On the Nutritive Process

There is much in the phenomena displayed by organized, and living beings to excite the interest, and awaken the curiosity of both educated and untutored minds. To none of these phenomena perhaps does this statement apply with greater force than to that of growth, developement, maintenance and decay - That a minute vesicle which can be rendered visible only by microscopic aid, should, after the lapse of a few short years present itself, as a stately fair proportioned animal - that the tiny acorn, which lies unheeded where it falls, and which could be crushed and destroyed by an infant, should in no long time be transformed into a gigantic oak - that such occurrences as these should take place we say, cannot fail to arrest universal attention - The question naturally arises in every mind, how are such phenomena as these originated? What is the proximate cause of results so wonderful and stupendous? The answer will involve a consideration of the subject of Nutrition - to which we now adress ourselves -

By the term Nutrition we understand that process, by which the various parts of a living organism are sustained entire, in form and composition, in the midst of agencies which would effect their decay and dissolution - In evidence of the importance of this as a subject of thoughtful consideration, and diligent study, it may be sufficient to point, to the extensive and elaborate machinery, with which the higher classes of beings are endowed in subservience to its accomplishment - The abdominal and thoracic viscera of vertebrate animals, so varied in structure and immediate function have, as their ultimate design, scarcely anything beyond the elaboration of material wherewith the formative process may have its wants supplied. Its value appears moreover, when we consider the extent of its field of operation. No part of a living fabric can be disclosed which is not indebted to this universal benefactor for its continued preservation — Even those very organs whose sole purpose it is to contribute nutritive materials are themselves dependent on its ministrations — To the Physician it must obviously appear a profitable, and paramountly important subject of investigation, when the fact is borne in mind that disorders of this process are the essence of almost every disease with which he is called upon to deal —

I. The evidence of the existence and necessity of Nutrition. It appears most natural to take this first into consideration, although its introduction as a department of the subject must not be understood to imply that it is ever called in question by an enlightened mind — Were any bold enough to deny that Nutrition must necessarily be carried on, his own returning appetite might be adduced as a satisfactory answer. Wherefore is the introduction of a copious and regular supply of aliment so indispensible to living beings, if it be not the fulfilment of some such object as this? Unquestionably some high end must be gained ere the materials taken into the body are excreted from it by the various Emunctories in new forms and combinations.

Its existence again is substantiated by reference to growth. We see an organ or a whole being rapidly increasing in weight and bulk, an occurrence for which no other explanation can be given than that it has been the subject of the process of Nutrition. Growth essentially consists of the insertion or superaddition of particles, similar to those of which the organ is already composed; and in that insertion or superaddition the function of Nutrition is exercised.

The necessity then exists for Nutrition, is best illustrated by an examination of the proofs we have that the various tissues of the body during the lifetime of the entire organism are undergoing constant disintegration and decay. This death of the integral parts of a living body, whilst the whole retains its health and vigour, seems to be brought about either speedily, by their being called upon to discharge their functions with unusual vigour, or more slowly from their having attained the utmost limit of the lifetime assigned to such parts. In some portions of the body the waste of cells composing it is visible to the eye. We refer to the skin and mucous membrane. The cuticular scales of the former are being constantly removed by the friction of rough bodies with which it comes in contact: and the epithelial cells of the latter are in like manner shed at intervals, probably assisted in part by the attrition of matters made to pass over their surface. In the developements of both the skin, (as in the hair and nails) and of the mucous membrane (as in the teeth, and secreting glands connected with the alimentary canal) the death and removal from the body of portions of its substance is peculiarly manifest – Though the same facilities for observing the decay of parts further removed from the surface of the body, are not afforded us, still many circumstances conduce in leading us to an analogous opinion with regard to them – Let us take the case of nervous matter, and muscle, every time their functions are discharged, we have grounds for believing that a certain amount of waste results. Prolonged and excessive mental exercise has been found to induce a marked increase ~~of~~ the alkaline phosphates in the urine voided shortly afterwards: a result which Dr Bence Jones has shewn to follow inflammation of the brain – Great and long continued muscular exertion is likewise found to affect the composition of the urine, causing ~~to~~ urea to be excreted in more than usual quantity –

Helmholtz by analysing the muscles of the limb of a frog, which had been made to undergo powerful and oft repeated contractions by means of Electricity, found it altered thereby in its chemical composition. It is true, we do not discover diminution in the bulk of an organ which has been actively exercised, though this might be expected if waste follows exercise. On the contrary we generally find that the size of an organ increases with the activity of its functions. This is explained, not by saying that the constituent parts suffer no decay, but that the process of growth and nutrition which that decay renders necessary, is called into more energetic action.

