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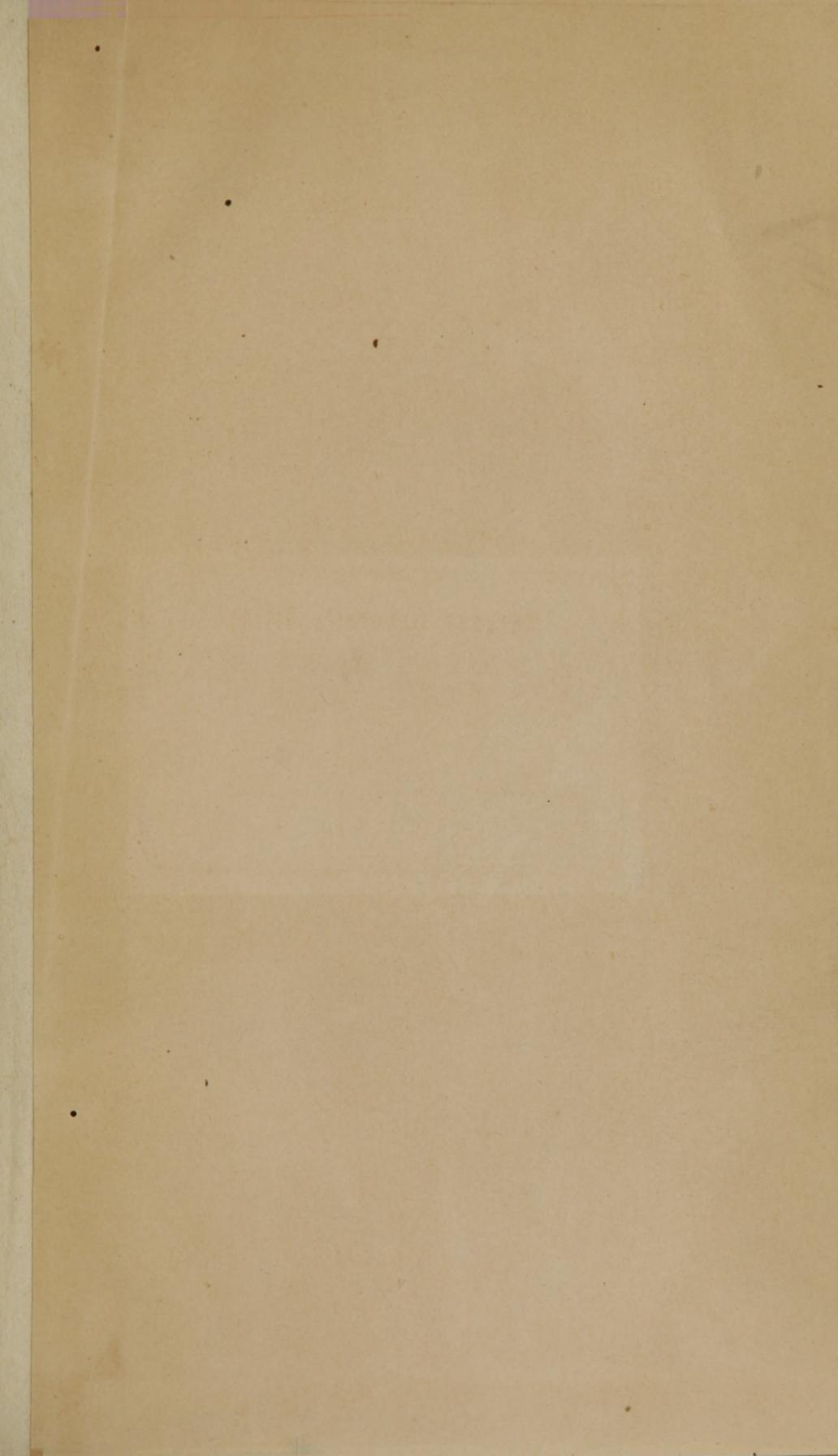
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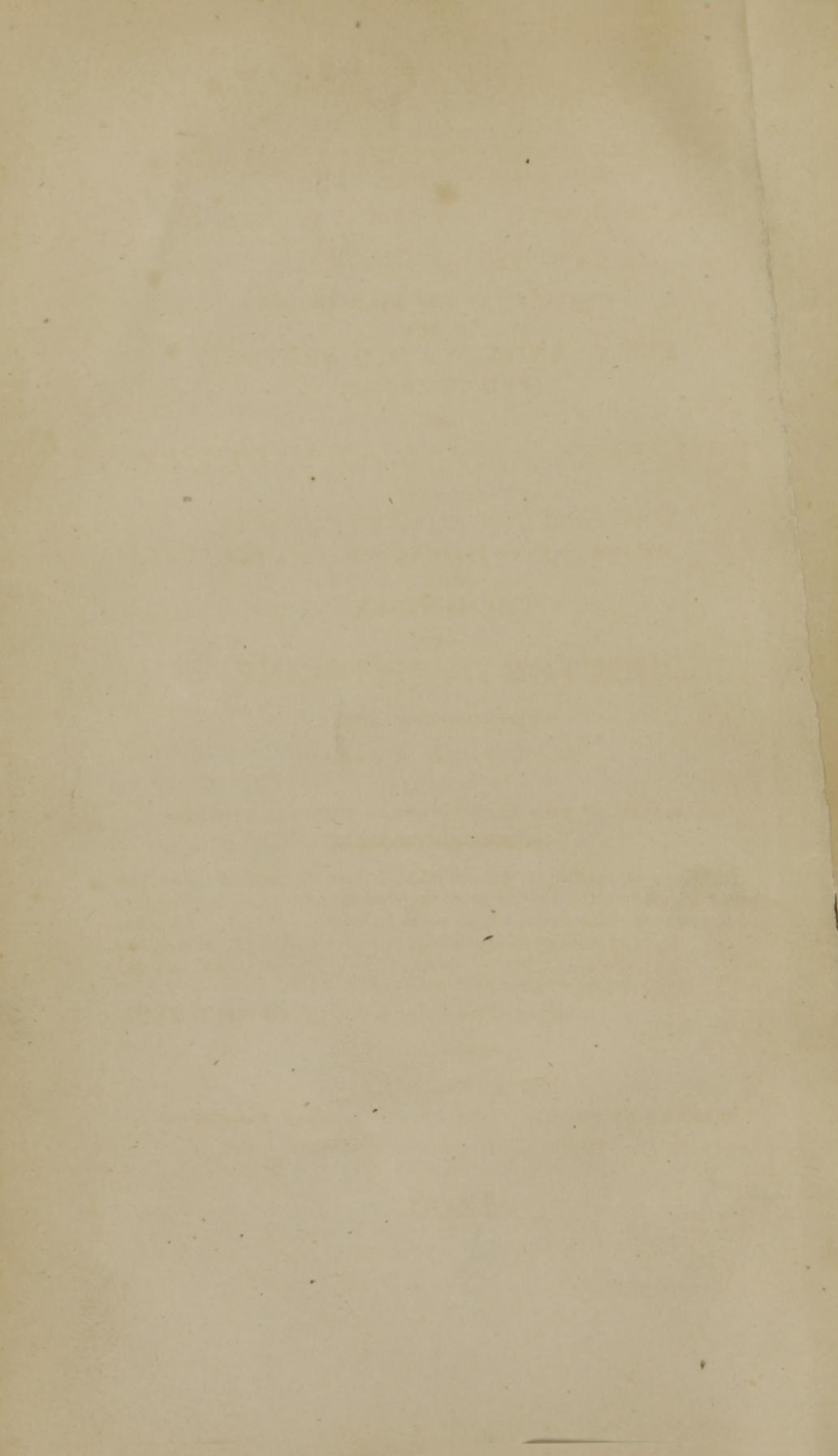
Section,

*Physiology*

No.

