Read. 1P Maxwell

Inaugural Thesis

on

The Maintenance of the Healthy Balance

of

Nutrition

in the body

by

Peter Mapleth

Edinburgh University
1862

The maintenance of the healthy balance of Nutrition in the Body.

In choosing such a subject as the present one for his Inaugural Thesis, the writer feels that he is unable for the task of fully setting forth the advantages which would accrue to the medical practitioner, in the discharge of his duties, from a correct knowledge of how the nutrition and health of the body is effected and maintained by the careful workings of Nature

During his studies in the clinical wards of the Royal Infirmary of this city, the writer has often observed with pleasure, how cases, which our forefathers, in the days of empiricism, would have actively treated with potions, pills, and Lancet, have, under Nature's efforts, guided partly in her own way by the hand of the practitioner, completely recovered Only from the effects of the disease, but from them in combination with the effects of powerful remedies had the patients to recover.

Nature was not thwarted in her means of cure, as in the dark days of medicine, when the medical man in his attempts to cure – as he said – the disease, only left it wings to hurry its course, and end the patient to an untimely grave

And the writer, in contemplating these cases, has often thought how great would be the advance in medicine were there only a more complete knowledge of, and more perfect reliance in, the "Vis Medicatrix Naturæ" among the medical men of the present day. By following more and more in the footsteps of Nature, Medical Science would not be retarded, nor the skill of the practitioner be less valued.

The Homeopathist says "Similia similibus curantur" and he gives his infinitessimal doses of nothing; but while he deludes his patient into the belief that the millionth part of a drop of 2 to 30. has cured him, does he himself believe so? He knows, that the globule did not work the cure, but that the credit of the recovery was due to the attention which he caused his patient to pay to Diet, Regimen and General Hygiene, by means of wh. Nature gradually attained the supremacy wh by incautiousness or unjudiciousness on the part of the patient she had lost

The Hydropathist says "Water cures everything" and has

patients believe him. But to what does all this quackery amount?
The water doctor gets a patient whom he finds Dyspeptic, Hypochondriacal & thinking himself afflicted with all the ills that flesh is heir to. What is to be done? The doctor finds that his patient has been for long living entirely at variance with Nature laws, attempting to force her to do things for which she is quite unable, and rendering abortive her attempts to accomplish that which ought to be done. And what does the Hydropathist do? He finds out where Nature first failed, and sets to work to restore those functions which have been arrested and when he cannot or at once restore, allows Nature time to assert her power. By water he clears the skin and stimulates that organ to healthy action; by water he clears out the sluggish bowels; by low diet he rests the stomach, which probably for many days back had strived but laboured in vain. And thus by rest on the one hand, with excitement on the other, where either is necessary, he gradually allows the system to innovate itself and the patient is restored to health — not by the power of water except so far as that is an adjuvant to the workings of Nature

And though not subscribing to the principles of those two bodies of men, yet the Allopathist might with profit take a few lessons from their practice, in trusting more to Nature

and less to Physic. Not that he is to stand by, careless and inert, but rather ready & watchful, so that whenever he observes a failing of the Natural powers, he should be prepared to administer such remedies as he knows will be useful in stimulating and restoring such decaying strength.

The true medical man never attempts to cure a disease; he only treats it, guides its course and gives the patient a chance of recovery. The self healing power inherent in all animated beings ought to be known and encouraged - not thwarted - by all who attempt to heal disease

The function of Nutrition, which is a great compound process, is the one on the proper performance of which, the health and strength of the body primarily depends. And in the present Thesis, it will be endeavoured to be shewn, how, in the healthy state of the body, Nature regulates those processes wh. go to constitute the function of Nutrition, so as to maintain a healthy balance between them; and how in disease, where the proper balance is destroyed, she endeavours by various means to restore it. And it is by observing her modes of healing disease, and adopting his remedies accordingly, assisting her when failing, modifying & restraining when she runs inclined to overpass the proper limits, that the medical practitioner is enabled successfully to cope with disease

As the blood is the source whence all the tissues of the body derive their nourishment, it is but right that we should first discuss this fluid, before commencing to consider the influence which, through it, the several textures exert on each other. Through the instrumentality of the blood, which has not inaptly been called "the life of the flesh," the various changes attendant on the phenomena of life are accomplished

Blood as it exists in the body is of two kinds distinguished by the names, arterial or pure, & venous or impure; and these two kinds differ most materially from each other, both as regards their constitution and function.

For the purposes of nutrition and the support of life it is necessary that at all times arterial or pure blood should be circulating through the body. Were no blood circulating through the system death would be the result, and alike would be the effect of a circulation of venous blood. For a time however, a slight admixture of the two fluids might be compatible with life, as instanced in the Cyanosis of children and in some cases of cardiac & pulmonary disease, but long continued the result is death. For the maintenance of life and health, a full & free circulation of arterial blood, from which the tissues

Can alone derive their nourishment, is necessary

The differences between arterial & venous blood are various. They differ 1st in colour, the arterial being bright red, the venous claret-coloured; 2d in temperature, that of arterial being two or three degrees higher than that of venous" 3d in the amount of Carbonic acid each contains. This last constitutes the greatest physical difference, the venous blood being loaded with this gas, the arterial containing more pure Oxygen and only a small quantity of Carbonic acid gas; and to this difference also is due the 2d. Viz that of colour; for it is now believed that the change of colour in the blood is due to alterations in the shape &c of the blood-corpuscles, to which the presence of either O or CO_2 gives rise 4th The arterial blood as it circulates carries with it the nutritive material, which goes to supply the place of the waste & changed matters which the venous blood bears in its stream

(1) Davy

As it is from the one source – arterial blood – that the whole body, in all its parts various in their form and constitution, is nourished, it follows that this fluid should contain all the elements required for this purpose and on this account must be very composite. It has been examined and analyzed by many skilful & experienced chemists & found to contain, Water, Blood corpuscles, white

and coloured, (and those again made up of many constituents,) fibrine, albumen, extractive matter, fat, various salts, the presence of all which is required for the proper maintenance of the vital fluid.

