

**A dissertation on the process of nature in the filling up of cavities, healing of wounds, and restoring parts which have been destroyed in the human body : which obtained the prize-medal, given by the Lyceum Medicum Londinense, for the year MDCCLXXXIX; and was ordered to be printed for the use of the Society / by James Moore.**

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A  
DISSERTATION  
*ON THE PROCESS OF NATURE*  
IN THE  
HEALING OF WOUNDS, &c.



A  
DISSERTATION

ON THE  
*PROCESS OF NATURE*

IN THE FILLING UP OF CAVITIES, HEALING OF WOUNDS, AND  
RESTORING PARTS WHICH HAVE BEEN DESTROYED IN THE  
HUMAN BODY;

WHICH OBTAINED

THE PRIZE-MEDAL, GIVEN BY THE LYCEUM MEDICUM LONDINENSE,  
FOR THE YEAR MDCCLXXXIX; AND WAS ORDERED  
TO BE PRINTED FOR THE USE OF THE SOCIETY.

By JAMES MOORE,

MEMBER OF THE SURGEON'S COMPANY OF LONDON.

*Detur inoffensæ metam tibi tangere vitæ,  
Qui legis hoc, nobis non inimicus, opus.* OVID.



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“ IN WHAT MANNER ARE CAVITIES, WHETHER FORMED BY SUPPURATION, WOUNDS, OR OTHERWISE, FILLED UP?—WHAT ARE THE APPEARANCES OF THEIR FILLING UP PROPERLY?—IN WHAT MANNER IS THE NEW SKIN FORMED?—WHAT ARE THE SYMPTOMS OF ITS FORMING PROPERLY?—IN WHAT CASES, AND IN WHAT MANNER ARE THE PARTS, WHICH WERE DESTROYED, RESTORED?”

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WHEN any accident or disease injures the human frame, it was early observed, that the body possessed within itself a power of alleviating or remedying the evil. This salutary disposition was named by the schools, the *Vis Medicatrix Naturæ*. In consequence of this power it happens, that whenever the structure or functions of any part of the body are disturbed, such operations are immediately excited as have a tendency to restore the machine to its former state. This looks

as if some spirit of Health, some invisible Hygeia were diffused through the body to remedy its disorders. But though the existence of such an invisible agent was supported by the famous Van Helmont and others, it has long been rejected as a mere chimera; and indeed it is an idea more resembling the fiction of a poet, than the theory of a philosopher.

But although this personification cannot be admitted, yet the principle of the *Vis Medicatrix Naturæ* is undeniable. And on no occasion are its operations observed more strikingly than in the filling up of cavities, in the formation of new skin, and in the restoration of parts which are destroyed. In these cases the power of the *Vis Medicatrix Naturæ* is obvious; whereas in most others it is obscure or doubtful.

In the consideration of this subject, I shall follow exactly the order in which the questions are placed; for they are judiciously arranged, according to the natural succession of events which occur. But though there are five questions proposed, as these form three principal divisions, by uniting the four first into two, I shall make only three sections of the whole.

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*SECTION I.*

“ IN WHAT MANNER ARE CAVITIES, WHETHER FORMED BY SUPPURATION, WOUNDS, OR OTHERWISE, FILLED UP?—AND WHAT ARE THE APPEARANCES OF THEIR FILLING UP PROPERLY?”

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**NONE** of the cavities, which are here spoken of, naturally exist in the human body. They are all produced by a solution of continuity of the solids, and are formed either in consequence of some external injury, or internal disease. This division of parts, which naturally cohere, must prevent or disturb their functions. In order to alleviate or remove this inconveniency, the *Vis Medicatrix Naturæ*, or the natural power of the body, endeavours to fill up or obliterate such cavities.

To accomplish this purpose, inflammation is excited all over the internal surface of the cavity.

The intention of the inflammation seems to be, to enable the blood-vessels to form a substance capable of uniting the opposite sides of the cavity, or filling it up. This substance must be either living animal-matter, or something capable of becoming so: the blood-vessels, in their natural state, are not capable of forming the new medium, it is an office not usually required; but when it becomes necessary, inflammation takes place, and the blood-vessels suffer a change which empowers them to perform this new function.

What particular alteration takes place in the vessels, enabling them to form the new substance, is a circumstance as yet unexplained. The principal change, which we are able to observe, is their being augmented in size, so that a vast number of the capillaries, which in a natural state are invisible on account of their admitting only the transparent parts of the blood, become during an inflamed state very apparent, by their diameters being so much enlarged as easily to receive the red globules.

Inflamed vessels seem likewise to acquire a great deal of additional strength, or at least they act with greater energy than formerly; for the blood is observed to circulate with far greater rapidity through an inflamed, than through an uninflamed part. But neither of these circumstances throw much light upon the subject, there must certainly be some other change, besides an increase of bulk and action. It seems most probable that it is the mouths of the arteries which deposit the new substance, although they are so extremely minute, that we can discover nothing of their structure even by the finest microscopes.

During an inflammation there is likewise an effusion of a watery fluid into the cellular membrane, or neighbouring parts; but this does not seem at all to assist in the extinction of the cavity; it is, probably, nothing more than an increased quantity of the interstitial fluid which is common upon internal surfaces. The lymphatics usually absorb this fluid as fast as the arteries deposit it; but when inflammation takes place, the blood-vessels being increased in size, and the circulation going on in a more rapid manner, the interstitial fluid is effused faster than the absorbents can take it up, of course there must be an accumulation.

Besides the local appearances which occur in inflammation, the general constitution is affected with febrile symptoms, which are termed, "The symptomatic fever."

The inflammation is usually considered as the cause of this fever, and sympathy, or some nervous influence, is by some supposed to be the intermediate agent which produces it. This hypothesis although extremely ingenious, yet, when thoroughly examined, will not, I suspect, be found just. In my apprehension it seems more probable, that the inflammation instead of being the cause, is the effect of the fever; or, in other words, that the fever consists of certain actions which take place in the constitution in order to produce the inflammation.

I know that this opinion, as well as some others which shall be given afterwards, is different from what has been published, and what I have heard taught, by some of those gentlemen who are to determine concerning the merits of this paper. Yet, as I know they are too generous to condemn an opinion merely because it is different from theirs, I shall, without hesitation, set down exactly my real sentiments.

Many reasons could be given, if it were not improper here to enlarge upon this subject, to evince the impropriety of considering most of the symptoms of fever, as sympathetic with, or caused by the inflammation. I shall only mention in particular, that the fever is always antecedent to the inflammation; and it is impossible to suppose that an effect should precede its cause. Besides, it appears very improbable, that sympathy should in every instance of considerable inflammation produce a set of symptoms which are frequently dangerous, and sometimes fatal.

But the supposition that the fever is the cause, not the effect of the inflammation, is not embarrassed with the same difficulties. For when a solution of continuity of any of the parts of the body has occurred, it becomes requisite to unite this breach in the solids; the divided parts must therefore inflame; and in order to produce this inflammation, certain actions take place in the constitution. A spasm seizes the capillaries on the surface of the body, the contraction of the heart and vessels are increased and quickened, an unusual heat, and the other symptoms of fever follow. By these extraordinary constitutional actions, and by some local ones, inflammation is generated.



The symptomatic fever is, therefore, the constitutional agent or cause which produces inflammation.

It is no objection to this opinion, that a fever frequently occurs without inflammation. For a fever alone cannot occasion inflammation, without the local action likewise.

The febrile symptoms are not only requisite to form, but to keep up a violent inflammation; and as soon as the fever abates, the inflammation decreases. However, the inflammation does not always disappear entirely with the fever, for the local action can go on of itself, although with less violence, after the fever has ceased.