The necessity and importance of nutrition may be further made apparent by considering the consequences of its impairment. The sources whence this derangement may arise, are multifarious as the conditions required for its healthful maintainance. A few examples may be sufficient to shew how indispensable Nutrition is, to the vigour and even life of an organ or being; but indeed examples are scarcely needed, for what are all organic diseases, but instances of exalted, diminished, or perverted Nutrition? The following case of Gangrene of both Extremities recorded by H. W. Fuller of St. George's Hospital, in the London Med: Gazette Vol: 40. may serve as well as any other to illustrate the direful consequences of obstruction to the circulation and consequent obstruction to Nutrition. "The patient" he says: "a tolerably healthy woman aet 37. was suddenly seized on the 8th June with a severe pain in the right foot, which extended up the leg. Three days afterwards when admitted into the Hospital her right leg was so exquisitely tender, that the slightest touch caused intolerable pain. Her Extremities however were neither discoloured nor oedematous - with the exception of albuminous urine there was no evidence of constitutional disturbance, or of any real mischief at the seat of pain. Ten days after the commencement of her illness the superficial veins on the right foot and ankle became rather more distinctly marked than usual, and the foot rather cooler than the corresponding extremity - On the 22nd the coldness became so manifest, and the foot at the same time so distinctly mottled in appearance that there could no longer be any doubt on the matter - The gangrene which had commenced continued to spread till it had involved the whole of the right extremity. On the 30th the left foot began to mortify, and ultimately the left leg, and corresponding thigh - The parts throughout remained icy cold - She sunk on the 15th of July - On making a post mortem examination every organ was found perfectly healthy, with the exception of the Kidneys, which presented a well marked specimen of granular degeneration - The blood vessels both arteries and veins presented a healthy appearance. But the lower part of the abdominal aorta, the arteries given off by the superior mesenteric, and the arteries of the affected limbs, together with their corresponding veins, were completely blocked up with firm fibrinous coagula, which were in great measure discoloured, and slightly adherent to the internal coats of these vessels". In this case the circulation of the nourishing fluid throughout the lower limbs being obstructed by these fibrinous coagula, the nutritive process in the various tissues could no longer be upheld, and as the result the limbs died "en masse" shewing us emphatically, how necessary it is for the life of a member that nutrition be unceasingly carried on—

Another example may be given from the experiments of Magendie to shew the fatal results of impaired nutrition. He took a dog three years old, fat, and in good health and put it to feed upon sugar alone, and gave it distilled water to drink. It appeared very well in this way of living, he says, for the first seven or eight days; it was brisk, active, ate eagerly, and drank in its usual manner. It began to get thin the second week, though it had always a good appetite, and took about six or eight ounces of Sugar in twenty four hours. Its alvine evacuations were neither frequent nor copious; that of the urine was very abundant. In the third week its leanness increased, its strength diminished, the animal lost its liveliness, its appetite was much lessened, ultimately it became so weak that it could neither chew nor swallow; for the same reason every other motion was impossible. On the thirty second day of the experiment it expired. On subsequently opening the body it was found totally destitute of fat; the muscles were reduced more than five sixths of their ordinary size, the stomach and intestines also were much diminished in volume and strongly contracted. In this case though an adequate supply of blood was furnished to every organ of the body, yet because that blood was deficient in quality, the animal lost flesh & strength and speedily died. Such an experiment as this, and others of a like nature instituted by Magendie, while they supply us with information respecting the dietetic combinations required for maintaining the quality of the blood, at the same time illustrates the necessity of a constant and healthful activity in the process of nutrition, which that blood is destined to sustain —

II The conditions requisite for healthful nutrition. The following may be regarded as the chief of those conditions, though there are no doubt others of less import —

1. A due supply of nutritive fluid
2. A proper quality of nutritive fluid
3. A healthful state of the part to be nourished
4. A certain temperature -
5. A certain influence of the nervous System.

These we shall bring under consideration seriatim —

1. A due supply of nutritive fluid — In animals the blood constitutes this nutritive fluid. In vegetables the sap. It is easy to understand how this condition should be so necessary from what has already been stated with reference to the waste of tissues from exercise, and their decay from old age. Unless there was

at hand a supply of material from which these disintegrated particles might be replaced, atrophy and speedy death could not fail to follow. Examples of this kind are so common that illustrations are scarcely required. To this cause we must ascribe the death of a limb after ligature of its main artery, when collateral circulation has been imperfectly established. Dry gangrene occurring in the limbs of an old man whose arteries have become calcareous, and whose heart is enfeebled in its action — And the sickly aspect and diminished stature of trees whose trunks are begirt with ivy — It is this principle which the Surgeon frequently applies in the treatment of Erectile tumours. He places a ligature firmly around their base, and in a few days they blacken, die, and are separated from the body. Thus we see that the diminution of the supply of nutritive fluid interferes with nutrition and thereby endangers life — But the opposite extreme an excessive supply of nutritive fluid likewise induces a depart-ure from the healthy standard of nutrition. Hypertrophy of organs seems very often to arise from this cause, and an excess of blood is the chief feature, and gives an explanation of the prominent symptoms of inflammation in any part. That a determination of blood is the primary cause of hypertrophy appears evident. That it is so in every case however, may be fairly called in question. Such an experiment as that of Hunters, when by transplanting the spur of a cock to its comb it was found to grow to an enormous size, The in-creased growth of hair around a chronic ulcer — and the enlargement of bone whilst necrosis is taking place in the neighbour-hood, proves that exaltation of nutrition follows an afflux of blood, and in such instances it is reasonable to regard the latter as the determining cause — There are other cases however where the enlarge-ment of the vessels and increased supply of blood seem to result from an exaltation of the formation power of the part - the latter in those cases being the primary cause of hypertrophy. The formation of many homologous tumours can be best explained in that way - some of which at no time present much vascularity -