*18605*





AN  
INAUGURAL ESSAY,

ON  
*THE MUTUAL SUBSERVIENCIES OF THE DIFFE-  
RENT PARTS OF THE BODY,  
And the power of one part to perform the  
Function of Another.*

SUBMITTED TO THE EXAMINATION  
OF THE  
REV. J. ANDREWS, D. D. PROVOST  
(PRO TEMPORE)  
THE  
TRUSTEES & MEDICAL FACULTY  
OF THE  
UNIVERSITY OF PENNSYLVANIA,  
ON THE TWENTY-FIRST DAY OF APRIL, 1806.  
FOR  
THE DEGREE  
OF  
DOCTOR OF MEDICINE.

---

BY EDWIN L. McCALL,  
OF GEORGIA,

CHAIRMAN OF THE PHILADELPHIA MEDICAL SOCIETY.

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And the eye cannot say to the hand, I have no need of thee: nor again, the head to the feet, I have no need of you. Nay, much more those members of the body, which seem to be more feeble, are necessary, and those members of the body, which we think to be less honorable; upon these we bestow more abundant honor, and our uncomely parts have more abundant comeliness.

*Epist. Paul to Corinth. chap. xii. ver. 21. 22, 23.*

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.....  
1806.

INAUGURAL ESSAY

DR. LEMUEL KOLLOCK,

AND

DR. WILLIAM PARKER,

TRUSTEES OF THE MEDICAL FACULTY

OF THE

UNIVERSITY OF SAVANNAH (GEORGIA)

Gentlemen,

I entreat your acceptance of this little pamphlet, not on account of its merits; but from the motives which induce me to offer it: They are gratitude, affection, and respect. That you may long live to enjoy the luxury of doing good, is the ardent prayer of

Gentlemen,

Your friend and pupil,

EDWIN J. McALLAN

1808

TO  
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# CHAPTER I.

OF THE MUTUAL CONNECTION AND DEPENDENCE OF THE  
CONSTITUENTS OF THE SYSTEM.

## SECTION I.

In a physiological point of view, the human body has been justly compared to a circle, for so intimate is the connexion of the different parts with each other, that the functions and attributes of no one of them can be explained abstractedly from the rest.

It yet remains a disputed point whether the heart be formed previously to the brain, or the brain to the heart? The probability is, that they are both evolved at the same time, and the microscopical observations of Spallanzani corroborate this opinion.

The brain is a mere blank without the organs of sense, the organs of sense cease to be so, the moment their connexion with the brain is destroyed. The alternate contractions and dilatations of the heart and arteries owe their existence to the influence of the brain; and the brain on the other hand collapses, as soon as a certain tension of the carotids and vertebrals is taken off. The heart and arteries are stimulated to contract by the blood

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brought by the veins. As every pulsation of the arteries dissipates more or less of this vital fluid, which exclusively possesses the power of exciting equable contractions; the whole mass would soon be expended, in repairing the waste and adding to the bulk of the body, were there not in the secretions a contrivance for keeping up the due quantity. Part of these is restored; the uses to which the arteries apply a large proportion of the blood, unfit such parts to be returned, and they are therefore expelled from the body in the form of perspiration, catamenia, urine, and cystic bile.

THE arteries sent to the stomach appropriate a part of the blood which they receive from the heart to the formation of gastric juice, which dissolving the aliment, fits it to be acted upon by the absorbents of the intestines, which convert it into chyle. The pulsation of the neighbouring arteries and the contraction of muscles, urge forward chyle to the great reservoir, the thoracic duct, by which it is discharged guttatim into the left subclavian vein, where mixing with the blood, it gradually assumes the nature of blood, by an assimilating process peculiar to that part of the animal body. Thus the blood vessels, absorbents and blood, are as subservient to each other, as the brain, organs of sense and heart.

HERE to a superficial observer the circle would seem to be interrupted, but a nearer view will only confirm the principle of mutual dependence and subserviency more strongly. In vain would the gastric juice be capable of dissolving aliment: in vain would the jaws be capable of masticating: they must be supplied with materials to act upon. Here the labor of the muscles (whose locomotive power depends upon the particular manner of their attachment to the bones, and upon their connection with the brain) commences. The mind, seated in the brain, directs their exertions. Thus the natural structure of man, proves a priori, that he was "born to live by the sweat of his brow."

THE bones constitute no inconsiderable share of this mutually dependant machine. They give form to the body, and their shape and connexion admirably fit them to be acted upon and moved by the muscles. In return for the support and strength which they give to the body, they receive protection and nourishment. They also receive life, which enables them to resist those tendencies to which their chemical constituents would otherwise subject them.

THE skin forms for the whole a covering, compact, strong, and pliable. Its exposed situation subjects it to a thousand mechanical injuries, but the arteries, the blood, and the

nerves, which ramify and circulate through it, in return for the protection which they receive, give it life, and are always at hand to repair its injuries and supply its losses.

THUS the circle appears complete. The actions of the economy are not performed without an expenditure of the materials which compose it. Parts are formed for the purpose of procuring, others for acting upon, materials, by which the waste is repaired. The first are very intimately connected with the brain. Vain would be the contractions of a muscle, if they were not directed by the mind, and equally vain would be the efforts of the mind, if muscles were not ready to obey its mandates.

A mutual subserviency pervades all nature. The death and decay of one vegetable furnishes life and nourishment to others: the air contaminated by the respiration of animals, becomes the food of vegetables, which in return, leave the pure air for the animal to reinspire.

## SECTION II.

### *Of the mutability of the actions of Secretory Vessels.*

It is foreign both to my design, and to the object of this essay to detail the various hypotheses, which have in turn, been agitated,

adopted, and laid aside by physiologists. The following general remarks may suffice.

1st. The blood is the source of all the secretions, except that of chyle, which is formed from the solution of aliment in the gastric fluid.

2nd. They are performed by the arteries, with the exception of the bile, and the chyle; the former being elaborated by the vena portarum, and the latter by the absorbents.\*

3rd. Secretions are divided into I. Such as reenter the mass of circulating fluids, after serving some useful purpose, such for example, as saliva, gastric and pancreatic juices, synovia, fat and hepatic bile. II. Such as are thrown out of the body after having served some useful purpose; such as the cystic bile, liquor amnii, cerumen, &c. and lastly, such as are rejected as totally excrementitious, as urine, perpirable matter, catamenia and pus of diseased ulcers.