The symptomatic fever is, in general, proportioned to the extent and violence of the inflammation; so that where the inflammation is very inconsiderable, or very languid, there is either no fever at all, or so little that it cannot be perceived.

But an higher fever, or a more powerful action in the constitution, seems requisite to produce inflammation in tendinous and ligamentous parts, than in the more vascular parts.

Although I cannot admit that the fever originally is occasioned by the inflammation, yet I make no doubt but that after a part has inflamed, the pain and other circumstances increase the fever. For pain alone is capable of producing many of the symptoms of fever. And perhaps no better explanation can be given of this circumstance, and of some others, than by saying they are produced by sympathy.

There are two remarkable stages or kinds of inflammation by which cavities are filled up; although the circumstances hitherto mentioned are common to both. The one kind has been very properly named, "The adhesive inflammation," as an adhesive substance is formed during it; and the other, which is attended with the formation of pus, is named, "The suppurative inflammation."

As we know nothing of the mechanical structure of the mouths of the arteries, either in an inflamed or in an uninfamed state, it is vain to expect that any explanation can be given of the exact particulars which occasion the different effects in these two kinds of inflammation. Both of them, however, have the effect of

obliterating cavities; but as they accomplish this by very different means, it is necessary to treat them separately.

“ OF THE FILLING UP OF CAVITIES BY THE  
ADHESIVE INFLAMMATION.”

WHEN a cavity is affected with this inflammation, the blood-vessels enlarge, and the circulation is conducted with increased velocity. There forms, soon after, upon all the inflamed surfaces, a buff coloured substance, like a new membrane.

This substance, when first thrown out, is soft in its texture; but, as it is frequently found adhering to the internal surfaces of inflamed veins, it is either at no period liquid, or else it is of a very tenacious nature, otherwise it would be washed away by the current of blood.

The quantity of this matter is not very great, it seldom exceeds in thickness, the eighth or fourth part of an inch. In colour and appearance it strongly resembles the coagulable lymph of the blood when freed

from the red globules ; and, without doubt, it consists principally, if not altogether, of this lymph.

When the internal parts of a cavity are lined with this tenacious substance, if the opposite surfaces are in contact, they adhere together and obliterate the cavity. This adhesive matter, which is usually named, the inflammatory exudation, is at first unorganized, and forms a very slight union. But it does not continue long in that situation, for blood-vessels soon sprout into it from all the inflamed surfaces, and branch through its whole substance. It is in this manner that cavities are obliterated by the adhesive inflammation ; which, rather than a filling up of cavities, might more properly be denominated, a growing together of their internal surfaces.

As the exudation is not very great, it is obvious that a cavity cannot be obliterated by it, except the opposite sides are nearly in contact. But when blood intervenes it forms no impediment, but rather assists in the extinction of the cavity.

This is a very curious circumstance. When blood is extravasated in a part of the body free from inflam-

mation, it is usually absorbed; and so completely so, as to leave no trace behind. But when blood is extravasated into a cavity where the adhesive inflammation has either already taken place, or where it takes place soon after, it is by no means wholly removed. For, after coagulating, it is surrounded on all sides by the inflammatory exudation; blood-vessels begin, in a little time, to shoot into the exudation, and they likewise pass into the coagulated blood, and branch through every part of it. These vessels become more and more numerous; the red globules, and superfluous parts of the blood, are by degrees absorbed, and at length the coagulated mass is changed into an organized piece of living flesh.

This extraordinary fact was completely proved and demonstrated by injection, many years ago, by Mr. John Hunter.

It is not necessary for me to enter here into the controversy, Whether the blood does, or does not, possess the living principle? This is a subject which has of late been very much canvassed, and the circumstance just mentioned, of the conversion of the blood into living flesh, is given as a strong proof of its possessing this property. If the blood does not possess the vital

powers when circulating in the body, and when first extravasated, it is at least an excellent medium for the blood-vessels to branch into, and it then acquires these powers. It is unimportant to my present purpose, at what period this takes place. Whether the food receives the principle of life during chylification or sanguification; or whether it is bestowed upon the blood after coagulation? There may be the same dispute, likewise, Whether the adhesive exudation possesses the vital powers before or after its organization? But in whatever manner these points are determined, certain it is, that this property is acquired somewhere; for the coagulated blood and inflammatory exudation become as much an organized living part, as any other in the body.

Cavities then are obliterated or filled up during the adhesive inflammation, either by the interposition of the inflammatory exudation alone, or by that exudation and coagulated blood.

If this explanation is just, no such thing can ever occur as the union of divided parts by inosculation; a mode of healing which was once taught. That is to say, it never happens that the cut vessels of two

wounded surfaces, when brought into contact, unite and inosculate in such a manner, that the blood circulates across the wound by the same vessels as formerly. This can never take place, for the blood-vessels of a wounded part contract, and are plugged up by coagula of blood. And as blood, when coagulated, never to our knowledge becomes again fluid, the cut vessels will remain obstructed and obliterated for ever. In order therefore to unite the solution of continuity, and carry on the circulation across the wound, inflammation comes upon both surfaces, and the inflammatory exudation is formed.

In all wounds healed by the adhesive inflammation, or by the first intention as it is usually named, there are, therefore, interposed between the wounded surfaces, two layers of the inflammatory exudation; and most commonly two layers likewise of extravasated blood. These layers are, indeed, sometimes extremely thin; and they acquire in a short time blood-vessels, lymphatics, and nerves, and become an excellent bond of union between the divided parts.

As coagulated blood and the inflammatory exudation constitute the medium through which the union by the

first intention is accomplished, it must follow, that if either of these substances lose the quality of being a proper medium, no union can take place.

Whether the blood is ever rendered by disease unfit for uniting divided parts, is a doubtful point : but even in a healthful state, it certainly loses this property when freely exposed to air.

When blood is extravasated into any of the internal parts of the body, except the lungs and primæ viæ, if the integuments remain entire, there being no access to the air, the blood can receive no injury from it. But in all wounds and compound fractures, the extravasated blood is necessarily exposed, and liable to any impression that air is capable of making. If the exposure is only for a short time, no bad effects seem to follow ; but if the exposure is lasting, the blood putrefies, and consequently the union of the wound by this medium fails.

Those physiologists, who maintain that the blood is possessed of the vital principle, explain this fact by saying, that the exposure to air first deprives the blood of the powers of life, and it then putrefies like other dead matter. In the same manner, as the exposure of



a tendon, or any other similar part where the vital principle is weak, is apt to occasion sloughing.

Those persons, on the other hand, who do not believe in the living principle of the blood, will say, that it putrefies in these cases, simply because it is exposed to a very considerable degree of heat, and to the free access of air; circumstances favourable for that process.

In such speculative questions, which admit not of positive but only of probable proofs, men of abilities can bring ingenious arguments on both sides. But in whatever manner the air acts, it is evident that it has a strong tendency to deprive the blood of the power of being a proper medium for the union of parts by the first intention. In wounds and compound fractures it is therefore requisite, in order to accomplish this union, to exclude air by approaching the lips of the wound together and covering them. Sticking plaster, lint, and a bandage, which are the means commonly employed, accomplish this purpose very completely. For the lips of the wound are brought contiguous, and the bandage or lint, by absorbing some of the blood, and growing hard and dry, forms a cake impenetrable to the air.

But although no large wound ever heals by the first intention, if left to itself, yet very slight cuts and scratches usually do; for some of the blood which lies upon the hurt, dries, hardens, and prevents the access of air to the rest.

The inflammatory exudation is the second substance by which an union by the first intention is accomplished. The formation of which is absolutely requisite for the extinction of cavities; whereas the blood is not essentially necessary, although it causes no impediment.