The Blood, however, is not a self maintaining fluid. It has not the power within itself of forming those substances whereby its proper standard is preserved. Were it able thus to maintain itself, many of the processes which go on in the body and many others external to it would be unnecessary. It is required that from without crude material should be taken into the body, and acted on by various changes within, chemical physical or vital, in order to be rendered fit for assimilation by the blood & then it by the tissues. And there must also be a continued giving off by the blood, from within to the external world, matter which if retained, would not only be useless to, but come ultimately to deteriorate the fluid.

And though in their present state, those matter thus given off, be of no more service in the economy, yet, by a series of changes without, also chemical physical or vital, they come through time, to be again fitted in one way or another for entering the body as crude material. There is thus a continued interchange going on between the body and the external world, which interchange cannot be arrested without danger to all life

A supply of crude material as food, we know we require to take into our bodies, in order that the blood & tissues may be renovated. But, that it may be useful, this food must undergo several processes of change; it must be masticated and mixed with the fluids poured into the mouth; by deglutition carried to the stomach, there to undergo important changes by its admixture with the Gastric juice &, from this organ it passes as chyme into the Intestines, where it is again subjected to the influence of various secreted fluids. The nutritive matter now receives the name of Chyle, and as it passes along the Intestinal canal, is gradually taken up & conveyed to the lacteal system of vessels, by means of wh. it reaches the thoracic duct, along which channel it is carried till with the lymph, (the nature & origin of wh. we will see hereafter) it is poured into the general circulation at the junction of the subclavian & Jugular Veins.

The chyle as it passed along the lacteals at first presented a molecular appearance, which however by some changes wrought on the fluid as it passed thro the series of Mesenteric glands in its way to the thoracic duct, gave place to a corpuscular structure. The corpuscles now found in the Chyle, when they reach the Lungs & come in contact with the Oxygen of the air become coloured & assume the appearance of blood corpuscles, which, in reality, they have now become.

We thus see how substances formerly entirely without the body, are taken into it, & by the several processes mentioned prepared for entering the blood & by thus enriching this fluid, fit it for being sent forth & minister to the wants of the economy.

It is not a matter of indifference however, what sort of material we take into our bodies as food; a proper choice of this, constituting the first stage of nutrition is most important. An error here will require great care afterwards for its rectification

As regards Diet, then, all kinds of food may be included under the two following classes 1st Nitrogenous, Azotized or Flesh-forming; 2d Non-Nitrogenous or Respiratory. Either of these kinds, separately taken are unfit for maintaining the structure & functions of the body. Both in proper admixture are necessary in order that the tissues may, through the blood, be properly nourished. The proportions required of each may vary however, according to several attendant agencies

The Nitrogenous articles of diet are called Flesh forming, because their purpose is to maintain the structure, and repair the waste of those parts of our body which are Nitrogenous compounds. To this class belong, Albumen Fibrine, Casein &c, all of which contain as an essential ingredient more or less Nitrogen

Among the Respiratory articles of diet are the Sugars Oils, &c which contain no Azote, but are remarkable for the large proportion of Carbon in their constitution

Great mental or bodily exercise of any kind, results in the waste of those textures, through which this activity of function is manifested; and if the function of the parts is still to be performed, the renewal of such parts as have thus been consumed, is necessary; and the material for such repair is supplied by a diet, consisting of solid nitrogenous food. Again, in all climates, but especially in those where the atmospheric temperature is considerably lower than that of the body, a certain amount of heat must be developed within the latter in order to maintain life. For the purpose of producing this caloric, advantage is taken of the second class of food - the Respiratory -. These consist chemically of C. H. + O. in various proportions, and the advantage they possess is, that they are easily acted upon and decomposed, giving out during their decomposition within the body as much heat, as the same processes would do if carried on in the Laboratory. All the animal heat of the body is thus chemically produced; and it might be kept up by the decomposition of the nitrogenous tissues alone, but slowly, for those are but little combustible, and a larger amount of them than of the other would be required in order to keep up the requisite amount.

The non-azotized matters in the blood may be considered as Parathiptics, preventing the waste of the Azotized; for the former being present in small quantity, the latter, which are with more difficulty replaced, must be consumed in order to keep up the heat.

It is not, however, the mere taking into the body of nitrogenous & non-nitrogenous matters, in certain proportion, that will sustain life. In order to fit those articles for replenishing the blood, the various elements "must be converted into Albumen fibril so as to produce those elementary molecules found in the Chyle, and which form the substance out of which nuclei and cells are developed" (i) Those changes result from the several processes of digestion.