There are structures in the body which possess no bloodvessels - the non vascular tissues as they are called such as cartilages, cuticle, the vitreous humour, and cornea. These at first sight would seem to be independent of the condition under consideration, a due supply of blood - They are nourished, grow, and undergo changes like other parts of the body to which blood is indispensable, yet they contain no blood in their interior - The explanation of this apparent exception to the rule laid down is not difficult. A due supply of blood is needful for their nourishment, but it is not requisite that that blood should penetrate their structure, and come into intimate contact with them - It is enough for them that it freely circulate on their surface. Their component particles have an affinity for those constituents of the blood capable of nourishing them. So strong, that they attract them at an unusual distance. These instances do not teach us that a nutritive fluid can be wanted, but that it can afford support to certain organs at some little distance from them -

2nd <u>A proper quality of nutritive fluid</u>
However abundant may be the amount of blood in the body generally, or in an individual part, if it do not attain to a due standard of quality the process of nutrition will be interrupted or perverted - No doubt there is a certain latitude within which the constituents of the blood may vary, consistently with health. Indeed if the blood was invariably composed of the same elements, in the same proportion, the nutritive process, and the health of human beings might be seriously interfered with - There are certain states of the body in which an increased

demand exists for particular elements of the blood. The Esquimaux for example has a great demand in his system for hydro-carbonaceous matters in order that he may keep up the temperature of his body. To comply with this want. (his appetite impelling him) he eats and thereby loads his blood with an enormous quantity of fatty matters. The blood may be said to be of the proper quality when it is adapted to the wants of the tissues -

The causes which may produce derangement of this condition are exceedingly numerous. They are such as the following. Deficient supply of the elements of nutrition from without. Diseases of the digestive organs interfering with chylification - Diseases of the organs of respiration, and of the organs of excretion - Foreign matters received into the circulation from without &c &c - In briefly considering the derangements themselves we shall include most of them under the following heads. 1. Excess of the nutritive constituents of the blood 2. Deficiency of the nutritive elements of the blood. 3. Extraneous matters present in the circulation.

We have an example of the first class of these derangements occurring in conjunction with superabundance of the quantity of the blood in what is called Plethora. A condition which becomes established when the growth and increase of the body has been completed, and the blood still continues to be formed abundantly. The patient generally lives well, and takes little exercise, thereby hindering the activity of the organs of excretion. This condition though not of itself eminently injurious must be regarded as both unnatural and unsafe. Inflammations occurring in such a system are well known to be peculiarly violent. Sometimes we have evidence of the presence of one particular constituent in unusual abundance. As in the case of fatty matters. When these are not eliminated in sufficient quantity by their peculiar channels of excretion the lungs and the liver, they are stored up in cells in certain unoccupied localities throughout the body. In these positions they may increase to such an enormous extent as ultimately to prove fatal. Fibrine too is sometimes very abundant as in cases where the process of disintegration is going on rapidly in certain structures. Puerperal women have it circulating within them in unusual quantity, whilst the muscular tissue of the Uterus is undergoing rapid diminution, and in inflammations its excess is manifested by the well known buffy coat. The bad consequences of this unnatural condition are usually prevented by the facility with which the blood rectifies itself through the channels of Excretion — As an excess of nutrient material in the system generally is injurious, so locally it may prove injurious, bringing on a state of hypertrophy —

2. The opposite derangement referred to. A deficiency of nutritive materials. When

it affects the whole mass of blood, and is associated with diminution of its quantity constitutes Anaemia. This state is seen to arise when blood is abstracted intentionally in small quantity at short intervals, or when the same result is produced by disease, as in bleeding piles and uterine hemorrhage. These causes by long continuance induce great pallor of the skin, so that the ailment of the patient might be confidently predicted before subjecting him to an examination. The blood of such patients when withdrawn betokens its poverty to the eye. It is seen to be unusually watery, and to form but a scanty clot on coagulation. This condition of the blood is seldom present without giving origin speedily to some ailment. Functional disease of the heart. Irregularities of the circulation. Local determinations of blood, & in Girls to amenorrhoea &c. It is a morbid state ~~state~~ less easily remedied than the one we have already referred to. Consequences equally injurious follow the withdrawal of one particular element of the blood while the others are present in normal quantity. We have already alluded to Magendie's Experiments, which give satisfactory proof that animals can subsist only for a limited period when fed upon non nitrogenous substances; and that the absence of the oily constituents of the blood may give rise to serious disease has in more modern times been established by the researches of Dr Bennett. The mineral elements are required in less quantity than the others, but are not less indispensable. This is well illustrated in the case of common salt. Feeders of cattle are well acquainted with its singularly beneficial effects on the condition of their stock under certain circumstances.