This exudation is formed by the arteries when they are affected by the adhesive inflammation; and the filling up of a cavity by the first intention, depends upon the exudation being formed on the whole divided surfaces, of a proper quantity and quality. As this exudation is formed in consequence of inflammation, the appearance of a cavity being properly filled up by the adhesive inflammation, must therefore be denoted by such symptoms as demonstrate a due degree of inflammation.

This is a different position from the commonly received notion, that there is a better chance of a wound

healing by the first intention, in proportion as the inflammation is slight. But if this were true, it would establish what daily experience contradicts; namely, that a wound could heal better in a languid, feeble, and diseased body, than in a vigorous, strong, and healthy one: whereas the fact is, that inflammation is usually less violent in the weak than in the strong; and wounds generally heal better in the strong than in the weak.

Inflammation is the process by which the *Vis Medicatrix Naturæ* fills up cavities. The *Vis Medicatrix Naturæ* acts most effectually in the strong, and in the healthy, during the prime of manhood. It is, therefore, that degree of inflammation which takes place in these most perfect bodies, which tends most effectually to fill up and obliterate cavities. In the sanguineous temperament, the inflammation is apt to be too violent; in the phlegmatic, to be too languid. But the exact and due degree of inflammation takes place not in any peculiar temperament, but in those more happily constructed bodies, where no individual temperament prevails, but where there is a fortunate mixture of them all. If the inflammation is too languid, the exudation is not thrown out in sufficient quantity; or it is of a bad quality, and no union can be produced. And if it

is too violent, the excessive action of the vessels is likewise inconsistent with the union of the sides of the cavity.

This opinion which I have advanced, that the obliteration of cavities, and healing of wounds by the adhesive inflammation, sometimes fails from the parts inflaming too slightly, may appear singular, and perhaps unfounded; yet I have been led into the opinion, not from any theoretical idea, but from what I have frequently observed in the course of my practice.

A person receives a flesh-wound with a cutting instrument, and the lips of the sore are brought and retained in contact. If the adhesive inflammation is extremely languid, the inflammatory exudation will either be of a bad kind, or so small in quantity, as not to be able to form the union. This mode of obliterating the cavity of the wound failing, Nature has recourse to the next; namely, suppuration. So that the adhesive inflammation being too slight, becomes the indirect cause of the suppurative taking place. These cases happen most frequently in the debilitated, in the phlegmatic, and aged.

When we attempt to heal a wound by the first intention in such weakened bodies, it frequently happens that, instead of a brisk inflammation coming on in a few hours, there are hardly any symptoms of inflammation for some days; but at last it gradually comes on, then runs too high, and terminates in a plentiful suppuration of the whole wounded surfaces. Instead of imputing this suppuration to the adhesive inflammation being at first too languid, and the necessity Nature was in of exciting suppuration in order to obliterate the cavity of the wound, it is generally imputed to the direct opposite cause, a too violent inflammation.

I hope, however, that the fallacy of this appears from what has been said; and that it will be allowed that the filling up of cavities properly by the adhesive inflammation, must be produced by a due degree of that inflammation.

What then are the symptoms of a due degree of the adhesive inflammation?

The symptoms of the adhesive inflammation are exactly the same with those of the phlegmonous, only usually milder than when suppuration occurs. It is

impossible by language to discriminate exactly the different shades of inflammation. All that can be done is to give a general account; and the experienced alone can determine in particular cases, whether the inflammation is in the proper degree for uniting cavities, or not.

When a phlegmon is coming on, the constitution is first affected with the ardent or inflammatory fever. The local symptoms which follow, are, throbbing, pain, heat, swelling, tension, hardness and redness.

Those symptoms are in proportion to the extent and violence of the inflammation; and to the importance and nature of the parts affected.

In a slight wound of superficial parts, where the adhesive inflammation is of a just degree, the constitutional symptoms are not perceptible, and the local ones are very trifling.

In a large wound, or other severe injury, the symptoms are proportionably more considerable. Some fever is requisite to usher in a proper degree of inflammation. The pulse is more frequent and hard than usual, the

skin hotter, the tongue whiter, and the thirst greater; there is likewise a slight degree of heat, swelling, and pain in the part.

These symptoms prove that a degree of inflammation sufficient for obliterating the cavity has taken place; and yet they are not so violent as to render suppuration at all probable. But the most certain mark of this being the case, is, when the above symptoms come on quickly, and soon subside. When the adhesive inflammation comes on most favourably, it is at the height in twelve or twenty-four hours, at which time the inflammatory exudation is usually formed, and the symptoms of inflammation abate immediately after. But if the symptoms continue increasing after that period, particularly if they augment after the second or third day, there is then great reason to believe that suppuration is coming on.

The union of cavities, by the adhesive inflammation, much more frequently fails from too violent, than from too languid a state of inflammation. And the less the wounded parts are injured by being bruised or lacerated, there is the better chance of the union by the adhesive inflammation.

Therefore when a wound is made by a sharp cutting instrument, it will be much more likely to heal by the first intention, than when it is made by a blunt one. And when parts are bruised or lacerated much, their tone is so much injured, that they are incapable of going through the adhesive inflammation properly, and the symptoms become so violent, that suppuration or gangrene takes place.

When the injury is such as to occasion the death of any of the parts, the extinction of the cavity by the adhesive inflammation becomes impossible: for the dead parts putrefy, and ulceration comes on in order to separate them from the living; which is a process incompatible with the union by adhesion.

The interposition of foreign bodies likewise must prevent the adhesion of the parts between which they lie; and suppuration usually occurs in order to throw out the foreign body. But it sometimes happens that bullets, and other substances which have penetrated deeply, do not excite suppuration, and remain quietly in the body, surrounded by a coat of the adhesive exudation.



It is not uncommon for the deep seated parts in wounds to unite by the first intention, and the skin and superficial to suppurate. This seems to be occasioned by the opposite edges of the superficial parts being more distant; and to the blood on the surface, from its exposure to air, losing the power of being a proper medium for union and putrefying; while the blood in the deep seated parts which is not exposed, becomes organized. It likewise sometimes, though rarely, happens, that the wounded skin heals, while the deep parts suppurate. This is owing to the latter being more lacerated or injured by the wounding instrument, and the inflammation consequently is more violent. When this occurs, the cavity cannot be filled up by the adhesive inflammation, another mode becomes necessary; which shall next be considered.

“OF THE FILLING UP OF CAVITIES BY THE  
SUPPURATIVE INFLAMMATION.”

THERE is a great variety of circumstances in which those cavities, that have been treated of, cannot be filled up by the adhesive inflammation. On which account the body is endowed with the power of ac-

completing this purpose by another means, which is, suppuration.

This process takes place after the inflammation has failed to obliterate the cavity, provided the affection is not of so violent a nature as to occasion gangrene.

In cavities formed by wounds or other injuries, the circumstances which occasion a failure of the union by the adhesive inflammation, have been already mentioned. Those which have been formed by suppuration must, of course, be filled up by the suppurative inflammation, as the adhesive has terminated before the cavity is formed.

The essential distinction between the two kinds is, that in the suppurative there is secreted a fluid substance, named pus ; and in the adhesive there is no such secretion.

Before suppuration takes place in a cavity, it is preceded by the adhesive stage, by which the inflammatory exudation having been thrown out, all the cells of the reticular membrane are united together, and the pus,

when formed, is confined to the cavity.\* If it was not for this circumstance, the matter would diffuse itself among the cellular membrane, which actually happens in the erysipelas: for in that disease there is no exudation of the adhesive substance; and if pus is formed, it insinuates itself among all the neighbouring parts, and gives to the touch a sensation similar to that felt by pressing a quagmire. In this case, however, before the cavity can be filled up, the inflammatory exudation must be thrown out, and then it becomes exactly like a common suppuration.

