coloured fibrine intersecting each other. Large portions of loosely coagulated blood were found in all the cavities; some of these clots were of a rusty colour, others approached nearer to the natural colour of the blood. The lung was compressed against the spine, and the whole surface of the pleural sac was coated by a false membrane, about two lines in thickness, formed by coagulated fibrine. The fibrine which lined the pleura pulmonalis and pleura diaphragmatica, presented on its inner surface a smooth and polished appearance, and in colour exactly resembled the yellowish fibrine found in the clots of the heart of this patient. So uniform was the coating, and so continuous was it throughout its whole extent, that it looked at first merely like thickened pleura; but this appearance was easily destroyed, by peeling off this adventitious membrane from the serous tissue, which there presented the same appearances as the pleura on the opposite side, with the exception of not being quite so smooth: there was neither thickening nor the slightest increase of vascularity in this pleura. A large rent, from which the hæmorrhage had proceeded was found in the substance of the lung.

CASE XL. A man was attacked with diffuse cellular inflammation of the inferior extremity, which terminated in two days with extensive gangrene of the skin. In the superficial and common femoral veins were extensive coagula; these did not completely fill the veins, but slightly adhered at different points to their internal coats. These clots still retained, in some places, the colouring matter of the blood, whilst at others the colourless fibrine alone remained; in both veins, the clots were enveloped in a perfectly transparent, smooth, and polished membrane, presenting the appearance of a serous tissue. In the structure of these membranes were several distinct arborescent vessels, minutely injected;[1] some of these vessels were of sufficient size to allow of the blood being made, by gentle pressure, to circulate through them; but no communication could be traced between these vessels and the coats of the veins. The membranes were easily peeled off from the surface of the clots with which they were in contact. The interior coats of the veins presented their natural colour and polished surfaces, except at the points where the slight adhesions above-mentioned existed.

ON THE MECHANISM OF TEXTURAL NUTRITION.

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THE first step in the actual process of nutrition, is the attraction of the homogeneous part of the blood by the tissues.[2] The blood being contained in the vessels, that part only which transudes through their walls into the parenchyma of the organs can contribute to nutrition. Hence, even though a large quantity of rich healthy blood be circulating through the vessels, the textures will be imperfectly nourished, unless sufficient

[1] Mr. Gray, the Curator of the Museum of St. George's Hospital, has recently shewed me the outer layer of an effusion of blood into the arachnoid cavity, injected from the middle meningeal artery.

[2] VALENTIN's Physiologie, Band 2, Sect. 2068. MUELLER's Physiologie, p. 75.

exudation takes place; but nutrition will be restored, so soon as an adequate quantity of blood is made to pass through the walls of the vessels. An excessive exudation of serum into the parenchyma, no doubt, likewise impedes nutrition, by producing pressure on the textures, and thus impeding their attractive power. That this is probably the case, may be inferred from the following considerations: 1. The evolution and nutrition of organs is impeded by pressure from without; and the same effect is no doubt produced by pressure from within. 2. The textures become atrophied, whenever they are pressed on by an adjoining part which has had its bulk enlarged by inflammation or other causes. 3. Inorganic processes are retarded by pressure; thus, crystallization can only take place when sufficient space is afforded. The organic processes, then, consisting in a selection and attraction of sinular parts, have the greater need of sufficient space.

The process of nutrition may then be supposed to be modified by all those forces, which cause an alteration in the quantity or quality of the blood effused into the parenchyma; or rather, by those influences which affect the transudation of the nutritive part of the blood through the coats of the vessels. The forces which modify the exudation of blood through the coats of the vessels are the following:—

1. *The Quantity of Blood Circulating in the Vessels.* The larger this quantity is, the more the vessels and their pores are distended, and more blood passes into the parenchyma, and *vice versâ.* If a fluid be driven through an elastic tube, the latter will be distended in proportion to the force applied.

2. *The Quantity of the Blood-Corpuscles.* Many blood-vessels *(vasa serosa)* are of smaller diameter than the blood-corpuscles; and hence must be distended when they pass through them. It is incorrect, and quite in contradiction to physical laws, to assert, with some physiologists, that the corpuscles are compressed and become elongated, in passing through these vessels. Being propelled by a *vis à tergo*, they must become broader, but never more slender. On pressing an elastic globe through an elastic tube, the former will not become thinner, but both will be distended. Hence, the more corpuscles there are in the blood, the more the vessels and their pores are distended.[1]

3. *The Energy of the Forces which Propel the Blood into the Small Vessels.* The capillaries and their pores are distended in direct proportion to the energy with which the blood is sent into them by the heart and large vessels. This may be demonstrated by forcing, with varied pressing power, a quantity of fluid through an elastic tube.

