome? What different effects are produced by a hot and dry, and by a hot and moist atmosphere? How has Delaroche established this point? How, then, may the benefits of perspiration in some diseases be accounted for?

What is the next function of the skin to be noticed? What is the mode of its operation? Give a familiar example of the process of absorption. Another. Another. Another.

How is the process of absorption carried on? Describe the properties of the *absorbents*. Why are they called *lymphatics?*

How does the disease called *diabetes* incontrovertibly prove the doctrine of absorption? What was the ancients' belief on the sub-

ject? With what reason? What weight of evidence for and against this function do the phenomena attending immersion in a warm bath bring?

Relate some experiments made by Dr. Edwards on animals in proof of the absorbing principle. What retards absorption in the human frame? When is the impediment greatly removed? In what cases and by what means has the principle of absorption been successfully applied?

How is the obstacle to absorption presented by the cuticle generally overcome? When is friction necessary and unnecessary?

What becomes of the perspiration when confined to the skin by injudicious clothing and want of cleanliness? What is the effect to the health? Illustrate this in the case of water-proof dresses worn by sportsmen and others.

What reasons have we to believe that marsh miasmata are absorbed by the skin? What good effects have resulted from the wearing of woollen clothes? Why? Give some instances in men. In animals. What is the practical inference?

What general law of organic action explains some difficulties with regard to the functions of the skin? How do a dry and a moist atmosphere respectively affect the several processes of exhalation and absorption? Why is the predominance of the *lymphatic* system remarkable in the Dutch? What adds to the probability of malaria being absorbed by the skin? What preventative should be adopted? What course has been pursued with regard to the British army and navy in conformity with these views of the absorbing influences? What has been the success?

How may the doctrine of exhalation and absorption bear upon the prevention or contraction of the plague? Illustrate.

How may the objection of two opposite functions being performed by the same organ, viz., exhalation and absorption, be answered? To what constituent part is the office of *touch* and *sensation* intrusted? In what way does the skin act in this respect? In what respects does the skin resemble the other organs of sense? What gives rise in all instances to the impressions received from the organs of sense?

How is the skin provided in order to transmit the impression to the mind? What is essential to its texture and vitality? Illustrate the great utility of the nerves from the case mentioned by Dr. Yelloly.

Is the *principle* of sensation in the surface of the body uniform? Where is it most predominant? What proof is there that sensation depends upon nervous endowment? Illustrate the fact. What is the difference in the distribution of the nervous *papillæ* between man and fishes?

In what is the nervous tissue of the skin essential to our continued existence? Illustrate this fact in the case of cold. Of heat. How are the *spirits* affected by the healthful or morbid action of the nervous parts of the skin?

What is essential to the due exercise of sensation? Give an exemplification of the causes of pain and insensibility.

What is another essential? How does the arterial blood affect sensation? What is occasioned by the violent return of the arterial blood after its temporary expulsion?

What important office does the nervous tissue of the skin perform? How does the accuracy of its decisions vary?

By what is the skin materially operated upon? How are the changes in the skin produced by mental operations? Mention some extraordinary cases.

What is the reverse influence which the condition of the nervous matter exerts upon the rest of the system? Upon the mental operations in particular?

What effects do sickness and literary pursuits produce on the nerves of the skin? What may be ascribed as the reason? What is the general complaint of sedentary persons, and how may it be removed?

What other parts and elements are noticeable in the substance of the skin? Describe them. Relate their uses.

CHAPTER III.

In what sense is knowledge power? What is the subject of this chapter?

What important fact is furnished us by the London bills of mortality with regard to infants? To what may this extraordinary result be attributable? What is the state of the skin at birth? What connexion has the mortality among infants with the functions of the skin? What may be observed concerning the practice of bathing infants in cold water?

To what error may this practice be ascribed? What is the real state of the case? Support this by facts. By the custom in France. In what are legislators lamentably deficient? What is the unhappy consequence?

Into what opposite pernicious evils do parents run? What may be said of too much heat and clothing as applied to infants? Relate the effects produced by it.

Of what is the insensible perspiration composed? Why should this be particularly removed in early life? Why is daily washing and frequent change of clothing essential in that age?

What are the several and particular properties of the skin in youth? How is the temperature kept up? What rule and certain maxim may be laid down with regard to cold bathing? What pernicious habit is observable in the young of both sexes? State the circumstances which produce its severe consequences. How do these operate upon youths, especially females? Upon those of a consumptive habit? What precaution is to be taken? What remedy?

What is to be said of excessive clothing? How are rules to be

laid down? What general rule may be deemed sufficient? What other mode of preserving necessary warmth ought to be pursued besides clothing? What beneficial effects has it? From what complaints does it secure us?

In what important point is female dress faulty? What disorders arise from tightness in dress? How does each part or function of the body operate upon the other?

How do wet and cold feet produce disease? Is it the mere state of wetness that causes the evil? Mention an instance in point.

From what principles may the advantage of wearing flannel be proved? State its particular advantages, and how it operates on the skin. What should be its substitute in delicate constitutions? Why? What general rule should be observed in the assumption of flannel clothing? Why?

Give the substance of the testimony adduced by Sir George Ballingal in favour of flannel clothing. Give the substance of Capt. Murray's testimony.

To what may the superior health of the crew of the Valorous be attributable? Why?

What other rule of conduct may be practised to obviate the bad effects of cutaneous exhalations? In the case of flannel? What is the preferable practice? What excellent practice, common in Italy, should be adopted? Why is this so consonant to reason? What is the reverse custom of the poor Irish in Edinburgh? What are its dangers?

What influence has the solar light on the skin? What is observable in those who are deprived of it? In the inhabitants of towns? In vegetables? To what else may paleness be attributed? What should be provided for in the erection of new streets?

What is the consequence of not removing the exhalations of the skin? Why was ablution a religious observance? What proofs have we of its necessity? What ought to be as common as a change of apparel? Where is it more frequently practised?

How is the importance of ablution compared with its observance? Among the North Americans? In the United States? In England? In public charities and schools? Which is more suited for general use, the *warm* or the cold bath? Why?

Mention the extraordinary connexion of the *bowel complaint* and cutaneous exhalation in the case of a lady. *See note.*

When may the cold bath and the shower bath be used with advantage? With what limitations and exceptions?

How should the time of immersion in a cold bath be regulated? What has been found the most beneficial season of the day?

What practice may be substituted in the case of those that are not robust? With what qualifications and limitations?

What is the safest and most valuable for habitual use? At what stage of temperature? For what length of immersion? How may the most suitable temperature be best estimated? What is its effect? How often may it be used?

What is the *best* time for valetudinarians to receive the benefit of the bath? Why? What precautions are to be taken therewith?

When ought bathing not to be employed? In what cases is it beneficial? Has it any tendency to produce a cold? What has been the testimony of experience in its favour? How does it operate in pulmonary disease? *Note.*

What advantages would bathing have in being used in manufactories? How has the waste warm water from the steam-engine been profitably used? *Note.* What has been effected in the Caledonian Pottery at Glasgow? *Note.*

What is the state of *vapour* bathing on continental Europe? By what beneficial effects is it attended there? What prejudices are there against its use? On what are they founded? How are they falsified by the fact? How is this exemplified in Russia and in the north of Europe? What difference is there in the state of perspiration produced by exercise and in that generated by a vapour bath? Why?

How does common experience illustrate the above principle in the case of a room *imperfectly* warmed and one *comfortably* warm? Explain the principle.

In what cases may the vapour bath be hence a preservative and remedial agent? With what cautions must it be administered?

In what cases may a vapour bath be prejudicial? Why? What may be a substitute?

To what are the preceding remarks specially applied? To what may they also be extended? Why? Illustrate the case. Give some instance. What objection has been made to the tepid or warm bath? How is it erroneous? Give some instances and testimonies in favour of it. When does it sometimes fail to be beneficial?

How has the affusion of cool water on the head during immersion in a warm bath been successfully applied?

With what limitation and caution are the above facts to be received?

What are always available substitutes for the warm bath? What the consequence of their neglect? To what reflections does man's inconsistency in his treatment of himself and animals give rise?