SECRETION, like many other processes of the animal economy, is veiled in impenetrable

\* Doctor Boerhaave after referring to Sylvius, Steno, Wharton, De Graaf, Malpighi, &c. for discoveries concerning glands, has the following suggestion by way of quere. "are there not more secretory organs than glands, as lacteals, vasa exhalentia, &c.?" Acad. Lect. vol. 2. p. 209. Thus it appears, that this opinion, claimed by the moderns, originated with, and appeared not improbable, even to the circum-spect and judicious author above mentioned.

darkness. It belongs exclusively to living bodies, is not confined to animals, and is perhaps, the most important of their functions. Their life and growth depend upon it.

The phenomena of life are so much influenced by agents external to the body, that life itself has been said to depend solely upon the presence of stimuli. These agents, varying in their nature, and the force of their impressions, we are prepared to expect a corresponding variety in the functions which the different organs of the body perform. Secretion partakes with other functions in the changes wrought by them. They all act, 1st upon the fluids passing through the secretory vessel; and secondly, upon the secretory vessels themselves. Consequently, the secretion of any gland, to be uniformly alike, must have the same species of fluid to act upon, and the same state of vessel.

As the blood appears to be passive, in general, the varieties which occur in the secretion of a gland, are attributable to a difference in the action of its vessels, and not to an alteration in the blood; but I shall not contend that the blood is never concerned in producing these changes. In gonorrhoea, we have no reason to suppose, that the blood takes any active part in the vitiated and contagious fluid poured into the urethra; but in scurvy, natural small pox, measles and hydrophobia, I contend that there is a change in the blood.

THE power possessed by the vessels, of effecting changes, by their action upon the blood, will be clear to us on the first view of what goes on in a secreting surface, where the structure is simple, and the phenomena within the cognizance of our senses. Here we see an artery bearing red blood to a certain extent; but in an instant the fluid ceases to be blood, being transformed into a secretion, and now contains substances which neither the glasses of the optician, nor the most delicate test of the chemist, could detect the instant before. The phenomena of secretion then, prove the almost incredible power, which an apparently simple tube possesses, of effecting a total and complete change in the appearances and properties of the blood. Although this interesting function, in the present limited state of our knowledge, cannot be satisfactorily explained, we must admit the fact.

THE secretories then, like every other moving fibre in the animal economy, are subject to variations in their actions. What the specific nature of these variations is, or by what immediate causes induced, no one has yet been fortunate enough to discover; but I infer that they do so vary, from changes so obvious in the fluid secreted by the same vessels at different times. These shall be enumerated in the order they have been mentioned.

I. SALIVA. This fluid, when the salivary glands labour under no unusual irri-

tation, is insipid, inodorous, and mild; but if they be stimulated by mercury, as in ptyalism, it becomes a stinking slime, endowed with deleterious properties. In the experiments of Dr. Boerhaave, \* it proved fatal to dogs and other animals. Insects are also killed by it under similar circumstances.† In Rabies Canina it becomes the source of the most dreadful of diseases.

2. **GASTRIC JUICE.** This fluid is poured into the stomach for purposes which I need not repeat. When the powers of the stomach are over rated, as by the glutton, the epicure and the dram drinker, the gastric arteries cease to pour out a salutary fluid; but instead thereof, an acid and fermentable saburra. The aliment remaining long in a membranous bag, subjected to 96 degrees of heat, its chemical tendencies not restrained by a dissolving fluid; ferments, and produces a train of the most distressing symptoms—flatulency, colic, acid eructations, &c.

3. **PANCREATIC JUICE.** This fluid does not often come under our cognizance; but the immense quantity poured out under certain circumstances of the system, gives us reason to believe, that the pancreas like every other secreting organ, labouring under preternatural stimuli, pours out a fluid different from what it does in health. Do those enervating

\* Acad Lect. vol. 1 page 141. † Med. Rep. vol. 4 page 427.

diarrhoeas, which come on during a mercurial course, proceed from the inordinate action of the pancreas?

4. **SYNOVIA.** The synovial glands suffer changes in their actions, as appears in the crackling noise heard in the movements of the joints in aged people, and in the profuse and wasting discharge which they make when a wound penetrates a joint—also in those “loose cartilaginous substances” as they are called, formed there constituting a disease, which the knife or the bandage only, can relieve or cure; the former is used by every surgeon, the latter was proposed by Mr. Hey.\*

5. **FAT.** The fat is properly included in the number of those secretions which reenter the circulation after serving an useful purpose. It forms a warm covering to the muscles, “fills up vacuities, and gives the limbs that soft contour and elegant form represented in the figure of a woman.” It shields the nerves from the too acute sensations, to which, without this protection, they would be exposed. But it is not merely for ornament and beauty, or for obtunding the keenness of impressions on the “branches of the nervous tree,” that the fat is secreted. The Bear, the Dormouse, the Rattle Snake, and other animals, go into winter quarters

with their membranes loaded with this nutritious fluid ; but come out in the spring, lank and emaciated. “ A corpulent man, suddenly restrained in diet, becomes visibly thinner in a short space of time: the size and weight of the body diminishes by the absorption of fat, which supplies the deficiency of aliment. It may be considered as a *corps de reserve*, by means of which, nature always finds materials to supply daily consumption, notwithstanding the diminution of food.”\* This secretion is liable to changes, becoming gelatinous in leucophlegmatia ; and is found to a morbid excess in polysarcia.

6. HEPATIC BILE . This, altho' one of the most important, is like other secretions liable to changes, from corresponding changes in the actions of the liver. These changes were long supposed to be the cause of most diseases of warm climates ; but they are now with more propriety, considered as the effect of impressions on the liver, either direct, or thro' the intervention of the mind. To the late Dr. George Gatterer, a learned German physician, who resided some time in Georgia, I am indebted for the following very interesting fact. A near relation of his, an uncle, returned to Germany from the East Indies with a fistulous ulcer in the right side, communicating with the liver, the remains of the liver disease. Yellow bile ordinarily distilled from the orifice ;

\* Richerand's Physiology.

but whenever he became angry, the colour instantly changed to green. He being of an irascible disposition, his friends had many opportunities of observing the fact. A change in the action of the liver is further shewn, by the acrimony, and irritating quality, which the bile manifests in cholera morbus. This state of the liver is temporary, and is, I think, corroborative of the very ingenious suggestion of Professor Rush, who, along with other very important uses of the liver, considers it "a waste gate of excessive impressions."\*

*II. Mutability of the actions of vessels pouring out Fluids, which, after serving useful purposes, are thrown out of the Body.*

1. CYSTIC BILE. What was said when speaking of the liver, renders it superfluous to go into further details.

2. LIQUOR AMNII. Doctor Monro, in his learned and ingenious essay, on the Nutrition of the Fœtus, † in which he contends for its being nourished exclusively by the placenta, takes notice of the liquor amnii being sometimes so acrid or vitiated, as to be totally unfit for affording nourishment to a young and tender Fœtus. May not a morbid state of ~~the~~ the vessels which secrete this fluid be sometimes the cause of still born children?

\* Rush's MSS. Lect. † Med. Ess. vol. 2. page 159.

3. CERUMEN. In the healthy state of the meatus auditorius, this secretion is unctuous, bitter, and adequate to all the purposes it was designed to answer; but from constitutional or local diseased action, it is so changed, as to become, occasionally, a cause of deafness.