When a phlegmon affects a cavity, the inflammation (as has been mentioned) is at first of the adhesive kind; and some degree of fever occurs before the inflammatory exudation is formed. The febrile symptoms requisite for that purpose are usually, however, inconsiderable, in comparison with those which are necessary to produce suppuration; for this process demands a much greater effort of the constitution. The first attack of fever is, therefore, usually moderate; but if suppuration is

\* Suppurations of the surfaces of mucus membranes are not preceded by the adhesive inflammation. But that is a subject foreign to the present.

coming on, instead of the febrile symptoms remitting when the exudation is formed, they increase greatly. The pulse becomes more hard and frequent; pains are felt in the head and loins, and the body becomes very hot. Rigours or cold fits also sometimes take place; which are particularly apt to occur immediately previous to the formation of matter.

These seem to be occasioned by a spasm which affects the vessels on the surface, in order to produce a more violent hot fit. For the rigours are soon followed by a hot stage; during which the action of the heart becomes violent, the spasm disappears, the vessels of the part affected in particular enlarge in size, and the circulation is there conducted with great rapidity. By this great effort, both of the constitution and of the part, suppuration takes place, and the fever gradually subsides.

The constitutional affection occasioning suppuration in no respect differs from the ordinary symptoms of fever; but the local changes are of a complicated nature, and shall now be mentioned.

There are two distinct situations in which suppuration takes place. In the first, there is either an exter-

nal opening, or a communication with some of the outlets of the body, by which the pus flows off and is evacuated. In the second, there is no opening whatever, and the matter is confined in a cist formed by the adhesive exudation. This last kind is named an abscess.

I shall, first, describe that affection, where there is an opening ; and, lastly, the abscess.

As there is a breach of the integuments in all wounds and compound fractures ; whenever a cavity occasioned by one of these accidents suppurates, the affection is necessarily of the first kind ; and these injuries always do suppurate when left to themselves, except the wound is very small. The progress by which these cavities are filled up by the suppurative inflammation, is as follows.

The whole cavity is, in the first place, filled with blood ; and when the hæmorrhage stops, the blood coagulates.

The adhesive inflammation then comes on, with all its symptoms ; but these, instead of decreasing in a few hours, become more and more violent. Heat, pain, and throbbing, are felt in the wounded part, which be-

comes red, tense and swollen. The lips of the wound, which at first retract a little from each other by the natural elasticity and contraction of the parts, become somewhat inverted and farther separated by the swelling. In suppurating wounds the blood does not become an organized body, as in those which heal by the first intention; but, on the contrary, it quickly dissolves down into putrefaction: this renders the smell, at first, very offensive.

The discharge from the wound during this period is, principally, the putrid serum and crassamentum; but this is soon mixed with a thin serous secretion formed by the wounded surfaces. This discharge, by degrees, acquires a whiter colour and thicker consistence; and about the fourth or fifth day, pure pus is discharged, and the inflammation abates.

In suppurating wounds, something more is requisite than what takes place in those which are healed by the first intention. For there is always a considerable gap by the opposite parts retracting from each other. This gap is, of course, greater in wounds with loss of substance, than in others; but it occurs in all. In order to fill up this vacancy, a growth of new flesh is neces-

fary, and accordingly there sprouts up a new kind of substance, which is named granulations, from all the inflamed surfaces.

This substance is of a florid red colour, it arises with small irregular round points, something like little grains, (hence the name) or rather resembling the head of a cauliflower.

The surfaces of the granulations are moist by their constantly secreting pus; and they are so tender that they bleed if touched a little roughly. This delicate production springs up in a very irregular manner from the whole suppurating surfaces; in some parts it sprouts up exuberantly, sending forth pyramids and columns; while in others it goes on very slowly.

In general the principal growth is from the bottom and deeper parts of the wound; very little arising from the superficial.

When two granulations come in contact, they adhere and grow together. In this manner they increase and unite, until the whole cavity of the wound is filled with them as high as the skin.

This new flesh is of the same nature and appearance, from whatever part of the body it springs; even that which arises from bones, differs in no respect from that which grows from the softest parts. When granulations are cut, they appear an uniform mass without fibres running in any particular direction. They seem principally composed of blood-vessels; and as the blood circulating in them is nearly in contact with the air, it acquires the florid red colour, which good blood always receives when in that situation. There are a great many lymphatics in granulations, which is proved by salivations having been induced by dressing sores with mercurial applications. Nerves likewise enter into their composition, as is evident from their sensibility; and besides this congeries of vessels and nerves there is, probably, a connecting substance uniting all these parts together.

Such is the nature of the new flesh which arises to fill up a suppurating cavity, and to unite the solution of continuity. But this substance does not begin to spring up for the first three or four days. During that period the fever is high, there is a great deal of redness, hardness and tension in all the parts contiguous to the wound, and the pain and heat are considerable.



These symptoms gradually diminish. At length all pain and tension disappear, and the redness is confined to the surface of the sore, and less than a quarter of an inch around it. The discharge, likewise, alters materially. It is at first of a thin consistence, of a ferous colour and offensive smell; and by degrees it becomes thick and viscid, of a yellowish or white colour, and nearly inodorous.

The sore then granulates, and in proportion as the granulations arise, the discharge lessens in quantity, and becomes thicker in consistence. Whilst the wound is granulating, the edges of the sore approach to each other, which diminishes its width.

It seems extraordinary, that the wounded parts, contrary to their natural elasticity, should approach each other in this manner. Some have accounted for this fact by supposing, that the granulations are endowed with muscular powers, and that Nature had contrived this method of lessening wounds, and preventing large cicatrices. But if wounds are narrowly observed, it will be perceived that there is no necessity for bestowing these extraordinary properties upon granulations; and that this phenomenon is simply owing to the abatement

of the swelling. For when a wound is first received, the elastic and contractile powers of the parts occasion a retraction of the wounded edges to a certain distance. When the swelling comes on, there is a still farther separation; for the internal parts are increased in bulk by the swelling, consequently the skin cannot cover so much of them as before; and the lips of the sore are often a little inverted; this occasions the wound to gape very wide. But when the swelling abates, and the inversion of the lips of the wound disappears, the sore must, unavoidably, decrease in size. Besides the abatement of the swelling, in considerable wounds there is always some degree of wasting of the neighbouring parts, the skin is therefore relaxed, and enabled to cover more than formerly. From this it happens that the edges of the wound collapse over the sore, and give the same appearance as if they were contracted.

Thus we have endeavoured to explain in what manner the cavities of wounds are filled up by the suppurative inflammation.

As there are some material differences in the mode by which the cavities of abscesses, or collections of matter

which have no communication externally, are obliterated, we shall next treat of them.

In these cases, previous to the formation of the cavity, the suppurative inflammation has taken place with all its symptoms. The pus is deposited in a vacuity formed by an absorption of some of the solids, and lined with the adhesive exudation. When the pus is fully secreted, the fever usually abates or disappears, together with the inflammatory symptoms. This is not, however, always the case; for it sometimes happens that the inflammatory symptoms continue augmenting until the matter is discharged. This is particularly apt to occur, when the pus is confined by bones, fasciæ, or other unyielding parts.

In other instances, after matter is fully formed, the abscess appears a soft yielding tumor, accompanied with little or no fever, pain, or uneasiness.

There are two ways in which the cavities of abscesses are obliterated.

In the one, the pus is absorbed; and in the other, an opening is formed, and it is evacuated.

The first is by far the most agreeable mode, as it occasions no pain, no breach of the skin, and usually a more speedy cure.