3. The quality of the blood again may be impaired by its admixture with a foreign substance. These foreign substances are frequently of so subtle a nature that they escape the scrutiny of chemical

analysis. Their peculiar characteristics being ascertained indirectly by the unequivocal symptoms which their presence in the system invariably induces. There are others however which while their presence is suspected by the peculiar symptoms they generate, are also detected in the blood or tissues by the more direct instrumentality of Chemistry. Let us glance at the sources of these poisons. Many of them, indeed the majority are introduced from without, and their channels of Entrance are numerous. Some most easily obtain a passage into the circulation by following the course of the nutritious Elements of food - Passing along the alimentary canal they may be absorbed by the veins at once if in a fluid form, or surviving the processes of chylification and assimilation they may enter the circulation by the lymphatics. Of this class we have examples in many poisonous drugs. Others, or it may be the same poisons are introduced through the skin by inoculation, reaching the circulation either by the lymphatics or veins. The various contagious diseases, properly so called are transmitted through that channel. The poison of infectious diseases would seem also partly to gain entrance by the skin, though they are in a gaseous form. We know that poisonous gases may produce their effects on the body when the skin is the only channel through which they could enter the system, as has been illustrated by Carbonic acid. An animal enveloped in an atmosphere of that gas, perishes in a short time, although permitted to breathe pure air. Poisons in the gaseous form however pass into the blood more easily through the lungs, the channel we have next to mention –

In the lungs there is a most extensive surface exposed to the inhaled air which is separated from the circulating blood merely by the intervention of comparatively thin membranes. Interchanges between the oxygen of the ~~blood~~ atmosphere, and the Carbonic acid of the blood are continually taking place to an enormous extent in health, the oxygen passing in and the carbonic acid passing out. There is therefore the greatest facility for the ingress of a virus which has the gaseous form, and is floating in the atmosphere. Of the class of animal poisons which reach the system through the lungs, we may specify the strictly infectious diseases, which operate though the patient giving origin to them be at a considerable distance. The morbid material whatever it is being wafted through the atmosphere, is inhaled, and easily absorbed into the system. These infections we have said may reach the system by the skin, but as they can be brought into so close a proximity to the blood by the lungs, they no doubt get entrance chiefly through that channel. There are other morbid poisons whose source is within the system, and some of which exist normally in the blood in small quantity, their great accumulation only being attended with danger. We have instances of these in the excretions. Urea Bile. Carbonic acid and Sugar — These are present in undue proportion when the several organs set apart for their removal from the system have become so diseased as to be incompetent for their functions. Pyemia — a too frequent sequela of Surgical operations is another example of a poison generated in the body itself. In this case however the morbid matter does not exist normally in the blood, but is formed from the blastema exuded from it in certain circumstances, and can only enter the circulation through the open mouths of cut or torn veins —

It is necessary in this place to advert to a theory first suggested by Treviranus and subsequently developed and extended by Mr. Paget. A theory which if true, would lead us to regard as sometimes poisonous, substances which have hitherto been thought only beneficial and nourishing in their action. Treviranus expresses himself thus. "Each single part of the body in respect of its nutrition, stands to the whole body in the relation of an excreted substance". The evident interpretation of this is, as Paget remarks, that every part of the body by taking from the blood the peculiar substances which it needs for its own nutrition, does thereby act as an excretory organ, inasmuch as it removes from the blood that which if retained in it, would be injurious to the nutrition of the rest of the body. The hypothesis is upheld by reasoning in this way. The polypiferous Zoophytes all excrete large quantities of calcareous and siliceous earths. In those which have no stony skeleton these earths are absolutely and utterly excreted; but in those in which they form the skeleton, they are, though retained within the body, yet as truly excreted from the blood and all other parts, as if they had been thrown out and washed away. So the phosphates which are deposited in our bones, are as effectually excreted from the blood, and the other tissues, as those which are discharged with the urine". "Each nascent organ" Paget says, in applying the theory to the history of developement "takes from the nutritive material its appropriate constituents: so it will cooperate with the general self developement of the blood, to induce in it that condition which is essential or most favourable, to the formation of the organs next in order to be developed". By means of this theory an explanation is offered of the connection between the developement of the sexual organs, and the growth of the various appendages of the integument which furnish the sexual characters. The latter he believes to be a consequence or necessary coincidence of the former. They have no manifest connection in their external office, but Mr. Paget believes that the connection lies in their nutrition, "one being partly formed of the materials left in the blood by the formation of the other". The hypothesis is certainly one of great ingenuity and beauty, and so far as we are aware, no facts which militate seriously against it, have as yet been adduced. Whether it is universal in its application however may perhaps be fairly questioned - Before embracing it in all its extent, it is desirable that the facts on which it is founded should be more numerous and better sifted -