### *III. Mutability of the action of vessels, which pour out excrementitious Fluids.*

1. URINE. This fluid occupied a high station during the reign of the humoral pathology. It was supposed to throw great light upon the state of the blood, to furnish the most unerring diagnostics, and to point out the most certain indications of cure; in consequence of which, it was particularly attended to, and its various morbid appearances were recorded with a fastidious care by the older authors.

Every one is familiar with the different colours which it assumes in different periods of life, in different seasons of the year, and at different times of the day. Its chemical properties are no less diversified; being saccharine in diabetes mellitus; earthy in calculous diatheses; and insipid in diabetes insipidus. Passions of the mind influence it greatly. It is pale in a paroxysm of fear,\* and high coloured

\* I visit an hypochondriacal patient who makes yellow urine for the present; but upon hearing some disagreeable news, a sudden constriction follows in the kidneys, and they only secrete a thin pelucid water.

in anger. Diseases produce an endless variety in its properties. It is black in some malignant fevers; turbid during the paroxysm of an hectic; pale in the intermissions; and deposits clouds of all colours in almost every disease which "man is heir to."

2. PERSPIRATION. In health, when proper libations are practiced, this excrementious fluid possesses scarce any odour; but in certain states of the system, it becomes ammoniacal, acid; bitter; fœtid; urinous.

3. CATAMENIA. The diseases from irregularity in the actions of the vessels of the uterus are so numerous, that Hippocrates said "all diseases of women may be produced by their suppression or retention, and they may be all cured by bringing on the discharge again." Those alarming hæmorrhagies which take place on some occasions, and the suspension of the action of the uterine vessels on others, sufficiently establish the mutability of their actions. There is an intimate connection between the catamenia and conception:—few women conceive who are obstructed. There are others who being neither malformed, nor suffering any apparent menstrual derangement, in the same unhappy situation. May not this oftentimes arise from a morbid state of action in the catamenial arteries, although the *appearance* of the discharge, has not been *observably* morbid? And might not a salivation, or other revolutionary reme-

dies change this, as it does so many other morbid actions of the system?

4. Pus. Every Surgeon is well aware of the changes which take place in the secretion of an ulcer; the colour, consistence, smell, &c. affording him the principal guide in his treatment of them. A sore which appears to be going on rapidly in the act of restoration, will, in consequence of a full meal, too much exercise, or careless dressing, cease to pour out good thick white pus, and secrete a fœtid, acrid, and corrosive ichor.

I might enumerate a thousand examples, of the mutability of the action of secretory vessels, and of corresponding changes in the fluids they pour out; but it would be needless to multiply facts in support of a principle, which all will admit, upon the slightest reflection. Where the secretions are morbid, if the principle be correct, we are at no loss where to direct our remedies, viz. to the secreting organ. The return to health, is in many instances spontaneous; as in vaccine and ptyalism. In others, we must have recourse to local applications. In others again, we have no resource, but in constitutional remedies, as in diabetes; and in some, no art hitherto discovered, has effected a salutary change in the action, as in genuine cancer, in which case, the parts labouring under the morbid action must be extirpated.

## SECTION III.

*Of the relations of the different secretions  
to each other.*

IN warm weather, the quantity of perspiration is great, that of urine small:—the very reverse obtains in cold weather. This is a fact familiar to all. Every practitioner knows, that it is more difficult to excite diuresis, when the skin is kept warm and moist, than when cool air is admitted to the body of his patient. Thus it appears, that there is a reciprocity of actions between the skin and kidneys. The same thing obtains in every other secretion.

If the saliva be lavishly thrown away, the secretion of gastric juice is increased, and the gastric vessels, like every other part of the body acting inordinately, become weak, in consequence of which, the fluid they pour out, is not only increased in quantity, but essentially changed in quality. The debility of the stomach, which succeeds a prodigal waste of saliva, is produced by the preternatural exertion which it makes to subserve the place of the saliva.

A check to the discharge by the skin, not only favours an increase of that by the kidneys; but that by the bowels. “The Duke of Ferrara was affected with an obstinate cos-

tiveness, for which medicines were given internally; but in vain. His physician at length ordered him to rise from bed, and walk upon a cold marble pavement. This had the desired effect.”\* The preternatural action of the perspiratory vessels, being reduced, the healthy action of the fibres of the intestines was restored. What physician is there, who does not consider a moist, warm skin, as a favourable symptom in Diarrhœa, Dysentery, &c.? Hufeland builds a theory of dysentery upon the reciprocity of actions between the skin and abdominal viscera. “The long continued action of heat, increases the action of the superficial vessels, and augments the flow of fluids into them; in the same proportion, it exhausts the internal parts, and weakens the organs of digestion; by being continued, it acts upon the constituents of our body, causing new combinations and evolutions of stimulating and acrid matters, particularly in the perspirable matter and bile, and gives them a tendency to the surface. In this state is the body when cold and moisture are applied; the habitually increased action of the skin is suddenly suppressed, and reflected upon the intestines, from natural consent of parts, and their previous debility. The acrid matter of perspiration is now thrown back upon them, and the consequence is cholera, or dysentery, as the upper or lower part of the intestines, is affected.”

\* Barton's Mss. Lect.

The truth of the principle is further shewn, by the success which attends the practice of salivating in hepatitis; the stimulus of mercury upon the salivary glands exciting such a profuse secretion in them, that the liver does not pour out pus. In the chronic inflammation, which affects the thoracic and abdominal viscera, a serous fluid is secreted; constituting hydrothorax and ascites. A paucity of urine always attends in these cases; but if the kidneys can be excited to pour out their due quantity, the disease is cured, so far as it depends upon the presence of a fluid in either of those cavities. Again: if the vessels of the intestines act preternaturally, and pour out an increased quantity of fluids, and we can excite a free and permanent sweat, we are not very apprehensive of the event of the case.

Thus it appears, that where one secretion is increased, others are proportionably diminished. When, from organic affection, or the pressure of neighbouring parts, the action of a secretory vessel is diminished, an increase of other secretions takes place. The subservience of the different parts of the body to each other will appear still more strongly, when we come to the consideration of that interesting phenomenon, of *one part performing completely the function of another*, to which I now hasten.

## SECTION IV.

Having shewn that the action of a secretory vessel is not immutable; that there is a reciprocal connexion of the secretory organs as regards the quantity of fluid elaborated by each; I shall next endeavour to make it appear, That the suspended action, or the destruction, of a secretory gland, is not necessarily followed by a cessation in the appearance of the fluid which such gland had poured out. Thus, if the action of the kidneys be suspended, other parts, are capable of secreting urine.

1. URINE. The kidneys are the proper organs for secreting urine. We have seen that they do not always secrete the same kind of urine. In diabetes mellitus they do not secrete urine at all; but a fluid, possessing sensible and chemical properties, as widely different as alkohol is from water. The particular nature of the remote causes, and their *modus operandi*, by which such alterations in the actions of the secretory vessels, are effected, will probably remain in obscurity, until our knowledge of this interesting function shall be more extensive. I shall therefore leave this part of the subject untouched.