4. *The Temperature.* Within certain limits, a high temperature favours distension of the vessels, while a low one causes them to contract.[2]

We find, in the above principles, the explanation of many of the phenomena of health and disease.

I. The similarity between the symptoms of anæmia and those of hyperæmia, is evidently accounted for. In both diseases, nutrition is interrupted; in anæmia, by want of blood; in hyperæmia, by its super-

[1] HAAS (Dr.) Ueber die Function der Blutkörperchen. Œsterreichischer Jahrbücher, Jan. 1848.

[2] VALENTIN's Physiologie. Band i, sect. 1086.

fluity, which produces pressure on the tissues, and impedes their power of selection and assimilation. In hyperæmia, the vessels are over-distended, and too much blood passes through their coats into the parenchyma.

II. We find an explanation of the general organic weakness, which is constantly observed in fevers. The heart being, in these diseases, too energetic in action, the vessels are over-distended, and an excessive quantity of blood is effused, producing effects similar to those which occur in hyperæmia.

III. The secretions, as the urine, sweat, and saliva, are impeded in fevers by this pressure of the blood on the textures. In spite of the presence of a large quantity of blood in their parenchyma, the organs are in want of material to furnish the secretions; for they require a large proportion of water, which is not afforded by the blood which passes through the pores of the vessels in a fibrinous state. Bruck's experiments shew, that a large proportion of water and soluble salts, and very little albumen, pass through small pores; but that through large pores, such as there are in fevers, there pass very little water and saline matters, and much albumen. The parenchyma of the secreting organs, then, contains very little water in fevers. This impediment to the secreting functions, causes the retention in the blood of a large quantity of urea, saline matter, etc.; but after the fever had subsided, when the action of the heart has diminished, and the vessels are less distended, the quantity of blood is not only diminished, but becomes more watery: the secreting organs are stimulated to action by the matters which have been retained, and the blood is also more able to remove them. The urea and salts increase in the urine, producing a sediment, the appearance of which denotes a *crisis*.

IV. A diminution in the quantity of blood is the cause of the summer sleep of the amphibia. Berthold and Davy found the temperature of these animals always lower than that of the atmosphere: this is produced by the evaporation of water from their bodies increasing with the temperature. Hence, in a high temperature, the quantity of blood in these animals is much diminished by their losing a large quantity of water; and, in circulating through the vessels, it does not distend them sufficiently to allow the nutritive part to exude. Nutrition, then, being partially suspended, the animals fall into a lethargic state. This explanation is an accordance with the fact, that the amphibia creep into a hiding place in dry, and awake in wet weather. They are not awaked by being carried into a cold room, but by being immersed in water.

V. A similar explanation will account for the fact, that animals are unable to live longer than twenty days on dry food, without any fluid, while they can exist for fifty days when supplied with water alone, but in sufficient quantity. As long as the animals get no fluid, the blood loses water daily in the urine, saliva, sweat, and breath. This loss can never be repaired by dry food, for the stomach cannot digest a sufficient quantity. The blood, thus reduced in quantity, passes through the vessels without being able to distend them, and afford nutritive material, as in the summer-sleep of amphibia. The want of water also causes a thickening of the blood, which co-operates with its want of power to distend the vessels. But if the animals are supplied with a sufficient quantity of water, without any food, they survive for a longer time. Although water contains no nutritive material, and cannot be transformed into nervous or muscular tissue, it nevertheless indirectly contributes to nutrition, by increasing the quantity of the blood. The vessels are sufficiently distended, and the blood passes into the parenchyma, and supports life longer, in spite of its possessing very low nutritive power.

VI. The winter-sleep of animals has its origin, like the summer-sleep, in an interruption to nutrition. The summer-sleep is caused by the loss of water; the winter-sleep by the diminished activity of the heart's action, consequent on the influence of cold. It has been found that in hybernating animals, at the commencement of the winter-sleep, the pulsations of the heart subsided from 200 to 50 in a minute. The heart being thus weakened, is not able to propel the blood with sufficient force to distend the vessels, which are much more contracted in cold weather. In such circumstances, no blood passes through the pores into the parenchyma, nutrition is interrupted, and the animals fall into a state of asphyxia, losing the power of feeling and perceiving. The reason why some animals only are subject to hybernation, is to be found in their various degrees of sensibility. Those whose heart is unable to resist the weakening influence of cold, are seized on by winter-sleep. This explanation is confirmed by the fact, that we observe young animals asphyxiated by a degree of cold, which they would bear with impunity if full-grown. Legallois observed this in rabbits, six or eight weeks old.