It is not our design to enter into a consideration of the manner in which the individual poisons exercise their injurious influence on the body; though such an undertaking would be less extensive in the present day, than at an earlier period of the history of medicine, during the reign of the humoral Pathology. Suffice it, that we allude to a very interesting fact in relation to nutrition which certain of these morbid matters point out and establish. viz: that particular parts of the same tissue may at the same time be possessed of very different affinities. This has been well brought out by Dr Wm Budd in a paper on the Symmetrical diseases, inserted in the Medico Chirg: Transactions. Those morbid materials in the blood which produce their evil consequences by entering into combination with particular tissues of the body, are not taken up by every part of these structures, but passing by some parts, they are absorbed and incorporated with others, which have an affinity for them - We are made aware of the presence of such poisons as the Syphilitic, the Mercurial, and the Lead in any of the solids of the body by the changes which their presence gives rise to, and while we see some spots of an individual tissue suffering from their presence, we see other spots healthy and unscathed. This occurrence cannot be explained by supposing that the poison had never been presented to these healthy parts, for we often observe ~~these~~ ~~healthy~~ affected parts scattered amongst the sound portions, and we cannot but suppose that both are exposed to the same tainted fluid - It cannot depend on a difference in anatomical structure, because the tissues are identical. The only rational explanation left us, is that the affinities of adjacent portions for the poison are different - Dr Budd has also shewn that a law of symmetry on the corresponding parts of the body prevails in most eruptive diseases. The most complex patterns assumed by the eruption on one side of the body, being delineated on the other with the greatest exactitude. He admits that there are many causes at work to interrupt the manifestation of this law, but argues that the frequency of the occurrence of symmetry renders it excessively probable that these diseases have a tendency to shew themselves in that manner. From this we learn that though adjacent portions of the same tissue on one side of the body have different affinities for a particular morbid material; the portions of tissue occupying a similar position on the two sides are possessed of the same. We cannot well account for such facts. Had the tissues been different in which the diversity of affinity appeared, it would not be so strange, but so far as appears to the acutest observers their structure is not to be distinguished. Though it be difficult to explain such facts, we are evidently taught by them that the affinities exercised by the solids in the nutritive process are of a peculiarly nice and delicate description: and that these affinities are similar on the positions corresponding to each other on the two sides of the body.

Having said thus much on the second condition essential for the right performance of the process of nutrition, we proceed to speak shortly of the,

3rd. A healthful state of the part to be nourished. The nutritive fluid and the solid tissues constitute the parts betwixt which the process of nutrition is conducted. We have already discussed the former of these, shewing the importance of its presence in due quantity and quality, and this we have been enabled to do by referring principally to the evil consequences of deviations from these conditions: for their importance can be best appreciated by attending to the evils resulting from their absence. It would seem that the earlier Physicians were duly or rather unduly impressed with the importance of healthy blood. They gave it a first place amongst the four humours, which in their opinion were the primary seats of every variety of disease. This exclusive and undue regard to the fluids in pathology prevailed from the days of Hippocrates down to the time of Hoffman - when, principally through the instrumentality of the latter and his followers there was a complete revulsion of the prevailing views, and the solids began to be looked upon as the only source of disease - In speaking of a healthy state of the solids to be nourished, it is right that we should have a ~~right~~ just understanding of what is included under the term "Solids". It appears to us that the term is not to be restricted to the various structures of the body, in which the component particles are held together by areolar tissue. We would classify amongst the solids those globules which are not maintained in close juxta position but float about in a surrounding fluid - The blood globules would therefore come under this category - for in respect of their nutrition they are to be regarded in the same light as a nerve or fat cell - the only difference being that they are placed within the vessels instead of outside - The nutritive material in order to reach them, has not to pass through capillary coats, but merely through the thin walls of the globules.

After what has been said on the importance of a right quality, and due quantity of the nutritive fluid, it will not be difficult to perceive that the nourished parts must likewise be in a healthful state in order that nutrition may be carried on normally. The solids as they are generally in a fixed position are regarded as giving origin to the affinities or forces by which nutritive materials are abstracted from the moving blood. Any alterations of the affinities therefore may be reckoned as due to the solids. We have made reference already to the great delicacy and exactness of the assimilative force: which is illustrated by the presence of a morbid material in the blood. So refined does it seem to be that cells of the same kind lying side by side may attract and incorporate with themselves entirely different materials from a common fluid - This force is exercised in withdrawing from the blood matters similar or capable of being made like to the cells from which the force issued, as is implied by the term Assimilation. In both health and disease does the latter statement hold good - While the textures themselves retain their normal state, the affinities they exercise are normal, and matters capable of assuming all their properties are received by them - When from any cause the textures of the body become morbidly altered, their affinities likewise are changed, but still they absorb materials capable of assuming their altered form and properties. The persistence of cicatrices, and the changes effected on the blood by diseases which occur but once in the same individual are instances of parts altered by disease having a changed assimilation. The solids in order to perform their part in nutrition rightly must not only retain their healthy nature and composition, and thereby their normal affinities but they must exercise those affinities with a due degree of power. In the same way as the blood may be superabundant or diminished in quantity, so may the affinities be increased or diminished. And the bad results which follow the former, it is easy to understand will as universally follow the latter; indeed the results are very much alike. It is often very difficult to say which was the primary cause of Hypertrophy of an organ - an increased supply of blood, or an exaltation of the assimilative force. The two as we shall afterwards shew have an intimate relation to each other - An unusual abundance of nutritive material stimulates the assimilative force - And an increased assimilative force induces a determination of blood to that part. They thus act and react on each other. Sometimes Hypertrophy can be traced to the one cause. Sometimes to the other. Atrophy likewise in certain cases evidently arises from the withdrawal of the blood - in others it may be more fairly referred to diminished nutritive force -

