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With the Author's
Kind regards

So-called Sponge-grafting

by

H. Franks and P. S. Abraham

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ON SO-CALLED SPONGE-GRAFTING.

By KENDAL FRANKS, M.D., F.R.C.S.I., *Surgeon to the Adelaide Hospital, Dublin, &c.*, and P. S. ABRAHAM, M.A., B.Sc., F.R.C.S.I., *Curator to the Museum, and Member of the Court of Examiners, Royal College of Surgeons in Ireland.*[1] (PLATE XVI.)

THE idea of treating certain kinds of wounds accompanied by loss of substance, as well as ulcers, by means of a method called sponge-grafting, was first brought before the profession by Professor D. J. Hamilton. In an interesting and valuable paper, published in the *Edinburgh Medical Journal*, November 1881, he gives an account of his method of proceeding, and details the results he obtained in five cases in which he applied it to the human subject, as well as in certain cases in which he observed the effects of inserting pieces of sponge into the living tissues of rabbits.

The able manner in which Dr. Hamilton has introduced this subject, and the clinical success which has followed his method, solicit a further trial at the hands of surgeons, the more so that this method opens up new fields of investigation in the domains of surgery as well as in those of pathology and histology. It is not suggested as a new-fangled and empirical method of treatment to oust all former therapeutic means; it is the result of careful thought, and it fulfils an object which certain conditions require. When a wound is made in any part of the body, if unaccompanied by loss of substance, our object is generally to procure a healing of the wound as rapidly as possible. But if we find at the same time that a loss of substance exists, cicatrisation is not enough; it would in general be far better if we could ensure the restoration of the part which has been destroyed, a reformation of the tissue which has been lost. Sometimes, no doubt, an ulcer may heal level with the skin, but oftener it cicatrises, leaving a distinct and unsightly depression, What this new method proposes to do, in cases where there

[1] Most of this paper has been in MS. since July 1882. Dr. Franks is mainly responsible for the clinical part, and Mr. Abraham for the histological details.

exists a loss of substance, is to afford a scaffolding in which the new tissue can be built up, and this scaffolding is supplied by a fine porous substance like sponge. There are no special inherent properties in the sponge itself which render it essential to the process; it takes no active part in the growth of tissue; its rôle is purely a passive one. Dr. Hamilton proposes it as the material which hitherto proves itself the most suitable for the purpose, and up to the present we have no better substitute to offer.

When a sponge is placed on a granulating surface, it soon becomes fixed there, and it is now beyond doubt that new tissue forms in the interstices of the sponge. The manner in which this new tissue forms has been studied by Professor Hamilton, and the startling histological conclusions at which he has arrived by microscopical examination of the pieces of the excised grafts, seem to court further investigation.

It should here be stated that it has not yet been demonstrated whether different kinds of tissue can be reproduced in this way. Up to the present the cases in which it has been tried have shown the formation of granulation tissue, but whether under certain conditions this granulation tissue may not subsequently be transformed into the same material as that which surrounds the sponge, is a question which demands further inquiry. We have had a case under observation of necrosis of the femur, where, as soon as the sequestrum was removed, a piece of sponge, properly prepared and rendered aseptic, was placed into the space left by the sequestrum. We have also had a case where a sponge had been for some weeks imbedded in the muscles of the thigh, and which to all appearance became incorporated. It will be interesting to observe whether in such cases the material which has formed in the sponge meshes will eventually develop into bone and muscle respectively.

Since the appearance of Dr. Hamilton's paper very little has been published on this subject.

In the *British Medical Journal* for May 13th last, Dr. M'Ewen is reported to have shown some microscopical specimens to illustrate the process of "sponge-grafting" before the Glasgow Pathological and Clinical Society. He had grafted one-half of an ulcer on the outer side of the leg, but the result

did not come up to his expectations, and he did not therefore "find the process of any value." "The sections shown demonstrated the fact," says the report, "that absolutely no change had taken place in the sponge, and Dr. M'Ewen therefore objected to the term 'sponge grafting,' because the sponge tissue never became alive."

We hope to show presently that very important changes do occur in the sponge, and that as our own cases, as well as several others, prove, it is ultimately completely absorbed. Dr. Hamilton, moreover, never claimed that the sponge became alive, or that it acted otherwise in the body than would any other dead animal tissue. There is indeed no growth of the sponge itself, and on this account the term "sponge-grafting" is no doubt defective.

Case I.—The first case in which we tried the process was in that of an old woman, aged 70, who was admitted to the Adelaide Hospital, and came under surgical treatment on the 10th February 1882, for a large ulcer occupying the lower middle fourth of the right leg. The ulcer had inflamed elevated edges. The surface of the ulcer was occupied by a large slough which, when it separated on the 27th of the same month, exposed the muscles of the calf. The leg all round the ulcer had an inflamed erysipelatous-looking blush. Ordinary methods of treatment were employed until the 17th of March, when the first piece of sponge was grafted. It was not cut so as to cover the whole ulcer, but a circular piece, one inch in diameter and about half an inch in thickness, was used. On the third day it felt firmly adherent. A few days later five smaller pieces were grafted in different parts of the ulcer. They all became firmly adherent in a few days.