(i) Bennett

Certain mineral elements, as the salts of Lime, Potash, Iron are as essential to the due maintenance of the animal frame, as the two groups already mentioned, and in combination with which in our food they are most generally received into the economy.

Along with those matters derived from the Primary Digestion, there are continually added to the blood, substances derived from what is called the Secondary digestion. This consists in the taking back into the blood those particles of the tissues which have for the time being, served their purpose in the economy, & must be removed to give place to new material

(i) Bennett

Some of those substances which are thus continually being received into the blood from the decomposition of the tissues are of no more service, and must be conducted by various channels out of the body; others by various modifying processes are chemically changed & fitted for ulterior processes in the economy.

The Lymph or fluid of the secondary digestion is, like the Chyle, at first molecular, but gradually becomes corpuscular as it passes along the lymphatic vessels and through the glands. From those of the Lymph & Chyle, the corpuscles of the blood are being continually formed, so that whatever loss of the latter may be sustained during life, so long as the processes for the proper formation of those two fluids go on harmoniously, the waste is repaired.

The blood as it exists in the body consists of a straw-coloured transparent liquid, the Liquor Sanguinis, in which the corpuscles, whose formation has been just described, float and this Liquor, containing all the substances necessary, directly or indirectly, for the formation of the tissues and secretions. In it also the corpuscles are ultimately dissolved, and it, received by the tissues through the capillaries, is the foundation for all the formative processes of the economy.

In order however that the nutritive functions of this fluid may be performed, its distribution throughout the body is

requisite. For the purpose of thus disseminating the blood we have the circulation, which is performed by means of the Heart and Vessels, proceeding to and from that organ. To consider at present the mechanism of the circulation would carry us too far; so that having already seen, how in part the blood is maintained in its healthy condition, we will go on to consider how from the circulating medium, the different tissues obtain their proper quantity of nutrient fluid.

Every part of the body is supplied with blood vessels, from the fluid within which, it may derive its nourishment: But all parts of the body are not thus equally supplied. Some organs and tissues which, in the discharge of their functions, are more active than others, require in this account a more abundant supply of blood. Each part of the body has its own function to perform, and let that function be what it may, all exercise of it produces a corresponding waste of the tissues through which that function is exercised, and such disintegration must be repaired, if the functional activity of the organ is to be maintained. The more active the function, the greater waste & therefore greater necessity for a full and ready supply of restorative materials being at hand

(1) It is asserted by some, and there seems to be little doubt of the assertion that every particle of the body has a certain length of life allotted to it, at the end of which time it naturally dies & is cast out

(1) (Carpenter)

By exercise however this period of decay may be hastened. Whether by exercise or rest, the particles of the body are continually being changed; old matter is being taken away from the tissues and replaced by new; so that after a lapse of time, the body, though it may seem to be the same as it was, is entirely made up of new particles

In order that the interchanges between the blood and the tissues may go on, it is necessary, as a general rule, that the former should be in intimate contact with the latter. The function of bringing about this close connexion devolves upon the capillaries, which are very delicate tubes, terminating the arterial system of vessels and commencing the veins. They have thin membranous walls, which permit by the mechanical process of endosmose & exosmose, such interchanges as are necessary, between their contents and the tissues around. The number of capillaries in, and amount of vascularity of, any part is in great measure regulated by the activity of its function, & the amount of waste produced. In some structures no vessels have as yet been found, such as cartilage, the cornea, lens &c. those after they are fully formed, very probably undergo little if any organic changes as their office is for the most part mechanical. Whatever alteration is induced in them is slow - unless marked - and is quickly supplied repaired from the blood circulating in the vessels of adjoining textures, thus cartilage from the vessels of the adjacent tissue

But organs such as the Lungs, Heart &c, which are in constant exercise & actively engaged, are richly supplied with blood in order to remove the enormous waste produced.

As the blood issues from the left ventricle of the heart it is loaded with the nutrient elements resulting from the changes wrought on the products of the primary and secondary digestions, and a large quantity of Oxygen received in the Lungs; and thus provided the arterial blood passes on to the Tissues.

During the growth of the body the amount of nourishment taken up by the tissues from the blood is greater than the waste produced; for, owing to the gradually increasing demand for a greater discharge of ordinary function, the different parts of the body must be enlarged and strengthened to meet the demand. In order to this, the waste is repaired and the surplus assimilated. But when growth is at an end, and the body has become fully developed, it is only necessary that the waste produced should be repaired in order to maintain this state. During growth the body increased in size equally in all its parts, but in the fully developed state, increase in size & strength takes place only in one or more organs which, more than the others, have been called on to perform an extra amount of their usual function. As was said before, Nutrition is regulated by functional activity, and examples of our nutrition from extra work are abundant in both health & disease, as when the left ventricle

of the heart becomes hypertrophied from the increased effort required to overcome obstruction at the aortic orifice; and any set of muscles become enlarged from frequent use. It is also true that diminished functional activity produces atrophy or feeble nutrition; as exemplified in wasting of the muscles of the lower extremities from long continued confinement & the recumbent posture.

Growth and maintenance are analagous, only differing in degree. In the former more material is added than is merely required to repair waste; in the latter just sufficient for that purpose is taken up.

But how comes it that from this one source, all the tissues & organs of the body, so varied in their nature and composition, are enabled & nourish themselves & be maintained?