It is probable, that in every abscess the lymphatics absorb a little. But as the arteries generally secrete pus faster than the lymphatics absorb it, it rarely happens that collections of matter are dispersed or removed by absorption. This sometimes, however, occurs; and it is produced by the arteries ceasing to form pus; and by an uncommon exertion in the absorbents. When in consequence of this the quantity of matter is diminished, the cavity of the abscess lessens in proportion; and when the whole pus is absorbed, the opposite sides of the cavity coming in contact, unite together like a wound by the first intention.

The symptoms of this operation going on properly are very simple, being only a cessation of the pain usually occasioned by the abscess, and a gradual diminution of the tumor.

It sometimes happens that the pus of an abscess is partly removed in this way; and the rest is discharged by an external opening. But the total dispersion of

collections of pus is a rare occurrence, especially when the suppuration is considerable.

The next and most usual manner in which the cavities of abscesses are obliterated, is by the pus being discharged by a natural opening proceeding from the bursting of the abscess.

There has been a variety of opinions respecting the mode by which this is effected. Some have imagined that pus is a menstruum which dissolves the solids; others, with far greater ingenuity, maintain that it is a ferment, which, by a peculiar kind of fermentation, converts the solids of the body into its own nature. But the opinion which seems to me best founded, and which, I believe, is now most generally adopted in this country, is, that the opening of abscesses is occasioned by the absorption of the solid parts which contain the pus.

The lymphatics are, therefore, the active powers, by which the constitution rids itself of all collections of matter. Sometimes these vessels absorb the pus, and convey it into the circulating mass of fluids; at other times they absorb the solids themselves, forming a

perforation by which the matter is poured out of the body.

The absorption or ulceration of the skin is usually attended with some degree of pain. When the matter of an abscess is first evacuated, its internal surface appears generally of a whitish colour; but a fresh inflammation immediately supervening and producing granulations, the internal surface assumes a reddish hue. This renewal of the inflammation is usually not very violent, nor attended with pain; for the relief which is produced by the evacuation of the matter, and by the distention of the parts being removed, is so great and immediate, that this small renewal of the inflammation is little regarded. At first the opening or openings, for there are frequently more than one, are small, and the skin being relaxed by the evacuation of the pus, the opposite edges of the sore are nearly in contact; but after a little time the opening enlarges. For the over-distended skin contracts to its former state; and the compressed internal parts increase in bulk in consequence of the inflammation which seizes them. These circumstances tend to enlarge the opening by separating the edges of the sore, and it is still more enlarged by the lips of the orifice ulcerating. This permits the matter

to flow freely out ; granulations then arise from the bottom, and fill up the whole cavity as in wounds.

I cannot help here expressing a strong disapprobation of a practice which is far too common. I mean that of applying caustics to abscesses indiscriminately ; or laying them open with a knife from one end to the other. In particular cases, where there are unfavourable circumstances for healing, or danger from delay, this useful, though severe, operation should be employed. But it ought by no means to be a general, far less an universal rule. For as Nature forms an opening for the healing of the abscess, she will generally take care that it shall be sufficiently large. And it ought to be the earnest wish of every surgeon in the practice of a science whose sole object is relieving the miseries incident to humanity, to accomplish every purpose he has in view by the mildest means possible.

I have now described the manner in which cavities are filled up by suppuration. And as it was formerly said, that the appearance of a due degree of the adhesive inflammation is the indication that a cavity is filling up properly by the means of that inflammation, in the same manner, the symptoms which demonstrate a

due degree of the suppurative inflammation are the proofs of the filling up of a cavity properly by suppuration. When this process goes on in the most favourable manner, the inflammation is neither too violent nor too languid, but in that moderate and just degree, which attends the healing of wounds in strong, youthful, and well constituted bodies.

The symptoms of inflammation are in proportion to the size of the cavity; it is, therefore, impossible to describe with precision the appearances which occur in every individual case. A general idea only can be given.

Where the suppurating cavity is very small, the constitutional symptoms are too trifling to deserve notice. But where the cavity is of considerable size, in order to fill it up in the most favourable way, it is necessary that the suppuration be preceded by a moderate degree of fever. For if there are few or no feverish symptoms, no increase or hardness in the pulse, no thirst, head-ach, or heat, the inflammation in this case is certainly too slight, the suppuration too inert and languid for the end we wish, and the cavity will not granulate favourably; and consequently the healing will either be tedious, or never accomplished.



On the other hand, if the fever runs too high, if the pulse is extremely hard and full, the respiration quick, heat violent, pains in the head and joints excessive; and lastly, if stupor and delirium come on, these are all indications that the cavity is not filling up properly, and even that there is danger of immediate death, or of gangrene.

For the speedy and favourable healing of wounds, and the filling up of cavities, it is not only necessary that the fever be moderate in degree, but also in duration. For if it is prolonged beyond the period in which suppuration has fully taken place, or if the strength does not gradually return, we may depend upon it that the process of healing is not going on right.

During the first stages of a wound, the fever, the loss of appetite, the discharge of matter, always produce debility and emaciation; but when the fever disappears, and the appetite returns, strength should be in some degree restored; however, until all discharge of pus is stopped by the complete healing of the sore, it cannot be expected that the body shall entirely recover its former vigour.

If instead of the favourable appearances, which have been mentioned, the following should occur ; alternate rigours and hot fits, followed by profuse sweats, a cough with purulent expectoration, increasing debility and emaciation ; it is then evident that a hectic fever has taken place, that the suppurating cavity is not filling up, but that the patient is sinking under the malady, and his gradual dissolution is threatened.

The local symptoms in favourable cases are, a moderate inflammation, which is indicated by the heat, pain, swelling and redness of the part affected being in a sufficient, not too violent a degree,

And these symptoms should abate and gradually disappear as suppuration advances. The granulations ought to be of a florid red colour, shooting up with irregular rounded points ; and they ought to rise as high as the level of the skin. But if they are of a dark red, or livid colour, or of a pale white complexion ; if they are too smooth and regular, too scanty or too luxuriant ; or, in short, if they differ in any respect from the former description, it evinces that the cavity is not filling up at all, or at least not filling up properly.

We can also form a judgment of the manner in which this process advances, by the nature of the matter discharged. If it is of a whitish yellow colour, of an uniform thick ropy consistence, with nothing very offensive in the smell, we may safely pronounce that all is right. But if the matter discharged is serous, bloody, extremely thin, and of an offensive smell; or if it is not uniform, but curdled or cheesy, we will form a contrary opinion.

## SECTION II.

“ IN WHAT MANNER IS THE NEW SKIN FORMED ?  
AND WHAT ARE THE SYMPTOMS OF ITS FORM-  
ING PROPERLY ?”

IN the first section it was shewn in what manner every breach of the internal parts of the body is filled up. It is requisite in this, to explain the mode by which the superficies is repaired.

As cavities are filled up in a different manner, during the adhesive and suppurative inflammations, there is likewise some distinction in the formation of cicatrices during these different states; which shall, therefore, be described separately.

When a wound is healed by the adhesive inflammation, the skin, as well as the parts more deeply seated, throws out the inflammatory exudation, and the whole is united by this exudation and extravasated blood, as was formerly mentioned.

Upon the surface of the sore a dry crust is formed; this consists partly of the extravasated blood, and partly of an exudation from the wound, which after coagulating hardens by the evaporation of the watery parts. This crust or scab adheres to the lips of the wound; if it is removed it gives some pain; the sore is then observed moist with a transparent fluid, and there generally follows an oozing of blood, some of the new vessels of the uniting medium being torn. The crust does not become organized, but remains like dead foreign matter. Immediately under it, and on a level with the cutis, the new skin forms, and covers the uniting medium. This new skin is a fine delicate membrane; but it gradually becomes thicker and stronger. The crust, at first, adheres to it so strongly that, if it is attempted to be removed, the cicatrix will be torn off with it. But when left to itself the crust becomes hard, dry and shrivelled; gradually loosens from the

cicatrix, and then drops off. The scar now appears red; but soon acquires a brown colour, and at last changes to nearly the same appearance as the old skin, though rather more white and glistening.

