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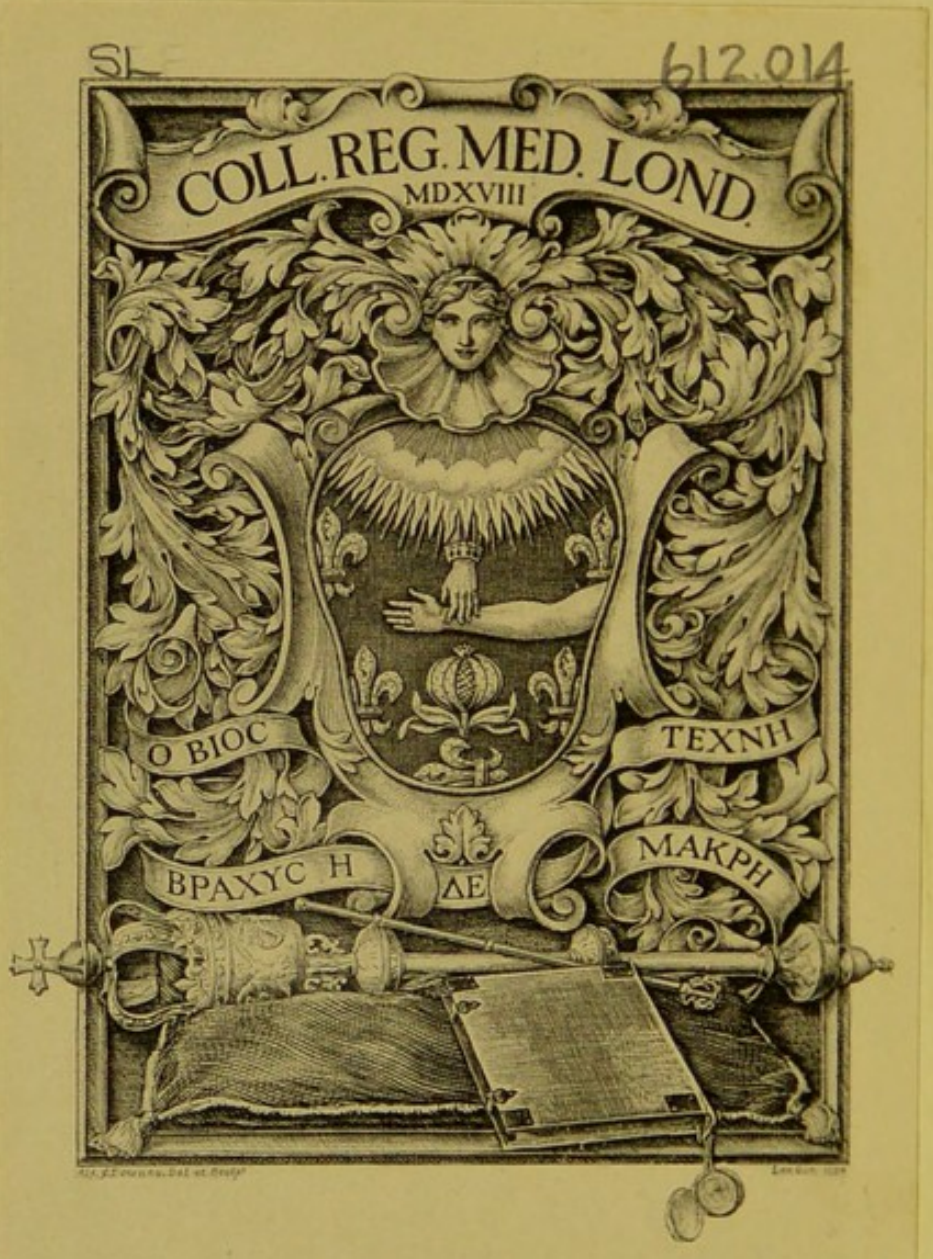

CELL THERAPEUTICS.

BY THE SAME AUTHOR.

HEALTHY AND DISEASED STRUCTURE,

AND THE PRINCIPLES OF TREATMENT FOR THE CURE OF DISEASE;

ESPECIALLY CONSUMPTION AND SCROFULA.

1 Vol. 8vo., with Plates, 12*s*.

CELL THERAPEUTICS.

BY

WILLIAM ADDISON, M.D., F.R.S.

"If results derived from microscopical researches be incorporated in the science of PHYSIOLOGY, and be received in explanation of appearances in morbid anatomy, they must also be admitted into the domain of THERAPEUTICS."—*Healthy and Diseased Structure, &c.*, 1849.

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CONTENTS.

INTRODUCTION.

UNDER the title of Cell Therapeutics we shall have to consider phenomena of cure and reparation in connexion with the Cell Physiology. Not simply the consideration of cure in mechanical injuries—a department which has been ably investigated by MR. PAGET—but methods of reparation in blood distempers and organic disease.

No great amount of argument is required to be convinced that the principles of MEDICAL SCIENCE, those of pathology and therapeutics must follow in the paths of physiology. Whatever is established to account for the varied facts of the parent science—for the normal course of life—must be held sufficient also in explanation of phenomena observed in the subordinate or collateral departments. That is to say :—If cells and nuclei are of such generality and importance as to take rank as agents in normal

growth, so that ALL healthy changes of structure and function be referred to them, they can hold no inferior rank, being present, in ALL therapeutical reactions against injuries and diseases. The cell doctrine has been gradually advancing its footing in physiology for twenty years; it has also gained a strong hold in pathology, and it seems now required that therapeutical changes in the qualities of the blood should be shown to be either in harmony with it, or capable of a rational explanation without it.

It has been elsewhere said that—"The microscope having demonstrated the presence of nucleated cells in the structures of plants, animals, and man, has thereby occasioned a great change in physiological doctrine, and in no case is this change more apparent than with respect to secretion. Blood-vessels and ducts used to be considered as secreting agents, but it is now known that all vessels or ducts from which a secretion is derived, are clothed with nuclei or nucleated cells, and it is to these the transformations constituting true secretion are referred."

In pathology, the microscope has shown in all cases, that granulations, whether of a white colour

and springing from the interior wall of an abscess, or red, as they appear at the surface of an outward sore, are forms of nucleated cell-growth. And of the matter termed pus, the former belief of its being a secretion is negatived by the use of the microscope, which proves that also to be another form of cell-growth. Such being the case, minute researches having brought into view elements common to normal growth and disease, and having changed in many important points both physiological and pathological conclusions, we propose here to trace the corresponding fitness of therapeutical doctrine. And in order to sketch out, introductorily, what this fitness is, let us take a brief review of some of the more common facts upon which the cell-physiology is founded.

Oxalic acid is formed in the leaves of some, and oil of peppermint in the leaves of other plants. The poisons of tobacco, digitalis, and opium are peculiar to the respective plants. The colour scarlet distinguishes the blossom of some, and the colours yellow and blue the blossoms of other plants. In fruits and seeds how various are the qualities of the different parts!

In animals and man there is not less of variety in the different organs. Bile is the secretion of one gland, milk, saliva, the tears, urine, &c., the secretions of other glands, notwithstanding in each case the organ derives its materials from a common source, the blood.

In all these examples the differences are attributed—in the doctrine of cell-growth—to the agency of cells and nuclei, to the several ways in which the exterior matters, absorbed by different kinds of cells, are dealt with or changed in their interior; or attracted by nuclei, are altered outside them in their vicinity. Nothing, it is said, can gain entrance into the cells, whilst they are growing, but what is specially admitted, and what is specially admitted is changed in different ways by different kinds of cells. In these operations, the materials outside the growing cells undergo changes also, and necessarily, for what is taken into the cells is taken from the matter which surrounds them.

This physiological doctrine is now placed in the van of science, and following it out we shall find that the formation of an abscess and the discharge of sloughs without bleeding; the opening of blood-

vessels for the junction of new ones; the discharge of poisons or injurious matter from the blood, and sundry changes of texture observable in organic diseases are phenomena referrible to the properties of nucleated cells. And such being the case, we may extend to INFLAMMATION, views first propounded in our work *On Healthy and Diseased Structure*, in explanation of the phenomena of SCROFULOUS DISEASE.

It has been said with reference to the doctrine of cell-growth, "How unlike, in the important particular of referring phenomena to general laws, is SCHWANN'S cell-theory of fermentation to LIEBIG'S reference of that process to the contagious influence of chemical action."* We do not admit the justice of this animadversion, for as long as the distinction between organic and inorganic matter remains, the contagious influence of chemical action, however widely instanced, can claim no more generality than the laws of living matter.

A solution of salt and water and an infusion of sage leaves placed aside together in summer, both undergo changes; crystals may be found in the one

* "Sequel to Outlines of Medical Proof," by Dr. Mayo.

and animalcules (cells) in the other. In both cases visible and regular bodies appear, and the fluids have undergone changes; in both there has been a species of attraction, decomposition, and growth. The changes in the saline solution are in obedience to physical laws; those in the vegetable infusion are, we think, rightly considered in subjection to the laws of vital action, to the formative power and metabolic processes of cells. A room full of air will remain a long time unchanged, but if a multitude of living individuals—plants or animals—be placed in it, a change in the air speedily ensues. The individuals exhibit activity—*the plastic power of cells*—and changes in the air, thus crowded with living beings, are referred, not to mere chemical action, but to the performance of vital acts, *the metabolic power of cells.*

In the domain of Science there is a primary and fundamental division into things possessing and things not possessing life. As long as this classification is preserved, the microscopical physiologist is constrained to frame his theories in subordination to it, to refer the chemical changes observed in the

structures of living beings, and those also which living bodies effect in the matter which surrounds them, and upon which they live to the principle of life. *The plastic power and the metabolic power of cells* are but subsidiary expressions, the one comprehending the various changes observed in the bodies of the cells themselves, the other, the changes in the matter which is outside, but surrounds them, both merge into *the cause* to which we attach the idea of Life.

CELL THERAPEUTICS.

I.

OF REPARATION.

A PROPERTY of repair inherent in the human body is proved by the healing of wounds and fractures. This we propose for examination with reference to inflammation and organic disease.

In scalds the part speedily becomes red, and the cuticle rises into a vesicle filled with lymph. If this be punctured with a fine needle, and the raised cuticle smoothly replaced, new cuticle is formed, the injured one peels off in flakes, and the wound heals spontaneously. In burns, the body inflicting injury is hotter, its influence extends deeper, and a portion of skin is killed. At first, the dead skin adheres strongly to the part beneath, but when a discharge

of *pus* is established, a line of separation appears. The dead skin loosens, and may afterwards be easily removed, as a slough. When the slough has been detached, a new texture comes into view, in the shape of innumerable red points, termed granulations ; and, upon inspecting these through a lens, new blood-vessels are to be seen in them. The period during which the granulations may remain, varies in different cases, but, gradually, they change into a fibrous texture or cicatrice, which heals the wound.

Case.—A forgeman was struck in the eye with a small particle of iron which remained impacted in the cornea. He had been suffering from the accident for four days. The blood-vessels in front of the eye were extremely red, and there was a weeping of tears, which, instead of being transparent, were turbid, from a great number of colourless cells in the secretion. Through a lens, the wound in the cornea was seen filled with pus, and the particle of iron was still sticking in the middle of the sore. In fact, *abscess and ulceration* had taken place. And that these formed part of the natural effort to cast out the injurious foreign body in the manner of a slough, was rendered almost certain, because, upon

the surgical removal of it, the part healed in a very short time. Moreover, when a thorn enters the flesh, if it be not speedily removed, abscess and ulceration will take place in the parts around, and thus the offending body is often cast out. The wound remains until the foreign body be thrown off, but afterwards it heals spontaneously.

