THE LAW OF THE MORPHOLOGY OR METAMORPHOSIS OF THE TEXTURES OF THE HUMAN BODY.

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II. ANIMAL TEXTURES.

It may with great certainty be affirmed, that the blood contains the elements from which, in animal structures, the solid textures and the secretions are produced. Blood consists of a limpid fluid, holding in suspension a multitude of cells of two kinds; the one red, the other white or colourless; it may therefore with propriety be termed a *cellular or corpuscular fluid*. On its first discharge from the living vessels, blood is thin—that is to say, it drops like water, but it speedily becomes viscous or stringy, and then coagulates into a soft solid, which ultimately separates into two parts,—a red clot, and a yellow fluid serum. But blood, before it coagulates, frequently separates into two fluid portions; the uppermost colourless, and termed plasma, lymph, or liquor sanguinis, the lower red: both these portions coagulate, so that the solid clot is in part colourless, and in part red. The colourless part of the clot, which is uppermost, and formed by the coagulation of the plasma or lymph, is a coherent and elastic fibro-cellular texture, ordinarily termed the *buffy-coat*; it is usually depressed in the centre, with thin fibrous edges, and there is frequently a viscous, colourless, gelatinous mucus in the cup-like depression, that may be drawn out in strings like ordinary mucus.

The microscopic appearances in a film of blood *not* disposed to exhibit a colourless layer of lymph or plasma, are very different from those of a film of blood that *is* disposed to do so. In blood *not* disposed to exhibit a buffy-coat upon the clot, we see with the microscope numerous red corpuscles or cells, slightly cohering in strings and rolls, and a few colourless ones floating in a clear limpid fluid. In blood that *is* disposed to have a buffy-coat upon the clot, we see a much larger proportion of colourless cells, and multitudes of minute molecules floating with the red cells in the clear and limpid fluid; the red cells adhere more firmly to each other, and are congregated in larger and more irregular masses; and in the fluid, a network or tissue of interlaced filaments or fibrils is shortly observed to form. If a film of the colourless fluid, plasma, or lymph, be separately examined with the microscope, we find it mixed with innumerable colourless cells and isolated molecules; within the cells are a number of similar molecules, some of the cells containing much larger ones than the others; and when the coagulation commences, it is by the formation of fibres in the fluid. When water or a weak solution of potass is added to colourless blood-cells, they immediately begin to enlarge, gradually

swell out to double their former size, and then burst open, discharging their contents, which consist of a viscous mass, mixed with molecules, and apparently identical in all its properties with natural or healthy mucus.

All the mucous secretions and the saliva contain colourless cells, which cannot be distinguished by any specific character from the colourless cells of the blood, and there appears no reason to doubt that the viscous matter of these secretions is an animal product elaborated in the interior of cells identical with those which are seen floating or mingled with it. Moreover, both mucus and saliva readily form fibrils or fibres when acted on by appropriate agents. These and several other well-known phenomena observable in the animal secretions may be treated of analogically, with a view to ascertain the origin of the fibrillating elements of the plasma, or lymph of blood, the element to which its coagulation into a coherent fibrous or fibro-corpuscular texture is due. Milk, among others, is a complex animal secretion, elaborated in the interior of cells or corpuscles, and set free by the thinning away, dissolution, or rupture of the cell-wall. The yolk of an egg is an analogous example, where the cells are large, and their walls so very thin, that it is with the utmost difficulty they can be touched in the gentlest manner without rupture. To the unassisted eye, milk appears as a homogeneous, white, opaque, fluid; through the microscope its white appearance and opacity are found to be owing to myriads of minute molecules,—and it is well known to contain an oily element or *butter*, a fibro-albuminous element or *curd*, and a limpid fluid or *whey*, and to the sum of each of these products every milk-cell contributes its quota.

The plasma, lymph, or colourless element, floating on the surface of newly-drawn blood, appears to the unassisted eye, when first seen, as a semi-transparent colourless fluid, gradually becoming viscous, and then fibrous and solid; and it is well known to contain, not only the solidifying fibrous, but a soluble albuminous and oily element. There are then the very same reasons for concluding that the fibrinous and albuminous elements of the blood, plasma, lymph, or liquor sanguinis, are derived from colourless cells similar to those found in it, as there are for concluding that the elements of milk, saliva, or any other complex animal product, are derived from cells; and the plasma or lymph of blood, therefore, is as much entitled to the term *secretion*,—to be considered as the products of cell-elaboration, as any of the other fluid or solid materials of the structure.