In attributing the secretion of urine to other parts than the kidneys, I shall endeavour to shew, that the opinion of the ingenious Dr.

Darwin, concerning the retrograde action of the absorbents, is unfounded; and as the celebrated case of Lucy Foster, which is clearly and amply detailed by Dr. Senter, in the "Transactions of the College of Physicians of Philadelphia." is well calculated to impose a belief, that such a power is possessed by those vessels, I shall direct my observations principally to that case. The two following, are precisely analogous to the Doctors case. They being short, I shall give them in full; but the length of the other, forbids the insertion of it.

*Case 1.* "A Franciscan nun, of a thin and delicate habit of body, and who had long been subject to hysterical complaints, was attacked with pains, spasms, and swellings of the abdomen, to which succeeded a violent and alarming suppression of urine; soon after this, she felt a pain which she described as ascending from the lower part of the abdomen to her stomach, and she vomited up a fluid, which without any difficulty, was known to be urine. This vomiting continued 40 days, during which time, the patient voided no urine by the usual channel, unless the surgeon drew it off with the catheter, and even then, the quantity scarce amounted to an ounce a day. At the end of 40 days the urine resumed its natural course, and in a day or two, the patient found herself perfectly recovered: but the vomiting of urine returned, and at the end of 27 days, the patient

complained of very acute pains about the region of the pubis. The surgeon was desirous of relieving her by means of the catheter; but there was such a contraction of the urethra, that he found it impossible to introduce even a probe into the bladder. The vomiting of urine has continued, and what is remarkable, there is no appearance of food mixed with it, even when the vomiting takes place soon after meals.”\*

*Case 2.* “Mr. Lemery is acquainted with a Monk, who, for about 8 years, has been subject to a periodical vomiting, the fits of which, are as regular as those of a quartan ague. Five hours or thereabouts, before the vomiting begins, he complains of violent pains in the kidneys. The vomiting continues, with intervals, four or five hours. What he vomits is of a dirty red colour. It is almost entirely water; but has a strong urinous smell, and the patient has no doubt of its being really urine, as he eats but very little, and drinks more than the usual portion of a Monk. He drinks only wine, the colour of which agrees with that of the fluid which he vomits. A few hours after the vomiting he finds himself well and remains so till the next fit.”

The following are the observations of Miraldi upon the first of these cases. “This singular case would lead one to think, that

\* Mem. Acad. Royale des sciences 1715, pag. 12.

there is an immediate, though hitherto undiscovered communication, between the stomach and the urinary bladder; but Maragoni and the celebrated Lancisi are of a different opinion; they both of them think, that in cases of this kind, a suppression of urine takes place in the kidneys, that is to say, that the kidneys cease to extract this fluid from the blood, and in their stead, the glands of the stomach perform this function." "It is a known fact that in nephritic pains, which are always occasioned by obstructions of the kidneys, the patients are subject to frequent vomiting, and that what they bring up smells much of urine."\*

In the case of Lucy Foster, Dr. Senter did not give his opinion, decidedly, whether the urine got to the stomach, or lower part of the intestinal canal, by "a direct though hitherto undiscovered communication" or, by a "retrograde action of the absorbents." He seemed rather inclined to adopt the latter. If there be any choice in erroneous opinions, he inclined to the best: for no anatomist pretends ever to have seen this communication. To say that the urine *transuded*, is contrary to every received principle in physiology. There is no such thing as transudation in the living human body. Therefore, the cases are not explicable, either upon the notion of a direct communication, or that of transudation. The

\* Mem. Acad. Royale des sciences 1722,

following observations upon the doctrine of retrograde action of the absorbents, are intended to shew, that the phenomena are equally inexplicable on that principle.

Wherever absorbents have been seen, they were uniformly observed to be valvular. These valves are more numerous in the absorbents than in the veins; from four to seven being found in the space of an inch. They differ from the veins, in having valves in the viscera and great cavities, as well as in the extremities. This valvular structure is for purely mechanical purposes. The valves, both of the lymphatics and veins, resist the passage of fluids, in a retrograde course, as strongly in the dead as in the living body. They are so placed, that they connive at the passage of chyle and lymph, in one direction only, viz. towards the thoracic duct. They are so strong, that the sides of the vessel give way before they will yield. The absorbents possess no inherent power of propelling their contents towards the thoracic duct;—if they did, there is no necessity for valves. This circumstance proves, that they depend upon external forces for the propulsion of their contents. These are, the pulsations and contractions of neighbouring arteries and muscles, which, pressing them laterally, give their contents a tendency in every direction; but the valves and sides of the vessel, op-

posing them on all sides but towards the thoracic duct, they of necessity go in that direction. A valvular structure is essential to the passage of fluids through the lymphatics; they have no *vis a tergo* as the arteries and veins. Their flaccidity renders it impossible for them to act upon the principle of capillary attraction; because capillary tubes must be rigid: their diameter must not exceed one tenth of an inch, and they take up fluids indiscriminately; but so delicate is the structure of these vessels, that it is difficult to perceive them. They collapse from their flaccidity; I have seen them on the liver one-sixth, and the thoracic duct is sometimes half an inch in diameter; and they refuse to take up any fluid which they cannot convert into chyle. Thus it appears, that the very mechanical structure of an absorbent, proves, that it is capable of carrying its contents only in one direction, viz. towards the thoracic duct.

The absorbents are woven into a net work over every part of the body, and they are so numerous that Cruickshank says "he can as easily conceive a part to be without arteries as without absorbents." This network, which resembles the anastomoses of veins, may be thought to admit of the passage of fluids in other directions than towards the thoracic duct, and thus, after urine has been absorbed from the bladder, it may be conveyed to the branches spread upon the surface of the sto-

mach and rectum. To this I answer, that altho' there are anastomosing branches in the venous system, it does not follow that there shall be a retrograde course to the blood; because, at every such branch, there is a valve which prevents it. So in the absorbent, every anastomosis is as carefully guarded by a valve, as any part of the trunk, and which gives the lymph the same course as the valves in any other part of the vessel. Therefore, so long as the valves continue to perform their office, a retrograde course of the fluids cannot take place.

Again, admitting there were no valves, or that they ceased to perform their function, you gain nothing; because, the lateral pressure would force the fluid back into the bladder, as fast as it is taken up. Admit that part is sent forwards in the course of the vessel; would it not be diffused in an irregular manner throughout the body, and every part of the system where the valvular structure was wanting, receive a portion of the fluid? To say, that those vessels, which lead from the bladder to the stomach and rectum only, are divested of valves, is entirely hypothetical. It is a *petitio principii*, which cannot be admitted. The doctrine of a retrograde action of the absorbents, is therefore, repugnant to anatomy; that polar star from which the physiologist should never take his eye; that clue, which

he should always hold in his hand, when he ventures to walk in the labyrinth of the human body.

But there are yet other objections to the explanation upon the notion of retrograde action. I deny that the urine which came from the stomach, was that which had been in the bladder: in doing which, I restore to the absorbents the consequence, which the making of them dependant upon lateral pressure seemed to impugn.