Case.—A young lady, aged nineteen years, suffering from fever, had been in bed fourteen days. At the time I visited her there was a slough upon the skin on the lower part of the back, as large as a crown-piece. It was black and dry. It adhered very firmly to the parts below, and a slight attempt to remove it produced pain and bleeding. But when a discharge of pus appeared the slough loosened and fell off spontaneously without pain or bleeding.

Here there must have been severance of the bond previously uniting the dead with the living parts. The severance was concomitant with the establishment of granulations and purulent discharge, and it was accomplished without any loss of blood. In these, and all other examples of reparation, lymph, granulations, new blood-vessels, and pus, one or more, take part in the operation. In slight accidents

lymph only may appear, as in scalds. In other cases, lymph, granulations, and new blood-vessels. But, in graver injuries, where the dead part is to separate from the living, we see the whole series,—lymph, granulations, new blood-vessels, and pus.

In Small Pox there are numerous pustules, or little abscesses in the skin. With the ripening or maturation of the pustules the disorder declines. The liver, or kidney, is sometimes the nidus of a parasitical creature, termed an "acephalocyst." In such cases an abscess forms, and we see the outlet of its contents barred from taking a dangerous direction, by adhesions formed between contiguous surfaces. At the same time, its evacuation is promoted in another direction, by absorption of interposing tissue. By these opposite, but concomitant operations, the matter of an abscess is prevented from discharge in a dangerous direction, and is, as it were, conducted to some safer outlet,—the intestine, —or perhaps the bronchial tubes of a lung. In the lungs, if an abscess—the result of softening tubercles—be near to the surface of the organ, and likely to burst into the cavity of the chest, the accident is provided against. Adhesions form between the wall of the chest and the lung at the threatened spot, by

which the escape of the matter in that dangerous direction is very often prevented.

When a blood-vessel has been ruptured in the brain, a clot is formed. Lymph is effused, and the contiguous parts are softened by a species of abscess. If all other circumstances be favourable to the progress of repair, the cyst or wall of the abscess changes into fibrous texture. Absorption of a considerable part of the clot ensues. What remains is protected from the tender brain substance, and the patient, in a great degree, recovers from the accident.

These cases comprise the points for discussion :— What are granulations and pus, and what are their properties ? How is it that an abscess occasions thickening and adhesions in the texture surrounding one part of its circumference, and thinning of the surrounding texture, with ulceration, at another part ? What account can be given of the apparent incongruity, that inflammation, after mechanical violence, seems necessary to the process of repair, and on other occasions is looked upon as a disease ? What are the relations of healthy to unhealthy inflammation ?

The lymph of vesicles or vesications differs from

the lymph of blood only in the larger proportion of water. Both contain colourless cells. Pus is well known to be composed of cells ; and granulations are groups of cells. Granulations and pus are, then, two forms of cell-growth. Granulations a vascular form—pus a deciduous form. The cells of granulations, structurally united by their new blood-vessels to the living parts, are, we know, susceptible of change into fibrous texture. The cells of pus, on the other hand, incoherent, and without any structural bond of connexion with the body, seem well fitted for discharge, and to be the medium of separation for sloughs. The new blood-vessels of granulations are entirely surrounded by cells. We have, on many occasions, examined the coats of the vessels in newly formed granulations, and we find in them neither the nucleated nor the outer fibrous coat of the natural vessels. But new blood-vessels, thus differing in structure from the pre-existing ones, and which give evidence of this difference by bleeding,—sometimes spontaneously, and always upon the slightest touch, could not transmit onwards the stream of blood without free connexions with the older vessels. The fact of the circulation going on through the new vessels is the proof of some removal or absorption of the coats of the older vessels. That is to say :—

Blood-vessels must have been opened before the circulation of the blood could pass on in the new vessels of granulations. But how are they opened without any loss of blood ?

Now, if granulations and pus be two forms of cell-growth, it is to the purpose to refer to some of the most general properties of cells. For it may be found that these will help to explain phenomena of reparation, abscess, and ulceration ; throw light upon the process by which the living part separates itself from the dead, and openings are made in blood-vessels for the junction of new ones, without bleeding.

II.

OF CELLS, AND CELL-GROWTHS.

That the structures of all organic beings—plants and animals—originate from minute CELLS, was first announced by Oken,—the fact has been ably illustrated, and enforced by Schleiden, Schwann, Barry, and other physiologists, and is now universally concurred in, as a truth of the highest interest to all who would investigate phenomena of health, disease,

and reparation. The cells here spoken of, are microscopic objects, various in colour, and usually consist of four parts :—1, an exterior integument ; 2, a nucleus ; 3, an interior, sometimes viscous matter ; and, 4, granules or molecules. The exterior integument or cell-membrane is, for the most part, a thin transparent pellicle, through which the interior contents of the cell may be discerned. The nucleus is apparently, a compact body, adherent to some point of the cell membrane. * And the viscous granular matter and molecules are the ingredients to which, in many cases, if not in all, the sensible qualities of the cell must be referred. For in unripe fruits, (the plum or cherry,) the cells of the pulp contain an abundance of green granules—and the taste of

* Much more importance than is here indicated has latterly been attributed to "nuclei." But whether the investigations of Mr. Savory on the development of striated muscular fibre, or those of Dr. C. H. Jones, on the liver, lead ultimately to some modification of the cell doctrine or not, will affect but little the facts and argument in the present essay. For in all the examples we shall adduce ; "*nucleated*" *cells* are present. And should it be proved that the "nucleus" is the point or pole of activity, it will simply have the effect of referring the active properties of nucleated cells to a definite part of their structure,—one to which the formation of the cell is already attributed.

the pulp at this time is sour and astringent, or very much the same with that of the leaves. But when the fruits have ripened, the cells are much larger, they are now filled with a much blander and sweeter fluid, and at this time nearly all the green granules have disappeared. Again, the pith at the extremities of the young and tender shoots of the Elder (Sambucus niger) is composed of cells nearly filled with green granules, which gradually diminish in quantity towards the older part of the branch ; and where the woody tissue has formed, they are almost altogether wanting. In the former situation, the cells of the pith are green and have the strong sensible qualities of the plant ; in the latter they are white and quite insipid. The skeleton integument of the cells and the nucleus remain, forming the white pith, but the green matter and the qualities which gave taste and smell to the green pith have disappeared together. The same kind of observation has been recorded by SCHWANN in the mature and immature shaft of a feather. He has observed the granulous contents of the cells in the immature and growing part of the shaft, and the larger cells without granulous matter in the perfected part of the feather.*

* "Microscopical Researches into the Accordance in the

That the cells of vegetable structure perform independent functions, and that the sensible qualities (taste and smell) of plants are derived—not from the cell-membrane, nor from the nucleus—but from the interior contents, the green granules or granular matter, further appears from the following :—If one of the fleshy leaves of *sedum acre* be crushed with a drop of water, between two slips of glass, numerous cells with a thin transparent integument, and apparently without any nucleus, but which contain an abundance of green granules, will be seen. And the biting quality of the plant seems to reside in the green matter, for in autumn, when the leaves have turned to yellow, the biting quality is lost. In a parti-coloured petal, for example, the garden pansy, each cell may be seen to possess its own colour, without the least intermixture with that of the adjoining ones. Cells filled with a rich purple pigment are observed with a microscope in juxta-position with others filled with a brilliant yellow, and cells with these colours may be seen in apposition with others of a pale primrose, or with others without any colour. It is evident from these examinations that, differences of colour, and other qualities,

Structure and Growth of Animals and Plants," page 82—plate 2—figs. 10 and 11.—Syd. Soc. Ed. 1847.

in different groups of cells,—fruits, flowers, and leaves, arise from an independent function in each cell of the group. The purple pigment, or the bitter and acrid principle, is formed in one cell, and the yellow pigment, and other qualities, in another cell. In the pansy there is no intermingling of colours, each coloured cell is perfect in itself.* The same observations apply generally to those animal cells from which the secretions, saliva, mucus, &c., are derived.

In many kinds of vegetable cells a movement or circulation of their contents may be seen. In the hairs on the filaments of *Tradescantia*, the molecules, by which the circulation is detected, are exceedingly minute, whereas, in the leaves of *Myriophyllum*, the matter which circulates round and round the cells is mixed with much larger granules, and the same sort of granules appear incorporated with the cell-membrane. In many kinds of animal cells, for example, those of mucus, blood, saliva, and pus, extremely active movements have been seen in the molecular or granular matter of their interior. Moreover, many animal cells have cilia, moving to and fro with great rapidity.

* "Experimental and Practical Researches on Inflammation and Tubercles, &c." 8vo. Plates. 1843. Churchill.

"It is certain," says LORD BACON, "that all bodies have perception, for when one body is applied to another, there is a kind of election to embrace that which is agreeable, and expel or exclude that which is ingrate, and whether the body be alterant or altered, evermore a perception precedeth operation, for else all bodies would behave alike to one another."

"I am prepared to admit," observes DR. FARADAY, "that in water, a particle of hydrogen in combination with oxygen is not altogether indifferent to other particles of hydrogen, but to have an affinity towards them, which, in many cases, produces effects rising into considerable importance." If such be the opinion of some of the greatest philosophers, if they speak of "elective affinity" as a property of the molecules of inorganic and amorphous matter, we are the more prepared to meet with a conclusion of an analogous kind in respect of nucleated cells; bodies which exhibit internal movements, and are always present in the growth and changes of more complex living structures.

And thus it is "selective absorption," that is to say, the absorption of some things and the exclusion of others, is assumed and accepted as a common property of cells. It is said to be performed by the one single cell of which each individual, among the

lowest forms of animal and vegetable beings, consists. And it is admirably illustrated in a parti-coloured petal, where, as we have said, cells filled with one coloured fluid are in apposition with cells filled with another fluid of quite a different colour.

"Absorption," says KOLLIKER, "is manifested by all cells. The cause of it, is not to be sought, solely, in endosmose or imbibition, but, as Schwann has indicated, in this :—that while the cell membranes grow by attraction of material from the surrounding fluids, by virtue of their porosity they allow substances to penetrate into their interior. This filling, however, does not take place by the cells admitting every kind of matter indiscriminately, but they exhibit peculiar relations, so that they take up one constituent, and reject another. And the constituents so taken up are altered, in some cells one way, and in others in another way." In plants the elements by which absorption and secretion are performed no doubt consist of cells. And this is true of animals. The agents in the absorption of fluid in contact with the roots is neither the woody tissue, nor the vessels it contains, but the succulent cells at the growing extremity of the rootlets. Also, the chief agents in the absorption of nutriment in contact with the alimentary canal, are the cells or the cellæ-

form nuclei, of the villi distributed upon the mucous coat of the intestine.