When a wound or sore heals by the suppurative inflammation, the cicatrix does not begin to form until the granulations have arisen to the surface of the old skin, or nearly so.

When the healing is most favourable, the granulations arise exactly to the level of the skin; if they shoot much higher no cicatrix will form, until the exuberancy is removed by an internal process, or by the surgeon's art: and if the granulations are much too low, the cicatrix likewise does not form. A mathematical exactness, however, is not required; for cicatrization generally takes place when the granulations are nearly of the same height, although still a little higher or lower than the old skin.

The formation of the cicatrix begins from the edges of the old skin. The redness which existed during the inflamed state abating, the swelling subsiding, and the edges of the sore uniting with the rising granulations.

The margin then acquires a bluish white or pearly colour, which gradually extends itself to the centre till the whole sore is covered with new skin. It sometimes happens in broad sores, that cicatrization takes place not only from the circumference, but likewise from one or two points in the centre; these appear like islands in the midst of a sea of granulations; they are of the same colour as the healing margin; and they become larger by extending in every direction. In consequence of cicatrization going on from different central parts, it happens not unfrequently during the progress of healing, that one broad sore is divided into two or three smaller ones; and when this happens, the cure must go on faster. There is always more or less of a cuticular covering upon the cicatrix, which being constantly moistened by the discharge from the granulations, is soft and pulpy, and occasions that whitish colour observable on the edges of healing sores. I have sometimes removed this cuticular substance, and have observed underneath the real new skin, which seems a very fine membrane of a red colour, the granulations shining through it.

When a suppurative sore is nearly healed, if it is not kept moist by some application, a scab is apt to form

in the same manner as in those wounds which are healed by the first intention. This crust consists of pus dried by the evaporation of the watery parts; the new skin forms under it, and it soon after falls off.

From the surface of the cicatrix there is no secretion; there are only the perspirable vessels. While it is forming it is kept moist by the discharge from the uncovered granulations; but when completely formed, the cicatrix is as dry as any other skin.

It appears that the new skin, at first, cannot form a good cuticle and rete-mucosum, for there is always a succession of scales falling off for some time; at last this ceases, and the new skin is covered with a good cuticle and rete-mucosum, like other parts. The cicatrix changes successively from a redish colour to a brown; and lastly it becomes whiter, and of a more shining appearance than the original skin. This is a curious circumstance and merits some attention.

The cutis, as every anatomist knows, is not a smooth polished membrane, but is full of eminences, which are named papillæ. These, in some parts of the body,



run in waving rows, and form in others irregular lozenges and triangles. The rete-mucosum and cuticle, which lie immediately over the cutis, are marked with furrows analogous to the eminences of the cutis. The cuticle is of a light colour, and semi-transparent. The rete-mucosum is white, yellowish, brown or black, in men of these various colours. And the cutis is extremely vascular; the blood contained in these vessels shines through, and gives the florid fleshy tint to the body. The colour of the skin, then, depends partly upon the rete-mucosum, and partly upon the blood which circulates in the cutis. In white men the cuticle and rete-mucosum, which cover cicatrices, appear similar to that which covers other parts; but there is a great difference in the quantity of blood which circulates in the old and new skin. For the new is far less vascular than the old; or, at least, the greater number of its vessels are of a much smaller diameter, and admit a lesser quantity of the red globules of the blood. It happens in consequence of this, that cicatrices are of a whiter colour than the original skin. In negroes, the reverse takes place, their scars being generally blacker than other parts, owing to a darker rete-mucosum forming in them upon scars, than upon the old skin.

Besides the difference of colour, a cicatrix has a glossy, shining look, which the skin does not possess: this is owing to the scar being a smooth polished membrane without hair, or any of those papillæ which are upon the cutis; both the papillæ and hair are parts which are formed in the first organization of the body, and are never afterwards produced.

As scars are less vascular than the old skin, it is probable that they have fewer nerves; for blood-vessels and nerves are generally in proportion to each other. But as nerves can hardly ever be traced to the surface of the body, we can only judge of their number there, by the degree of sensibility; and this is considerably weaker in cicatrices than in the old skin. This indeed might naturally be expected, for scars have no papillæ, which are supposed to be the principal seat of the sense of feeling in the skin.

It is observed, that scars are generally far less moveable than the original skin; the latter being commonly attached by a loose cellular membrane to the deep seated parts; whereas the scar forms itself immediately upon the granulations, and is so intimately connected, as to make the same substance with them. This is the rea-

son, likewise, that although a scar is, at first, exactly level with the skin, yet after a certain period, it often is considerably depressed. For during the healing of a sore, particularly if the discharge is great, the fat and neighbouring flesh are considerably wasted by absorption. But when the whole is healed, the internal parts recover their bulk, and the fat is regenerated. The skin being attached loosely, readily yields and accommodates itself to this increase; whereas the cicatrix adhering closely, and being as it were tacked down to the parts upon which it is formed, appears depressed.

It sometimes happens that a cicatrix, instead of being depressed, rather projects above the skin, owing to the exuberancy of the granulations upon which it is formed; and very often the scar has an irregular uneven appearance, from the granulations rising to unequal heights.

Having said so much respecting the appearance and formation of the new skin, I shall now endeavour to give some idea of what it is.

Its appearance is so different from real skin, that although every one agrees that it is not the same, yet

there are very different opinions with respect to what it really is.

Some authors assert that it is a distinct membrane; others, that it is only the cellular membrane condensed; or, as one or two French writers have termed it, An exciccation of the surface of the sore. Mr. Bell of Edinburgh, in his excellent System of Surgery, says, "That a dry pellicle of a scarf-skin forms over wounds."

But it is certain that, upon every cicatrix there is both a cuticle or scarf-skin, and likewise a rete-mucosum, which may be raised by a blister in the living body; or may be removed in a dead body by maceration. After these membranes are taken away, there is discovered underneath a smooth polished surface, which is, properly speaking, the new skin. If it is attempted to dissect this from the deep seated parts, there is found no line of separation, no distinction of parts, but all is uniform. The operator, therefore, if he persists in his attempt, does not know whether to cut to the depth of the fourth, eighth, or tenth of an inch; the substance of the whole, except the smooth external surface, being similar.

It is, therefore, a mere dispute of words to contest whether there is a new membrane or not. If it is said that there is one, it must be allowed to be so intimately attached to the parts upon which it is formed, that no separation can be observed. And if there is said to be no new membrane, it must be granted that the surface of the sore loses its extreme vascularity, the power or disposition of secreting pus, and becomes smooth, polished, and able to form a cuticle and rete-mucosum.

The substance of the new skin is, then, exactly of the same nature with the new flesh upon which it forms; and although it has by no means the same elasticity as the old skin, yet it is nearly as strong and able to resist mechanical violence. It is, therefore, a good substitute for the other.

The difference in its appearance from the original skin is at first striking; this dissimilarity gradually lessens with time, but never vanishes entirely. For as the scar cannot acquire the papillæ, or the same degree of vascularity with the cutis, it continues distinguishable during life; as is proved by the wound of even the finest lancet in bleeding.