An abundance of colourless cells, filled with a viscous matter and molecules, are at all times discharged or thrown off, mixed with a viscid mucus, from the mucous membranes, and their numbers are increased upon the slightest irritation or inflammation. Similar cells are at all times discharged or thrown off

from all wounded and healing textures, where the process of reparation is going on—where new and conformable elements of growth are appearing, and where, therefore, the process of nutrition is normal. Similar cells are also discharged or thrown off from diseased textures, ulcers, and abscesses, from scrofulous joints, and from the cavities of the lung in consumption; in these latter instances more especially the cells have received the distinctive appellation of *PUS*.

Pus varies in consistency: it may be nearly solid, or quite fluid,—that is to say it may be solid enough not to drop like water, and in this state it is a *corpuscular texture*, analogous to the incoherent corpuscular textures of the lower forms of vegetation, and the green parenchyma of a leaf. Recently excreted *pus* displays under the microscope an abundance of colourless cells, the interior contents of which, in various states of elaboration, present various appearances. Old *pus* has a different microscopical aspect, which it is well should be remembered in considering the origin of tubercles, consisting chiefly of minute molecules and granular matter, resulting from the breaking down of the cell-walls. The cells or corpuscles of healthy or recently excreted *pus* vary in magnitude and appearance; active molecules are frequently visible in their interior, and when water, or a weak solution of potass is added to them, they swell, burst, and discharge their contents, consisting of a viscous matter mixed with molecules.

No wounded, irritated, or abraded texture, heals or ulcerates without the presence, of a greater or less abundance of incoherent colourless cells; and there are no certain, specific, distinguishing marks between the colourless cells of blood, lymph and pus. When, therefore, a healing wound discharges *pus*, it can be regarded in no other light than as indicating a superabundance of nutritive cells, which from an actual excess in number, or some other cause, do not meet with the conditions required to make them deliver up their contents, and take part in the metamorphoses required for the reparation of the texture; but when an ulcerating wound (where there is no reparative process at all,) discharges *pus*, it would appear in that case, that all the cells from some inherent defect have lost the power of a conformable metamorphosis.

This explanation of the appearance of colourless cells, both in healing and ulcerating textures, implies in the former case a great excess of agents in the performance of a specific office or function—viz, the healing of the wound, and this so far from being, as might hastily be imagined, contrary to, is in fact quite in accordance with, the usual plan of nature as observed in other things, and in analogous instances. The pollen-cells of vegetables, for example, have an important and specific function, and in what apparently excessive abundance are they produced. Of the myriads of pollen-cells discharged from the anther, how few are

actually expended in the fertilization of the embryo, compared with the myriads which *seem* to be wasted. In animals the analogous fact, too, may be produced in illustration. Again, in the repair of a fractured bone, what an apparent excess of nutritive material or *callus* is collected for the cure, which is subsequently removed when the fractured extremities have been united. Moreover, there are other facts in surgery pointing to the same conclusion; for healthy granulations, copiously discharging what is called healthy *pus*, heal rapidly by moderate and regulated pressure, which by diminishing the amount of blood flowing through the innumerable vessels of the young texture, diminishes also the amount of colourless cells, whereupon the quantity of *pus* diminishes, and the granulations then becoming covered with a coherent, fibrous, non-secreting, instead of an incoherent, corpuscular, secreting texture, are said to cicatrize or heal. Colourless cells, therefore, in all cases of nutrition, appear as the primary and active agents, the results depending upon their metamorphosis.

From these facts and observations, and from others fully detailed in former researches, I draw these important conclusions:—

First, that in all living structures,—in all plants, and in all animals, the elements of growth and secretion,—that is to say, the peculiar and characteristic solid and fluid matters of the structure, are prepared or elaborated in the interior of minute vesicular bodies, variously termed corpuscles or cells, which may either be coherent, forming a strong or solid texture, or incoherent, forming a soft or brittle, and more or less a fluid one; and that the elaborated material, when set free by the opening or rupture of the cell-wall, undergoes ulterior changes, or metamorphoses, and either constitutes a part of the solid structure, or remaining fluid forms a secretion.

Secondly, that the incoherent cells of the parenchyma of the leaf are the primary elaborating cells of vegetables, and the incoherent cells of blood, the primary elaborating cells of animal structures. By the metamorphosis of the former, all the subsequent textures and vegetable colours and secretions are produced; and by the metamorphosis of the latter, all the animal textures and secretions. The incoherent parenchymatous cells of the leaf are in all their stages stationary; and the air necessary to their respiratory functions passes to and fro around them by the motive power of heat. The incoherent protoplasmic cells of blood flow in streams throughout the body, traversing in their course the walls of the coherent cellular and aeriferous texture of the lung, into and out of which the air passes by the motive power of muscles.