"Among the cells composing the germinal membrane of the incubated egg, certain of them," says Schwann, "throw out stellate processes which come into contact and coalesce. The septa are then absorbed, and thus a network of canals, which become capillaries, is produced." Here the removal of the septa or partitions must be referred to cells or their nuclei, for there are no vessels to which absorption can be attributed. There is cell-growth over the whole of the human ovum. At one spot of this a placenta forms. And if the connexion between placenta and uterus be carefully examined, it is stated by VIRCHOW, that the embryonic cell-growth will be found to have penetrated through the coats of the maternal vessels by absorption. If this be so, it is an example of the opening of blood-vessels by cell-growth without bleeding. In the *plexus choroides* of the brain, and in the synovial fringes in joints, there are special cell-growths. And that these have relation to absorption, may be argued from the extremely limited quantity of fluid existing in health in the cavities with which they are connected, as compared with the very large amount that sometimes collects from injury or disease, and

which is often very rapidly absorbed upon recovery. There is, however, no necessity for arguing from doubtful instances, inasmuch as it has been established that—

"There is no essential difference between the lowliest plant and the highest animal in regard to the act of selective absorption, in both it is accomplished by cells."

That the cells of granulations and pus should exhibit peculiar relations to the surrounding parts, a property of selective absorption, would therefore be only a particular instance of a general function—a property established for these forms of cell-growth, which is found universally in all other kinds of such growth. What are the facts bearing upon this inference? An abscess is occasioned by a species of cell-growth, it is a collection of Pus-cells in a closed cavity; and the interior surface of an abscess is also composed of cells.

"An abscess," says Mr. Lawrence, "is both a secreting and an absorbing surface. It may be regarded as a kind of new organ developed in the body."

"In the first processes toward suppuration, where the living surface is to separate from the dead parts, we may remark," says Mr. Hunter, "that nature

can carry on two operations at the same time, for whilst the separation is proceeding by the absorbents, the parts are forming themselves for suppuration."

An abscess, during the time pus is accumulating, will make its way from the deeper parts to the surface of the body by absorption of the overlying integument ; and numerous small blood-vessels have their continuity interrupted without bleeding.

In ulcers the natural texture is eroded or absorbed, and here numerous cells flow away in the discharge. Blood-vessels, too, are frequently divided by ulceration without any loss of blood.

In both abscess and ulceration there is evidence of two simultaneous operations—first, cell-growth,—and secondly, absorption or disintegration of the vascular-tissue without hæmorrhage. Appearances are very different in an abscess as compared with an ulcer—because, in the former, the new matter, the new-growth, pus, being confined, its accumulation causes swelling, and this hides from view the loss of the existing texture by absorption, whilst, in the latter, an ulcer, the new matter having a free discharge, the loss or disintegration of the existing texture is the most prominent feature. Truncate an abscess or pustule, allow the pus to escape, and an ulcer with a soft pyogenic surface, or with granu-

lation, remains. What, in these cases of abscess and ulceration, are the agents by which absorption is effected and blood-vessels opened without bleeding?

CASE.—An acute abscess, which rapidly came to a head, was opened, and a quantity of cream-like pus was discharged. The cells of the pus were nearly uniform in size, figure, and appearance. In contact with tepid water, they increased greatly in size by absorption, and, within the enlarged cells, numerous minute molecules were seen in active motion.

CASE.—A chronic abscess, which had existed a long time, was opened, and the matter discharged had a very different appearance. It was more fluid, not so white, and there were many flakes and clots in it. Upon examination, scarcely any entire or perfect cells could be seen. The difference in these two cases seemed connected with the qualities of the pus-cells. For, in the acute abscess, where cell-growth and absorption of the overlying integument were both actively proceeding, the cells were found uniform in figure and appearance,—"laudable pus." Whereas, on the contrary, in the chronic abscess,

where cell-growth and absorption of the overlying integument were both extremely languid, or had stopped, the cells were found fewer in number, more broken, shrivelled, and otherwise irregular in shape, —"unhealthy pus." Whatever the agents of absorption in thinning the integument over an abscess are, the same, we must suppose, sever blood-vessels without bleeding, and make openings in the older vessels for the junction of new ones. And in cell-growth there are agents having attributed to them properties which seem most fitted for the purpose. Messrs. Tomes and De Morgan, in a paper in the Philosophical Transactions, on the structure and development of bone, distinctly refer the absorption of bone in a case which they examined, to a granulation texture composed of nucleated cells. "What the bone lost in bulk," they say, "the cells gained; the cellular mass presenting a perfect cast of the surface of the bone, suggesting to the mind that the soft was growing at the expense of the hard tissue."*

In small-pox every pustule arises with inflammation, and becomes an abscess filled with cells;—it is a focus of cell-growth. Other persons will take small-pox disorder by inoculation with matter from the pustules. This is strong evidence that the cells

* Philosophical Transactions, 1853. Part I. p. 129, &c.

of the pustules have absorbed and conveyed injurious matter from the blood to the vascular tissue for discharge. In measles and scarlet fever, recovery from the disorder is concomitant with an exfoliation of cell particles from the skin, and, that these discharge poisonous matter from the blood seems proved, by the contagious properties which it is well known they possess.

In inoculated small-pox a poison is undoubtedly introduced into the blood,—this produces illness in the person and numerous little abscesses in the skin ; with the maturation of the pustules, illness subsides. Other kinds of poisonous matter may be absorbed from wounds or sores, and this is often followed by inflammation, abscess, and ulceration, not only in the sore itself, but also in other distant parts of the body. In these cases, it has been observed, that with the discharge of the contents of the abscess, the patient has recovered. In a paroxysm of gout the attack passes off concomitantly with a copious extra-exfoliation of cuticular particles from the skin, and that matter, injurious to the blood, obtains an outlet from the circulation at the part affected, is presumable, from the nature of the material deposited in the tissues around the disabled joint. From these cases we are naturally led to follow up the inquiry

as respects absorption by cells, under the heading of our next section.

III.

OF BLOOD DISTEMPER.

Blood may be injured or distempered by unwholesome food, by impure air, by suppression of the natural secretions, and by sundry poisons. What are the phenomena in such cases? To this question we reply generally, some form of inflammation. In local violence from mechanical injury, the place of inflammation is determined. It appears at the site of injury. In blood distemper, on the other hand, the place of inflammation is not always so precisely determined. In rheumatism, erysipelas, and gout, it may shift its position. It may begin in one part and pass over to another. Blood flowing in all parts of the body, and vascular tissue existing wherever blood flows, elements of inflammation would seem to exist no more in one spot than in another. Yet, in discrete small pox, inflammation always appears in spots on the skin, and the pustules

always stand out isolated and distinct. In scarlet-fever and measles, the redness of the skin is always more general. What in these cases determines the difference ?

That poisons of various kind affect the blood, and that some poisons act specially upon one organ, others upon other organs, may be safely affirmed. Laudanum, and chloroform, act upon the brain. The action of strychnine as a poison is shewn in an especial manner by muscles ; and that of mercury by the salivary glands, &c. In these cases, the amount of injury, or gravity of the symptoms, is in proportion to the quantity of poison,—at least it is generally so. In epidemical disorders there appears the same kind of special action from aërial poisons. In some seasons, the air tubes of the lungs, or the glandules of the skin,—at other seasons, the mucous membrane of the bowels, or the substance of the brain, is most affected. That is to say, sometimes influenza or bronchitis, small pox or scarlet-fever,—at others, diarrhœa, typhoid fever, or cholera, are epidemic. How is this accounted for ? We may say, the miasm or aërial poison is specially determined to the part affected. But how determined ? In all secreting organs, the parenchymatous elements consist of different kinds of cells. In animals, as in

plants, secretion is performed by the agency of cells, which, in the former case, select from the blood the materials it is their province to assimilate, and discharge them into canals, by which they are carried out of the system. The cells of secreting organs have a property of selective absorption. And we argue of small-pox, that the poison acts most upon the glandules of the skin, in virtue of peculiar relations in the elements of that species of parenchyma to that particular poison, in a way analogous to that by which mercury affects specially the salivary glands, viz.—by selective absorption. Such being the case, and the glandules of the skin lying separate, and distinct, with considerable intervals between them, the spots of inflammation are distinct, and the pustules distinct.

In scarlet fever, we argue in the same manner—that the poison—in virtue of a property of selective absorption—acts most, or primarily, upon the deep cells of the epidermis or cuticle. And, these being universally distributed upon the skin without intervals, the redness, therefore, is general.

"That sores give rise to very different kinds of pus," says Mr. HUNTER, "is evident to the naked eye, and that the different parts of which the blood is composed will come away in different proportions

we can make no doubt; and we find that whatever is in solution in the blood comes away more in one kind of pus than in another." Again: "A person shall have a sore upon the leg, which granulates freely; the granulations shall appear healthy, the skin forming round the edges, and all shall be promising well, when all at once the granulations shall lose their life and fade away. New granulations may afterwards spring up, and these shall undergo the same process, and so they would continue to go on, if some alteration in the nature of the parts be not produced."

Differences in the qualities of pus and granulations are here referred to differences in the quality and composition of the blood. Things in solution in the blood coming away more in one kind of cell-growth than in another.

It is not a new doctrine to say the blood is distempered by an aërial poison; or that poisons are determined to particular organs. Nor is it new to argue that vesicles, pustules, abscess, or some other critical discharge, cure the distempered blood. The cause of fever, according to HIPPOCRATES, was some poison in the blood, which in a certain number of days was brought into a state in which it can be separated from the rest of the blood and expelled,

either by some increased secretion, or by eruption, pustules or abscess.

"An epidemical disease," says SYDENHAM, "must be regarded as an effort of nature to restore the health of the patient, by the elimination of the morbific matter, which would otherwise undo the fabric of the body. During the febrile ebullition the elements which fret the blood are picked out, gathered together, and made over to the fleshy parts of the body for expulsion."

Now, selective absorption by cells is an accepted doctrine of physiology. If, therefore, we argue special relations in the parenchymatous organs to different poisons—aërial and others—in virtue of a property of selective absorption in their component cells, we do no more than put forward a well-known and very general function of cells, as a *vera causa* in a most interesting class of pathological and therapeutical phenomena : as the method by which opium especially affects the brain, though received by the stomach ; by which, in epidemical disorders, a particular part is peculiarly affected by a particular miasm ; by which, in small pox, inflammation appears in spots, and in scarlet fever is general upon the skin ; by which, in short, one poison or medicine affects one organ, and another poison another organ

especially. And if, as appears to be the case, the turning point of the symptoms—the crisis—in small-pox and scarlet fever, be determined by the maturity of cell-growth, then in other epidemical fevers there is ground for arguing that the crisis of the disorder is also determined by the maturity of cell-growth, different sorts or species of cells requiring different times. And it is to be observed in small-pox, as a type of these cases, that the blood improves, or becomes better fitted for its normal purposes as the cells grow. For what are the facts? In small-pox there are hundreds of little abscesses in the skin, each one of them a focus of preternatural nucleated cell-growth. The blood is continually passing the pustules, and the growth of the cells and a change in the qualities of the blood are concomitant effects. We do not know what the change in the blood is, further than it appears in the removal of injurious matter, but it may be argued, that with the change in the blood the conditions necessary to the cell-growth are exhausted. The growth ceases and the patient recovers.