The cold-blooded animals are also very soon overpowered by cold; but this is dependent on two causes. Not only are they more susceptible of the influence of cold, but their small quantity of blood acts at a disadvantage. The quantity of blood would be sufficient, if the heart acted with sufficient energy: but the heart's action failing, the blood merely circulates in the vessels, without being able to pass through their coats.

VII. The diminished activity of the heart, and the contraction of the vessels, in cold weather, explains why we are compelled to take a larger quantity of food in winter, or when living in a cold climate. We endeavour to supply the want of one force which contributes to nutrition, by increasing others—to make up for the insufficient action of the heart by increasing the quantity of blood. If a fluid be pressed through an elastic tube, its walls will be less distended as the force is diminished, but more distended if the quantity of fluid be increased. If the quantity of fluid be increased in the same proportion as the propelling force is decreased, the distension of the vessels remains the same. The degree in which cold impedes nutrition, may be observed in the inhabitants of the frigid zones. They are stinted in growth; their bodies are short, their muscles thin, their senses obtuse, their mental faculties very weak, and the sexual instinct, the catamenial flow, and the fecundity, are much less than in other people. The same quantity of blood, which is sufficient for nutrition in a warm climate, is not so in a cold one. In the latter also, the heart is less active, and the vessels more contracted. For effecting adequate nutrition, a certain quantity of blood must pass into the parenchyma; and if the heart cannot act with sufficient energy to propel sufficient blood to distend the vessels, the absolute quantity of blood must be increased: otherwise a general stinting of growth results.

As the blood is the carrier of animal heat, we encourage, by increasing its quantity, and especially its penetration through the walls of the vessels, not only the nutrition of the tissues, but also the sensation of external warmth. We possess more blood in winter than in summer, and are hence more disposed to inflammation in the former season. We more easily, and for the same reason, bear a high temperature in the winter than in the summer. Warmth excites the heart's action, and promotes distension of the vessels: and if these at the same time contain much blood, congestions and inflammations are liable to occur.

The opinion of Liebig, that we are obliged to eat more in winter than in summer, because we inspire more oxygen, is not adequate to explain the facts above referred to: 1. According to Liebig, we possess in summer more blood than in winter, in which latter season the oxygen consumes more of the blood. If it were so, the tendency to inflammation ought to be greater in summer than in winter. 2. It ought not to be easier to bear a high temperature in summer than in winter. 3. Liebig's view does not explain why the amphibia and young animals become more easily asphyxiated in cold weather. The oxygen cannot have consumed a sufficient quantity in such a short time. 4. If an organ be subjected to the influence of cold, it loses sensation, as if deprived of blood.

VIII. The same instinct which compels us to take more food in winter, also invites us in the same season to make use of spirits. These, by exciting the heart to more frequent and energetic contraction, directly oppose the influence of cold, which weakens the heart, and prevents it from contracting with energy. By increasing the activity of the heart's action, spirits cause the greater distension of the vessels, and thus contribute to the nutrition of the organs. But, though to a certain extent equivalents to food, they never contribute directly to textural nutrition.

The protection which spirits afford against cold, is produced by the diffusion of animal heat by means of the effusion of blood into the parenchyma. Liebig explains this phenomenon, by the evolution of warmth from the combustion of spirits by the oxygen: but this opinion is liable to the following objections: 1. If the increase of animal heat by the use of spirits were dependent on this chemical action, the same quantity of spirits should produce the same amount of heat in all persons. But experience shows that this is not the case. Individuals, who are not accustomed to spirits, feel very warm, and even perspire, on taking a small quantity, while those who are addicted to their use, feel no effect from the same quantity. This agrees entirely with the statement above given,—that the effect produced by spirits is the consequence of their stimulating action on the heart: 2. Spirits are never burnt at such a temperature as is generally found in animals: 3. They are expired generally by the lungs, and not therefore burnt: 4. Fat is likewise burnt as by the oxygen; and yet we do not feel warmer after making use of it.