Relate the process by which a diseased state of the skin operates upon the lungs and produces pulmonary complaints. What effect will the restoration of the cutaneous circulation produce? In some chronic affections?

What are the two remedies which enjoy the oldest reputation in the successful treatment of pulmonary consumption? To what do they owe much of their influence? What has been their course of treatment of late? How far has this treatment proved serviceable? How does riding prove efficacious? How does a voyage by sea benefit? Mention in detail the benefits derived from sea-sickness in the case of the author.

Narrate at length the benefits which subsequently accrued to his health by the practice of riding on horseback.

How far are the advantages to be derived from the healthy action of the skin to be insisted on? For what reasons? What is a not unfrequent fallacy among medical men? To what is it owing? What functions of the human system have had their respective patrons? How has the doctrine of each been sustained? What does this prove?

With what qualification is the importance due to the state of the skin to be received? Illustrate the case with an example. How will its treatment prove efficacious?

What connexion has free perspiration with acidity in the stomach? Relate the case of Lord Byron, and give the principle of his cure.

What is the doctrine of M. Donne? What facts corroborate the accuracy of his views?

CHAPTER IV.

What is the subject of this chapter? What position do the *muscles* occupy in respect to the skin? What functions of the body are less familiarly known? Why ought the muscular system to excite our attention?

What are the muscles? What constitutes the red, fleshy part of meat?

Of what is every muscle composed? Relate the manner in which the muscles are separated and connected with each other? What produces the roundness of the limbs, or the contrary, in persons? How do the muscles enjoy their freedom of motion?

How may the muscles be divided? What are their names? Which is the most important? What is the *belly?* How are the muscles affected in the lifting of any weight or in overcoming any resistance? What would produce a violent contraction of the muscles? What is, in general, effected by the contraction of the muscles? In what manner? Explain the nature of the *origin* and *insertion*, and their mode of attachment.

Draw the figure and explain its several parts. Show also the manner in which contraction of the muscles is effected from it.

What difficulty presents itself in the attachment of the muscles? What considerations obviate this difficulty? In what do the fleshy fibres of the muscles terminate? To what are *tendons* or *sinews* conducive? Have all muscles osseous attachments or tendons? Which have no bones? Which no tendons?

What is the usual colour of the muscles? Upon what does this depend? How is this ascertained? What is the consequence? What is the true characteristic of muscular fibres?

How is the direction of muscular motion determined? Recount separately and distinctly the various directions of the muscular fibres. Give examples of some of the particular uses of these variations.

What is the chief use of the muscles? To what else are they conducive? Mention these uses severally and clearly.

What is requisite for healthy and vigorous muscular action? What arrangement and law are observed in the animal economy to this effect? What phenomena attend the action of the muscles? The reason? What result is produced to the muscular system from loss of blood?

What produces such misery upon the young manufacturing population and the inmates of boarding-schools? Explain the evils and their causes.

What is necessary to sustain the growth of the animal system in youth? What if this be neglected? Where has this important principle been disregarded? To what is it owing? What regimen should be observed in the nourishment of the young? With what caution is this course to be adopted? How is this illustrated in cases of shipwreck?

What else besides mere muscle is required to produce regulated or voluntary motion? How is this stimulus conveyed to the muscle? What is this stimulus? What produces intense excitement to muscular action? If this stimulus be withdrawn, what is the consequence?

What *three* things must be in operation to effect voluntary motion? How are the number and size of the muscles distributed, and why? Why have some smaller muscles a greater quantity of nerves than others double their size?

What arrangement is adopted where bulk of muscle, though necessary in ordinary cases, would prove inconvenient? Give an illustration in the case of birds? Show the reverse adaptation in fishes.

How does the nervous stimulus operate upon voluntary motion? Injuries and diseases of the brain? Sleep and narcotics? Ardent spirits? How is semi-intoxication sometimes suddenly removed? What else is requisite, besides the soundness of the brain and muscles, to give effect to voluntary action?

What is the number of the muscles of the human body? How are they distributed? How is muscular contraction effected? Show this in the *sterno-mastoid* muscle in the figure? In the *rectus* or *straight* muscle? In the *sartorius* or *tailor's* muscle?

Relate the variety of operations and effects of the *rectus* or straight muscle.

Show the wisdom and design of the muscular arrangement in the case of *respiration*. What wholesome impulse is thus given to the stomach and bowels? What is one cause of costiveness?

Explain the action of the muscles *a*, *k*, *l*. What combinations are produced by the muscular system? To what extent are the muscles used? Upon what does their simultaneous action depend? Why? From what necessity? Give an illustration. Why does the same muscle receive nerves from different quarters? What difficulty does this explain?

Give a farther illustration of the influence of the nervous agen-

cy? What characterizes healthy and sustained voluntary motion? How is this stimulus adjusted? Give some instances in which its accuracy is discernible?

What does the excess of action in the *nerve* effect, when not balanced by the operation of the muscular fibre? What, if the *muscles* predominate?

Are great muscular power and intense nervous action often conjoined? What do they constitute when united? In what instances has this been eminently displayed?

What error long obtained with regard to the functions of the muscular nerves? How has this been rectified? What distinction is to be made between the muscular and cutaneous nerves? What are their different sensations?

What leads us to suppose that the muscular nerves, though running in one sheath, are double, and perform distinct functions? What is the doctrine of Sir Charles Bell on the subject?

How does Sir Charles divide the muscular nerves, and define their separate functions?

What error does he contravene as to the office of the muscular nerve? What are his reasons?

How does he query the difficulties and exigences of the case? What is his conclusion?

Relate his views concerning the functions of two distinct filaments.

What is the meaning of the *muscular sense?* What is its use and importance? What would be the several disadvantages to man arising from the want of this sense?

How are we guided by this sense on ordinary occasions?

What is essential to muscular power besides the nervous stimulus? What would be the result if the body were deprived of both? What fact does this prove?

By what law is muscular action governed? In what does it properly consist? What is the most fatiguing muscular employment? Why? Illustrate this. Give another illustration.

What does the principle just stated explain? What are most conducive to muscular development? What has been the prevailing system of female education? What has been its inconveniences and results? What evil effects proceed from some ordinary implements for sitting? What awkward remedy has been perniciously attempted? In what has its evils been shown? In what is the formal walk deficient?

What remarkable fact is produced by Dr. Forbes as to the practical results of the female boarding-school system?

To what is the inadvertence of teachers and parents owing? Show to what their mistaken view of decorum have led.

Give Mr. Carmichael's testimony with regard to St. Thomas's Parochial School, Dublin. With regard to the Bethesda School of the same city.

Why should some salutary physiological reforms be adopted in the school system? What reforms? Why should there be some

intermission for bodily relaxation during study hours? To what is weariness and uneasiness often owing? Give some illustrations of this of common occurrence.

How ought the employments of the young to be regulated? How is this preferable to the opposite system? How does nature universally authorize this reformation? How does it operate on boys? Why should it be adopted in infant schools?

What aids and co-operates with muscular activity?

Give an illustration. To what is this difference owing? What may be referable to the same principle? What is necessary to give muscular action its full play?

In what extraordinary cases has the nervous stimulus shown itself to have been beneficial? Show the different effects produced by the absence and presence of the mental stimulus in a particular case.

Show the difference in the case of the retreat of the French from Moscow. In Dr. Sparrman's incident. In other cases. In that of an engineer.

What is the story told in the Spectator? How does it apply?

Relate the anecdote of an Englishman. How does it illustrate the principle? What are the necessary deductions and reflections?

When may a walk simply for the sake of exercise be beneficial? Repeat the lines of Dr. Armstrong in favour of the principle of combining harmonious mental excitement with muscular activity.

How may the union of mental impulse and muscular action be directed in the young? In what particular case will this union fail to produce the desired effect? What is necessary in order that the union should be successful? Why?

What has been sometimes the plea for neglecting bodily exercise? In what consists its fallacy?

What effects does exercise produce upon the organs employed? What the cessation from exercise?

What is the effect of exercise taken frequently and at moderate intervals? What if resumed too often or carried too far? What if neglected?