4. A certain temperature.

The exact degree of temperature best adapted for nutrition in organized beings varies exceedingly; but for each of them a certain temperature is needed in order that they may be developed, and grow, and sustain themselves - The distribution of plants and animals over the earths surface is greatly owing to this cause. Some are only to be found and can only thrive in the cold and wintry regions of the frigid Zone - Others again require the elevated heat of the tropics - Human beings it is true are scattered everywhere.

over the globe. The same individual could subsist either in the polar regions or in the torrid zone. He is enabled to do this however, not because he is insensible to the effects of temperature, but because by his ingenuity he is enabled to devise means for maintaining the requisite amount of heat - Although there are plants and animals which require a low temperature for health and even life; it may be stated as a general rule that within certain limits heat is more conducive to nutrition than cold - The plants produced in the northern latitudes are stunted and dwarfish in their appearance, and are thinly scattered. What vegetation does exist, germinates and grows chiefly during the brief periodic visit of the sun - As we advance from the cold-freezing climate of the poles, through the temperate zone to the tropics, vegetation is seen to grow more abundant and luxuriant - Under the influence of an elevated temperature the operations of vegetable life are carried on with amazing rapidity, and to an enormous extent - A seed which has been buried in the ground a few days, makes its appearance above the surface, puts forth its leaves, and in no long time attains a gigantic size. When we desire to promote and hasten the growth of plants, it is the well known resort to place them in a hot house, a fact which gives the testimony of Experience to the salutary effect of heat in the nutritive process. In warm blooded animals a temperature higher than the surrounding medium is usually necessary for the operations of nutrition, and that condition is fulfilled by a wise and beautiful provision - The very process of nutrition for which heat is necessary, itself produces that requisite heat - The effete carbonaceous matter of the tissues, passing into the capillaries, comes in contact with the oxygen which has been carried thither from the lungs either in a combined or free state - and meeting each other they unite to form Carbonic acid, and in so doing evolve heat. In short combustion takes place, and as it does so in every quarter whether arterial blood is propelled, and wherever nutrition is carried on, the temperature of the body is at all points upheld. We thus see that the operations of living beings are carried on, on principles of the strictest Economy. Nothing is permitted to run to waste which can be applied to a useful purpose. The materials which can no longer maintain their place as a part of the living fabric are turned to the useful purpose of supporting a condition essential to the assimilation of fresh particles -

5. The influence of the Nervous System

This is a condition evidently not so indispensable to Nutrition as the others; because we perceive that in many cases, as in the vegetable kingdom, and in the lowest class of animals - the process is carried on extensively where no nervous system exists. In the higher classes of animals and especially in man where the nervous system is highly developed it no doubt modifies the action of nutrition, and is as essential to it as it is to all other vital actions. Its effect on nutrition and secretion is frequently produced in an indirect manner by affecting the circulation. This it may do either by producing some effect on the hearts action, or by acting on the capillaries so as to accelerate the flowing of blood in them. That it does affect the flow of blood is evidenced by the results of emotions of the mind, as in the blush of shame, and the pallor of fear. It is well known that the coats of the bloodvessels are abundantly supplied with nervous twigs from the sympathetic system. So that the varying supply of blood to particular organs resulting from these emotions is easily explained. This indirect influence is exerted, in increasing or diminishing the function of nutrition and secretion according to the various wants of the system in health - and it is understood to play a prominent and essential part in the phenomena of disease - It is supposed by many that the first step in the inflammatory process is taken by the nervous system. An impression being made on the extremities of sensory nerves, it is transmitted to the nervous centre - A stimulus is thence reflected to filaments distributed on the bloodvessels, causing an increased determination of blood - But while the nervous system may thus affect nutrition indirectly, there is reason to believe that it also exerts a direct and immediate influence on the molecular changes of which the function of nutrition consists - This is perhaps best illustrated by instances of vitiated secretion which emotions of the mind generate - A mere increase or diminution of the quantity of a secretion, brought about by mental emotions, may be explained as occurring indirectly, through the intervention of a determination of blood. But when the secretion becomes altered in its character we apprehend that it must be ascribed to a direct influence exerted by the nervous system on the secreting apparatus - An Examples of vitiated secretion we sometimes have in the milk - The following interesting case is frequently quoted to illustrate it - "A carpenter having quarrelled with a soldier billeted in his house, was set upon by the latter with a drawn sword. The carpenter's wife at first trembled with fear and terror, and then suddenly threw herself between the combatants, wrested the sword from the soldier's hand, broke it in pieces, and threw it away. During the tumult some neighbours came in and separated the men. While in this state of strong excitement, the mother took up her child from the cradle, where it lay playing and in the most perfect health, never having had a moments illness. She gave it the breast and in so doing sealed its fate. In a few minutes the infant left off sucking, became restless, panted, and sank dead upon the mother's bosom." Dr. Carpenter relates another case in which a strong impression was produced on the mind of a mother, on hearing that the infant child of an intimate friend had died suddenly. She shortly afterwards gave her child suck, and placed it in the cradle asleep, and apparently in good health: her attention was shortly attracted to it by a noise, and on going to the cradle she found her infant in a convulsion which lasted for a few moments, and then left it dead.