In the blood we have the elements of nutrition, but we have not those elements combined & ready made up, only requiring to be taken up & added & each texture. And as it is one and the same fluid that is distributed & each & every portion of the economy and we know that no known tissue of the body exists in the blood, it may well be asked, what laws regulate their maintenance? There must be some powers at work to arrange the elementary molecules, received into the circulating fluid. That this arranging power does not exert its influence on the Blood while yet in its proper vessels we have seen, so that we must

look outside of them for an explanation of the Phenomena

When the body is examined microscopically it is found that all the tissues of which it is composed are cellular in their structure. The cells are variously aggregated together to form the organs & tissues. Each of the many cells of each organ has its life & death & during its life a function to perform; when it does it is of no more service and is cast out of the economy. To those cells during their life the elaboration of the nutritive elementary material of the blood is ascribed. While they live they have the power of attracting matter from the blood, which by a vital property inherent in themselves they transform, so as to fit them for being added to the various parts of the body. Those cells also produce their successors and so long as these processes of cell growth & function go on the body maintains its similarity of form & constitution

The ascription merely of an attractive power to those cells would not fully explain the phenomena of nutrition. No physical law can as yet explain how it is that the proper material is at all times taken up by the different sets of cells; so that we must ascribe to those minute sustainers of the frame, not only a vital power of attraction but likewise a vital power of selection, whereby in health they are enabled at all times to furnish a suitable pabulum, from which the various tissues they compose may be nourished

We find those laws of attraction and selection governing in morbid as well as in healthy growth. A morbid growth - as a Tumour - so long as it is supplied with blood, will attract & select materials, which it will assimilate to itself & thus increase in bulk

Secretion was for a long time supposed to be something opposed to growth, its object being to abstract matter from the body, while growth tended to add to it. But by more minute investigations into the subject, it has been ascertained that the same laws we saw regulating growth are in force here By the maturation, & decline of cells, variously endowed with their vital powers of attraction and selection, all the secretions of the body are formed. When these secreting cells have fulfilled their functions, they break down & are ejected; their places being taken by new cellular formations, which in like manner fulfil their duties & die. In breaking down the matters which they have secreted in their interior are liberated. Some of those secretions are immediately got rid of along with their producing cells; others are, either directly or indirectly, received back into the blood, and have important purposes in the economy. Of this latter, the Salivary, Gastric, Hepatic & Pancreatic secretions are examples; the three mentioned being of great service in preparing for assimilation the food taken in by the mouth

A similar re-use, is probably made of some of the

matter taken back into the blood from the worn out tissues of the body is found. Prof. Laycock thinks it probable that the fatty remains of the lately impregnated ~~ovaries~~ ova are taken up into the blood, & serve to assist in the formation of the mammary secretion

By a combination of cells such as those, whose functions have just been described, the different organs of the body are formed & by means of those organs the various functions of locomotion, sensation &c are enacted. By means of cell-life alone can those organs grow & be maintained in a fit condition for performing their functions. Cells are in truth the real agents whereby nutrition is carried on, & by the peculiar life of each cell or set of cells only, can the body be maintained in a healthy state. In the words of Prof. Bennett "A plant or animal is in fact a living creature, composed of millions of corpuscles the sum total of the lives of which make up its own"

On account of the constant destruction or waste of tissue that is going on in the body, a constant supply of new material to supply the place of such waste is required; and the source whence such repair is obtained we have before said to be the blood. But should there by any neglect or otherwise be a deficiency in the blood of its necessary solid or liquid ingredients, the want is made known by two feelings — hunger & thirst; the former

expressing a sense of want of solid food, the latter of liquid.

That those two sensations are not due merely to an empty state of the stomach or depress of the powers, is now pretty well agreed upon by physiologists. All are satisfied that they are caused by a condition of the system at large, produced by an abnormal state of the blood, but the mind refers the sensations to the parts before mentioned, as those from which it generally receives such impressions. In Tabes Mesenterica for instance, where from Tubercular matter deposited in the mesenteric glands, the Chyle is altogether obstructed in its passage to the blood, or what does pass is, from the faulty condition of the glands, imperfectly fitted for entering the circulation a continual craving for food is present. For a short time this yearning for food is appeased by the introduction of food into the stomach, but ere long it returns with unabated force, the system being little if at all benefitted by the ingesta received, the momentary relief being the result of a false impression on the mind. In fevers we have great wasting and wearing away of the tissues whilst little or no desire for food is felt. But the need for it is seen by the onlooker in the great weakness emaciation which accompany such diseases. The unconsciousness of his need by the patient may be supposed to be owing to derangements of the nervous system, whereby the mind is unfitted for receiving such impressions as would render it aware of the wants of the economy. During convalescence from fever, when the mind

has agained its powers activity, the wants of the economy from the great previous waste, are keenly felt, and great care and watchfulness are necessary in our endeavours to appease the great cause of hunger.

For the production of these two sensations, hunger & thirst we have the nervous system brought into play; and there can be no doubt that this system exercises an unbounded influence over the nutrition of the body, both in health and disease.

The nervous system, like all other parts of the body, is made up of cells, which while they possess, in common with other cell bodies, the power of attracting and selecting from the blood their nutrient material, are endowed with the property of conducting impressions & eliminating nervous force, the latter either mental or motor. The cells making up nervous tissue must be kept in constant repair if their functions are to be performed. And as by the † condition of the nervous system, the nutrition of all parts of the body is considerably influenced, it follows that its functions being disordered by some already existing deficiency in the nutritive processes, such derangement will be greatly increased from want of its regulating powers.