In the preceding theory, we find the explanation of the fact that drunkards live on a small quantity of food. A small quantity of blood affords as much nutrition to them, as a larger quantity to other persons; for, in consequence of their taking spirits, the heart propels this small quantity of blood into the small vessels with such energy, that they are as much distended by it, as by more blood, with the normal activity of the heart. After having abstained from spirits for some hours, the drunkard feels very weak, and is not better till he has again taken liquor. He does not feel strengthened by taking food, as other individuals do. The reason of this is his general anæmia. By the use of spirits, the heart is caused to propel the blood forcibly, so as to distend the vessels, and the tissues are nourished. But the stimulus being removed, the activity of the heart subsides to its normal standard; the blood in the parenchyma is partly consumed by the tissues, partly absorbed by the lymphatic vessels. As the normal activity of the heart is insufficient to propel the small quantity of blood, the tissues are soon in want of food: hence the individual feels weak. But the simple use of food cannot strengthen him, because the quantity of blood cannot be restored with sufficient rapidity, as has been explained in my observations on the starving of animals by the use of dry food. The drinking of water or other fluids is more effectual than taking food. The quantity of blood is increased; and the vessels and their pores being distended, nutritive material is more exuded into the parenchyma. In this way we may explain the cure of delirium tremens by drinking a large quantity of water. The want of appetite in drunkards is a natural consequence of the chronic inflammation of the stomach.

IX. In the same manner as spirits, warmth supports animal life. Animals partially starved, and already insensible, can be roused by artificial warmth. After ten minutes, the animal rises up, takes food, passes fæces and urine; and is, during the application of warmth, lively and merry. Warmth excites the heart, and distends the vessels: so that the blood, in spite of being reduced by fasting to a very small quantity, passes through the walls of the vessels more readily than before heat was applied. In this way the tissues obtain nutritive material; and the organs again recover their activity.

X. But animals die sooner after being subjected to artificial warmth, than when left insensible. This is to be explained by the same remarks as I have made in speaking of summer-sleep, and of the starving of animals when restricted to the use of dry food. In all these circumstances, the animals die from the want of blood in the parenchyma, produced by the loss of water. For, when awaked, they part with a large quantity of water in the urine, sweat, and breath; all which secretions are, like the nutritive material, furnished by the blood. The blood is thus much more diminished, than if the animals had been left in their state of asphyxia. Chossat asserted, that pigeons, which were undergoing starvation, lost twice as much weight when roused by artificial warmth, as when left quiet.[1] This is more the effect of secretion, than of the process of nutrition.

XI. In the principles which I have laid down, we find an explanation of the changes which the blood undergoes under various circum-

[1] CHOSSAT. Récherches sur l'Inanition, p. 121.

stances. There can be no doubt, that any impediment to the process of nutrition must produce an alteration in the blood in the vessels; for those materials, which ought to be applied to nutrition, and transformed into different textures, remain in the blood. It being established, that the quantity of blood in the vessels, the number of blood corpuscles, the energy with which the propulsive agents in the circulation act, and the amount of temperature, produce modifications of the nutritive process, it is equally probable that they tend to alter the blood in the vessels.

In order to show what parts of the blood increase with the augmentation, and decrease with the diminution of nutrition, we must show what materials are subservient to this process. These are, besides some salts, fibrin and albumen. The corpuscles, being unable to pass through the walls of the vessels, cannot be considered as affected by the increase or diminution of nutrition.

The albumen and fibrin, though both subservient to nutrition, are destined for distinct purposes. The fibrin nourishes the tissues; but the albumen is transformed into fibrin and corpuscles. That the blood-corpuscles are formed from albumen, is proved by considering that they must be formed *in* the vessels, as they cannot pass through their pores; and as they are similar in composition to albumen, they are without doubt formed of it. That the fibrin is formed from albumen, can be demonstrated by the following facts: 1. The chyle contains more albumen and less fibrin, than the blood; consequently, a part of the albumen must have been transformed into fibrin. 2. The chyle, immediately after being absorbed by the lacteal vessels from the intestines, contains more albumen, and less fibrin, than that which has passed through the mesenteric glands. 3. Lymph contains much more fibrin, and less albumen, than blood-serum. But as the lymph is formed in the parenchyma of the organs from the blood-serum, which contains but little fibrin, the fibrin in it must be formed from albumen. 4. The arterial blood contains more fibrin, and less albumen than the blood in the veins; and this can only result from the transformation of the latter material into the former.