Pursuing this line of argument, it follows, that the cells of the pustules of small pox, which grow and multiply by absorption from blood, tainted with the poison of small pox, must differ in qualities from

those discharged from a wound occasioned by mechanical violence. And that this is so, seems proved, inasmuch as has been said, the one kind of cells will reproduce a specific disorder, which the other kind of cells will not do. The pus of small-pox performs a physiological or therapeutical function, or is "laudable," if, discharging a poison from the blood of one person, it be capable of producing small-pox in other persons. And, in other cases, granulations and pus are "laudable," not so much from a comparison with any fixed or ascertained standard, as when their component elements perform the required function in particular instances. Such are the separation of sloughs, the expelling foreign matters by the safest channels, the elimination of poisons from the blood, the establishment of new blood-vessels without bleeding, and the repair of solutions of continuity by the metamorphosis of granulations into fibrous texture.

Are we to suppose that the natural powers of reparation, which heal wounds—discharge sloughs without bleeding, and produce new bone for the repair of fractures through the medium, or by the agency, of a nucleated cell-growth—stop there? On the contrary, we argue from the facts that these powers are exercised in blood distemper and organic

disease, through the same medium,—the properties of nucleated cells. The evidence, we contend, as clearly proves that cell-growth will effect a therapeutical change in the quality of blood, as that it effects therapeutical changes of texture in the common cases of reparation.

That the poison of small-pox destroys, in the very severe cases, the natural parenchymatous cells of the glandules of the skin, is probable from the pits which remain. Yet in the pustules we see new preternatural cells which seem generated by the poison. This is agreeable with the laws of nature. Nothing is more common than lowly species of cells growing upon weakened textures of a higher grade, and flourishing under conditions which injure or kill more complex structures. We may be unable to discover, with the microscope, differences in different kinds of laudable pus, that of small-pox, from that of a common suppuration, but this is not to be wondered at. For different species of animal cells, unless deeply coloured, are very much alike to one another, and some kinds of animalcules which live in decomposing animal and vegetable infusions, would be scarcely distinguishable from pus cells were it not for their varied and spontaneous movements.

That there is abundant evidence of a provident

intent and action in all cases of abscess and ulceration can scarcely be denied, when we contemplate the vast solutions of continuity which occur, without bloodshed, in the most highly vascular parts of the body, from large abscesses and spreading ulcerations. This provident action we designate by the term CELL-THERAPEUTICS ;—a term which in its broad physiological sense, is by no means to be limited to cure and healing. For in every case of abscess and ulceration, whether success or reparation be or be not achieved—whether the patient recover or die—nevertheless, the formation of the abscess and the spreading of the ulcer, both furnish wonderful examples of the provident properties of cell-growth. Solutions of continuity are effected, dead and useless parts slough off, and new blood-vessels are formed which join on to the older ones, without bleeding. Surely, it is to take a very partial view of the salutary operations of Nature, if we limit them by a technical *idea*, by the medical sense of cure or recovery.* Arguing the absorptive and therapeutical properties of cell-growth, in no way interferes with the function of absorbing vessels. For instance :—Of an abscess in a gland of the groin from ulceration in the foot,

* Vide the chapter on Etiology in Healthy and Diseased Structure.

the argument is, that a poison, entering the circulation by absorbent *vessels*, is arrested and discharged by the *cells* of the gland in the thigh. The phenomena being inflammation, abscess, and purulent discharge. An *indiscriminate* absorption by vessels, may thus be supposed, rectified by the *discriminate* activity—the metabolic processes—of cells. We do not presume to determine the office of the lymphatic glands, but in support of our argument we may point to their situation, properties, and connexion with absorbent vessels. Glands composed of cells are numerously placed along the course of absorbent vessels, and they readily suppurate upon poisons reaching them through the vessels. And this being so, a basis seems laid for arguing the therapeutical *intent*, if not always the therapeutical *result*, of purulent cell-growth in such cases. And what is called the *vis medicatrix naturæ* would seem referrible to the properties of a nucleated cell-growth.

If the circulation of blood be observed with a microscope in vessels of a transparent texture, the stream is seen flowing so rapidly that it is impossible to discriminate the corpuscles, except that here and there a few colourless cells, slowly gliding along the coats of the vessels, or adhering to them, become discernible. But if the part under observation be

slightly injured or irritated, a much greater number of colourless cells are seen separating from the red stream, and becoming stationary upon the coats of the vessels. A line of lymph is at the same time visible between the blood current and the coats of the vessels, and in this the stationary cells seem to be embedded.

It has been said this appearance has no reference to inflammation. We think, it is the first phenomenon of new cell-growth in the vascular tissue, the first act of a much more speedy change in the coats of the vessels than occurs in natural adult growth. The appearances certainly show a disposition in the blood, circulating in the living vessels, to separate into two parts, which are the same with those observed in many cases of inflammation after venœsection—that is, where a buffy coat forms. And if, from other facts, it can be proved that the coats of the blood-vessels yield, and are replaced by new cell-growth, then the observation referred to, shows how the blastema of such growth may accumulate,—the colourless elements of blood being the first to occupy the breach. And from these elements, composed, as we know they are, of lymph, and cells, may proceed, we argue, the further appearances and properties of cell-growth.

"The blood-vessels," says Mr. Hunter, "are probably the very first active parts of the system, for we find them in action before they have formed themselves into a heart, and in such a state of parts we find them the only part that has any strength, while the other parts are only preparing for action; this is so remarkable that we can dissect the vessels of a chicken in the egg without injection, the other parts easily giving way." In all cases of natural growth the blood-vessels are among the first parts to acquire strength or coherency. In inflammation we find them the first parts losing strength or cohesion. In natural growth the change in the coats of the vessels is from nucleated cells to fibrous tissue. In new cell-growth the change is from fibrous tissue back again to cells.

We shall here state, in the form of propositions, the spirit of the conclusions we aim at, and afterwards the discussion will be resumed.

1. Reparation in the human structure is not limited to wounds and fractures from mechanical violence. It extends to injuries of the blood, and to disease in the parenchymatous organs. It is accomplished by a new or preternatural cell-growth, in the common vascular tissue—and of this growth

there are two prominent forms,—the one a vascular form, GRANULATION, the other a deciduous form, termed PUS.

2. The Cells of granulations and pus exhibit peculiar relations to the surrounding parts,—a property of selective absorption. Those of granulations open blood-vessels for the junction of new ones, and are elements of repair in virtue of a capacity, in the cells or cell-contents, of metamorphosis into fibrous tissue. Those of pus are elements of repair, in virtue of the deciduous mode of cell-growth. The same sort of vital activity which causes leaves to fall in autumn, discharges sloughs from sores, and poisons from the blood, without bleeding.

3. During the formation of granulations and pus, the natural blood-vessels undergo a species of retrograde metamorphosis, for the fibrous coat of the vessels becomes the seat of new cell-growth. A state of growth in which we know in the embryo, blood-vessels bleed upon the lightest touch, and multiply with great rapidity.

4. The formation of granulations and pus are accompanied by phenomena termed INFLAMMATION. That is to say, inflammation is the sign or signal of a change commencing in the coats of the blood-vessels, and thereby is distinguished from congestion,—

in which there is no morphological change in the coats of the vessels.

IV.

OF INFLAMMATION.

Inflammation is sometimes acute, sometimes chronic. The argument is that inflammation is new cell-growth in the common vascular tissue. The term acute means rapid. Cell-growth is a rapid growth.

"I once," says MR. HUNTER, "scraped off some of the external surface of a bone of the foot, to see if the surface would granulate. I remarked *on the following day* that the surface of the bone was covered with a whitish substance, and when I touched it with a probe I did not feel the bone bare, but only its resistance. I conceived this substance to be lymph, thrown out from inflammation, and I thought it would be forced off when suppuration came on, but, *on the succeeding day*, I found this very substance vascular, and appearing like healthy granulations. *Upon now touching it with a probe it bled freely.*"

"I opened the tunica vaginalis of a young ram, and the testicle was exposed. The surface, *almost immediately*, showed great vascularity; very soon lymph appeared, and *in twenty-four hours* the matter looked like common pus.

"A wound was made into the abdomen of an ass, and a solution of salt and water was thrown in to bring on inflammation. At the end of *sixty hours* the animal was killed, and on examining the abdomen, the outer coat of the intestines had become extremely vascular, the convolutions adhered together by lymph, and pus had been discharged into the cavity of the abdomen.

"I have seen two granulations on the head—one from the dura mater after trepanning, and the other from the scalp, unite, having the bare bone between them—so firmly *in twenty-four hours* that they required some force to separate them, and when separated they bled."

In the egg of a chicken, blood and numerous blood-vessels have formed by the end of the third day of incubation. They are plainly visible to the naked eye, or through a lens, on the fourth day. In blood-distempers inflammation is reckoned acute. Counting the first day of illness as one, small-pox shews its pustules commencing on the third day.

By the tenth day they have arrived at their full growth and maturity. In measles and scarlet fever inflammation reddens the skin on the second or third day, and the cuticle exfoliates on the ninth or tenth day. The conclusion is that inflammation agrees in time, as in other particulars, with the qualities of cell-growth—so that what is affirmed of the one may be affirmed of the other. For example :—

A person may suffer mechanical violence at a time when the blood is unhealthy. New cell-growth would arise at the site of injury, and the purulent form of it would be proportional to the blood disqualifications—the wound not healing until the qualities of the blood be changed or improved.

Cells thus growing under very different conditions of blood, must be supposed themselves to be different. Things in solution in the blood—as Mr. Hunter expresses it—coming away more in one kind of pus than in another kind. And if there be varieties of cell-growth from different states of blood, then are there different kinds of inflammation.

Case.—At eight o'clock in the morning of the 28th December, a physician who was assisting at the post-mortem examination of a lady who had died of puerperal peritonitis, unfortunately pricked his

finger. At eight the same evening he felt some pain and uneasiness at the part, and had it touched with nitrate of silver. During the night, shiverings came on, and he felt extremely restless. On the morning of the next day, 29th, the finger was much swollen, and red lines extended up the arm. Leeches, fomentations, and poultices were applied. In the evening, the symptoms not abating, there was great prostration of strength. On the 30th, the hand and arm were greatly swollen, the finger had put on a livid appearance, the glands in the axilla were affected, and the pain was very great. On the 31st, the pulse was from 90 to 100, and the breathing irregular, with torpor and drowsiness. In the evening, all the symptoms were increasing, and now an erysipelatous blush from the axilla extended over the side of the chest. During the night the breathing became more difficult, and the drowsiness gradually passed into a deep stupor. Death took place at six o'clock on the morning of the 1st of January, not four days from the infliction of the wound.

In this case we should not attribute the fatal event to inflammation, but to blood distemper. The swelling of the glands in the axilla and the other signs of inflammation, were they not efforts of

nature to arrest the progress of the poison, though they failed? And they failed, apparently, because the blood was so much injured, that life gave way before the natural effort at relief could fairly come into operation. This case seems analogous to one of very severe mechanical injury, where the patient dies from the shock, before inflammation has time to become established. In mechanical violences we conceive a difference between dangers from the injury, and the danger from inflammation and suppuration, incidental to the effort at repair. And in such accidents as that related, it must be important to separate, as far as can be done, the symptoms and dangers referrible to some poison in the blood, acting deleteriously upon a vital parenchyma, from the symptoms and dangers really attributable to inflammation.