The absorbents possess the power of converting to one uniform fluid, the various substances presented to their orifices, or subjected to the action of their sides. The arteries convert blood into a variety of different substances; bone, muscle, cartilage, tendon, &c. and into saliva, gastric juice, bile, &c. No less power do the lymphatics possess. They reconvert those very bones, muscles, &c. and bile, gastric juice, &c. into chyle, or lymph. The most delicious luxuries which decorate the table of the epicure, and the coarse and homely fare of the rustic peasant, are converted into the same simple chyle. They recognize no distinction of food; and every thing which refuses to yield to their equalizing influence, is rejected. The experiments of the courageous Fontana, render it probable, that even the venom of the viper, is con-

vertible into chyle. Such then is the power of the absorbents over aliments.

The hardest and most refractory parts of our body, are continually undergoing changes; bone, muscle, cartilage, &c. are absorbed, also, the pus of ulcers: and this last, from a limited view of the subject, was supposed to be the cause of hectic fever. The urine too, is often taken up by them when the bladder is distended.\* Yet, who ever saw boney matter, tendon, cartilage, &c. in the chyle? Who ever saw them in the blood? Who ever saw any of the secretions in the blood? I conclude therefore, that the urine like other secretions, like bone, &c. is converted chyle, and reconverted into blood, and as such, goes to other secretory vessels, where it undergoes those changes, which they are disposed to effect.

Upon the whole then, I give it as my humble opinion, that as there could be no transmission of urine directly from the bladder to the stomach, and taking into consideration the mutability of the actions of secretory vessels, and the power of the arteries, to convert blood into fluids essentially different: *that the arteries of the stomach, took on an action, by which they converted blood into urine.* Conse-

\* "I have had the strongest calls to make water, and felt that the bladder was full; but not having it in my power to quit the company, the symptoms in some little time after have gone off: in an hour or two after, on attemptning to make water, I found that the bladder contained little or none."

Cruikshank on the absorb. page 119.

quently, the destruction or suspension, of the proper action of a secretory organ, is not necessarily followed by the absence of the fluid ordinarily poured out by such organ.

2. CATAMENIA. The uterus is the proper organ for secreting the catamenia. There is no part of the body which has not, at some time or another, afforded an outlet to the menses. "A certain maid has lived for these three years past in the hospital of Amsterdam, (1724) who is every month subject to a sweating of blood from the head, which is so extraordinary a spectacle, that there are a thousand men living who have come thither for the sight."\* Hippocrates pronounces, that in those who have a suppression of the menses, and a distension of the breasts, the blood takes its course to the head, and occasions madness. He observes likewise, that those who have a spitting of blood, from a retention of the menses, are cured by a return of that flux. A case of this kind came under my own observation. A negro girl, belonging to William Barnard, Esq. of Wilmington island, Georgia, aged 15 years; accustomed to domestic labour; of robust constitution, until several months before I saw her, had been regular. A short time previous to a period, she was trodden upon by a heavy man, whilst sleeping. Slight inflammatory symptoms supervened, which soon

\* Boerh. Acad. Lect. vol. 5. page 115.

subsided, leaving a sense of weight and oppression of the breast; but unattended with cough. She continued in this situation until the recurrence of her period, when her sufferings were aggravated by sensations of fullness and distension; accompanied with redness of the eyes. A discharge of blood now came on from the lungs; accompanied by a slight cough, which continued three or four days, and then ceased, together with her other symptoms, and she continued apparently well until another month elapsed, when the same train of symptoms returned, which terminated in the same way. Such was the situation of the patient when she was prescribed for. The remedies were directed to the uterus, with the view of restoring the discharge to its natural outlet. These remedies succeeded, and as soon as the uterine vessels resumed their action, the discharge from the lungs ceased, together with every other morbid symptom. This case occurred in the year 1804, and first suggested to me, the possibility of one part of the body performing the function of another. In the month of January 1805, I stated it to the Medical Society, and made use of it, in conjunction with other facts, to prove that such a principle did exist in the animal economy.

Dr. Boerhaave,\* states a similar case, "I remember to have seen such an Hæmop-

\* Acad. Lect. vol. 5. page 118.

toe which became habitual, florid blood being every month spit up with a slight cough, without any apparent damage to the patients health." "I have sometimes" says he "known them discharged by a vomiting of blood, sometimes by a Diarrhoea or sweat, and sometimes even from the internal angles of the eyes. In all these cases, the discharge is the same florid blood, which will burst forth in any part of the body, when the vessels of that part *acquire a like disposition to those of the uterus*, for as soon as any part of the body becomes more dilatable than the uterus, the blood will flow into it, and discharge itself from that part, as it did before from the uterus."\*

Boerhaave was unacquainted with those observations and experiments which prove, that the catamenia, are as essentially different from blood, as any other secretion of the body. The explanation which he gives, of its appearing in other parts of the body, in consequence of that part becoming "more dilatable," comports with the mechanical doctrines which he taught.†

Hippocrates‡ tells us "that all diseases may arise from the menses, and may likewise be

\* Acad. Lect. vol. 5. page 118.

† Saunders was the first who considered the catamenia as a secretion. The Experiments of Hunter prove how correct the opinion is. This fluid differs from blood, 1. In having no red globules. 2. It does not coagulate. &c.

‡ De Morbus Mulierum, cited by Boerhave.

cured by them. That if a woman who has had a phrenzy, should be restored to her menstrual flux, she will be certainly freed from her disorder. Thus, obstinate headachs, are removed by a return of the menses. Nor is this at all surprising, since those disorders are occasioned by a plethora, by removing which as the cause, the disorder as the effect, ceases."

These remarks shew, that Hippocrates was well acquainted with the changes which the uterine vessels undergo, and that they were capable of being restored to that form of action which fitted them to pour out the *blood*, as he calls it.

These translations of action have been thought explicable upon the ground of general plethora; but no correct observer will ever think of attributing menstruation to plethora, either general or local. A plethora of the vessels exists no doubt, but this is the effect of their action, and not the cause of the discharge. We should be careful not to confound coincidence with cause and effect.—If plethora was the cause, the most plethoric women would have the most profuse discharge; but the very reverse is known to obtain.

Concerning the Bile, Milk, and perhaps other secretions, I might enter into details;

but as my object is more to establish a general principle than to quote cases; I shall proceed to the business of nutrition, where, we shall meet with facts calculated to shew, that the secretion of chyle is not confined to an immutable process, or to the small intestines.

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CHAP. II.

OF NUTRITION.

SECT. I.

*Of the Subserviency of other parts of the body  
to the Stomach.*

The Stomach, Brain, and Heart have been called the tripods of life. Their importance in the animal economy is shewn by their universality. The stomach, like every other part of the body, loses its tone when burthens are imposed upon it beyond its strength, and to this cause, most of the diseases of civilized life may be attributed. Gout is unknown beyond the enervating sphere of civilization; the temperate labourer is a stranger to Dyspepsia. Professor Rush happily remarks, that "the stomach is to the body, what the conscience is to the mind; never

failing sooner or later to punish the offences committed against it."