Thirdly, that the relations subsisting between animal textures or secretions, and the blood, are analogous to those subsisting between vegetable textures or secretions, and the leafy parenchyma; and therefore that the

law of the morphology of animal, must be analogous to that of vegetable, structure. In the latter instance, the doctrines based upon the law do not profess to give any reason why the parenchyma of one leaf differs from that of another,—why oil of peppermint is formed or secreted in one set of green cells, and prussic acid, opium, or bergamotte, in another; nor does it enter upon the question of the differences prevailing among the green granular cells of different parts of the same plants: on the contrary, the doctrines trace the form and mechanical properties, rather than the physiological function of the textures; so that the main features of morphology are only secondarily affected by differences and variations in secreted products. So likewise it appears to be in animal textures, that the morphology, in respect of form, is a branch of physiology sufficiently distinct from the morphology of secretion; and to admit, as is the case in plants, of a separate consideration.

"If we consider," says MOHL—and he is speaking of the cells of plants—"the place at which, in the interior of a cell, new cells are on the point of being formed, and at which the nuclei have already made their appearance, we find that the future mother-cell contains a *viscous colourless mass, mixed with minute granules*; and since this viscous mass everywhere precedes the first solid formations, I trust it will be considered justifiable, if I propose to designate it by the word *protoplasma*, a term which recalls to mind its physiological function.*

Now it is evident, in the universally-existing process of cell elaboration, and whether the result be new cells, or permanent, cellular, or fibrous structure, or fluid secretion, that two distinct stages are recognised. *In the first*, the elaborating matter,—the *protoplasma* or primary element, (adopting the term proposed by MOHL,) is in progress of preparation within the cell, shut out from all extraneous or exterior agents, except those specially admitted through the cell-wall to assist in the elaboration. *In the second*, the elaborated matter having been set free by the opening or rupture of the cell-wall, undergoes its ulterior metamorphosis, subject to the action of new agents, which may influence conformably or unconformably, the completion of its permanent phase.

The liquor sanguinis or lymph which rises to the surface of newly-drawn blood is, if we adopt MOHL's term, the *protoplasma* of animal structures, and the buffy coat, is a *protuplasma*, a fibro-corpuscular

texture, which, were it still within the vital influence of the whole structure, would, according to its analogies, become a secreting texture; and, moreover, the mucous or jelly-like matter often found in the depressed centre of the buffy coat is, in reality, the last change or secretion of this altering cell-texture.* "The glairy fluid termed mucus, being nothing more than an altered state of the fibrillating liquor sanguinis, the change from the one to the other being coeval with the changes within the cells. Hence, if we take the red portion of the buffed clot, and the red cells to represent blood, then the colourless layer of liquor-sanguinis (*the protoplasma*), will represent the first remove from blood, and mucus or pus will be next; and it would appear, generally, that the nearer the cell is to, or the fewer the stages of its removal (*by morphological changes*), from the circulating current, the more nearly it resembles the colourless blood-corpuscle, and the more decidedly and visibly its fluid contents, when they escape, fibrillate; whereas, the further the cell is, or the greater the number of stages of its removal (*by morphological changes*), from the circulating cells, the larger it is, and the less perfectly do its fluid contents fibrillate.†

"The blood can hardly be said to be organized, yet from the physical characters of coagulated fibrin, it is evident that while circulating in the body it holds a peculiarly endowed animal principle, (fibrin,) requiring only a moments rest to constitute solid, organized (I do not say vascular,) tissue. The texture, formation, cohesion, toughness, and elasticity, are all proofs of its organized nature; and it at once, without further aid or assistance, assumes all these properties, even after its removal from the body in venesection, or after death in its own vessels. There seems then, to be but one step between the microscopic capillaries and the fibrin of the blood; the former are minute fibrinous channels, the latter may (not inappropriately,) be termed *organized tissue, circulating with the blood.*" (*Medical Gazette*, March 26th, 1841.) These are sentiments expressed upwards of five years ago, and subsequent researches have confirmed *the idea* I then entertained. The term 'fluid texture,' may be objected to, nor can I contend for the congruity; but this does not alter the fact that the blood is a *cellular fluid*, and a clot of blood a *fibro-cellular* texture. The incoherency or brittleness of the lower portion of the clot is owing to the predominance of cells; the coherency and toughness of the upper part to the predominance of fibres.

* See MOHL's paper "On the Circulation of the Sap in Plants," in the "Annals and Magazine of Natural History," July, 1846. (Translated from the *Botanische Zeitung* for Jan. and Feb., 1846.) This author objects to the term *mucilage*, employed by Schleiden to designate this substance, as the term "vegetable mucilage," in the sense in which it is ordinarily used in chemical works, conveys a totally different meaning. The *protoplasma* of MOHL is termed "plastic element" in my "Researches," &c.

* *Prot-apophismus*—the mucus having the same relation to the solid fibro-cellular texture that the *protoplasma* has to the incoherent cells of blood.

† "Second Series of Experimental Researches," p. 16, &c.—Churchill; London.

(To be continued.)