In eruptive fevers—small-pox, for instance—it is contended that the local inflammation and pustulation are not rightly to be considered as the disease, but rather as the expression of the ways of Nature in setting free injurious matter in the blood in that particular instance. And if this argument hold in eruptive fevers, then we think it may be extended not only to the case related, but to other cases of

external inflammation. In erysipelas and gout, the disease is some disqualification of the blood, and dangers may arise from that source ; the local action is an effort at reparation, and dangers may arise from that also. But we shall have occasion to recur to the argument which touches upon the point of remote and proximate causes. In the meantime, it is very necessary the distinction between the vascular tissue and the parenchymatous elements of an organ, shown by the microscope in physiological anatomy, should be clearly comprehended, with respect to pathology and therapeutics. This will form the subject of the next section.

V.

OF THE BLOOD-VESSELS AND CONNECTIVE TISSUE; AND OF THE DISTINCTION BETWEEN THEM AND THE PARENCHYMA OF THE SEVERAL ORGANS.

In the structure of the human body three orders of parts are readily distinguishable—blood-vessels,—the blood,—and the different organs : brain, muscles, liver, kidney, &c. Blood circulates through every

part of the body in vessels termed arteries, veins, and capillaries. What is the structure, and what are the relations of the coats of these vessels ?

CASE.—A young woman was struck with a stone on the forehead, and some connective or areolar tissue protruded from the wound. This was removed and examined with a microscope. The texture was composed of strands and bands of waved fibres, intricately interlaced. The coats of the arteries and veins, down to a magnitude not larger than the $\frac{1}{500}$th part of an inch, consisted of a double—or of two nucleated membranes. The "nuclei" of the inner one were arranged with their length parallel—those of the outer one, transversely to the axis of the vessel. The outer or third coat of the vessels was fibrous, and the fibres appeared identical with those which formed the connective tissue.

The coat of the capillaries was a thin membrane, with here and there nuclei attached to it at distant intervals. An examination of the structure of blood-vessels in other parts furnished the same results. And in all cases—whether blood-vessels enter the brain or muscles, or a secreting gland—in proportion as the vessels diminish in size, the thickness of their

outer fibrous coat diminishes, until at last in capillaries, a thin nucleated membrane only is interposed between the parenchyma of the organ and the blood; and in this membrane no interstices or outlets are visible.

THE CONNECTIVE TISSUE is as extensively diffused throughout the body, in some form or other, as the blood-vessels. It invests the exterior and enters with the vessels into the interior of every organ. Its elements everywhere blend with the outer coat of arteries and veins. And in most parts, the strength or thickness of its membranous expansions bear a proportion to the strength and thickness of the coats—or to the size, of the vessels. In the dura mater, pia mater, and pericardium, the elements of the membranous texture are of the same kind as those of the outer coat of the vessels. The vascular membrane which adheres to the outer surface of the bones, and that which penetrates to their interior, are, both of them, expansions of connective tissue. Both blend their elements—their fibrous elements with the coats of the blood-vessels, and the outer one—the periosteum—blends its elements with those of fasciæ, ligaments, and tendons.

At the early periods of life the outer coat of the blood-vessels and the connective tissue proceed in

growth together, altering their forms almost simultaneously. When the outer coat of the vessels is composed of cells, connective tissue is cellular also. Sometimes—in embryo-growth—the coats of the vessels are seen formed of a gelatinous and transparent material; in such cases the connective tissue —the membranous tissue between the vessels—is gelatinous too. And when in progress of growth the coats of the vessels become fibrous and elastic, the connective tissue is fibrous and elastic likewise.

These facts indicate a common nature in the outer coat of arteries and veins, and the several forms of connective tissue; and a distinction between these and the particular substances of the different organs. For instance, we not only distinguish the brain from the liver, and both these organs from the muscular flesh, &c. But also in each organ—and this is the point—we distinguish the vascular connective tissue from the parenchyma not only in healthy, but also in pathological anatomy. Let us substantiate this point. In some birds the periosteum is almost black, from radiating spots of dark pigment. In these cases the tendons are tinged black, and the outer coat of the blood-vessels is spotted black. In cattle, where the skin and hair are patched with black and white, we have seen the pia mater with

broad patches of pigment also; and in the dark patches, the outer coat of all the blood-vessels was deeply coloured with spots of pigment. In frogs, spots of pigment are common to sundry forms of the connective tissue, and to the outer coat of the blood-vessels.

If a portion of muscle be torn away by an accident, or if a part of a lung be destroyed, cure is effected not by a new growth of muscle or lung substance, but by a new growth of connective tissue, proceeding from cell-growth—granulations, or granulations and pus. And when inflammation attacks the brain, liver, or kidney—the skin or the eye, &c., it does not issue in any new parenchymatous elements, but always in a common cell-growth, lymph, granulations, and pus; so that whatever may be the difference in parenchymatous elements, there is a species of uniformity in the products of inflammation in the different organs; and whatever may be the requirements of repair, there is a kind of uniformity also in the issues of the efforts made towards reparation.

Upon these anatomical, pathological, and therapeutical facts, we ground the distinction between inflammation and organic disease—between new cell-growths in the common vascular tissue and idio-

pathic degeneration or decay of the parenchymatous substance of an organ. The exceeding minuteness of the scale upon which vascular tissue and parenchymatous elements are associated, and the constant presence of blood in the vessels make it almost a hopeless task to discriminate upon post mortem inspection particular kinds of cells ; nevertheless, we conclude the two classes of texture,—vascular tissue and parenchymatous substances,—to be distinct in nature, properties, metamorphosis, and diseases.

The argument substantiated by this anatomical distinction, is this—that when parenchymatous degeneration or organic disease so affects the blood-vessels as to render bleeding imminent, new cell-growth in the vascular tissue arises to anticipate or prevent it. Signs of inflammation being combined with the evidences of organic disease ; just as in mechanical injuries signs of inflammation become combined with the torn flesh or the fractured bone.

And if the facts related in the next section make good this argument, it follows of the things seen in organic disease, whether with the naked eye or with the aid of a microscope, that some are elements proper to the parenchyma ; others, elements of new cell-growth in the vascular tissue. Some, elements of the diseased parenchyma, others, elements

of inflammation, and it may be, demonstrative of efforts at repair—efforts limited no doubt within the sphere to which reparation extends,—and this sphere, we have said, does not extend to the reproduction of a special parenchyma, though it clearly does to the healing of blood-vessels and the reproduction of vascular connective tissue, as we now proceed to show.

VI.

OF ORGANIC DISEASE AND THE PROCESS OF REPAIR.

The chief organs of the body are then composed of substances different from each other, and from vascular tissue. The brain, liver, kidneys, and lungs are examples. These are liable to idiopathic disease, degeneration, or decay. Softening of the brain, fatty degeneration of the liver or kidney, and tubercles in the lungs are established instances of organic disease.

Tubercles in the lungs are a species of parenchymatous decay, which originates in the midst of numerous capillary and other blood-vessels, in a part

of the body where venous blood changes into arterial. Tubercles destroy these vessels, and fill up the air-spaces. When they are small, there is no sign of inflammation in the pulmonary texture around them, but when they have increased in magnitude, and have implicated vessels of larger size, inflammation appears, marked, as in other cases, by effusion of lymph, granulations, new blood-vessels and pus. Or, to use terms of the new physiology—marked by the *exudation of blastema and the growth of nucleated cells.* Some of the cells attached to the new blood-vessels form *granulations*, others appear in the deciduous form of *pus.* This cell-growth softens the tubercle, separates it from the more healthy portions of the parenchyma, and forms an abscess, which contains pus and the softened tuberculous material. Abscess and ulceration deep in the substance of a lung is seriously pathological, upon the same ground as abscess and ulceration in a compound fracture, or in the substance of the liver from the growth and irritation of an "acephalocyst." But, the question here entertained is, whether there is evidence denoting any relation to the process of repair, any indication of a therapeutical operation.

A tubercle increasing, destroys blood-vessels of increasing size. Bleeding from the lungs is some-

times one of the earliest signs of the existence of the disease. Persons sometimes die of the hæmorrhage. At the Brompton Hospital it has been observed that a considerable majority of the cases of hæmoptysis occur before any sign of softening of the tubercles can be detected with the stethoscope. The process of softening, or new cell-growth, seemingly being associated with prevention of hæmorrhage. * This corresponds with what we have seen in ordinary cases of abscess, ulceration, and sloughing, where severance of blood-vessels and of bonds of union take place without bleeding. In the case of advancing tubercles in the lungs, the urgency of a provision against bleeding cannot be known before-hand. And the proclivity of hæmorrhage being unknown—the signs which denote the commencement of new cell-growth—those of inflammation, softening, and ab-

* "Dividing the disease into two periods, viz., 1st, that characterized by the deposition of tubercular matter in the crude state; and 2nd, that, subsequent to the softening of this matter or the formation of cavities, we find in 453 males, that hæmoptysis occurred in the ratio of 73 per cent.; and in 243 females, in the ratio of 72 per cent. *in the first period.* . . . . . These figures show unquestionably that hæmoptysis is much more frequent (nearly three to one) in the first period of the disease, and nearly equally so in both sexes."—*Medical Report of the Hospital for Consumption*, 1849, p. 30.

scess—intended as we argue to anticipate or prevent it, may seem supererogatory and purely pathological. On the other hand, a therapeutical view of the properties of abscess and ulceration, even in tubercular disease of the lungs, seems corroborated by the great rarity of bleeding from the walls of an abscess, although very large blood-vessels may be destroyed and severed in its track. Moreover, in the lungs there is a double circulation. The one, parenchymatous or special, serving the function of respiration, the other, the ordinary or general circulation as it exists in other places. The disease called tubercles affects the parenchyma and the parenchymatous vessels, whereas the cell-growth, which produces abscess around tubercles is administered to by new vessels, which form their connexions, not with those of the parenchymatous circulation, which are the ones diseased, but with the vessels of the general circulation, which, in all other instances, furnish the elements of repair.

We have often examined the lungs of those who have died of pulmonary consumption, and have seen in the same lung small hard tubercles, larger and more irregular tuberculous masses partially softened —small abscesses filled with pus—and larger cavities, half filled with air and half with pus, and softened

tuberculous matter. We have also seen blood-vessels of almost all sizes, as it were cut across by the disease, but we never recollect meeting with any escape of blood into an abscess, except in those cases where hæmoptysis had been present as a symptom during life. In some of the abscesses a soft cell-texture, with new blood-vessels—a granulation texture—formed the interior or pyogenic surface ; in others, this surface was firmer and more fibrous, and the contained matter was less purulent, more gelatinous and mucus-like. And where these conditions existed, the parts were certainly advancing towards cure.

In the largest cavities it was usually evident, from the appearance and character of their walls, from their hard, dry, and brittle properties, that the original tuberculous disease and phenomena of inflammation had long proceeded together, that many successions of granulation-texture had arisen and faded ; the new cell-growth and the contiguous portions of lung substance having both changed into tuberculous matter. Nevertheless, even in these instances, there was always abundant evidence of therapeutical operations in the large size of the blood-vessels which had been broken up by the disease, but which had been effectually sealed further

in, in the more healthy parts of the substance of the lung, against hæmorrhage. *

* "The pulmonary arteries and veins as they approach the larger vomicæ are suddenly contracted: a blood-vessel which, at its beginning, measured nearly half an inch in circumference, sometimes (though it had sent off no considerable branch) could not be cut up farther than an inch; and when, outwardly, they are of a larger size, yet, internally, they have a very small canal, being almost filled up by a fibrous substance; and frequently, as they pass along the sides of vomicæ, they are found quite detached, for about an inch of their course, from the neighbouring parts. That the blood-vessels are thus obstructed, and that they have little or no communication with the vomicæ, is rendered still more evident by blowing into them, or injecting them. By blowing the air does not pass into the vomicæ, excepting very rarely, and then only by some imperceptible holes. And after injecting the lungs, upon cutting into the sounder parts, numberless small vessels may be seen filled with the wax; but in the diseased parts there is no such appearance. The injected vessels in the sounder parts may be traced a long way dividing into smaller branches, but those which lead to tubercles and vomicæ, a very short way, and only to their principal branches. The wax was rarely found to have entered the middling sized vomicæ, and never the smaller or larger ones."—*Morbid Anatomy of the Lungs in Tubercular or Pulmonary Consumption.* By William Stark, M.D. From Posthumous Works. London, 1788. *Edinburgh Medical and Surgical Journal*, Vol. 45, 1836.