How does sensation serve as a guide to exercise? Give the different cases.

How may rules be deduced for the promotion of the healthy development of the muscular system by exercise?

Give some illustrations of the general principle. How do these apply to the objections urged by many sedentary people? How may their inconsistency be ridiculed?

Sum up and state the three conditions on which exercise may prove salutary to the human system. Why do those who resume it only at long intervals never advance?

CHAPTER V.

What remains to be explained in this chapter with regard to muscular exercise?

How do the functions of man fit him for his condition? What is to be observed in the manner his organs are adapted to their purpose? What is to be observed with regard to the action of the muscles on the bloodvessels? Point out the muscles in the arm according to the figure. Point out and describe the *humeral* artery. The *radial* artery. The *ulnar* artery.

What is the position of the bloodvessels in the system? What is the consequence of this position? How is the circulation of the blood exemplified in this instance? What expedient is made use of in blood-letting to accelerate the flow of the blood? For what purpose is muscular action provided? To what are sedentary people subject?

Show how the connexion between muscular exercise and the circulation of the blood operates upon the whole system.

Show why the hurried breathing and quickened circulation resulting from exercise fit us to continue the exertion.

Show the reason for the benefits arising from *shampooing*.

Show why sedentary persons are habitually subject to costiveness.

What are the converse effects derived from the want of exercise?

At what times ought exercise to be taken so as to produce beneficial results?

In what state of the animal system? When does this take place? What does an opposite procedure produce? For what reason?

Why is exercise *immediately before meals* injurious? If severe or protracted? What is the rule?

Why injurious immediately *after* a heavy meal? Prove this in he case of two dogs.

What and when is the benefit of a mere stroll?

Under what circumstances are we to take precautions in regulating our diet?

Why is it injudicious to reserve the time of exercise till the close of the day?

Why should part of the forenoon be chosen? How is the power of mental application increased or diminished? What practice should be imitated?

How ought exercise to be rendered as beneficial as possible? Illustrate.

How ought *nature* to be consulted in all respects? What is the testimony of Dr. Forbes? How are stays and absence of exercise injurious to the beauty of the female figure? What is the effect of prejudice and habit? Are there any *cases* of *health* in which stays are beneficial?

What does the comparison between savage and civilized man teach us? What is the testimony of Mr. Henry Marshall? How is this testimony supported?

What singularity is to be observed in the terms of this corroboration?

What is Stevenson's testimony concerning the *Araucanian* Indians?

What is the object to be attained in the pursuit of exercise? Why is walking insufficient? What other methods should be adopted? How does nature intimate this?

How might pedestrian excursions be beneficially directed? How is this managed on Continental Europe? What is said of the ancients? Why is their practice discontinued?

What is common among the young Scotchmen? How is this custom to be appreciated? What abuse of the principle is common among youths? What are its evil effects? What are Dr. Johnson's sentiments? Give some instances. By what rule are we to be guided? What is the practice of sportsmen?

Relate in full the cases of two students of Cambridge.

Relate the case of a clerk in Edinburgh.

Relate at length the salutary effects produced by *riding*.

From what is its peculiar advantages derived?

Give the advantages and disadvantages of *dancing*.

How is the value of *gymnastic* and *callisthenic* exercises to be estimated?

What exercises may be said to be not only graceful, but beneficial? Why? What may be said of other exercises? What are they? Why are they unnatural? Why dangerous?

What is said in defence of some of them? How is the fallacy of the argument shown?

What ought to guide us in the selection of exercises for the young? What ought to be particular objects kept in view?

What may be said of *fencing*? Of the *club* exercise? Of *shuttlecock*? Of the play called the *Graces*?

What may be said of the advantages and disadvantages of *dumbbells*? What caution should be observed in the use of them?

What can be said of *reading aloud* and *recitation*? How do they operate upon the human structure? What evils and benefits does public oratory produce on the speaker? How did this operate in the case of the celebrated CUVIER? On what considerations is his recovery to be accounted for?

What are the most perfect of all exercises? To what does the ignorance of parents tend? Illustrate.

What has been the design of the preceding remarks?

Illustrate the whole by the anecdote of a young gentleman, and show in every particular case how it accords with the foregoing principles.

What order of *muscles* has been passed over, and why? What is the use of the *involuntary* muscles? Which is the chief of them? Which are the next in importance? What are excellent examples of the same class? How is the beneficence of Providence in withdrawing them from our control manifest?

What is to be observed of the different constitution of the *voluntary* and *involuntary* muscles? In what is exhibited the wisdom of the Divine arrangement? What would have been the effect of a different disposition of muscular activity?

CHAPTER VI.

How are the *bones* adapted to their purposes? What do they effect?

For what are some bones designed? What uses do they subserve in general?

In what respects is the animal frame the most wonderful of all combinations of machinery?

Why are the bones composing the skeleton so numerous? What would have been the effect of an opposite arrangement? Recount the benefits of the present system. How is the safety of this disposition manifest?

What is the fabric resulting from the combination of the bones called? What is the difference between a *natural* and an *artificial* skeleton? How many bones enter into the composition of the human skeleton? How are they connected with each other?

What are the three great divisions of the skeleton recognised by anatomists? What does the second include? What does the third comprise?

Of what does the head consist? What is the use of the scull? How and for what reason are the bones of the scull constructed?

Of what does the *trunk* consist? Point them out in the figure. How is the *spine*, *vertebral column*, or *back-bone* constructed? What is the use of the *vertebræ?* Why are they called so? What are the *cervical* vertebræ, and how many? The *dorsal?* The *lumbar?* Upon what does the base of the column rest? How are the vertebræ connected? What do they secure? Give an illustration. What prevents us from perceiving at once this to be the case?

What is the use of the *body* of the vertebræ? Of the projecting ridge behind and rugged processes at the sides? What is interposed between each of the vertebræ? What triple purpose does it answer?

What is the number of the *ribs*, and how are they attached? What are the seven uppermost called, and why? What are the five lower called, and why? What is their use? What their action?

How is the *pelvis* formed? Point it out in the figure. How may a general notion of its bones and their uses be formed?

What are the bones of the upper extremities? Point out the *scapula.* The *clavicle.* The *humerus.* The *radius.* The *ulna.* The *carpal* and *metacarpal* bones. The *phalanges.*

What is the *scapula?* How is it familiar to young ladies? What is its use? What is the *collar-bone?* What is its chief use? Why wanting in the lower animals?

How is the *humerus* adapted, and to what is it liable, and why? How are the *radius* and *ulna* connected? What is peculiar to this articulation? How is the movement of turning round the hand effected?

Of what do the lower extremities consist? Point them separately out in the figure.

How is the *thigh-bone* ariticulated? What does it thus effect? How is the *thigh-bone* compared with the *humerus?*

What is the *patella* or kneepan? What is its use? What is the *tibia?* What does its lower end form? What is the *fibula?* To what do the *tibia* and *fibula* contribute, and how do they compare with the knee?

What may be said of the *tarsal* bones? Of what importance are they to the subject?

Of what do bones consist? What are the properties of each kind?

What does the *animal* portion constitute according to Berzelius, and of what does it consist? How do the animal and earthy portions vary? In infancy? In middle life? In old age?

What is the effect of muriatic acid on the bone, and how is its *animal* constituent procured? What is the effect of fire on the bone, and how is the *earthy* constituent procured? What do you mean by the *animal* constituent? What by the *earthy* constituent?

What important purpose is served by the different proportions of the animal and earthy elements of bones? In early youth? In middle life? In old age?

What is the process of the formation of the bone? To which part do the vital properties essentially belong? Why may they be said to belong to both?

With what organs are all parts of the body provided to carry on the processes of waste and renovation? What is the use of the arteries? The exhalants? The veins? The absorbent vessels? The nerves? What may be said of the bones in these respects?

Prove the fact that the bones are provided with bloodvessels. With nerves.

Show by DUHAMEL'S experiments that the bones are provided with absorbing and exhaling vessels.

What objection may be raised against this view?

What circumstances may be satisfactorily alleged in answer to such objection?