These sponges were all removed at different periods; one on the eighth day, one on the fourteenth, one on the thirtieth, and the remainder on the forty-eighth day. Sections of these sponge-grafts, some of which have been photographed by the kind assistance of Dr. R. Hayes, will be referred to presently.

These experiments have served to supply us with material for histological and pathological study; we shall presently see that the results observed during the period the sponges were allowed to remain in the tissues are of much surgical importance.

Case II.—The next case in which this method of treatment was adopted was in a boy aged 9, who suffered from necrosis of the lower portion of the right femur. As part of the sequestrum had separated, an incision was made about five inches long on the outside of the thigh in its lower half, and parallel to the femur. This incision, of course, reached down to the bone in the greater part of its extent. The sequestrum was removed. Into the lower angle of the wound a

sponge was placed on June 15, 1882; it was made wedge-shape, so as to reach down from the surface of the skin into the cavity in the bone. It measured one inch and a half in length, three-quarters of an inch in depth, and three-eighths of an inch in width. The next day it was adherent, and granulations could be seen making their way into it from each side. It rapidly filled with new tissue, and only a small central oval piece on the surface could be recognised after a month. The margins had become covered with new skin. Later on it completely disappeared. A piece of sponge placed in the upper angle of the wound on June 24th was considerably larger, and measured two and a half inches in length, one inch in depth, and half an inch in width. It was also made wedge-shaped, and reached from the bone to the level of the skin. It became adherent the next day, and seemed to fill rapidly with granulations. In a short time, however, it began to rise above the skin level, and in consequence it was trimmed down. In another week it had again transgressed the surface, and the trimming process was repeated, the operation being accompanied by bleeding. On July the 18th the piece seemed much loosened in the wound, and long bridges of granulations could be seen running from the sides into the sponge. It was then removed, the boy being placed under the influence of chloroform for a few minutes, whilst a sharp pair of scissors divided the granulations at their base. This was done, (1) because the graft did not promise to be clinically successful, and (2), because it promised to afford a good opportunity of investigating the process taking place on both sides of the sponge simultaneously. This excised piece of sponge was prepared for microscopical examination in the same way as the former ones.

Case III.—A cook, aged 22, was admitted to the Adelaide Hospital on December 28, 1882, suffering from an ulcer about the size of a halfpenny on the inner side of the left leg, and a smaller one higher up on the calf about the size of a threepenny bit. Both were circular and punched out, with unhealthy sloughy bases. She attributed them to constant standing in the kitchen, and had suffered from them for over three months. Astringent lotions had been tried, and constant bandaging, but without effect. The discharge was scanty and of a reddish-brown colour. There was no history or evidence of syphilis. The larger ulcer was grafted on January 3rd last. The sponge, which was prepared in the usual manner, was an inch in diameter, and about one-eighth of an inch in thickness. In two days it was firmly adherent, and in a few days bled when pricked. On the ninth day the ulcer had contracted to the size of the sponge. On the twenty-fourth day the centre of the sponge was invisible, being hidden by the granulations which had made their way through the sponge and appeared on the surface. Four days later this island of granulations was the size of a fourpenny piece, and was surrounded by a circle of sponge. Eight days later, only a small ring of sponge remained; three skin-grafts were then placed on the surface, within the ring, and when examined three days afterwards, one was found to have acted in

a manner similar to that observed in ordinary cases of ulcers when skin-grafts are applied. A few days later the graft measured two lines in diameter.

Case IV.—A woman, aged 60, was admitted to the Adelaide Hospital on January 12, 1883, suffering from an irregular-shaped ulcer on the inside of the right leg, measuring upwards of three inches in diameter. The edges were elevated and indurated. The base of the ulcer was very unhealthy and callous. The skin all round the ulcer was brawny and livid. She had suffered on and off for nearly thirty years from this condition. The exciting cause was evident, as she had several large varicose veins, tortuous and prominent, a little below the knee. The day after admission three pieces of sponge were placed on the surface of the ulcer. The largest piece, circular, about one inch in diameter and a quarter of an inch thick, was placed near the centre. Two smaller pieces, about three quarters of an inch long, a quarter of an inch wide, and one-eighth of an inch thick, were placed, one above and one below the central piece. They were all adherent the next day. The immediate effect on the ulcer was very remarkable. It assumed in a few days a much healthier appearance. The edges gradually lost their hard elevated character, and cicatrisation proceeded rapidly round the circumference. On the 25th the ulcer was not more than half its original size, and the smaller sponges were becoming rapidly incorporated. One of them became detached to a very slight extent, being partially undermined by the new epidermis encroaching upon it from the margin of the ulcer, but the rest of this piece became almost unrecognisable from the surrounding granulations. The larger piece of sponge required to be cleaned every day, as pus collected in its upper portion. It has not yet revealed granulations on its surface. The veins were now treated radically, by passing acupressure needles beneath them, and dividing the veins between two of these. This has so far not materially affected the process going on in the ulcer or sponges.

We have employed "sponge-grafting" in several other cases besides those detailed, but as they revealed no points of especial interest which have not been illustrated by the cases recorded, we have not reproduced them here.