But in superficial cuts, in those small abscesses called pimples, and other slight ulcerations, and in the mild species of the smallpox, where the surface of the cutis only is affected, and where it is not pierced through, no lasting scar is left. Because in these cases an entire portion of new skin is not required, as some of the old remains, from which the roots of the papillæ and hair shooting up, the temporary scar disappears and the part regains its former appearance. But when the pustules of the smallpox, or other ulcerations, corrode so deep as to destroy the cutis or papillæ, the cicatrix or scar never disappears; as is often cruelly exemplified in the bad species of smallpox. The pustules sometimes heal with a depression or pit, as it is called; and sometimes where no pit is left, but all is level, a glistening white mark remains for ever. For papillæ once destroyed never again spring up; for which reason the cicatrix never acquires an equal degree of vascularity with the original skin.

When a sore heals properly, the patient's strength, in as far as it has been diminished by the discharge, is gradually restored as that discharge abates. But when very old ulcers, to which the constitution has become

accustomed, and by which it is benefited, are healed, the stoppage of the salutary drain they produce, sometimes has dangerous consequences.

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SECTION III.

“ IN WHAT CASES, AND IN WHAT MANNER ARE  
 THE PARTS, WHICH WERE DESTROYED, RE-  
 STORED ? ”

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**T**HE destruction of a part of the body may be occa-  
 sioned by mechanical and chymical powers, by ulcera-  
 tion, and by mortification.

When any organ essential to life is destroyed, all  
 animal operations cease, and death must ensue. But  
 when a part not absolutely essential to life is destroyed,  
 the body continuing to breathe, the blood to circulate,  
 and life to go on, various efforts are made by Nature to  
 repair the injury.



It has been a matter of much controversy, particularly in France, Whether there ever is a restoration of any parts of the human body which have been destroyed? In the heat of the dispute, each party have made assertions not confirmed by experience, and have denied facts that are.

One party insists, that in wounds, abscesses, and ulcers, there is always a growth of flesh of the same nature with that which is divided or destroyed. If a muscle is cut through, or part of it destroyed, the new flesh, they assert, becomes muscular; if the same injury happens to a gland, the new substance becomes glandular; or if to a tendon, tendinous; and so on of all the different substances of which the body is composed.

It would be happy for mankind if this constant restoration took place. And perhaps the opinion was at first admitted, from the tendency natural to men, of easily believing what they wish to be true.

The other party is equally positive, that in wounds and ulcers there is no growth of new flesh of any kind or quality whatsoever. They insist that the cavities of sores are obliterated, not by new flesh arising

from the bottom to the height of the skin, but by the parietes of the cavity shrinking to the depth of its bottom. And notwithstanding that they must often have been obliged in their practice to oppose the exuberant granulations by bandages and escharotics, yet nothing would compel them to swerve from their opinion, and to trust to their eyes. They exerted their ingenuity in proportion to the difficulties they had to encounter, and have displayed wonderful subtlety in attempting to prove, what one can hardly conceive they believed.

It would certainly be very different from the usual processes of Nature, to remedy the inconveniences resulting from the loss of an ounce of flesh, by causing the neighbouring parts to waste a quarter of a pound; but this is in effect what Messieurs Fabre and Louis have asserted and endeavoured to prove, by long dissertations, in the Memoirs of the Academy of Surgery at Paris.

That there always is a growth of flesh of the same nature with what is divided or destroyed, is certainly erroneous: that there never is any growth of any kind, is equally unfounded.

The truth then, probably, lies between those two opposite opinions. And we shall endeavour to shew that when parts of the body are destroyed, different effects follow in different situations.

In some cases the body is unable to produce any new substance to supply that which is lost; and nothing more is attempted than simply to throw a cicatrix over the sore.

In other cases a new substance is formed which fills up the vacuity, but is incapable of performing the offices of the old. And lastly, it sometimes happens that a new substance is produced similar to the old, and fit for all its offices.

I shall now treat of the particular situations in which each of these consequences follow, after the destruction of parts of the body.

In the first section it was shewn that cavities which are formed by wounds, suppurations, or otherwise, were filled up by a growth of new flesh.

Whenever any part of the body, therefore, is cut out, or destroyed in such a manner as to leave a cavity, there is always a growth of some new parts to fill up the cavity, and occupy the place of that which has been lost.

But when an extreme part is entirely removed, by whatever means, from the body, in which case no cavity remaining where the part formerly existed, no attempt whatever is made by Nature to reproduce that which is lost.

If a hand or finger, for example, is struck off, as there is no cavity left attached to the body in which that part lay, it is never regenerated. But if a piece of bone is sawed off, or muscular flesh is dug out from the body, the cavity, which is necessarily left, will be filled up with a growth of new substance.

This new substance is usually, however, less in quantity than what has been destroyed. If indeed the opposite sides of the cavity were to remain at the same distance from each other, that they were before the part was destroyed; then it is probable that the new flesh would be exactly of equal dimensions with that which

was lost ; but this never happens ; for the sides of the cavity collapse together, and consequently a less quantity of new parts is wanted to obliterate the cavity, than what formerly filled it. The quantity of new matter then depends exactly upon the distance which the sides of the cavity are kept from each other. If they are brought into close contact, the new parts are in small quantity ; but if they are separated considerably, the growth of the flesh is proportionably greater.

When a part is destroyed without leaving a cavity, it has been said, that no attempt is made to reproduce it. It is not to be understood, however, that in these cases there is, literally, no new flesh generated ; for some granulations always arise for the cicatrix to form upon. But these are very inconsiderable, as they do not advance higher than the plane of the skin ; consequently no attempt is made to reproduce the part that has been destroyed.

From these observations it may be known in all cases, whether there will be a growth of new parts, or not, to fill up the place of what is lost. But some instances, which are particularly curious, deserve to be noticed.

When an abscess or ulcer forms on the flat surface of the tongue, and corrodes a deep cavity in its substance; if the sore should afterwards take a favourable turn and granulate, the cavity will be entirely filled up, and the tongue restored nearly as before.

But should a part of the tip or edge of the tongue be eat away by an ulcer, or cut off by a knife, so as to remove or destroy the skin both on the upper and under surfaces, there will be no reproduction of this lost part. For here no cavity remains where the part was, and the granulations will not sprout above the level of the skin, but a cicatrix will form from the edges above and below, leaving a dent where the lost substance was.

The same thing takes place on the glans penis; an ulcer, which eats a hole on the flat upper surface, is replenished; but one on the corona glandis destroying the projecting part, with the duplicature of the skin on both the surfaces, occasions a loss which is never restored; for the cicatrix commences from the edges of the remaining skin, and spreads directly over the ulcer.

The same circumstances follow in ulcers or wounds of the lips, ears, and other parts of the same kind.

Having shewn the situations in which, when a part is destroyed, there is a growth of new flesh to occupy the place of that which is lost, it is requisite to explain the changes which this new substance undergoes. And it is proper to remark that in simple wounds without loss of substance, if there is a cavity formed, there is exactly the same growth of new flesh to replenish the cavity that there is when a part is destroyed.

The recent appearance and nature of the new flesh, which fills up cavities, was described in the first section. It is, at first, tender, uniform in its texture, and extremely vascular. The excessive vascularity, however, gradually lessens, and the new substance becomes strong and fibrous.

The most natural way I know of explaining this change, is by supposing that the lymphatics absorb the softer and gelatinous particles, and that the arteries deposit a considerable quantity of the earthy and firmer materials of which the human body is composed. The new flesh continuing thus to be fashioned by means of the arteries and lymphatics, it is, at length, converted into a fibrous mass resembling the cellular membrane.

When this substance lies between parts which have no motion, the fibrous texture is less remarkable, and it is often hard and callous. But when it is situated between parts which are naturally moveable, the fibres are more apparent. In this situation, as it unites all the parts in close contact, it must, at first, either prevent, or considerably impede the motion; but by degrees the fibres usually lengthen, so that after a certain time, there is generally the same, or nearly the same, freedom of motion as formerly.