A difficulty of digestion is but one, of that host, which follows in the train of luxury and intemperance. A total inability to effect any salutary change in the food is among them. In this case, all that the stomach can do, is to reject whatever aliment is thrown into it. What language can be more expressive!—It admonishes us to give it repose;—But the repose of an organ which performs so important a function, as that of digestion, would soon be followed by repose of the whole body, if there were not other parts to which we might appeal. The facts which I shall adduce will, I hope, tend to prove, that a cessation of the digestive power of the stomach is not necessarily fatal, and that, other parts are capable of converting aliments into true and perfect chyle. The part which I shall first speak of, is the :

**SKIN.** The progress of pus towards the skin, in an abscess, which is occasioned by the absorption of the soft parts between the most exterior part of the pus and the cuticle; and the removal of the rete mucosum of the negro, from unknown causes on some occasions, and from known causes as on the following occasion, prove that the absorbents do exist in the skin, and that they perform the same function there, that they do every where

else. The case which I allude to, is mentioned by our learned and amiable Professor of *Materia Medica*. "A negro man in Virginia, took a large dose of the *Polygala Senega*, which produced a disagreeable sensation in the skin, and a disappearance of the rete mucosum in several parts of the body."\*

The experiments of Seguin, Rousseau, Dangerfield and Klapp, upon cutaneous absorption, are very decisive, so far as they go. But the absorption of active medicines is doubtful, even when taken into the alimentary canal. It will always be recollected that their experiments were made with such articles: and I might admit that they were not absorbed, without giving any weapon with which those gentlemen could injure me. Aliments and medicines are very different things; but it is difficult, and perhaps we shall never be able to distinguish a priori, the alimentary from the medicinal parts of matter. That there is a foundation for such distinction I have no doubt; and to the chemist we may look for a discovery of some test, with which we may detect and separate, aliment from poison.

Absorption, then, being the great distinction between aliment and medicine, and the absorbents of the intestines being allowed on all hands to take up the alimentary parts of substances: it remains for me shew, that although

\* Barton's *Mss. Lect.* This is not an insulated fact. See "Collections &c." page 33.

the cutaneous absorbents may refuse medicines, that they do certainly absorb aliment.

This is an antient doctrine, but not in my opinion, entitled to any more confidence on that account. I shall therefore pass over Hippocrates' notion of the "body perspiring from within outwards, and from without inwards."—The story of Democritus at one hundred and five years of age, being "kept alive for the space of three days by the vapour or scent of new bread, that he might not die within the time of the feast of Ceres, and disturb their ceremonies:"—And the assertion of Paracelsus, that he "saw a man nourished by means plasters which were applied to the hypochondria," without telling us what the said plasters were composed of; but shall rest the point upon the testimony of the moderns, whom we can depend upon.

Mr. Cruickshank gives us the following interesting fact. "A patient of mine" says he "with a stricture in the œsophagus, received nothing, either solid nor liquid, into the stomach, for two months; he was exceedingly thirsty, and complained of making no water. I ordered him the warm bath, for an hour, evening and morning, for two months; his thirst vanished, and he made water in the same manner, as when he used to drink by the mouth, and when the fluid descended readily into the stomach."\*

\* Cruickshank on the absorbents. page 108.

The history of the sufferings of lieutenant Bligh, is familiar to every one: while his misfortunes command the sympathies of mankind in general; they furnish an interesting fact to the physiologist.

Hence it appears, that although active medicines may not gain admission into the system through the cuticle; water, an alimentary substance, certainly does.

**THE COLON AND RECTUM.** The colon is more capacious than the whole of the small intestine taken collectively. Like them it is thickly spread over with absorbents, but not in such great numbers as on the jejunum and ileum. The mesenteric glands, also are fewer. The absorbents on the intestines, have been called lacteals, to distinguish them from those on other parts of the body, where they receive the name of lymphatics. These names were given to them, from the appearance of the fluids which they contained at the time of their discovery.

The colon has been by some, considered as a mere cloaca, receiving from the small intestines the recrementitious parts of food; but although the aspect of it differs considerably from them, I hope to shew that the alimentary part of food is absorbed by the lacteals on this portion of the alimentary canal, in the same way as in others.

The different degrees of consistence, which its contents acquire, as they advance towards the extremity of the rectum, shew, that the aliment is not divested of nutriment in the ileum. From which I infer, that the colon performs as important a share in chyli-fication, as either of the other intestines possessing the same number of lacteals.

These vessels not only act upon food, which has passed through the small intestines; but upon substances presented to their orifices by injection. They (lacteals of the colon) were not known to Dr. Boerhave in the human body; but he infered that they were there "from the use of glysters made of Nitre, honey, and water in inflammatory diseases, which would hardly be of any service, if there was no passage from the larger intestines into the blood, no part of the liquor of the glyster being discharged again, which evidently demonstrates an absorption of the same made by the lymphatics."\* It is not my business to comment upon Boerhaave's particular notions, concerning the modus operandi of Nitre, whether it entered the circulation in its formal state. The fact is clear, and his authority in matters of fact, few who are acquainted with his piety and ardent love of truth, will be willing to question.

Dr. Cullen, no less respectable, says, "I have known two pounds of water absorbed

\* Acad. Lect. vol. 1. page 321.

from the intestines in the space of an hour.”\* Cruickshank says, “copious and nutritious glysters, have been given by the rectum, which never returned in that form.”†

I might multiply facts to shew the activity of the absorbents of the colon; but these are pointed, positive, and come from sources which it would be heresy to doubt: As medical facts, they are as well attested, as can be required.

Having thus shewn the power, which these vessels possess, viz, of absorbing alimentary substances; and given what I believe to be a correct view of the changes which they effect upon them, forming chyle of greater or less degrees of concentration, according to the nature of the substance presented to them: it will be unnecessary for me to do more in this place, than detail a few facts, from which the reader will conclude with me; that when the stomach is so circumstanced as not to receive, or be able to effect a salutary change, upon the food; we are not to consign our patient to the grave; but may confidently assure him, that by enemata, administered in sufficient quantity, and often repeated, he may be nourished, and thereby allow those laws of the animal economy, which always tend to its restoration however circuitous the rout may be, to operate, and thus restore him to the enjoyment of health.

\* Mat. Med. page 77. † Cruickshank on the absorbents, page 165.

Boerhaave says, "we have instances of men kept alive a considerable time by nourishing glysters."\* "Cases are on record of their having supported the body for forty days or even three months."†

The subserviency of the colon to the stomach, then, being established: I shall conclude this part of the subject with an observation, which naturally grows out of the principle I have advocated. The practice of administering enemata, (although not directed as often as it might be to the advantage of our patients) is very prejudicial in diseases accompanied with increased arterial action. For as enemata are generally composed of articles somewhat stimulating, and easily convertible into chyle, as gruel, chicken water, &c. they must certainly be injurious, when bleeding, and the most rigid abstinence are necessary. The judicious physican therefore, in directing the use of enemata, will carefully accommodate his prescription to the state of the system.

Contemplating the human body in the light we have just stood; we are struck with the extent of the apparatus concerned in its nourishment. So definite is the action of all its parts; so complete and efficacious; so beautiful in their relations, that were we not surrounded by other works of *nature*, we might find enough to admire here, alone. But we are yet to come to that part of our subject,

\* Acad. Lect. v. I. P. 321. † Cruickshank on the absorbents, P. 165.

in which man differs from the brute : for in the business of nutrition, they are on a par, and here we shall find, that the same subserviency obtains in the organs of sense “the avenues of thought,” that does in secretion and nutrition.