What is the nervous condition of the bones when in health? Why? In what is the benevolence of pain manifest when they are in a fractured state? What is the habit of surgeons in order to produce the reunion of broken bones? Apply the principle.

What other advantage arises from the vitality of the bones? Exemplify this in the case of *water in the head.* To what is this power of adaptation owing?

How are the same phenomena exhibited in the bones of the chest?

How is the same principle manifest in the *diminution* of the soft contents of the osseous cavities? In the case of the brain?

Why does the adaptation of the hard to the soft parts seem improbable?

Exemplify its reality in the various stages of human existence?

By what two processes are bones expanded to suit the exigences of the several occasions? Give illustrations.

What proportion does the cartilaginous matter bear to the earthy in bones in early life and old age, and what different results does this variation effect?

What takes place in the osseous formation in some unhealthy states of the system?

What is the practical application to be made of our knowledge of the constitution of the bones? On what does their healthy condition depend?

How is the study of an organ or function often rendered incomplete? In the case of the *heart?* Of the *eye?* Of the *bones?*

What effect is produced in any part of the system if it is deprived of its natural exercise or action? Give an exemplification in the case of the large artery which supplies the arm with blood. Of a muscle. In the case of the bones. When the case is not extreme. What purpose do the bones answer, and what law must they fulfil?

What is one great requisite for the development and health of the osseous system? How must this be provided for? What is then a second requisite?

Why is this indispensable in the case of youth? What are the consequences of the non-fulfilment of this condition?

How is the wasting effect of action best illustrated? In the case of animals? What is the inference?

What is the law of the constitution in relation to this principle? When the action is momentary? When continued?

What results from a partial action of the system? How is this manifest in the muscular system?

What law, highly important in its practical consequences, regulates the active and inactive states of the animal functions? In what is the benevolence of this arrangement manifest? How is this obvious principle daily disregarded?

How does the law of exercise apply to the osseous system? What natural defects in the bones may be attributed to the neglect of exercise?

Give the testimony of Sir John Sinclair in favour of the benefits accruing to the osseous structure from the enjoyment of exercise. Give that of Delabere Blaine. Why do horses early and hard worked never arrive at their full size?

From what other causes besides inadequate exercise does defective nutrition arise? Among the poor? The rich? What are the consequences to both?

How may the relative uses of the bones and muscles be compared? How does this apply? In the case of infancy? In the diseased state called *mollities ossium?* In the case of fevers, acute diseases, and sudden fright?

When is the maturity and perfection of all organs and functions attained? Exemplify this *at large* in the case of the infant.

Of what practical use is the knowledge of this circumstance possessed? How is it often perniciously disregarded by some fond parents?

What is said of the effects of *leading-strings?*

What may be said of the indiscriminate use of *dumb-bells?*
What is said of the use of *stays* and the *inclined plane?*
What excuse is given for the tautology of this and the last chapter?

CHAPTER VII.

What is the subject of this chapter? What is necessary to be premised?

How many different kinds of blood circulate through the body? What is the property of the former? How is it distributed? What is the *aorta?* What great change does the blood undergo in its circulation through its two systems of vessels?

What two conditions are essential to the reconversion of venous into arterial blood?

How is the first condition fulfilled? How is the second?

Explain the manner in which respiration effects this reconversion. Into what do the venous ramifications terminate?

What distinction is to be observed between the pulmonary *artery* and the pulmonary *veins? See note.*

What circulations of the blood are there, and how are they carried on? What is the object of the former? Of the latter?

Why is the function of respiration of pre-eminent importance in the animal economy? What are the particular and more general meanings of the term *respiration?* What are the words *sanguification* and *aëration* used to denote?

What influence have the *quantity* and *quality* of the blood on the system? Exemplify in the case of *quantity.* In the case of *quality.* In consumption.

Why is a knowledge of the structure and functions of the lungs highly important?

How is exposure of the blood to the action of the air carried on in man and the more perfect animals? In fishes? In worms? Why is this exposure necessary?

Describe the lungs in man. How do they vary in different persons? Point out the position of the right and left lungs in the figure. Point out the large bloodvessels going to the superior extremities. The liver. What is the position of the diaphragm or midriff? How is the stomach situated? Which is the gall-bladder? What is the intestinal canal? What is its use? What do you mean by the *peristaltic* or *vermicular* motion? What does it resemble?

Of what does the substance of the lungs consist? What are the *bronchial* tubes? The *air-cells?* What is their appearance? Their size? Their internal structure? Their use? The extent of their lining membrane?

Does not the lining membrane prevent the action of the air on the blood? Prove the fact.

What bloodvessels do the lungs possess in common with other parts, and what are peculiar to themselves? What is their use?

What form the principal part of the structure of the lungs? Why are they provided with nerves?

What is pulmonary *exhalation?* How is it carried on? What is its use? How is the air which we breathe vitiated? What renders the breath offensive, and gives to rooms their sickening smell?

In what part does pulmonary *absorption* take place? How does it operate? What are sometimes its effects?

What practical advantages may we derive from the explanation of the structure and uses of the lungs? What is the *first* condition? How may this be applied to hereditary transmission of a constitutional liability to pulmonary disease?

Where may instances be adduced of these lamentable results? How might they be prevented? What course should be adopted by the young under such circumstances? For what reason?

What is the most frequent source of the more serious forms of pulmonary disease? How might medical men be useful in this case?

To what important fact has Dr. Clark drawn attention on the subject? How should this weigh with parents?

What is the *second* condition requisite to the well-being of the lungs and to the free and salutary exercise of respiration? To what may the morbid state of the lungs be frequently attributable? In the lower animals? In the manufacturing population? Among the higher classes? What is the case of butchers?

What is the *third* condition? How is this impeded? What are the consequences? What are Mr. Thackrah's calculations with respect to the relative pulmonary exhalations of males and females? To what two causes may be referred the minor quantity of the female exhalations?

What may be said of the relative harmony of the constituent parts of the animal frame? In the case of the muscular system and the function of respiration? By what other means is the same end greatly facilitated? By what else, and for what reason?

Why do the depressing passions predispose to pulmonary consumption? Upon what principle?

What effects do the depressing passions of the mind produce? The exhilarating passions? Why should such be the results of different kinds of mental emotion? What do these principles show?

What is a *fourth* essential condition? For what reason?

What does atmospheric air, when taken into the lungs, consist of? What changes has it undergone when expelled?

What simultaneous changes occur in the blood?

What two explanations are adduced to account for these changes? Which explanation is received? Upon what fact are all physiologists agreed? What inference may be deduced from it?

What estimates have been made by Sir Humphrey Davy and Dr. Menzies of the times and quantity of the human pulmonary exhalations?

What is a low estimate of the *inhalation*, and how is the vitiation of the exhaled air to be calculated?

Give illustrations of the evil effects produced by inhaling vitiated air. In a *mouse*. What is the real cause which produces death in hanging?

Exemplify the principle by the case of the 146 Englishmen shut up in the Black Hole of Calcutta in 1756.

Relate the incident which occurred in the case of Crabbe the poet.

What other instance is recorded in Walpole's Letters?

What practical inferences may be deduced from these extreme cases of atmospheric vitiation? What other instances may be adduced? What reason is there to believe that cases like these occur more frequently than is supposed?

Is it necessary to infer that the fatal results in all the above instances were produced *exclusively* by the vitiation of the air? Apply Dr. Bostock's estimate to the elucidation of the last case. What conclusion may be at any rate admissible?

What is the testimony of the most experienced medical officers of the army and navy? Of Sir George Ballingall? Of Sir John Pringle? Of Dr. Jackson?

Give another example in the case of the 4th battalion of Royals quartered in Stirling Castle.

What disease, according to Mr. Carmichael, is produced by impure air? Give his testimony in the case of the prevalence of the disease in the Dublin House of Industry.

What is one great deficiency in the education of the professional student? Give an instance of the truth of this charge. How does the case of the Professorship of Military Surgery in the University of Edinburgh become a general caution?

How has the renovation of the air served as a preventive against disease? Mention Sir Walter Scott's case. Give Dr. Joseph Clark's testimony.