Any thing interfering with the due supply of nervous force to any part of the body, as of the Extremities will induce paralysis of the muscles implicated, and if the sensory fibres are affected anaesthesia of the parts which those fibres are distributed.

In those parts also in which the influence of the nervous system is awanting various changes ensue which show that the healthy balance of nutrition is gone. The immediate agents of nutrition are present, the tissues & the blood, & both seemingly in proper working order, but yet the muscles dwindle away effusion of serum takes place into the areolar tissue, ulcerations of the skin occur from agencies which before would have had little effect; all showing that the influence of the nervous system is necessary in order that the proper relations between the tissues & their nutrition may be maintained. It may be that through the nerves distributed to them, the cells receive a stimulus to perform their functions; by exercise this stimulus is increased but in Paralysis is altogether in abeyance In Typhoid and other low forms of fevers where the nervine stimulus is not altogether awanting, but is weak, the same unhealthy nutrition is characteristic

That the mind acting through the nervous system influences to a great extent the course of many diseases is often well exemplified. All depressing thoughts, as fear, & forebodings of evil tend to render tardy the cure of many diseases otherwise simple, while hope and confidence aid greatly in recovery, other things being favorable. Great hopes however are often entertained by patients for whom all chance of recovery has been given up This is often seen in the last stages of Phthisis and is of bad

owner. It shows that the mind acting through an imperfectly nourished medium, is unable fully to appreciate the extent and danger of the disease under which its owner is labouring. This state has been called Euphoria (Εὐφορία.)

Imperfect nutrition acts unfavorably on the nervous system and an improperly nourished nervous system reacts with double intensity on nutrition in general, inducing many & varied diseases.

We have seen then how for healthy nutrition three are required, a healthy quality of the blood, a proper quantity of that fluid to each part: a healthy state of the part to be nourished and a certain influence of the nervous system regulating all. We have considered the three last of those requirements, and also in part we have seen how a healthy quality of the blood is maintained by a proper performance of the functions making up the Primary Digestion, and the abstraction of their proper nutrient materials by the Tissues. Diseases of Nutrition may arise from an increase or diminution in the blood of any of its constituents, and these two states may be produced by an increased or diminished amount of material introduced into the blood from without or from changes in the assimilative powers of the tissues. The assimilation by the Tissues must indeed be precise & perfect, to maintain the blood in its healthy condition. As Stevenanus has

observed "Each part of the body, in abstracting from the blood the materials necessary for its maintenance, acts as an excreting organ in regard to the others" If the muscles did not take materials for their nutrition, fibrine & their other constituents might come to be in excess in the blood; the bones failing in their nutritive functions, the salts of lime &c might be too abundant to the healthy standard of the blood departed from & in proportion to the amount of disturbance, the nutrition of other parts of the bodily framework would be interfered with.

The blood, as a floating organ, has its function to perform, and in order to perform that function must be properly nourished It has been already shewn how its nourishment is effected; but how precise must be the assimilation of matter by the blood, in order that the individual peculiarities in the nutrition of the many tissues of the body may be met. Long after the insertion of the vaccine virus, the system is no longer capable of being affected thro the blood with the same poison; for so precisely has the blood assimilated to its altered self the materials derived from the primary and secondary digestions that it is no longer amenable to the influence of the poison No doubt the assimilation to the healthy standard is as perfect as we thus see it to be to the most minutely altered

By sweats, diarrhœas &c which are merely the result of increased functional activity of the skin, bowels & the

blood is often enabled to rid itself of those superfluities which, being present, deteriorate it, and render it unfit for fulfilling its functions. But normally and at all times there is being given off from the circulation & cast out of the body a certain quantity of refuse matter; and our attention will now be directed to a consideration of the means whereby these Excretory processes are accomplished

From arterial blood, through the thin capillary walls the tissues derive their new material; & through the same delicate walls the refuse & worn out textures are returned back into the circulation & under the blood Venous We saw that in arterial blood a large amount of Oxygen was carried; one of the purposes of this gas is now fulfilled. It unites with those waste matters, converting them into new chemical compounds, more fitted for being taken up into the circulation, and more easily eliminated thereform The principal of these new compounds thus formed are Carbonic acid, Urea & water. The heat evolved whilst these changes are being consummated, is as great as that produced by like chemical combinations in the Laboratory. The heat produced by the union of O. with the blood in the lungs & the chemical transformations in the capillaries make up together the amount of animal heat in the body. On the activity of the circulation & respiration the temperature of the

body depends

The blood being now venous it is unfitted for sustaining life, and in order to its purification many processes are at work. The presence of a large amount of Carbonic acid we noticed before as the grand distinguishing character of venous blood, and the first change this fluid undergoes is being relieved of this gas, and having restored to it the bright scarlet colour of arterial blood. This change take place in the Lungs, where also a large amount of watery vapour is at the same time given off. And thus purified from CO_2 & water, the blood is sent to the left side of the heart as arterial. But arterial though it be, yet many matters remain in it which if retained would be most pernicious. At all times & in every part of the circulation, there must be a certain proportion of waste matter floating in the blood as Urea & Uric acid for instance, which shld exist in the blood sent forth from the left side of the heart, do not all pass on in a direct stream to the Kidneys to be excreted. They are diffused throughout the general mass of the blood, & only a portion of them directly reaches the Kidneys from the heart. But those organs, being in full & healthy operation are continually acting on the blood that reaches them, relieving it of what of those excreta it contains; and it is only when the Kidneys are deficient in this function, & an accumulation

if urea do not take place in the blood that serious consequences result

It is most important that those refuse matters be passed out of the economy, for if retained, they act as poisons. Some of the excretions are directly parted with as soon as they are separated from the blood; others secreted by one organ, re-enter the blood, and are carried to other organs, where they finally disappear.