Laënnec—to whom belongs the high merit of having first pointed out the evidences of cure in tubercular consumption, says—"I had often observed marks, puckering and cicatrices in the lungs, without knowing to what to attribute them, and without attaching much importance to the appearances. But after I was convinced of the possibility of cure in cases of ulceration of the lungs I began to fancy that nature might have more ways than one of accomplishing this end, and that cavities in the lungs after the discharge of their contents by expectoration and absorption might cicatrise in the same manner as solutions of continuity in other places."

The argument is, that parenchymatous or organic disease is an injury, influencing the common vascular tissue in the same way as other injuries. That is to say, degeneration or decay of parenchymatous structure calls forth new cell-growth in the common vascular tissue, in like manner and for the same end as do wounds, fractures, and distemper of blood. The cause of the disease, and the disease itself which brings on inflammation being quite distinct. For example: In mechanical violences we know there to be, *first*, the cause of the injury—some outward object; *second*, there is the wound, fracture, or injury which it has occasioned; and *third* and

last, arises the process of repair. In a burn the immediate antecedent of inflammation is not the hot body, but the wound, the spoilt integument, the injury inflicted. The heated substance inflicts the injury, and from the injury arises inflammation. The hot body is one thing, the injury inflicted is another thing, and inflammation, with its attendant consequences, is a third thing. And the second event interposes between the first and third.

In many cases of mechanical injury inflammation does not set in until hours have elapsed from the application of the cause of the accident. Again, in epidemical disorders, eruptive fevers, &c., we recognise the same sequence. There is, *first*, some evident or assumed outward cause; we call it an aërial poison—an impure air; upon this follows, *secondly*, blood distemper; and *thirdly*, from the blood distemper arises (in the manner already pointed out), inflammation.

If an aërial poison were the immediate antecedent of local inflammation, we should expect this to show itself either in the skin or lungs, these being the parts to which the air has access. Whereas, in epidemical fevers, inflammation often occurs in parts of the body, which can be injured by an aërial miasm only through the medium

of distempered blood. We have striven to express clearly our meaning, because the conclusion is, that neither heat nor cold, nor poisonous air, occasion inflammation, directly. These are not the logical antecedents of inflammation or fever. They occasion injury to the solid parts or the blood, and from the injury arises the inflammation. Extremes of heat and cold and poisonous air are dangerous to life, and reaction, in all these cases, is denoted by some form of inflammation.

In like manner with cases of tubercular consumption—the *cause* of tubercles is distinct from tubercles, and increasing tubercles are causes of inflammation. Tubercles commence and spread before inflammation appears. If, therefore, the first cause in the series,—that which originated tubercles,—continues in operation, then abscess and ulceration do not stop the march of the disease.

New cell-growth in the common vascular tissue, progressing with parenchymatous decay, may, in tubercular consumption, from what we know of its properties on other occasions, provide against imminent contingencies, anticipate bleeding from the diseased vessels, prevent the bursting of an abscess into the cavity of the chest, separate the diseased from the more healthy parts of the lung, and thus

prolong life without our knowing it. Yet if the original cause of the disease, continue in action, the completion of the therapeutical intent is defeated,—the new cell-growth fails of saving the life of the patient. On the other hand, if, by some happy change, by epoch of life, by change of air, diet, or habits, or any other means, the first cause or antecedent of the parenchymatous decay be arrested, then abscess, ulceration, discharge, and cicatrisation, do effect the cure. New cell-growth softens and separates the diseased from the healthy parts, to be expelled by cough or removed by absorption, and replaces the lost portions of the lung by connective tissue.

In the disease of the liver termed *cirrhosis*, there is slow wasting or decay of the parenchymatous cells of the organ, without bleeding, and as gradual a replacement of the lost parenchyma by a growth of fibrous connective tissue which occupies the void.* Here, we argue, there is reparation to the extent to which reparation goes in other instances. A secreting parenchyma wasting or destroyed, in no case is restored or reproduced by the

* Wedl's Pathological Histology. New formations of connective tissue in the liver. § 7. Liver, p. 428, &c. Sydenham Soc. Ed., 1855.

process of repair. Therefore, although in cirrhosis of the liver the continuity and outline of the organ may be preserved, hæmorrhage prevented, and somewhat of the bulk of the liver remain from an increased growth of connective tissue, occupying the spaces occasioned by the parenchymatous decay, still, as there is no restoration of the parenchymatous elements, the special function and secretions of the organ must gradually fail or diminish. Diminished or impaired secretion is a cause of blood distemper; and from blood distemper thus occasioned, secondary disorders and local inflammation in other parts, may arise.

Morbid growths not unfrequently present themselves in the body, the structure of which is composed of cells distinct from those of any of the normal textures; and it is interesting to remark in CANCER, that blood-vessels cannot be traced in it at an early period of its formation, but that they make their appearance, as in the normal development of the tissues, at a later date.* When a natural organ commences to grow, parenchymatous cells are the first to make their appearance, after them follows the blood, and after blood, the vessels and connective

* Human Physiology, by Dr. Carpenter. Third Edition, 1851, p. 181.

tissue.* Likewise in cancer, the same subordination of vascular tissue growth to the specific growth is observed. The relations of antecedent and consequent are the same in the morbid as in the natural growth. Cancer destroys the normal tissues, in the midst of which it may be developed, and when it has a power of rapid increase, the growth is said to be *malignant*.

Now, in tuberculosis of the lung, new cell-growth is excited in the common vascular tissue by degeneration or decay of the parenchyma. In cirrhosis of the liver there is increased growth or hypertrophy of the connective tissue, occasioned by atrophy or wasting of the parenchyma. In small-pox, new cell-growth arises in the vascular tissue of the glandules of the skin, from the circulation of distempered blood. The presence of other poisons in the blood will occasion abscess in the lymphatic glands. And in burns, carbuncle, &c., where the living parts are to separate themselves from the dead, new cell-growth arises in the vascular tissue. If in these cases it can be established as the rule, that the phenomena are those of a therapeutical reaction on the

* On the Containing Texture of the Blood. Lond. Med. Gazette, June and July, 1850. Figs. 1 and 2.

part of the common vascular tissue—as a distinct and, in some measure, independent texture—against the dangers threatening life, from disease or decay in another or parenchymatous texture, then there is ground for the inference, that fungosities, ulceration and discharge from a cancerous sore, are also phenomena of reaction on the part of the vascular tissue —therapeutical efforts to circumscribe, and, if it were possible, throw off a specific morbid growth, which by its increase destroys the normal tissues in the midst of which it has been developed. Especially is this inference corroborated when the fungosities or granulations alternately arise and fade away, new blood-vessels forming in all directions without bloodshed, and evident though unavailing efforts are made at the cicatrisation of the wound.

A specific and parenchymatous disease may be of rapid or quiescent growth; and growth in the vascular tissue around it may also be rapid or quiescent—acute or chronic. A malignant cancerous growth is in its own nature active, and when inflammation arises there is activity in the vascular tissue also,—a double activity—a specific morbid growth conjoined with inflammation growth. Tuberculosis of the lungs, on the other hand,

is of very gradual or quiescent growth, and until inflammation is aroused the vascular tissue is quiescent also. Therefore, in organic or specific diseases, there may be a double activity or a double quiescence, and phenomena will vary accordingly.

Physiological science forms as yet no reliable speculation as to the manner in which normal cells produce from common materials the manifold results they do, further than referring them to the vital or metabolic properties of the cells or their nuclei. There can be no expectation of going beyond the physiological interpretation in pathology or therapeutics. But if in natural growth the distinction between the common vascular or connective tissue and parenchymatous substances be established, the fact cannot be disregarded in phenomena of disease, or in morbid anatomy; and also, it must be admitted, in any endeavour to interpret the natural methods of cure.

VII.

OF CHRONIC INFLAMMATION.

There are then three causes of new cell-growth in the common vascular tissue 1. Mechanical violence. 2. Blood distemper. 3. Organic disease. In mechanical violence and organic disease the injury and inflammation are local. In epidemical disorders the injury which calls forth inflammation is referred to the blood; and inflammation locally appearing, discloses the parenchyma first or most affected by the circulation of the distempered blood. The signs of inflammation commencing are increased *heat* with *hyperæmia*, and the coats of the blood-vessels yielding, *lymph* exudes. To lymph succeeds cell-growth, *granulations*, *new blood-vessels*, and also in many instances *pus*. Lymph beneath the cuticle forms *vesicles*. Pus confined forms *pustules* and *abscess*. Granulations in exuberance are termed *fungosities*, and sometimes popularly, "*proud flesh.*" But when granulations lose their life and fade away *ulceration* remains.

A slough upon the skin or surface of the body,

is thrown off solid and entire, without difficulty and without bleeding. And we may conclude, in healthy persons, that we see the process—granulation, ulceration, and suppuration—which removes the slough, under the best circumstances. In all other cases of sloughing, difficulties interpose. In carbuncles, the dead areolar tissue is beneath the still living skin, and in necrosis of bone, the dead bone lies deep beneath the living muscles and skin. The process of separation and discharge is therefore chronic or protracted, until free outlets for the dead matter have been made, either slowly by the natural efforts, or, in a speedier way, by the caustic or knife of the surgeon. In the case of injured cornea before related (p. 2), experience teaches that inflammation, ulceration, and abscess, there observed, would have been protracted until the foreign body was expelled. In common issues,—granulation, suppuration, and ulceration are kept up or made chronic, by retaining the peas in the wound. In all these instances there can, we think, be no ground for misinterpreting the intention of the natural efforts—no doubt of the therapeutical end, the cure attempted—though the process is chronic and may fail through difficulty.

Again, in abscess of the liver or kidney from an

acephalocyst, difficulties arise from the conformation of the part. "Occasionally, says SYDENHAM, and he is speaking of epidemical diseases, "the process by which nature strives to expel the morbid influence, fastens upon a part wholly unable to get rid of it at all, and this may arise from the conformation of the part itself, as is the case with morbid matter impacted in the brain or nerves of paralytics, and with pus in the cavities of a thoracic empyema."

Tubercular consumption ranges in this category, for there are hindrances to the discharge of the contents of a pulmonary abscess, from the conformation of the part. The matter of tubercles cannot be got rid of except after complete softening and fluidity, and then only by cough and expectoration through openings made by ulceration in the bronchial tubes. The morbid material which is softened and separates from the more healthy part of the lung, is deeply seated in the interior of a vital organ. With these contingencies, that the process of sloughing, softening, discharge, and reparation, should be protracted and fail, is no more than what we see in other, and seemingly much less complicated cases. But the word fail is scarcely appropriate. For, as we have said, abscess and ulceration, though unequal to the

task of expelling the morbid matter, have yet prevented hæmorrhage.