What is Mr. Thackrah's testimony with regard to the first indications of pulmonary disease? How are they to be accounted for?

What is the imperceptible yet certain progress of the disease on the constitution? How is this ascertained? What is an error concerning its cause?

How is it difficult to impress some persons with a sense of these facts?

What attention may be expected to be paid to these strictures? What is the testimony of experience with regard to their truth? What important fallacy did the discussions on the Factory Bill detect?

To what should our attention be especially directed? What difficulty presents itself in persuading any rational and instructed mind that all care is superfluous? What would be the beneficial results of greater precautions? What instructive proof have we of this? Give the testimony of Sir John Sinclair. What is said of the Roman *Athletæ*? Of racehorses and gamecocks?

Why is necessity for adequate ventilation so urgent in the British manufactories? Give Dr. Clark's evidence. What other evils to the lungs attend cotton manufactories, spinning mills, and the work of many trades? Why?

How does the principle apply to our construction of houses? Of public rooms? Of bedrooms? What may be observed of bed-curtains and cow-houses?

Give an illustration in the case of the ill-constructed public rooms in Edinburgh. In what do the evils of the architecture consist? How does a knowledge of physiology thus show itself essential?

How have these remarks been verified in the lecture-rooms of Edinburgh? To what is the nuisance chiefly attributable?

How are they exemplified also in the case of the two British Houses of Parliament?

Why is the renewal of the air more particularly required in houses lighted with gas? What plan of ventilation should be adopted in them?

What may be observed in the ventilation of churches and schools? What are its effects in the close of the afternoon service?

What is said of the ventilation of churches during the winter?

What instructive incident was experienced by the author in the case of an imperfectly ventilated schoolroom?

To what reflections did his observations give rise? What confirmed him in these views? To what may the effects produced by confinement in an ill-ventilated apartment be compared? What are its chief effects according to Orfila?

Mention the case related in the note to prove the salutary effect attending the occasional relaxation of scholars and the ventilation of their schoolroom.

What other illustrative incident of bad ventilation in a church occurred to the notice of the author?

What is one of the evils of ignorance? How has this been universally manifest, time out of mind, in deficient ventilation? What has science failed to effect in one case, while it has been provident in another? In what is the inconsistency of ventilating only *hospitals* manifest? What would be the effect of making physiology a part of a *liberal* education?

What detrimental effects were occasioned by the influence of vitiated air in a *printing establishment*? What beneficial improvements were introduced into the apartments? Upon what natural principle did this benefit depend? How did it act upon the workmen? In another instance? What caution should be observed in introducing free ventilation? What diseases may be produced by extreme *draughts* of air? Give some instances.

What admirable expedient for ventilation has been adopted in the surgical wards of the Edinburgh Infirmary?

What is Mr. Perkins's invention for the warming and ventilation of houses and buildings?

How does this admirably succeed in Mr. Cadell's establishment?

How can the benefit of Mr. Perkins's apparatus be carried to any extent?

What are the chief merits of his plan? How is it safe and efficient under all circumstances? How does the attention paid by the Russians to warmth and ventilation compare with other nations?

What subject for consideration does the intimate relation between the functions of the skin and those of the lungs introduce?

What are the true sources of animal heat? Of what importance is its regular production? Why? In winter? In summer? In cholera?

What relation has the production of animal heat with the state of the respiratory functions? How is this evinced?

By what rule and in what case is animal heat the highest? How is the rule carried out in other instances?

What next condition affects the production of animal heat? Illustrate the case in depression of mind. In exhalation.

What are other important conditions? What appropriate example is mentioned by Franklin, Parry, and Richardson? How may this proposition be evinced? What phenomena may this explain?

What else produces and what obstructs the development of animal heat? How does exercise produce it?

What rule ought we to observe in attempting to increase the power of resistance to cold? How does the power of this resistance vary? What influence has the want or supply of adequate food on this resistance? Exemplify.

What influence has clothing in producing animal heat? To what is its failure in producing the desired warmth attributable? What are sometimes the effects of feather beds on animal heat? How should a feather bed be used?

What sufferings are produced by confining young people for any length of time in rooms insufficiently heated? What rules ought to be observed to afford them comfortable warmth? What plea is set up in defence of an opposite practice? Show its fallacy.

What caution should be observed in heating rooms and public halls? For what reason? What is the practice on Continental Europe?

What subject with respect to the lungs remains now to be treated?

In what respect is a judicious exercise of the lungs necessary? How should it be governed?

By what two methods may the lungs be exercised? What exercises are most serviceable when the object is their improvement?

How should these be practised when the chest is unusually weak from hereditary predisposition?

Show how habitual exercise in a hilly country has a powerful

tendency to *improve the wind* and strengthen the lungs? How was this fact experienced in the case of the author?

With what cautions is the foregoing exercise to be undertaken? In what case is it particularly advantageous?

How far may these exercises be carried with profit? What effects do they produce? What is the evidence of Jackson on the subject, and how far is it to be received?

What position of the body is unfavourable to the expansion of the lungs?

In what does *direct* exercise of the lungs consist? How far is it of value in these cases? Under what circumstances may it be highly beneficial? What *preventive* measure is recommended by Dr. Clark?

What effect have crying and laughing on the system? Why should the latter be encouraged? What is an incident before related? How does it bear on the present occasion?

What farther influence does the direct exercise of the lungs exert upon the anatomy of the human structure? Relate the whole process according to the figure. How do the other functions of the body suffer when this exercise is neglected?

In what light are we to view the practice of loud recitations in schools and of singing in infant schools? How may the efficacy of these exercises be improved?

What precautions are to be observed in the practice of direct exercise of the lungs? How is the system to be prepared for it? What inconvenience frequently occurs to young preachers from neglect of these preparations?

What is said of the illustrious CUVIER in illustration? What conditions must not be overlooked in the application of these principles?

To what other obvious rule does the same principle lead? Illustrate. In what cases ought not the lungs to be exercised? When is it difficult to convince the patient of this? Relate an instance in point.

Why should violent exercise be avoided during the active stages of cold? What apparent inconsistency is explained on this principle?.

In what stage of recovery from disease is exercise to be beneficially resumed? What is the error of parents in this respect?

Why should sudden transitions to a different state of atmosphere be avoided? By what expedient? Why?

Which is the most important time of life to a person predisposed to consumption? For what reasons? Why ought the health of the physical system to be then attended to? What mental phenomena occur during this period? How is the deficiency afterward compensated?

What course should be pursued under such circumstances? To prevent what effects?

What has been too much neglected during this period of life? What would be the results of proper care?

What evils arise to the young from their being left in entire ignorance of the structure and uses of the different organs of their own bodies?

What is the character of the age between seventeen and twenty-four? How is the accuracy of these statements incontrovertibly established? Give some results from Count Chabrol's *Statistical Researches* for the year 1819.

Give similar results for the years 1820 and 1821.

What do the above results prove, and what useful lessons do they teach? What ought the combined testimony deduced from the changes in a million of people to establish?

How is the earlier maximum of mortality in the male sex, especially in cities, to be explained? Where is the means of their destruction first learned?

What course of management may be observed with regard to those who are predisposed to consumption or weakness of chest? What is the consequence of too much attention being paid to mere intellectual education?

What work may be satisfactorily consulted with regard to consumption and scrofula?

CHAPTER VIII.

Of what is the *nervous system* composed in man and the higher order of animals? What is the subject of the present chapter?

What is the brain? Of what is it the seat and centre?

What is the structure of the brain? What are its principal divisions? What is the *dura mater?* The *cerebrum?* The *convolutions?* How are these represented in the figure? What does G G represent? What are the two *hemispheres* of the brain? What is the *falx* or *falciform process?* What is its chief purpose?

How is each *hemisphere* divided? Where is the *anterior* lobe situated? The *middle* lobe? The *posterior* lobe?

What is the *tentorium?* The *cerebellum?* What is the *pia mater?* What is its appearance when a little inflamed? Of what use is this minute subdivision?

What is the *arachnoid* membrane?