Other secretions likewise may become vitiated by mental emotions. The Urine has been observed to give off a peculiarly disagreeable odour under the influence of fear: and the halitus of the lungs is sometimes almost instantaneously affected by bad news, so as to produce foetid breath.

It has been made a question, which of the varieties of nerves has to do with the nutritive process. The motor, sensory or sympathetic filaments - Some have advocated the claims of one class. Some the claims of another. In behalf of each of them good evidence has been furnished: and it seems the most reasonable conclusion that they have all a more or less intimate relation to nutrition. The motor nerves however seem to influence nutrition in a somewhat indirect manner. When the motor supply is cut off from an organ, say the muscles of a limb - the extremity is shortly seen to suffer atrophy. But it has been pointed out by Dr. I. Reid that the ~~primary~~ cause of this wasting is not ~~an immediate effect~~ of the withdrawal of nervous influence from the part, but "the state of inaction into which the limb is thrown". The following experiment performed by him suffices to prove the point: The spinal nerves were cut across, as they lie in the lower part of the spinal canal, in four frogs, and both posterior extremities were thus insulated from their nervous connexions with the spinal cord - The muscles of one of the paralyzed limbs were daily exercised by a weak galvanic battery, while the muscles of the other limb were allowed to lie quiescent. This was continued for two months, and at the end of that time, the muscles of the exercised limb retained their original size and firmness, and contracted vigorously, while those of the quiescent limb had shrunk to at least one half of their former bulk, and presented a marked contrast to those of the exercised limb -

II. The mode in which the process of nutrition is carried on.

This is a department of the subject of peculiar interest and importance, but one which still continues, and is likely long to remain enveloped in much mystery - The molecular changes going on in the tissues of the living body are screened from the gaze of the most patient observer. All that we know about them therefore must be derived from indirect sources. The vascular system was at one time supposed to play an essential part in the process under consideration. By the contraction of the vessels, it was understood that the blastema was made to transude into the substance of the surrounding textures, and furnish them with nutrient material. But it is now known that the vessels are perfectly passive in the minute operations of nutrition, and serve no such mechanical purpose. It is necessary that the vessels be of small size, and possessed of thin coats, so as to permit the easy passage of fluids, to qualify them for ministering to nutrition. These qualifications are admirably illustrated in the capillary system of vessels. Their coats are so thin that it is with great difficulty they can be demonstrated under the microscope - and they communicate so extensively with each other forming a close meshwork that they bring the blood into close contact with all the tissues. On examining the circulation in the Capillaries by the microscope, which can easily be done in the web of a frogs foot, a rapid current is observed in the centre of the vessel, in which the red corpuscles are involved. whilst near the side walls of the vessel the fluid is seen to glide more slowly along. This lateral current consists of liquor sanguinis, together with a number of white corpuscles, and would seem to be that portion of the blood which is concerned in the nutritive process. Its composition and the slowness of its movement admirably adapt it for such a purpose.

Two actions appear to take place simultaneously in the nutrition of any part. The one being the passage outwards of the nutritive fluid through the coats of the capillaries into the intervascular spaces. The other being the passage backwards of the debris of disintegrated cells, and the unappropriated parts of the nutritive fluid into the current of the circulation. A similar change takes place between the oxygen of the blood and the Carbonic acid of the tissues. These two objects are attained by one process that of Endosmose and Exosmose. The albuminous fluid passing into the intervascular spaces furnishes at once the condition and stimulus for growth. New cells are generated from germs furnished by the adjacent tissues, and growing cells select and appropriate the the requisite elements. Those constituents of the tissues which have already reached the term of their existence break down, and intermingling with the surrounding fluid so deteriorate its composition as to render its removal, and a fresh supply of healthy material from the blood indispensable. We can easily perceive from the foregoing the necessity for the circulation of the blood. Were it to remain stagnant for any length of time, it would become charged with impurities and retain little of what is requisite for nourishment.