Sometimes the simplest wounds fester and ulcerate, trifling bruises run on into abscess, sprains bring on scrofulous affections, and common fractures will not unite by bone. Let us illustrate these general remarks by a few examples.

It has been observed at the hospital, St. Louis, in Paris, when the wind sets in from the slaughter-houses in Montfançon, that the healing of the wounds and sores of the patients is arrested,—they assume an unhealthy appearance, which continues as long as the wind blows from that quarter. It sometimes happens in a hospital, that the first part of the process of repair in a fractured bone proceeds satisfactorily, but completion of cure is arrested, the union remains soft, yielding, and flexible. In such cases, cure has been completed by sending the patient out of the hospital into the purer air of the country. Places which are notorious for the prevalence of epidemical diseases, and a high rate of mortality among infants and children, are also notorious for scrofulous affections—chronic forms of inflammation. Sailors at sea in hot climates are accustomed to tramp about the ship without shoes or stockings, and their feet and legs are consequently bitten by mos-

quitoes. The bites generally ulcerate, but much more so in some seasons than in others, and the ulcers frequently continue to enlarge, sometimes quickly—in a few days attaining considerable magnitude—at others slowly for weeks, and in spite of medical treatment, so long as the ship remains in the same latitude. But upon cruising in a different atmosphere and more temperate climes, the ulcers heal speedily, and without further trouble. In a large infirmary in London, when a piece of ornamental water, which was formerly stagnant, in front of the edifice, had a green scum upon it, surgical operations were not so successful as at other times, and a flow of fresh water has been introduced to prevent the miasm.

In these cases the process of repair is irregular or protracted, not from mechanical hindrances in the part itself, nor from the conformation of the parts, but from conditions of the general health removable by change of air and habits. And we argue of blood distempers, besides those of graver kind which create fever, inflammation, and critical discharge, that there are others of more lenient form, which, not marked by any special illness, are yet a cause of hindrance to new cell-growth established for the cure of local injury. That is to say—a

minor disturbance of the qualities of blood, compatible with healthy functions in all the natural organs, may cause a new and tender cell-growth springing up for repair of local violence to fade; the new growth being the first to show the effect of the blood deterioration. And if this minor deterioration of the qualities of blood be kept up or continually accruing—as we suppose it would be—by living in an unwholesome air, or by persevering in unwholesome habits, then forms of inflammation become chronic. "Granulations lose their life and fade away. New granulations may afterwards spring up, but these fade also, and so they continue to do until some alteration be made." An alteration in the properties of the cell-growth, by an improvement in the qualities of the blood.

Cell Therapeutics, then, may be protracted and fail. First, from mechanical hindrances in the part itself, which may be surgically removed: thorns in the flesh, peas in an issue, dead areolar tissue beneath the still living skin, dead bone beneath the muscles and skin, &c. Secondly, from the conformation of the parts and their situation beyond manual control, so that matter which would be easily discharged, could an exterior outlet be made, cannot get away:

a clot of blood upon the brain, abscess in an internal organ, &c. Thirdly, from a minor distemper of blood, one removable by change of air, diet, or habits : chronic or scrofulous ulcers healing by a better quality of food and water, or by a change of residence and habits. And, fourthly, in organic disease, therapeutics fail : when parenchymatous decay continues in progress. The reproduction of a parenchyma—such as brain, liver, or lung substance being beyond the province of repair.

These difficulties and hindrances we contend, furnish no valid ground of opposition to our argument : – That cell-growth in the vascular tissue is the general agent of repair ; that suppuration in small-pox, around tubercles and in other cases, has a therapeutical mission, though in some instances there may be insuperable difficulty. But why, such being the argument, it may be asked, is not cell-growth extinguished, if difficulties be insuperable, rather than it should happen that a process intended for repair goes on to be a cause of death ? This question can be solved only by assigning a reason for a general law of growth.

In natural growth a rule of normal form or symmetry exists—a certain order, limitations, regular stages, and fixed periods. Nevertheless, the rule

is far from being an inflexible one. Monstrosities are produced which cannot live an hour in the world. Also infants are born with one hand, or with more than the natural number of fingers or toes, without fingers or feet, with club-foot, hare-lip, divided palate, and numerous other more or less obvious irregularities.

In the embryo, growth once started does not cease because of irregularity, or because it is taking a wrong direction. The monstrosity without a brain—with an imperfect heart—without limbs or shape, goes on growing, though it must die as soon as born. In these cases, we cannot tell why growth goes on, when the failure of its purpose is decided, all that can be said is, that the rule extends to new cell-growth, arising for repair, which we know in many instances—in compound fractures or crushed joints for instance,—when once started, is not extinguished, by insuperable difficulties. That is to say, of both cases—of natural growth degenerating into monstrosity—and of new cell-growths in the vascular tissue assuming the characters of disease, they may cease only with the life of the individual.

There are those who argue that monstrosities are so from the very first, independent of exterior causes. But there are others who take another

view of monstrosities, and argue :—That nature decreed the perfect form, though imperfections may arise earlier or later from unsuitable exterior conditions. Persons who hold the latter alternative with respect to monstrosities, may agree with us, that irregularity, exuberance, chronicity, &c., as applied to inflammation, denote hindrances and difficulties in a process of repair.

VIII.

CONCLUSIONS.

We might have amplified the basis of our argument by embracing other examples of cell-growth, reparation, and disease. But enough, we think, has been adduced to warrant the following conclusions :—

First :—That cell-growth in the common vascular tissue is the natural method of repair, which, like all other growths, may succeed or not, according to contingent circumstances. Regularity or conformity to natural growth and success, entitle it to be called the process of repair, healthy inflammation, or cell-

therapeutics. Irregularities, exuberance, protractions, and failure rank under the term unhealthy inflammation, and are placed in the class of diseases.

Second :—This new growth appears in two prominent forms—granulation and pus. The former united to the texture from which it grows by new blood-vessels, repairs solutions of continuity by metamorphosis into connective tissue. The latter, a deciduous cell-growth—discharges sloughs, and in virtue of the property of selective absorption in the elementary cells—eliminates poisons from the blood. Vesicles, pustules, abscess, suppuration, ulceration, and fungosities are varieties, and may denote irregularities of cell-growth.

In support of these conclusions, the following reflections occur. In mechanical injuries the process of repair has at first a pathological aspect. We say inflammation arises. On the other hand, in gout, small-pox, scarlet fever, and measles, inflammation vindicates its therapeutical purport by the limitations it observes, by the order and regularity of its times and stages, and by the recovery of the person concomitantly with a discharge of morbid secretion or preternatural cells at the sites of inflammation.

Cell therapeutics, after mechanical injury, has then a mixed pathological and physiological aspect. The pathological part is the first part. The injury has been inflicted and there is need of reparation. This is responded to by new cell-growth in the vascular tissue, the primitive form of growth of that tissue. The new growth requires for its support new blood-vessels, and new blood-vessels appear. But these new vessels cannot carry on the circulation without joining to openings in the older vessels. The openings are made by the absorptive property which all cell-growths possess. And thus the new growth establishes itself at the expense of the existing vascular tissue. The proper healing or repairing part of the process cannot be said to have commenced while these operations are in progress—while cell-growth and new blood-vessels are increasing. It is only when these have accomplished their part—when cell-growth is beginning to give place to fibrous connective tissue, and new blood-vessels are diminishing in number—that regularity and success entitle the phenomenon to rank as the process of repair.

In like manner, in blood distempers the phenomena have a mingled pathological and physiological aspect. In small pox, the pustules arise with in-

flammation. These are pathological to the vascular tissue ; they alter the form and properties of the blood-vessels. But the new cell-growth performs a therapeutical act as respects the blood, the cells of the pustules transferring injurious matter from the circulation to the solid texture for discharge.

Cell-growth in the vascular tissue or inflammation —whichever term we employ—is at all times, and from whatever cause arising, a thing of mingled good and evil, even when accomplishing the process of repair with success. And we may agree, when the good purpose is evident and in course of fulfilment, to call it the process of repair, and when the evil predominates, a disease. This would be a consistent and intelligible distinction. But, to call inflammation when it observes a regular order, strict limitations, fixed periods, and is followed by cure, as in small-pox, scarlet fever, measles, and gout—*a disease,* when the distemper is in the blood—and inflammation and suppuration in burns and compound fractures, often greatly more protracted, more dangerous and exhausting to the patient *the process of repair,* as though they had nothing in common with each other, seems "an inappropriate form of mental apprehension to apply to the facts which cannot give rise to any exact or substantial know-

ledge." Whereas, if the evidence produced shows that forms of inflammation—described by Mr. Hunter as adhesive, suppurative, and ulcerative—and the process of repair, are both resolvable into forms of new cell-growth in the common vascular tissue ; that granulation, suppuration, and ulceration in burns, compound fractures, necrosis of bone, tubercular consumption, &c., separate the dead from the living parts, sever bonds of union, interrupt the continuity of blood-vessels and create new ones without bleeding ;—that vesicles, pustules or abscess are appointed means for the discharge of poisons from the blood, then the subject assumes altogether a physiological aspect, and therapeutical operations are based upon the properties of cells.

The first rounds of the ladder by which the loftier heights of science are attained, must not be overlooked, trite and common as they are. Water, air, and food are necessaries of life. Yet water will choke, a little air in the heart will kill, and the most wholesome food in excess will distemper the blood—in deficiency will starve. Opium will lull to sleep, mercury will stop diseased growth, and antimony relieve an over-charged stomach. Yet opium, mercury, and antimony are poisons. Growths may be symmetrical and normal, or unsymmetrical and

monstrous. And new cell-growth or inflammation may be a process of repair or a disease. Things—which in their proper place and quantity are right, or contribute to health :—misplaced, excessive, or deficient without alteration in their nature, are wrong, and constitute disease. New cell-growth in the vascular tissue is, we contend, the natural provision which severs and opens blood-vessels without hæmorrhage. Granulation, the natural provision for the repair of solutions of continuity ; and pus, for the throwing off of sloughs and poisons. If granulations are wanted, and they appear, they belong to the category of therapeutics. If they be in excess, so much of them as is in excess belongs to pathology, the rest are physiological. If pus be required to loosen and discharge a slough, and pus appears and performs the task, it belongs to the category of therapeutics ; but if pus, having performed its office, continues to form and be discharged when it is not wanted, we treat it as we would any other pathological growth—not by encouragement but repression. And thus it is that inflammation has two bearings.*

In mechanical violences the surgeon sees the

* See the subject more fully treated in Healthy and Diseased Structure, p. 69, &c.

amount of injury, whether simple contused, lacerated, or comminuted. And before the first part of the process of repair,—inflammation and suppuration,—has commenced, he has opportunity to form a judgment of the course and time it is likely to take. He views with dread a comminuted compound fracture, or a crushed joint, and perhaps doubts whether the case should be trusted to the natural efforts for cure even when assisted with all his skill. If his decision be in the affirmative, he prepares himself and his patient for granulation, ulceration, and suppuration, and the probable use of caustics and astringents to control the exuberance of cell-growth—holding in reserve, should any unmanageable excess or irregularity endanger the powers of life—the removal of the limb.