Certain of the excretory organs, properly so called, act in concert, the activity of one being increased, in proportion as that of the other is diminished. As we have variety in the kinds of food taken into the body, so we have variety in the effete matters discharged therefrom. Our food consists principally of Hydrocarbons and Azotised matters, combined with mineral matters; and our excretions are of like nature. And so we have organs for separating Hydrocarbons from the blood, in the forms of Carbonic acid & water, & also organs for separating the Nitrogenous & mineral excreta.

The excretion from the Lungs (as they are the first excretory organs the impure blood reaches) consists of CO_2 & water, produced by the disintegration of the Tissues, & their union with Oxygen, and received directly into the blood. Intimately connected with the Lungs in the discharge of these excretory functions, we have the Skin and Liver

From the former we have a daily excretion, to a considerable amount, of Carbonic acid, the amount being altered according as the Lungs are active or depressed in their functions. That the skin and lungs are associated in this way has been proved in cases, where, by covering the body of an animal over with an impermeable Varnish, so that no exhalation from the skin could take place, so much Carbonic acid accumulated in the blood, that the Lungs were unable of themselves to get rid of it, and the animals died, with all the symptoms of asphyxia.

The Carbonic acid which we have thus seen given off by the Lungs, was that which was received into the blood, as the result of the union of Oxygen with the Carbon and Hydrogen of the disintegrated tissues. But another source of this excretory product of the Lungs, is the conversion into this gas, in those organs, of substances formed in the Liver

The Liver is associated with the Lungs &c, for the purpose of purifying the blood from an excess of Hydro-Carbons, but the means by which it does so are indirect It is a secreting organ, and in order to supply it with the materials necessary for its secretion, a distinct & separate supply of blood is sent to it.

During the digestion of the food in the stomach and

Intestines, many substances pass directly into the blood vessels of those parts; those substances being chiefly, fat, dextrine & sugar. The blood, contained in those vessels returning from the alimentary canal, together with that from the Pancreas & Spleen, is collected into one channel, the Vena Porta & conveyed to the Liver; and from this source the secreting cells of the latter organ obtain their material

The substances formed in the Liver from such blood are Bile, Sugar & Fat. The principle function of the Liver is no doubt to secrete Bile, which secretion, as an excretion is got rid of in two ways. It is first poured into the Duodenum during the process of digestion, and exercises some important influence on the food passing through the gut. It is most probable that it acts on the fatty matters emulsifying them & rendering them more capable of being taken up by the Lacteals; for according to experiments by Schwann, animals, from whom the bile was taken by a fistulous opening, died with all the signs of inanition, such signs as would result from a want of Hydro Carbons in the blood. Part of the bile, including the colouring matter passes along the alimentary canal & is discharged directly per rectum. The greater portion however, is with the food taken up by the Lacteals, conveyed to the blood and carried

to the Lungs, where it is given off as Carbonic acid, formed by the union of Oxygen with its constituents If all the bile were to be passed out by the rectum, it would be a great waste of material; for by its oxidation in the lungs, it contributes to the keeping up of the animal heat

The bile absorbed from the Intestines must be greatly changed as it cannot be found as such in the blood; That which passes right through the alimentary canal is but little altered. In whatever way, the bile must by some mode of excretion be got rid of; and it is found that when the action of the Lungs is depressed, more bile is passed with the feces.

Should there, by any obstruction, be a hindrance to the passage of the bile from the Liver into the Duodenum, it accumulates in the Liver, and, unchanged, is taken up into the blood by the Hepatic veins, and circulating with the blood produces Jaundice. Yet an effort is made to get rid of this noxious material. The skin & Kidneys are called in to give their assistance, and excrete large quantities; and if once the obstruction to the proper path of the bile be removed, these organs easily get rid of the superfluity that still remains in the system

The bilious secretion, thus taken up directly into the blood, is not fitted for oxidation & excretion by the Lungs as Carbonic acid. By the skin and kidneys it is given off as bile; and therefore from this large quantity of oxidizable material being parted with without undergoing chemical transformation, there is a great waste of what, in health, is subservient to the maintenance of the animal heat. It has also been found that when the Bile is prevented from entering the intestine, & uniting with the food, that a larger quantity than usual of the fatty elements are passed by stool; so that here again we have a large amount of unoxidized matter passing out of the system And as it is necessary that the heat of the body should be kept up, fuel must, in those cases, be obtained from other than the usual sources. And thus if Jaundice be long continued, emaciation of the body results; due partly to the imperfect digestion of the food from want of bile, and partly to the excessive waste of the tissues, required to keep up the animal heat. The feeling of coldness, generally experienced in Jaundice, may be due to the imperfect supply of proper combustible material; or perhaps rather, to the poisoning influence of the bile circulating in the vessels of the brain, rendering that organ unable rightly to appreciate the sensations produced in it by the impressions received from the general surface