Endosmose and exosmose would cease, and consequently the operations of nutrition would likewise be brought to a stand - The circulation which in part maintained by the action of the heart, is not wholly dependent on it for its continuence. The blood is seen to circulate where no heart exists, as in the early foetus. It has been made sufficiently plain, that the molecular changes connected with nutrition in the parenchyma of organs, which themselves dependent on the circulation for their maintenance, do to a great extent aid in its production. How does the nutritive process thus lend a helping hand in upholding the circulation? Dr. Cappie gives the following explanation in a paper inserted in the CXCVIII No. of the Edinr. Medical & Surgical Journal. His representation of it appears to us so good that it may best be given in his own words" So soon as interchange has been effected to the smallest extent at any point, the tendency to its further continuance must immediately become diminished. but in regard to the fluid at an insensible distance behind it, in the direction of the arteries, this tendency is increased. To use a common form of expression, but not strictly precise, we may say that when interchange has taken place, the attraction of the fluid in the intervascular space for the blood within the capillary becomes at that point weaker, while it is comparatively stronger for the blood at an insensible distance behind it. The latter must therefore drive the other before it, and the same series of phenomena will continue to be repeated as long as conditions continue favourable. The vital operations constitute a constantly operating cause of change in the intervascular spaces, and the arterial blood presents a fluid capable of affording ready interchange, and of sustaining these vital operations. A constantly operating force is thus brought to bear upon the movement of the blood." —

It has been made a question respecting

Nutrition - (and it will not be out of place to refer to it here) - whether the materials destined for the nutrition of the tissues exist ready formed in the blood, and are merely withdrawn by the tissues - or undergo the necessary transformations in the tissues themselves, whilst they are being appropriated. The former hypothesis is defended by Mr. Paget, and is supported by arguing in this way. The blood on being subjected to the simplest Chemical analysis is found to contain those substances which by mere separation are fitted to give support to the various tissues - such substances for instance, as Fibrine - Albumen - Water - Oil, and Phosphate of Lime and Magnesia - Again certain cases of disease of glandular organs in which the secretions were found in the blood, and separated by other channels would seem to countenance the view, that all structures are formed by mere separation of the necessary constituents from the blood - Now while it is admitted that there are some secretions which are ready formed in the blood, and can be detected there, and are merely withdrawn by the secreting organs - there are textures which may be pointed to, containing substances which can by no means be obtained from the blood - We allude chiefly to gelatin, which can be obtained from many animal textures by boiling with water - while blood subjected to the same process cannot be made to yield it - The gelatinous tissues therefore evidently obtain their nourishment by transforming the elements of the blood -

There is only one other point to which we would direct attention before drawing these remarks to a close - By what power is it that cells, bathed by a nutritive blastema incorporate with their substance those elements required for their support? Are the phenomena of nutrition to be adequately explained by reference to chemical affinity alone?

Or may they more accurately be ascribed to what has been termed Vital affinity? Both views are upheld by able Physiologists. The former Explanation has been maintained by such men as Dr Daubeny and Baron Humboldt. And the latter has been defended in a most sagacious and philosophical manner by Dr. Alison. Let us understand these respective views more accurately, and point out wherein the difference of opinion rests. It is admitted by those who attribute the phenomena of Nutrition to Chemical action, that in the living body these actions undergo a most peculiar modification, and form products which which can be generated under no other circumstances. It is well known that the organic compounds are characterized and distinguished from the inorganic by great complexity in constitution & by the definite nature of their form, which is never crystalline and is regulated not by chemical constitution, but by the nature of their living progenitors, and the particles by which they are surrounded. These changes in chemical action however they believe to originate from, and to be satisfactorily explained by the peculiarity in the circumstances in which they are developed. On the other hand those who defend the doctrine of vital affinity, while they are of opinion that the phenomena of nutrition, viz. the selection and extraction from a compound fluid by a compound solid of certain portions of that fluid already elaborated are due to chemical action. they believe it to be ~~regulated~~ of so peculiar a nature and regulated by laws so unexpected that it may be termed an exercise of vital affinity - The vital principle it is right to state is a term expressive of what is supposed to originate those phenomena in living beings which are inexplicable by, and inconsistent with the laws regulating the changes in other matter - The chief point of difference between these views we perceive therefore to be - Whether the phenomena of nutrition should be reckoned as coming under a branch of Chemistry for their explanation, or should be removed to the Category of vital actions, so as to constitute a separate branch of Science, and deserve a separate inquiry. The points of agreement are so essential that the dispute may be regarded as to a great extent a verbal one; but we conceive there are advantages in adopting the view that the molecular changes in nutrition are due to vital affinity, and conclude by making the following quotation from a paper by Dr. Alison inserted in the Medical & Surgical Journal Vol LXXIX: in which the errors which may be committed by those who hold an opposite view are referred to: "So long as we adhere to the supposition that there is nothing truly vital or peculiar to living beings in their economy (as regards their organic functions) except motion, and that motion derived from contraction of solids and impulse, the notions that we can form of the nature of these functions in health, and of the deviations from that state in disease, must necessarily be erroneous, because we shall always be looking in the wrong direction for the cause of these phenomena; and at this precise point the most plausible medical theories of the last, and even of the present age have gone astray" –

James D. Maclaren