On the contrary, in blood distemperature and organic disease, the physician cannot know the full extent of injury, or foretell the amount of inflammation which may ensue. And when this has commenced, if the site be internal,—the spreading or limitation, the regularity or irregularity, the acuteness or chronicity of it,—has to be determined not by direct observation, but from symptoms,—the pulse, countenance, complainings, bearing and manner of the patient. And for exuberance or defi-

ciency producing exhaustion or danger, though he may employ interfering agents successfully in some cases, yet should these fail he has no amputation in reserve.

In the treatment of a burn, or other mechanical injury, if inflammation be only in the right proportion, the surgeon does not interfere, except to favour or promote the oncoming granulations, as upon these he is dependent for the separation of the slough, and the healing of the wound. When the slough has been detached, he expects the granulations to heal or give way to the fibrous cicatrix. If they do not, he no longer treats them with care and encouragement. On the contrary, strong pressure and caustics are used to arrest their luxuriance, or stimulants applied to awaken their inactivity. In surgical cases, these interferences are not the cure, but they open the way for cure. Analogously, in medical treatment, there are many medicines employed which are poisons; and it is a result of microscopical investigation, that in order to be beneficial they must partake of this character, inasmuch as they are employed to stop cell-growth. The principle upon which this is effected before disturbing healthy functions appears to be this:—The growth we wish to stop has the embryoniform type

—it is the youngest or last formed, the tenderest or most succulent, and therefore the first to fade upon the presence of unsuitable conditions—of alterative agents given for the express purpose of its removal. And the principle here seems to be the same as that before referred to in the case of the sailors, as keeping up chronic ulcerations. The sailors, in a hot climate, and living on salt provisions, had chronic ulcerations for weeks from some cause, which prevented healthy granulation, though it did not visibly affect their general health. Here therapeutics required a granulation cell-growth, and that which prevented it was the cause of the continuance of the ulcers. In the cases we are now speaking of, on the contrary, we want immediately to stop a granulation cell-growth. And some interfering agent is resorted to, to produce just so much qualitative change in the blood as shall stop it. The Art seems to consist in the selection of the proper agent, and the apportionment of it in such quantities, that a minor distemper of blood, sufficient to extinguish the morbid growth without materially interfering with healthy functions shall be produced. Just so much, in fact, as in the sailors mentioned, kept the chronic ulcers from healing.

The adult man resists influences which disorder

the child, and would altogether stop growth in the embryo. And so the natural organs appear able to resist the action of a medicine or a poison which will interfere and stop a new or recent embryoniform cell-growth. For what are the facts? All the principal organs of the body are composed of cells and vascular tissue. And when inflammation occurs, the vascular tissue becomes the seat of cell-growth. All these cells, natural and preternatural, take from the blood the materials of their growth. There is then, on the one hand, all the natural cell-organs to be cared for, and on the other, the exuberant new cell-growth in the vascular tissue to be arrested.

And the problem of cure seems to consist in selecting a medicine or a surgical application which shall prove remedial by stopping the abnormal cell-growth before producing an injurious influence upon any of the natural organs.* If microscopical research lead to the conclusion that all therapeutical operations are accomplished through the medium of a nucleated cell-growth, and if experience prove that mercury will check the progress of a preternatural cell-growth before producing salivation, surely we may endea-

* Vidé Healthy and Diseased Structure, &c., Ch. III. Therapeutics and Cure, p. 222, &c.

vour to interpret the medical, by the physiological fact. And if we accord to physiological cell-growth and "nuclei" the property of selective attraction or absorption, no reason has yet been shown why it should be denied to pathological cells and nuclei. Nor can any such reason be shown, if a physiological cell-growth becomes pathological without alteration of nature, simply by deficiency, protraction, and excess. On the other hand, the necessity for the exercise of medical and surgical skill and art in all cases is very apparent. And let us agree to rest the necessity upon the right basis.

The most anxious care and watching is required or befits a growth of the most tender yet active nature—an embryoniform cell-structure, which may arise in twenty-four hours (p. 33), establish itself in the vascular tissue, acquire blood-vessels, absorb the surrounding texture, and bleed in two days (p. 34):—Which is liable from nnmerous circumstances to irregularity, exuberance, or premature decay:—Which, if languishing,—struggling with difficulties, or in deficiency, may be assisted by manual and medical art,—may be aroused by stimulants, and cherished by warmth, moisture, and soothing appliances. But

which, if outstepping, the therapeutical limit must be, and is repelled by depletion and hostile interferences, or destroyed by caustics, poisons, and the knife.

Future discussion must decide upon the merit of the views we have here put forth. In the mean time, the Cell Physiology as at present established, though it places inflammation in a new aspect, nevertheless elucidates and confirms the principles of Medical Art.

IX.

OF UNITY OF DESIGN AND THE PHYSIOLOGY OF INFLAMMATION.

The most satisfactory evidence of UNITY OF DESIGN is derived from the study of the *development* of living beings. When we go back to the very commencement of growth, we observe that the evolution of the germ in the highest animals, as in the lowliest plants, begins by the multiplication and increase of nucleated cells. And it is not until this has proceeded to a considerable extent that it could be stated with certainty, from an examination of the

germ alone, whether it is that of a plant or of an animal. And when, again, the distinctive characters of the animal class first present themselves, it could not be predicated whether the germ is that of a Radiated, Molluscous, Articulated, or Vertebrated animal. The special organs, in every case, arise by a gradual change from the more homogeneous mass of cells,—the form and arrangement of the organs depending on the circumstances in which the Being is destined to exist. In the highest class of animals these special organs become more and more numerous and various in proportion to the complexity of the nutritive processes; still all those most appropriately styled Glands, or secreting organs, have the nucleated cell structure, and differ only in the peculiar adaptation of the cell elements of each, to separate preferably a particular constituent of the blood.

It may be more difficult to trace a fundamental Unity in relation to the *functional character* of the special glandular organs considered as instruments for particular ends, concealed as this is by that extraordinary variety which is the chief source of the diversity of forms presented by living beings. But, if in place of looking at the origin and connexions of the parts, we regard them with reference to the acts to which they are subservient, we shall

find in the higher orders of animals, organs specially set apart for the functions of absorption, secretion, excretion, and reproduction, whilst in the germ all these acts are traceable in the homogeneous cell mass which composes the germ organism. But this setting apart a particular organ for a particular function does not proceed to the extent of taking away entirely from the special organ the capacity for sharing in other functions. On the contrary, it is concluded by those entitled to speak on the subject, that the whole structure retains more or less of the primitive community of function. It is not our purpose to show in detail how this conclusion has been established ; we propose only to refer to those facts of glandular structures— of absorbing and excreting structures—which, substantiating the conclusion above stated, have at the same time a bearing upon the philosophy of Cell Therapeutics, or the physiology of inflammation.*

The villi of the intestine are special organs of absorption, but also, they excrete material no longer of any use in the operations of life. The lungs are

* "Edinburgh Philosophical Journal," July, 1837. "Human Physiology," ante pp. 575—585, &c. Also, "The Unity of Nature," by C. B. Radcliffe, M.D. A work which abounds with striking illustrations.

organs of respiration, but it is well known that the blood in its passage through them absorbs, on the one hand, from the air, elements which renovate its arterial character and composition, and on the other, excretes an exhalation. The skin is an excreting organ, yet it will admit of the passage of fluid into the interior of the system, especially when the supply afforded by the special channels is deficient. And a mucous membrane exposed to the air will take on the appearance and function of the skin. Each secretion appears as if it could be formed by its own organ alone, yet we may observe when the excretory function of a particular gland is suspended, or when it is not performed with sufficient activity, that other secreting organs, or even the general surface, appear to be able to perform it in some degree. It seems established by a great mass of observations that the *Urine*, or a fluid presenting its essential characters, may be secreted, or pass off by the salivary and mammary glands, by the mucous membrane of the intestine, by parts of the outer integument, and even by serous membranes, the ventricles of the brain, the pleura and peritoneum; and such a metastasis has not only taken place in cases in which the normal excretion was checked or impeded by disease, but has been induced experimentally—by

extirpation of the kidneys, or by tying the renal artery. So, again, if the excretion of *Bile* be checked by disease of the liver, its elements are discharged through other channels; the urine, the cutaneous transpiration, and even the sputa derived from the mucous membrane of the lungs being more or less deeply tinged with the colouring matter of bile. The secretion of *Milk* has been transferred to different parts of the skin, to the intestinal mucous membrane, to the bronchial tubes, and even to the surface of an *ulcer*. The whole structure retaining more or less of the primitive community of action.

Granulations and Pus have the most general type of organised structure—they are forms of nucleated cell-growth; we find them possessing the essential elements of glandular organs. In their *elementary composition*, and in the *acts* to which they are subservient, there is sufficient to excite an earnest attention. The sore occasioned by a common blister is an *excreting* surface; there is a copious discharge of cells from it, yet the influence of the blistering fly may be traced, extending by *absorption*, to the urinary organs. In other cases the influence of medicines and poisons may be communicated to distant organs if the medicine be brought into con-

tact with the granulations of a wound, although from these granulations there may at the time be a copious discharge of pus. An abscess is both an excreting and an absorbing surface. It may be regarded as a kind of new organ developed in the body. In the formation of an abscess there is purulent accumulation or cell-growth, which forms the principal part of the swelling ; and there is also at the same time absorption of the vascular tissue. Sores give rise to different kinds of pus, and we can make no doubt that the different parts of which the blood is composed, will come away more in one kind of pus than in another. The poison of small-pox comes away in the matter of the pustules. Each pustule acts as a temporary new organ for the excretion of the abnormal material from the blood. And when the pustules have performed their task, they fade away and disappear, as do many forms of temporary cell-growth during the development of the germ. There is no natural organ for the elimination of small-pox poison from the blood, therefore the common vascular tissue of the outer integument takes on the excretory function, and cells of the most general type eliminate the poison.

A common issue is established as a drain to the blood. But there can be no drain except in con-

junction with cell-growth. A sore having been made, and granulations established, the peas are inserted to prevent them healing. These foreign bodies, in contact with the granulations, fulfil the conditions we have supposed in tubercular consumption, in necrosis of bone, carbuncles, diseased joints, &c.; they are hindrances to the process of repair; they alter the destination of the young and growing cells, so that instead of becoming fixed in the granulations and proceeding to a fibrous transformation, they are checked, become deciduous, and fall away as cells, at the same time carrying out from the system the materials they have taken for their own growth from the blood. Such an operation as this upon any great scale must impoverish the blood. But in a smaller degree, and under particular circumstances—those, for example, in which an issue is required—the circulating fluid, by such an action, may be relieved of excrementitious matter, as it is by the several natural actions of the same kind. The granulations of the issue becoming a preternatural excretory organ.

Errors in diet, unwholesome habits, &c., vitiate the qualities of blood; and sedentary occupations long continued are known to be favourable to inactivity in the functions of the natural excretory organs.

Under such circumstances new cell-growth or granulations established for repair or cure of a local injury may fall into the condition of an issue. *Cell-growth is diverted from one form or quality to another by the condition of the blood;* and granulations, instead of metamorphosing into fibrous texture, continue to discharge deciduous excreting cells. Abscess, ulceration, and suppuration persist to the exclusion of the local reparation, as long as the abnormal state of blood remains. To cure the sore or wound, the condition of the blood must be altered, by arousing into activity all the natural excreting organs, and when this has been accomplished the excreting acts of the new growth cease and the sore heals.

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