What may be observed of the *convolutions* of different brains? Of the same brain? Exemplify. What is the *medulla oblongata?* What has been considered the connexion between the brain and spinal marrow? What is the true connexion?

Describe the character and position of the *nerves* of the brain. The *olfactory* nerve. The *optic* nerve. The *motor* nerve. The *Pons Varolii.* What is the use of this? Describe the *auditory* nerve. The *pneumogastric* nerve. What is its importance and influence?

What other nerves are there, and how do they arise?

What is said of the blood of the brain and its circulation?

What is agreed upon by most physiologists with regard to the functions of the different parts of the brain? In what do they

disagree? What is the opinion of *all* physiologists and philosophers? What is the anterior lobe considered to be by a large majority? What is the brain, by nearly universal consent, considered to be the seat of?

How do many animals stand in relation to man with respect to their nervous system? What is the property of a single organ? What is the doctrine of the *Edinburgh Review* with regard to the multiplication of the nervous mass?

What does the constant relation between mental power and development of brain explain? Give an example. Another. To what laws is every mental operation subject? Give an instance. Its practical application in opposite cases. What is the state of the ignorance of teachers on the subject of physiology?

What has been said in answer to the above practical application of the organic laws? How far is this true, and yet no exception to the general statement of the case? Give the reasons.

How may the necessity for a long vacation of idleness be obviated? Give an illustration. How would absence of exertion be irksome in both cases?

How must mind and brain be distinguished? Illustrate this in the case of the eye.

How are they inseparable? Show how the mind and brain reciprocate their influences.

If the mind and brain are thus closely associated, what becomes the object of primary importance in education?

What is the FIRST condition of the healthy action of the brain, and why? Illustrate the case.

In what case of minor importance may this hereditary influence be evinced? If the defect be on the mother's side? When both parents are descended from tainted parents? Why is hereditary predisposition a more usual cause of nervous disease among the aristocratic families of the old countries?

Why is hereditary predisposition more particularly to be dreaded? How is safety to be found, and the rule to be practically applied?

What else besides hereditary predisposition exerts an influence on the mental character and health of offspring? What is the testimony of M. Esquirol? In the case of the French revolution? In one remarkable instance? In the case of James VI.? In the case of a young lady?

What is Dr. Caldwell's testimony and advice? What precautions ought to be taken? What is the evil of a contrary custom? What are the observations of the Margravine of Anspach?

What is the SECOND condition required for the health of the brain? What are the extreme effects arising from differences in the quality of the blood? Give instances of two opposite extremes.

What effects are produced by slighter variations in the quality of the blood? In what instances are these commonly evinced? Why is the operation of the principle in these cases indisputable? Why is it not real debility which produces them? What origi-

nates nervous disease and delicacy of constitution more commonly than is imagined?

Why are the beneficial results from *intermissions* in school hours to be ascribed to the same principles? *See note.*

What condition requisite for the health of the brain is implied in the preceding? How does starvation or inadequate nutrition affect the brain? What does defective nutrition often depend on? What is the frequent consequence of insufficient food among the poor?

What is the THIRD condition of health in the brain and nervous system?

How does the brain compare with other organs of the body in respect to exercise? If it be doomed to inactivity? If it be deeply exercised? If it be overtasked?

What is to be first explained?

What is the consequence of disuse in other organs already mentioned? How does the same principle apply to the brain? Why is this not surprising?

What renders solitary confinement so severe a punishment to the most daring minds? How is this also the case in continuous seclusion from society? Mention the hard position of *governesses* in families, and its effects upon them. The case of those who are cut off from social converse by any bodily infirmity. For what reason? What is the inevitable result?

How is this fact particularly observed among the deaf and blind? What is Andral's testimony to this fact? How does he depict the situation and character of the deaf and dumb? Are the deaf and dumb to be considered inferior in mind to other men? What are the cautions of Miss Harriet Martineau to her deaf fellow-sufferers?

To what conclusion may we reasonably come from the above facts? What demonstrative evidence have we of this position?

What examples of mental and nervous debility may we find in society, arising from want of objects of interest upon which to exercise the mental faculties? What are the specific effects on the tone of the brain and mind? Why does the mind shrink within itself, and centre all its exertions in home?

How is the mind called out from such a state of things? What is the effect of the change? What is the real cause of this effect?

What example may be adduced in confirmation of these views? Mention a particular instance of a young military officer.

Who are the most frequent victims of this kind of predisposition to *derangement?* From what causes? How do their opinions become affected? What is the result to the brain? Ultimately to the mind?

What diseases arise from irritability of the brain? How? In what manner is this provided? Give a common instance. Apply the principle. What other instance may be adduced?

Give an additional illustration.

What is one great evil attending the absence of some impera-

tive employment to exercise the mind and brain? To what instability and kind of indulgences does it give rise? What defence is set up for these indulgences? In what is its fallacy evident?

What is the true remedy for these evils? To what does the patient have recourse? What should be his proper resource?

From what other cause do evils arise to the brain? By what may this be exemplified?

What analogy do these phenomena bear to the brain? What is the only difference? In what particular cases has even this difference been removed and the analogy been verified? Relate the case detailed by Sir Astley Cooper. That of Dr. Caldwell.

What expedient might be adopted to invigorate the mental operations? What proof have we of this effect? What confirms it? State the case of a senator at Washington. Of a member of *the House*. Of a member of the law of Transylvania. How may the cases of Whitbread, Romilly, Castlereagh, and Canning be explained?

At what particular time of life is excessive and continued mental exertion hurtful? In what is the analogy here complete? What is the case of scrofulous and rickety children? What is the cause of their early promise and their subsequent disappointment? How should they be treated?

What guide do the necessities of the constitution advise in regard to precocious and dull children? What is the usual course? What is the consequence of the error?

What is Dr. Brigham's testimony on the subject?

To what does he ascribe the error of the *infant school* system? Where is this more especially prevalent? In what may it be exhibited?

What facts in American schools does Dr. Brigham adduce in illustration of his arguments?

What is the state of the case in Great Britain? What relation does *physical* there bear to *mental* exercise? Adduce a case in proof of the fatal results.

How has it been customary to treat the fatal effects produced by this pernicious system? What is the case mentioned by Dr. Brigham? What purpose ought it to serve? What would render *infant schools* excellent institutions? What is Wilderspin's plan? What is the state of some schools?

What is the source of much mischief in schools? Why should the occupations of the young be varied, and frequent intervals of active exercise be allowed in the open air? How does the present system fail? What other besides mental operations has the body to perform?

To what lamentable effects of excessive mental activity in young men has ignorance of the organic laws given rise?

Adduce instances from the American Annals of Education, of the evils arising from the unnatural union of sedentary with studious habits.

What better system of training has been introduced to remedy

these evils? Describe its plan. What have been the results? What is the remarkable language of the Report? What is Dr. Fellenburg's plan?

What is a common case and consequence of an excessive and continued excitement of the brain? What is the case of Sir Humphrey Davy? What were his extraordinary habits and indulgences?

To what predisposing causes are fever and death often the effect, more than the intensity of the fever itself?

Under what other form does nervous disease from excessive mental labour and exaltation of feeling sometimes show itself?

Why should moderation in mental exertion be more observed as age advances?

How does the fate of Sir Walter Scott occur as an illustration of this truth?

What takes place from excessive mental exertion where a predisposition to insanity exists? Mention the case recorded by Pinel.

In whom, according to Tissot, do disorders produced by the efforts of the mind fall the soonest? What is his reason? What was the case of Boerhaave?

What field lies open for examples in this case? Who may be adduced as an instance in addition to Davy and Scott? What reasons may be assigned? Upon what classes of persons do nervous disorders most frequently fall? What is said of Gretry? Of Weber?

What is the reason that even educated people cannot assign the real causes of their nervous diseases? Relate the case of a young Christian. With what reflections and course of conduct ought his case to be improved by ministers of the Word?

CHAPTER IX.

What is to be taken into consideration in this chapter?

What is a law of the animal economy? What is hence the rule? Give an illustration What are the worst forms of indigestion and nervous depression? What are the circumstances of the case? In whom is this fact experienced? Why are they insensible to it? How is this organic law observed in dogs and horses?