Another of the functions of the Liver is the secretion of a substance, resembling Hydrated Starch, which, so soon as it is taken up by the Hepatic Veins, is converted into grape sugar, and as such conveyed to the Lungs, where it is oxidised, and given off as CO_2 & HO

Different views are held by various writers about this gluco-genic function of the Liver, and the excretion of the product. Some suppose that only a small portion of the Sugar is thus excreted & that the remainder is carried into the circulation, and gradually assimilated by the tissues But if this were the case, sugar should be a normal constituent of the blood, whereas only in that of the Hepatic Vein is it found. Again, Dr Savy supposes that the Liver secretes a substance which he calls Hepatine, and which, he says, in the healthy state of the circulation is not converted into sugar, but under certain morbid conditions is so, and thus produces the characteristic symptoms of Diabetes.

The fact of Diabetes being sometimes produced by stimulation of the respiratory organs, as by chloroform &c, thus hindering the due oxygenation of the blood, might favor Bernard's view of the decomposition and expulsion of the sugar mainly by the lungs, but the fact of impeded respiration implies a morbid & altered condition of the blood, so that the Hepatine of Dr Savy might thus also be transformed into sugar. Injuries to the brain

may act in producing Diabetes, directly, according to Bernards theory, by interfering with the Respiratory functions; or through this interference with those functions, altering the blood, and so converting the Hepatine of Pavy into sugar.

Whatever be the correct Pathology of Diabetes, it is sufficient for us at present to show, that the Liver is an organ devoted to the purifying of the blood from Hydrocarbons

Two of the modes in which it does so have been noticed, - by the secretion of bile & sugar or Hepatine. It also secretes from the blood a quantity of free fat, which sometimes becomes too abundant in the organ & interferes with its functions

Another mode of relieving the blood from an excess of Hydrocarbons, is the deposition in the subcutaneous areolar tissue of fat - constituting Adipose Tissue. The fatty matters are not here entirely thrown out of the Economy, but placed in such situations and under such circumstances as to relieve the blood for the time, while if again required they can easily be re-taken up into the circulation

As regards the azotised matters, the principal channel for their excretion is the Kidney; their elimination however not being the sole function of this organ. The Kidney purifies the blood by separating from it a large quantity

of water, which, by holding in solution the nitrogenous products of disintegration – urea & uric acid –, together with certain salts, renders those substances more capable of being discharged. The solution passes out of the body as Urine.

In the discharge of its function of watery excretion, we have intimately connected with the Kidney, the Lungs & Skin, but more especially the latter. The amount of water exhaled by either of these organs depends on various circumstances, which increase or diminish the activity of any one of them. The amount altogether is dependent, in great part, on the amount of liquid which is taken into the body as food or drink.

For the most part, the water excreted by the Skin is in the form of vapour, but when, from activity of the organ, the quantity is increased, or from hygrometric changes, what is excreted, cannot be properly evaporated, it becomes visible on the surface as sweat. In summer the discharge of water from the skin is usually large, while from the Kidney the amount is diminished; and in winter the reverse is the case. And in cutaneous diseases where the function of the skin is impeded, a larger quantity of water than usual is passed by the Kidney. But from long continuance, the kidney itself may come

be unequal to the fulfilling of double duty, and the water will thus become superabundant in the blood

There must be, in order that the mechanical processes of endosmose & exosmose, going on between the blood & tissues, may be properly performed, a proper dilution of the blood If, by failure of the organs which serve to maintain the proper standard of the blood in this respect, the circulating fluid becomes too watery, the aqueous superfluity must be got rid of by some other means. For this purpose the thin walls of the capillaries, in those parts of the body which are loose in texture, & able, for a time to accommodate themselves to slight distension, allow the water to pass through & thus relieve the blood from its overplus. And when the functions of the skin, kidneys &c are restored, & their activity heightened by therapeutic means they take from the blood so much of its watery ingredient, that the previous effusion is necessarily taken up again into the blood & maintains the proper standard of that fluid.

This will not account for all forms of dropsical effusions, but is merely brought forward to show, how the proper discharge of this function of the kidneys & skin is intimately associated with the proper constitution of the blood, and therefore with the healthy nutrition of the whole body

Those dropsical effusions, though thus at first beneficial

ficial by relieving the blood, yet by their gradual increase, may be productive of great harm, and ultimately cause death by the mechanical impediments which they offer to the free play of important parts

The water thus passed by the kidneys serves as a vehicle for the excretion of several substances, among which are Urea & Uric acid & various salts, of which the Phosphates constitute the greater bulk.

Urea is, in the healthy state, the most common & the most important of these excreta. It is a product resulting from the disintegration of the nitrogenous tissues of the body, and their union with Oxygen. The first change which those tissues undergo is into Uric acid, in which state they would remain were there an imperfect supply of Oxygen. But enough of this gas being present, the Uric acid, which itself & in most of its salts is very insoluble, is converted into the more soluble Urea & thus rendered more fit for elimination. There is always a small proportion of the Uric acid in the urine of man, which may be accounted for by his omnivorous habits; the carbonaceous food which he takes requiring a certain quantity of O. with which to unite, renders the amount necessary for the nitrogenous products rather less than it ought to be

Urea is however the most important solid constituent of the Urine, and, like all other excreta, from defect in the functions of its eliminating organ, it may become in excess in the blood. As said before, it exists at all times, in small proportion in the blood, and it has been found, that by the skin, as well as by the kidney it may be excreted. This fact is of importance to bear in mind in the treatment of Uraemic poisoning; for by keeping the function of the skin active we may in a measure relieve what can only be cured by a due return of the functional activity of the kidney.