The albumen is therefore not only consumed for the purposes of nutrition, but is in a great measure transformed into fibrin and blood corpuscles. Hence any increase or decrease in the quantity of albumen is not only dependent upon the various degrees of activity of the nutritive process, but also on the extent to which it is transformed into fibrin and blood-corpuscles. If this action be impeded, the albumen must, if it be restored by food, increase in quantity, in spite of the apparent performance of textural nutrition.

Fibrin differs from albumen, in its mode of reparation. Albumen is only restored by food; and if none be taken, the albumen is not renewed. But fibrin, being formed from albumen, is restored even if no food be taken. It is nevertheless to be remembered, that the chyle also contributes a share to the formation of fibrin.

We are now able to point out some laws, which regulate the increase or diminution of the albumen and fibrin.

The albumen increases: 1. When food is taken as before, if either the nutrition of the textures, or the formation of blood-corpuscles or of fibrin be impeded. In consequence of this, the albumen increases: (a) In chlorosis, where the formation of blood-corpuscles is impeded by the want of iron, or from some other cause. But if less food be taken than before, the albumen cannot be increased. (b) In many toxæmic diseases, as typhus, intermittent fever, bilious fever, &c., the poisons of these diseases in general impede the formation of fibrin:[1] and if the attack takes place on the same day on which food has been taken, the albumen will be restored by the chyle, and must increase. But if an animal be seized after fasting for some days, or if the blood be drawn three or four days after the toxæmic influence have first acted, we shall not find an increase of the albumen. The influence of food accounts for the albumen being sometimes in excess in chlorosis, and in toxæmic diseases, and sometimes in defect. 2. If, while the nutrition of the textures, and the formation of corpuscles and fibrin, are performed as before, more food is taken. In consequence of this, the albumen is increased in plethora.

The fibrin increases: 1. If, while it is being formed as before, nutrition is impeded. In consequence of this, it increases: (a) In all inflammatory fevers, where nutrition is impeded by the violence of the circulation, but where no cause operates to retard the formation of fibrin, which is still formed from albumen, even though very little food be taken. (b) After bleeding, when nutrition is impeded by the blood not being in sufficient quantity to distend the vessels. This increase is only relative, in proportion to the other parts of the blood; the loss of all parts has been equal, but the fibrin is soonest restored. The blood-corpuscles require time for renewal, and the albumen can only be supplied by food. (c) In abstinence, where the albumen is not restored by food, but the fibrin continues to be formed from albumen, the same phenomenon takes place as after bleeding. (d) In all diseases in which the blood-corpuscles are diminished, the vessels are not distended sufficiently to allow the fibrin to pass into the parenchyma of the various organs. This is the case in chlorosis, scirrhus, morbus Brightii, the latter months of pregnancy, and tuberculosis. Under all these circumstances, an access of fever determines an increase in the quantity of fibrin. 2. If, when the formation of fibrin continues to be performed as before, a large quantity of fibrinous food be taken. This is the result of an animal diet; for in this case, the chyle contains much more fibrin than when a mixed diet is used.

The albumen decreases, whenever its expenditure is greater than its supply by the food. This takes place in fasting; where, though but little albumen passes through the coats of the vessels, it is consumed in the formation of fibrin and corpuscles.

The fibrin decreases only if its formation be impeded. This takes place in various narcotisations and poison-diseases, as poisoning by opium, hydrocyanic acid, typhus, miasma, etc.

It is here the place to refer to the causes of the increase or decrease of the blood-corpuscles in different diseases. We have first to point out how they are *spoiled*, in the healthy state. On this point, we have

[1] It does not follow that every poison impedes the formation of fibrin; for all poisons are not alike.

only hypothetical ideas: but as it is established, that the small vessels are distended by the passage of the corpuscles, an amount of friction must be exercised, which must tend to render the corpuscles unfit for use. It follows, that the oftener the corpuscles circulate through the vessels, the more they are spoiled: but this rule is not without exceptions. It may happen, that the corpuscles are often propelled through the vessels without being injured; this occurs if the walls of the vessels are soft, and capable of yielding. In this case, the corpuscles must increase, if their formation be not impeded. They must decrease, if their formation be impeded, or the vessels be resistant, and the heart act more frequently. Hence they decrease in fevers, because the contractions of the heart are more frequent. They increase in typhus and other toxæmic diseases, where the vessels are yielding, which is denoted by the softness of the pulse; for as the vessels do not resist the pressure of the finger from without, they cannot be supposed to oppose the pressure from within. This is the result of the action of the poison. If, however, the formation of the corpuscles be impeded, they decrease, notwithstanding the softness of the vessels. This sometimes happens in chlorosis.

(To be continued.)