What is the practice observed by some classes of people and in the United States? How is the objection, arising from this practice, answered? When do the bad effects of indigestion show themselves? To what is the extreme prevalence of dyspeptic complaints among Americans partly owing? What is Dr. Caldwell's testimony?

What are the evils arising from studious application towards the period of night? At what separate times should the severer and lighter studies be engaged in? For what reason? To whom is this rule especially important? What was Sir W. Scott's practice?

Who may be exceptions to the general rule, and what may be observed with regard to them?

What is *periodicity*, and what is it the characteristic of? What does it hence require? What examples have we of this periodicity? What is its tendency?

What organic law is brought into operation in our acquiring readiness and forming habits? By what change is this effected? How does the organ of mind compare with the organs of motion?

What is little adverted to in mental and moral education? Why? What is necessary to induce facility of action in the organs of the mind? In what manner? How does this apply to *servants?* To reading?

How ought the principle of *repetition* to regulate the continuation of our *studies?* In schools?

How is this principle familiar to us in *physical* education? To what should it hence be applied?

How does the same principle apply in the cultivation of our *manners?* How should parents be governed in respect to their children?

How does the same principle apply to the cultivation of *morals?* Give an illustration. Another in an opposite case.

What differences arise from this source? In the case of the negro?

What is the next rule to be observed in the cultivation of the brain and mental faculties? Illustrate.

What ought not to be forgotten as to the subject of education? How is this readily admitted in the *external* senses, but altogether denied or neglected in the *internal?* In what is the inconsistency manifest?

What reformation would a general acquaintance with the laws of organization effect? In what would the merest savage surpass the philosopher? Give a full illustration.

How are we to turn to account the physical and mental organs which God has given us?

What occurred to the author after the publication of the third edition of his work? What important question was put to him, and what did it elicit?

Why is physiology first among the subjects which is important for *teachers*, as professional men, to be acquainted with?

Why is the *muscular* system an example?

Apply this principle to the exercise of a *bodily* power?

How does the same principle precisely hold for the training of the *mental* powers?

How does it apply to *moral* education?

What are the instances in which the *love of approbation* exemplifies this principle?

How might it also be exemplified in the case of our *sense of justice*, if exercised in its proper organ?

In the case of *religion?*

Why should one or several faculties not be cultivated to the exclusion of the rest?

What is the proper course to be taken to produce *moral* excellence in the young?

How does the training of the *moral* and *religious* compare with that of the *intellectual* faculties in the best directed establishments and private families, and for what reasons? What is its condition therein? How do sentiments act, and even in a stupid child? What is one of the most effectual methods of cultivating and exciting the moral feelings of children? By what considerations may this rule be enforced, or, rather, on what occasions has this rule been inconsistently violated?

With what qualifications are the preceding strictures on teachers and conducters of boarding-schools to be received?

What other delinquencies have come to the notice of the author, on the part of boarding school keepers, which have operated prejudicially to the moral training in the young?

With what feelings are these practices met in the first instance? What plea has been set up in defence of them? How is it answered?

What other immoral and disgraceful practice exists in many seminaries? Why is it so?

What excuse has been sometimes offered in justification of this practice? How is it answered?

Give some specimen of the above practice. *See note.*

What similar practice once existed between physicians and apothecaries?

To what are such delinquencies in teachers to be attributed, and how may they be remedied?

With what limitations is the above censure to be received?

What is necessary to be kept in mind with regard to the *moral* sentiments? How is *benevolence* strongly excited? How should it be ordinarily exercised? How does the cultivation of this faculty compare with the cultivation of some intellectual or physical faculties? How should the attention paid to the latter be extended to higher sentiments? What are the objects of benevolence, and what should be its extent?

What other moral principle should be cultivated? What is its nature, value, and use?

How far are these illustrations sufficient?

Why is the exclusive use of book-education as a means of conveying instruction unnatural and inefficient? How is this exemplified?

What is M. Duppa's testimony on this subject? What habit renders a man intelligent and judicious? What is the evidence of a contrary state of mind being generally prevalent? What is the reason? Why have they not the habit?

How are the *observing powers* to be directly cultivated? What is the contrary opinion?

What is therefore wanted in a system of education in harmony with the mental constitution?

What serious obstacle to entering upon the exercise here recommended presents itself? How is it often injudiciously treated? With what proper remedy should it be immediately met? How is this illustrated?

Why have the doctrines of *phrenology* not been alluded to in the preceding pages? What is the author's opinion upon that subject?

What important influence has been already noticed, and now deserves attention?

What are the phenomena and nature of the *nervous fluid* or *influence?* What is all that can be said of it? Give an illustration or two.

What effect have the changes in the quality or amount of the nervous influence on any organ? Give some instances of these changes and their effects.

What analogous to this is observable in the muscles?

When is the quality of the nervous influence the best, and for what reason? What ought to be our great aim, and why?

How do the efforts of the nervous influence vary? When is it the most grateful and efficient? From what wise arrangement of the Creator?

When is the stimulus far from beneficial? Why? What is the result?

How does over-exercise of the intellect and inactivity of the feelings effect the same? What is the case of persons so situated? What is an opposite case and its treatment?

How does the influence of the brain and sudden emotions operate upon the digestive organs? How do narcotics?

How do the mind and brain operate on the lungs and heart?

In what does the law of our constitution discover a beneficent Creator?

What is the result to it arising from shunning society and active duties? From engaging in the business and interests of life? From neglecting our faculties? What does this harmony between the moral and physical world thus induce?

By what facts is the state of the mind shown to be influential in the production and progress of disease? Give Sir John Ballingal's testimony. Vaidy's.

Of what service are the *feelings* in curative measures? What is the reason?

How is the influence of the state of mind on the health exemplified in recruits for the army? Give Mr. Marshall's testimony. How is it illustrated in France?

How has its influence been illustrated in an opposite effect? Give Sir Humphrey Davy's testimony. How do quacks profit largely by taking advantage of this principle, and how may it be improved by regular practitioners? What are Baglivi's observations? Give another remarkable instance.

How does the kind visit of a friend often alleviate the sick? What is the true reason? How far may this benefit be extended?

How does the influence of a regulated and well-educated activ-

ity in the moral and intellectual faculties on the health compare with that of active and boisterous passions? How is this illustrated by Dr. Caldwell in the case of the signers of the Declaration of Independence? In the case of mathematicians? Of poets?

From what causes does a visit to a watering-place or a journey through an interesting country tend to the healthy excitement of the bodily functions? What attention has been paid to this principle in the medical departments of the army and navy? In the exploring expeditions to the northern regions?

What important practical rule does this naturally suggest? Where are other apposite illustrations to be met with?

CHAPTER X.

What is to be considered in this chapter?

In how many different lights may bad health be regarded? What is the FIRST? What is the SECOND? What is the THIRD?

What are the practical results, if the first be the truth? If the second be true? If the third be true?

How far does the strictest observance of the moral laws and the purest devotion contribute to the preservation of health? What proof have we of this position?

How far is the second proposition tenable? How far untenable?

How far is the third view in accordance with observation and past experience?

What facts with regard to mortality among infants may be exhibited in proof of the truth of this view? State them.

How do the different rates of mortality in crowded cities and country villages equally demonstrate its truth?

How has the progress of knowledge and the increasing ascendency of reason tended to show the same truth?

How has it been shown in the case of the *smallpox?*

How in the case of ague?

How does the present condition of seamen in maritime expeditions, when compared with their former lot, show it?

Relate the case of Commodore Anson in illustration. What does it show?

What took place afterward on the voyage?

What is particularly to be observed in the above case, as corroborative of the author's views? How was the distemper, according to the testimony of the writer, considerably augmented?

What is the case of the Spanish squadron which sailed nearly at the same time? How does this compare with some late expeditions?

What case may admit of a fairer comparison with that of Anson? What wholesome precautions did Captain Cook take for the health of his men?

Show the beneficial results of these precautions to the health of his men in the course of the narrative.

How are the cases of the *Resolution* and *Adventure* to be compared with that of the *Centurion?*

What was the success of Captain Cook's admirable care and unwearied watchfulness? What is said of Lord Nelson?