This Uraemia results from the accumulation of Urea in the blood. This Toxaemic agent affects principally the nerve centres, producing coma, convulsions &c according to the portion of the Cerebro-spinal system engaged. Our means of relief are, the elimination of the poison as quickly as possible, either by the natural excretory channel the kidney - its activity being heightened by Diuretics, or as shown before by an exalted action of the skin, or by increased action of the bowels. Most commonly however the toxaemia ends fatally from the great power of the poison

As shown by Frerichs, and confirmed by other

observers, it is not merely by the presence in the blood, of an unusually large quantity of Urea that this poisoning results. They state that it is only when decomposition of this salt into Carbonate of Ammonia takes place, that poisonous symptoms occur. Persons in the last stage of Renal disease have their blood highly charged with Urea, yet no coma or convulsions arise, probably because the peculiar ferment for the transformation is not present. As Urea is a constituent of even healthy blood, we can easily imagine, how a slight amount of Uraemic poisoning might happen, if this theory be true, even without any hindrance to its elimination by the Kidney.

The salts excreted by the Kidney may be in excess, either from using food containing large quantities of them, or from rapid disintegration of those tissues which contain them. They may be deposited in the Kidney or Bladder as calculi, and give rise to serious dangerous often fatal symptoms.

Although mainly an organ for the excretion of nitrogenous material, yet sometimes the Kidney may be found acting as an excretor of carbonaceous substances, as in Jaundice, when the urine becomes very dark coloured from the presence of Bile. The normal colouring matter of the urine is probably also a non-azotised excretion.

The elimination of the solid excreta, is accomplished by means of the Intestines, whose tube terminates by a guarded opening - the Anus. The excretion by this channel consists of those parts of the food which have escaped digestion as they passed along the canal, together with portions of certain of the fluid secretions poured into the canal, and insoluble salts; the whole constituting the faeces, which in the healthy state are semi-solid, but from various causes may be altered in their consistence

The substances thus got rid of are for the most part insoluble and innutritious, and like all other excreta if retained within the body for any length of time, are apt to induce many bad and even fatal consequences. The symptoms thus produced in other and distant parts, are not perhaps so much due to any irritation of the alimentary canal by the retained faecal matter, as to the impediment which such matter offers to the free performance of their secretory functions by the various glands &c of the mucous membrane of the gut. Those glands eliminate from the blood certain materials, whereby they tend to preserve the proper standard of that fluid; and if their functions be arrested, the blood must be rendered abnormal, and thus changed may induce disease in any part of the body

By the use of certain drugs the activity of the intestinal mucous membrane may be greatly increased and the quantity of its secretions augmented, the excess being chiefly in the amount of water, whereby the feces are rendered more fluid; and by this means the intestines may be made to act vicariously with the kidneys & skin, when the functions of those organs are in any way arrested

By observing how in some cases these complementary excretions take place naturally, we are led to infer, that in disease with imperfect functional activity in one organ we may endeavour with great hope of success to excite a supplementary action in some other. The only channel for excretion which has no supplement is the intestinal, and its morbid states can, for the most part, only be relieved by acting on itself

We have thus, in the preceding pages, endeavoured to show how the different parts of the body are intimately associated together, for the purpose of maintaining the life and health of the whole frame. We have seen, how the least deviation from the healthy state in one part, inducing in it imperfect nutrition, & rendering irregular or completely hindering the performance of its

functions, will cause through time, corresponding deviations in other - it may be distant parts. The medium through which these changes are wrought is the blood, alterations in which however are not primary

So long as all the processes we have described go on harmoniously, the circulating medium retains its normal condition; but any interference with those processes immediately produces a morbid condition of the fluid

Thus by improper diet, substances may be added to the blood, which rapidly deteriorate it; or the blood, from impure air or imperfect respiratory action, may not receive its due supply of Oxygen; or the tissues may fail in abstracting the proper quantity of material from the blood, for their own nutrition or the formation of secretions, or those secretions, which, when formed, ought to be eliminated, may be retained and taken back into the blood. By all these different ways the Vitality of the blood may be impaired. By an imperfect supply of new materials also, though what is received is properly enough taken up, the blood becomes poor; the waste of the economy cannot be supplied, and so the body wastes and dies

In all disease the Blood will usually be found

altered in some way from its normal standard. But by acting directly on the blood, we do not attempt to arrest or get rid of the disease. The only sure and safe means is to endeavour to restore it to its healthy state those conditions on which the health of the blood depends We therefore give proper aliment, endeavour to have that aliment properly assimilated to the blood, & from the blood taken up in correct quantity by the tissues. We must also take care to have all effete matters got rid off by their proper channels, so that no accumulation of them may take place in the blood

In all so called Blood diseases, we must act not on that fluid directly, but endeavour to remove all those conditions, whereby the stage of nutrition primarily affected was deranged. And thus only can we hope to combat the disease successfully.

Finis