In by far the greater number of cases of wounds and ulcers, the new substance, which is formed to obliterate cavities, is of this kind, and continues for life. But this can, with no propriety, be called a restoration of the parts which have been destroyed; it is only a growth of new flesh to remedy some of the inconveniences which would result from a breach of the solids. A production of a much more useful nature, however, sometimes takes place. The cuticle and rete-mucosum, when removed, as was mentioned in the second section, are regenerated; and the scars of very slight wounds and ulcers, after a short time, totally disappear. These are the only instances in which new parts become *precisely* like the old. But there are several other parts,



which, when destroyed, the new substance assimilates to the nature of the old; that is to say, where it acquires a considerable resemblance and similar properties, so as to be fit for the offices of the old without being entirely alike.

These parts are the skin, tendons, ligaments, nerves, mucous membranes, bones, and perhaps some others.

Muscles and glands, however, appear to be a complete exception, and are not capable of ever being renewed. For the cicatrices of muscular and glandular parts, seem only a callous cellular substance, not endowed with muscular or glandular powers. What renders it probable that the cicatrix of a muscle has no contractile power is, that when put into action, it swells above and below, but not at the cicatrix. The cicatrix of a gland seems so different in texture from the gland itself, that we may naturally conclude it is not capable of secretion. This, however, might be ascertained by injecting the excretory duct of the gland, and examining whether the injected liquor enters the cicatrix; but hitherto I have not made the experiment.

The manner in which skin is produced, has been

noticed in a former part of this paper ; so no more need be said upon that subject.

The restoration of part of a tendon, or ligament, is by no means uncommon. As the new substance which grows up in cases where there is a solution of continuity, resembles the original fibres of these parts, very little further change is required. It is only wanted that the new substance should grow strong enough to be able to support the contraction of the muscle, or motion of the joint, without laceration ; and this, frequently, is effected. The appearance of these regenerated parts is different from the original ; the fibres are not so glistening and silver coloured, and are not so regular in their direction ; instead of the greater number of them running parallel to each other, there is more confusion in their arrangement. The new part is, likewise, somewhat thicker than the old ; so that there appears a kind of knot where the division was. Notwithstanding these differences, as strength is what is principally required, the new substance is an excellent substitute.

The free motion of the part, however, is sometimes impeded or destroyed by the new substance forming ad-

hesions. These sometimes occasion an absolute immobility; but they generally lengthen by degrees, so that the complete motion of the part is finally restored. This restoration happens with more certainty when the divided extremities are brought into contact, or nearly so. Although it sometimes has occurred even when they were kept at a considerable distance; and there is a far greater probability of this in cases of a division of parts only, than where there is some loss of substance.

Small portions of nerves are sometimes regenerated; this we know, because when a nerve is cut across, and sensation and the power of motion is lost in the parts to which the nerve goes, both have been observed afterwards to return. But this requires a considerable time, and happens rarely.

There are frequent instances in which mucous membranes, when destroyed, are reproduced. Parts of the internal surfaces of the urethra, fauces, bronchiæ, and even intestines, have been often destroyed by ulceration and other means, and the whole has healed, and a new membrane has been afterwards formed, fit for the offices of the old.

Bones, the hardest substance of which the human body is composed, are restored in a most remarkable manner ; and this restoration takes place not only when there is a simple division of the bone, or where part is removed ; but there have been instances of a new bone being formed, even when the old was entirely taken away : and this happens to the flat broad bones of the head, as well as to the cylindrical bones of the extremities. But it must not be imagined that the new bone is exactly like the old. It is very different in its appearance, and generally very irregular in its form. The new ossification is apt to be much too large, and requires therefore to be confined by the surgeon's art. The irregularity of the form, and the luxuriancy of the ossification generally occasion an anchylosis, when the calus is at, or very near a joint.

The new bone is formed exactly by the same process that the original bone was formed ; that is to say, by the arteries ossifying.

There is one instance where a fracture is very seldom united by bony matter, but almost always by a ligamentous substance, which is, the fracture of the patella, owing, I suspect, to this circumstance. The cavity of

the fractured patella must communicate with the cavity of the joint; the extravasated blood, therefore, cannot fill up the space between the fractured surfaces, as in other fractured bones, but it escapes principally into the joint; and the synovia insinuates itself between the broken parts. The synovia is not, like the blood, a proper medium for vessels to shoot into; consequently the fractured patella cannot be united as other fractured bones are, by soft parts afterwards becoming bony, except in a very few instances where the fractured parts are brought so closely together as to exclude the synovia. This, however, is rarely the case, for the muscles usually pull asunder the fractured parts in such a manner, as that it is impossible to retain them in contact. Although, therefore, the fractured surfaces of the bones inflame as in other cases; and although the adhesive exudation ossifies and covers the exposed cancelli of the fracture, yet as the fractured portions are not in contact, the cavity between the broken bone cannot be filled with living flesh, because it is occupied by synovia.

The usual mode of uniting fractures, therefore, fails here, and the following takes place: The cellular substance, which connects the patella to the skin, and which, when a fracture occurs, must form part of the

parietes of the joint, is lacerated by the accident. This inflames as well as the surface of the fracture; and all the cells are united by the inflammatory exudation, so as to prevent the synovia escaping. This forms an union between the fractured bones; it is weak at first, but becomes gradually stronger, of a ligamentous nature; and at length is able to support, without laceration, the full exertion of all the muscles that are inserted into the basis of the patella.

In the cases where the new substance which unites divided parts assimilates to the nature of the old, it would naturally be expected, if we judge from what happens to the skin, that the change should commence at the original parts; that is to say, if a portion of nerve, for example, is to be formed, the nervous power will be given first to the new substance, which is contiguous to the divided portions of the old nerve, and thence extend itself. As the progress of the restoration, probably, advances in this manner, it is evident, that the greater the destruction of a part is, there will be the less chance of the whole intermediate substance assimilating to the nature of the old; and where there is a simple division only, there is a greater probability that

the restoration will take place than if part had been cut out.

But this does not altogether apply to bone; for although ossification usually begins from the original bone, yet, when an entire bone is removed, this cannot occur; but in that case, the ossification commences at many parts at once, by which means this process, from its nature tedious, is finished more quickly.

Having mentioned those parts which when destroyed are sometimes restored, I shall just observe, that if we had it in our power to make an election of what parts we would wish the body capable of regenerating, and if there were some unavoidable necessity which prevented the whole from being restorable, we should certainly choose the very parts which, at present, are so. Not because they are more important than many others, but because the loss of them would occasion an extensive loss of other sound parts, and other inconveniences. The simple division of a nerve, for example, if it could not be regenerated, would render all the muscles and parts useless to which the nerve branched. The fracture of a bone would occasion a still greater loss; and what prodigious inconveniences would result from

wounds, if cicatrices did not form. But if a piece of muscle or gland is destroyed, when the remaining parts grow together, the loss is inconsiderable. For the muscle can, often, continue to act, and the gland to secrete, as before. No other loss being sustained, except simply the deprivation of the part which was removed.

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Having, at length, given the best answer in my power to the questions proposed by the Patrons of the Lyceum Medicum Londinense, I remain wavering in my mind, whether to lop off some of the least material parts of this dissertation, or still to lengthen it, and render it more minute and circumstantial.

In this uncertainty I am precluded from consulting any friend, by whose superior and more mature understanding I might be determined; for, unless the whole composition is my own, I must forfeit all right to the prize which I aspire to.

Such as this Paper is, it must, therefore, be submitted to the penetrating inspection of my judges, to whom,



even if they decide against me, however much my self-love may be mortified, it will be impossible for me to refuse my esteem.

THE END.





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