### CHAPTER III.

#### *Mutual Subserviency of the Organs of Sense.*

#### SECTION I.

Were we to trust, exclusively, to any one of our senses, we should often be deceived ; but by the conjoint operation of two, or more of them ; we may obtain tolerably correct notions of things.

The eye does not give us a correct idea of the distance of an object, until by frequently exercising the sense of touch, we learn, that it appears to diminish as we recede from it. The young man whom Mr. Chesselden couched, thought every thing which he saw, touched his eyes.

The sense of touch, if trusted to alone, would deceive us. Thus, if the middle finger be crossed over the index, and we roll a ball under the ends of them, we shall have the sensation of two balls. Persons who have been maimed, often find themselves scratching their wooden legs, or the floor, instead of the end of the stump.

We learn the distances of bodies emitting sounds, only by experience, and by frequently testing the correctness of the ear by the touch and sight. Ventriloquism consists in nothing more, than giving the voice the same tone and force, which we have been accustomed to perceive, when it was emitted at a distance.

It appears then, that there is a mutual connexion, and dependence of the organs of sense. We shall find, that they are still more nearly related to each other.

## SECTION II.

### *Relations of the organs of Sense, to each other.*

THE destruction of one organ of sense, is followed by an increased acuteness of those which remain. These shall be taken notice of, as the secretions were, in the order they have been mentioned.

1. SIGHT. The eye is the organ through which we obtain a knowledge of the colours, surfaces, and distances of objects. The following remarks will serve to shew, that he, who is "cut off from the ways of men, and the contemplation of the human face divine," finds a considerable mitigation of his privations in the acuteness which the remaining senses acquire.

Dr. Saunderson lost his sight by the small pox so early in his infancy, that he did

not remember to have ever seen. Notwithstanding this misfortune, he acquired such profound and perfect knowledge in the sciences of mathematics, natural philosophy and optics, that his lectures were remarkably clear and intelligible, His sensation of touch was so exquisite, that he distinguished with astonishing nicety, the peculiar properties of bodies that depended upon the roughness and smoothness of their surfaces. The following is a remarkable instance of his nice accuracy in this respect. A series of roman medals, some of which were true, and others false, were presented to his touch.

By running his fingers over them, he was soon able to distinguish the genuine antiques from those that were counterfeited, though the latter had been executed with such exactness as to deceive a connoisseur, who only judged by the eye. "I" says the Doctor "who had not that sense to trust to, could easily feel a roughness of the new cast sufficient to distinguish them by."

Dr. Moyes, like Dr. S. lost his sight by the small pox, in his early infancy. Possessed of native genius and ardent in his application, he made rapid advances in various departments of erudition, and not only acquired the fundamental principles of mechanics, music, and the languages; but likewise entered deeply into the investigation of the profounder sciences, and displayed a general knowledge of

most of the branches of the Newtonian philosophy.\*

John Metcalf, of Manchester, Eng. became blind at a very early age, so as to be totally unconscious of light and its effects. This man in the early part of his life, was employed as a guide in intricate roads, during the night, or when the tracks were covered with snow. He was afterwards employed as projector, and surveyor of high-ways. With the assistance of a long staff "he traversed roads, ascended precipices, explored valleys, investigating their several extents, forms and situations."‡

The blind organist of Amersfort, of whom Mr. Boyle speaks, "had such an exquisite feeling in the papillæ of his fingers ends, that he could distinguish the colours of objects, merely by that sense; which he enjoyed in the greatest perfection betimes in the morning, from whence it diminished, till by noon he could feel no better than other men."§ Mr. B. was satisfied of this with his own eyes, at the expence of a long journey.

2. HEARING. "D. Ammanus being moved with compassion towards a country lad, who was born deaf and consequently dumb, taught him to hear with his eyes by signs, by which means the unfortunate lad, learnt to read and write in six months time. He placed the lad oppositeto a preacher,

\* Mr. Bew remarks (Manch. Mem.) that when introduced into company, he continued some time silent. The sound directed him to judge of the demensions of the room, he determined pretty nearly the stature of those he was speaking with, by the direction of their voices.

‡ Manch. Mem. vol. 1, page 173. § Acad. Lect. vol. 2. page 206.

who was explaining the sacred text, and the lad fixing his eyes upon the mouth of the preacher, took down the sermon, of which he had not heard a word, so that he was able to repeat the same at home.”\*

### SECTION III.

#### *Subserviency of other parts of the body to the organs of Sense.*

We have seen that there is 1st. A mutual dependance of the organs of sense. 2nd, When one of them is destroyed others become more acute. The following facts will shew that the total and complete cessation of the function of an organ of sense, is not necessarily followed by a privation of the ideas of that sense.

Dr. Boerhaave, nephew to the celebrated professor of that name, having lost his hearing, acquired in its place an organ of hearing in every part of his body; thus if a book fell from a table, the oscillatory motion was conveyed to his feet, and from thence to the brain, which here served him as an organ of hearing. In the same manner, by laying his hand on a persons shoulder, he could distinguish every word he articulated, his hand serving him here, to transmit the oscillatory motion.‡

This is not an insulated fact. “Two pupils, male and female, of the College of the Deaf and Dumb, who had been placed near a cannon when discharged, without being susceptible of the sound, were one day taken by their humane tutor, (Abbé Sicard) into a room where the Harmonica was playing. He asked them by signs, if they felt any sensation. They replied in the negative. He then placed the hand of the girl upon the instrument, whilst it was playing, and repeated the question: she an-

Acad. Lect.

‡ Cullen's Clin. Lect.

swered, that she felt a new pleasure enter the ends of her fingers, pass up her arms, and penetrate her heart.

The same experiment was tried upon her companion, who seemed to be sensible of similar sensations of delight, but less acutely felt.”\*

“Madam E. related to me,” says Mr. Carr, an experiment which she once tried upon a young woman who was totally deaf and dumb. Madam E. fastened a silk thread about her mouth and rested the other end upon her piano forte, upon which she played a pathetic air. Her visitor soon appeared much affected, and at length burst into tears. When she recovered, she wrote down upon a piece of paper, that she had experienced a delight which she could not express and that it had forced her to weep.”†

It appears from these cases, that the division of the senses into intellectual and sensual, is not entirely without foundation. Nature seems to have taken more pains to secure to us the ideas of sight and hearing, than those of taste and smell; but even in this last, we are in many respects superior to the brute. The amiable St. Pierre says, “The pleasures of smell are peculiar to man, who alone is sensible to perfumes, and employs them to give more energy to his passions.” Mahomet said, that “they elevated his soul to heaven.” The eye and the ear, have been justly called purely intellectual. J. J. Rousseau calls the eye “the organ of the soul:” Rush says, “Life lingers longest on the ears.”

Here I shall conclude; but not without expressing a wish, that those who have more time and talents allowed them than I have, would take up the subject, and do it justice. The candid critic will look with an indulgent eye upon my errors, and recollect that I write from compulsion: The better informed will supply my deficiencies.

\* Carr's Stranger in France, page 214.

† Ibid. 215.





Med. Hist.

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