How is the case of the *Fury* and *Hecla* in point?

In what particularities were all the conditions of health attended to in these Northern Expeditions?

To what three causes may the extraordinary prevalence of disease at the Penitentiary of Milbank be attributed?

How far are these causes proved by subsequent changes and inquiries?

What is Dr. Latham's testimony in the case?

What would probably have been the fate of the crews of Cook, or Ross and Parry, if they had been left to undergo the ordinary vicissitudes of life at home? To what practical reflections does this give rise?

What other case is adduced by Dr. James Johnson, which illustrates those fatal effects of ignorance, which a little knowledge in physiology would have frustrated?

What where the fatal maladies brought on, and to what were they attributable?

What else besides the lungs suffered in this case?

What would easily have prevented these disastrous results?

What beneficial effects has increased attention to the organic laws produced? In England and Wales? In London? In Manchester and Glasgow?

In France? In Austria? Russia? United States? In South America? In Paris?

What may be observed of the great disparity of results obtained in England and abroad?

How is the principle, however, established even by many of the Continental returns? What do these statements sufficiently prove?

What error has been common with regard to the simple food and hardy habits of the poor? How is the reverse actually the case? In France? In London? What is Mr. Marshall's testimony?

What important considerations does the corresponding disproportion between the rates of mortality in the different classes of society in Great Britain suggest? What principle, frequently insisted upon, does it strikingly illustrate? What does blindness to this principle produce?

What criterion would have been infallible in the angry discussions which lately took place with regard to the reality of overworking the manufacturer?

How may the visitation of cholera to the British Isles be considered the act of a beneficent Providence?

What does the comparative exemption of the wealthier classes in Great Britain from cholera sufficiently show? What human precautions tended to mitigate its ravages? How did those who regarded such visitations as the direct inflictions of a vengeful

Providence, nevertheless act as if the Creator intended the health of the race to depend on the laws of organization?

What cases are there in which many individuals suffer from nearly unavoidable causes? How do the number of these compare with those whose health has been ruined by causes capable of removal or modification? What important truth is here stated? What important remark repeated?

How far may the influence of habit, in rendering situations and causes comparatively innocuous, which were at first dangerous, operate?

How do sudden and gradual changes respectively influence the system? What is the consequence of a sudden transition from a hot to a cold climate, or *vice versa?*

What of a change from a healthy situation to one only a little less favourable? In what axiom do these facts terminate?

How ought the argument for the adaptation of the constitution to circumstances be turned?

How far have advances in physiological knowledge and practice of late years been successful or deficient? In what does the difficulty of illustration in the latter case consist?

What practice observed in the army may be adduced in illustration?

How is it physiologically irrational? What are the statements of Mr. Finlayson and Count Chabrol?

How are these results to be viewed in connexion with the laws of animal economy in time of peace? What is Mr. Marshall's testimony? What is that of COCHE?

How are these results to be viewed in time of war? How does this apply in the case of the army in Spain, according to Sir James Mac Grigor?

What is the evidence of Marshall in the case of a French army? What is the testimony of Bonaparte?

How is this circumstance illustrated in the East India service? What is Sir George Ballingal's evidence?

How does Mr. Marshall support his positions?

What is Dr. Davies's asseverations? Why should recruits not be enlisted at so early an age? What is the cause of this erroneous practice?

Why has this topic been so long dwelt upon by the author?

Why is the author compelled to pass over other practices in which public or private health is concerned?

CHAPTER XI.

What has been the design of the preceding chapters? What is the design of this? Why do this class of sufferers stand in need of attention?

What is the condition of the nervous and insane? What are the consequences of proper attention not being paid to the subject

of *insanity?* What similar treatment has the *nervous* disease met with? What prevents the correction of these evils?

What is deficient on physiological principles in the state and condition of public and private asylums? How far are they serviceable? What is said of their active moral treatment? Why is it necessary? What is hence an object of extreme importance in establishments for the insane?

Why is the importance of mental and bodily occupation not exaggerated? Yet what is the case in the majority of asylums?

What becomes indispensable in the treatment of this unhappy class of persons? From what considerations arising from our knowledge of the *muscular* structure? Of the structure of the *skin?* Of the functions of the *lungs?* Of the nature of the *mind?* What hence are the inevitable demands of the case?

By what qualifications are these strictures to be limited?

What is a deplorable mistake with regard to the *feelings* of the insane? What rarely fail in the treatment of the insane when calmly persevered in? What hence becomes of inconceivable importance? What has been the general remark with regard to keepers of asylums? What does this suggest? What maxim has become every day more evident?

How do the above observations apply to the several stages of the disease? How should these be respectively treated?

What should then be our grand aim in the construction and management of public and private asylums?

How should the means of mental and bodily exercise be planned for the insane? What would render it more pleasant, more persevered in, and more salubrious to the individual? What would this latter condition tend greatly to effect? What employment would be best adapted to produce the desired effect, and why would not walking or riding be sufficient?

What should form part of an insane establishment in order to further these views? How have such additions to the asylums for the insane proved beneficial?

What is the particular character of man as a social being? How far does disease operate upon this character? How far may this be turned to advantage in *lunatic asylums?*

How may the patients of a higher class be profitably employed? How ought the talents of the patient to be made available?

What is a great desideratum in asylums dedicated to the middle and higher classes of society? What benefits would accrue from this plan? What may be an obstacle to its adoption? Through what kind of channels might this obstacle be removed? Illustrate these remarks.

What striking analogy has Pinel observed with regard to the treatment of the insane? What are eminently useful in both situations? When are they productive of the fullest advantages?

Where is an establishment for the insane, endowed with attendants of the description desired, to be found? How has the frequent admission of visiters in some measure supplied the deficien-

cy? What is said of the *Connecticut Retreat?* Why should the deficiency be made known?

Why are the *higher classes* of lunatics, as matters now stand, the most unfortunate of all? How is the deficiency very imperfectly supplied?

What is the case of the *poorer* patients? Why are they less sensible of the change?

From what has experience shown that great benefit is derived?

Why is this subject of importance to the general reader as well as to the professional man? Why is the knowledge on this subject, when confined to medical men, productive of no good effects?

How may the justness of the author's strictures be best vindicated?

Give an illustration of the defects of the present system in the cases of the City Asylum for the Poor in Edinburgh and the West Church Charity Workhouse.

Give, as a contrast, an illustration of the Middlesex County Asylum at Hanwell. Why is it to be preferred to the excellent institutions at Perth, Dundee, and Glasgow?

In what respects does the establishment at Hanwell benefit from the superintendence of Sir William and Lady Ellis? How does Miss H. Martineau confirm the author's representations, and in what does she err? What is the real state of the case? In what condition are the two great institutions of Bethlem and St. Luke's?

What is the state of the Edinburgh Pauper Asylum?

How does the Hanwell Asylum compare with that of Edinburgh?

What is the defective state of the Edinburgh Asylum?

What is a common condition of health to the insane as well as sane? How do the institution at Hanwell and others similarly managed act in subservience to this condition?

What defects exist in many private asylums which urgently demand improvement? With regard to ventilation? Why is this a serious evil? With regard to cleanliness? With regard to occupation and employment of the mind? What injudicious course has been followed in this respect? Upon what fatal mistake is this treatment founded?

How has ESQUIROL, in his private establishment, acted in this respect? Detail at length the excellence and suitableness of all his arrangements. Why are the French more successful than the English in procuring suitable attendants? How far, according to ESQUIROL, does gaining the confidence of the lunatic patient go to his cure? What is the value of this opinion?

What is the progressive course of treatment which ESQUIROL adopts? How may the necessity of adopting influential moral active treatment be conclusively shown?

In what light are the author's strictures on the Pauper Asylum of Edinburgh to be received?

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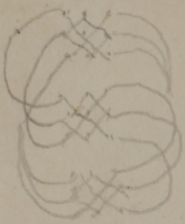

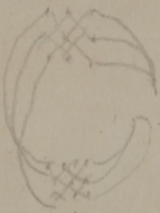

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