A patient of Dr. Kelly, of Jervis Street Hospital, Dublin, had been operated upon for hare-lip. All the tissues included between three needles and the "figure of eight" sutures had sloughed, leaving a most formidable chasm in the lip. A piece of sponge was fitted into the cavity and maintained in position by flexible collodion. Dr. Kelly thus writes, under date August 10:—"My sponge only declared off yesterday, and I write to tell you the result. As you are aware, cicatrisation extended under it rapidly, but did not displace the graft completely until a very remarkable result was produced. When the sponge finally separated I could perceive hardly a trace of a depression, and better still, the patient and her friends are charmed by a result which I awaited in fear and trembling."

Dr. Kelly informs us that he has since employed the method in two cases of loss of tissue of the fingers, with eminently satisfactory results.

Dr. Robert M'Donnell has kindly given us the particulars of a case which occurred many years ago in Steevens' Hospital in Dublin under the care of the late Dr. Hutton, and which is of great interest in its bearing upon the subject under discussion. Dr. Hutton had excised a large hydrocele of the neck. Shortly afterwards a sudden and profuse, probably venous, hæmorrhage occurred. In the absence of Dr. Hutton the surgical resident plugged the wound with a sponge and thus controlled the bleeding.

The sponge was not removed owing to a fear of the hæmorrhage recurring. Gradually the wound closed up over the sponge, and completely healed. The sponge was never seen again. There can be scarcely any doubt now, in the light of recent observations, that the sponge was absorbed.

It was formerly a not uncommon practice in the treatment of epistaxis to plug the nares with pieces of sponge. Experience then proved the importance of not allowing the sponge to remain too long in its new position without changing it. If permitted to remain *in situ* longer than three days, great difficulty was often experienced in removing it, and even before this period its withdrawal was nearly always accompanied by fresh bleeding. The same observations apply to the use of uterine sponge tents.

In all these cases the same results ensue as we observe when pieces of sponge are applied to a raw or granulating surface. When applied for a short time, forcible evulsion will tear the tissue which has permeated the meshes of the sponges; and if a longer period have elapsed considerable force may have to be used before the adhesions are torn through.

In preparing the sponges for the so-called "grafting," we have uniformly followed the method recommended by Dr. Hamilton. The sponge is first allowed to lie in dilute nitro-muriatic acid; we have generally allowed forty-eight hours for this stage. Then the sponge is washed, first in water, afterwards in liquor potassæ, and finally placed in a solution of carbolic acid (1 in 20), till required for use. Thus all silicious and cretaceous materials are dissolved out, and nothing remains but the horny framework of the sponge, which, being an animal tissue, does not act as a foreign body, but is absorbed after a longer or shorter interval, as our experience proves.

The process by which this absorption takes place, is shown in the microscopical preparations which we have been able to make

of the sponges excised at varying periods of the growth of tissue within them.

When a sponge so prepared is placed on an ulcerated surface, or into deeper tissues where a loss of substance has taken place, it probably first gets filled with lymph. The lymph then undergoes organisation, and according to Dr. Hamilton, in a manner similar to that which obtains in blood-clot.

When the granulations approach the surface in the case of an ulcer, skin begins to form, generally growing from the margins of the ulcer over the tissue in the interstices of the sponge.

One of our sections shows that the formation of epidermis may take place within the sponge itself over the new tissue which has formed within its interstices, and before the upper stratum of the sponge has become filled with granulation tissue. In case III., one of the three skin-grafts placed over the new tissue which had formed in the sponge became adherent, and materially assisted in the process of cicatrisation. The formation of skin, however, seems to take place more slowly over the new tissue so formed than over an ordinary healthy ulcer.

We have observed one effect which a sponge has when it becomes fixed on the surface of an ulcer, and which is sufficiently characteristic to call for some comment, namely, the general stimulating effect it produces on the process of repair. We have observed this in cases of unhealthy ulceration, where ordinary stimulating applications seemed to have very little, if any, effect, and where the whole character of the ulceration was indolent. As a general rule, within a few days after the application of the sponge the whole type of the ulcerative process seemed to change, the edges began to assume a healthy appearance, and the ulcer began to cicatrise. We are all familiar with the appearances which follow on skin-grafting; the delicate promontories of new cuticle which are thrown out from the sound skin towards the skin-graft. The same appearances are nearly always seen to take place in the region of the sponge which has been applied to an ulcer. This stimulating effect is so remarkable that we would recommend this process to be adopted in those cases of indolent ulceration which so often try the ingenuity and patience of the surgeon, even though the actual loss of substance be of the smallest.

The application of sponge to an ulcer sometimes fails, by reason of a sort of spontaneous amputation of the piece taking place. This we have not observed in the case of ulcers with undermined edges, when the sponge is cut level with the skin, and the edge of the sponge is slipped beneath the undermined edges of the ulcer. In these cases the skinning process seems to spread rapidly inwards from the edges over the sponge. But when the edges of the ulcer are not undermined, and the sponge stands up above the surrounding level, as cicatrisation is greatly stimulated by the sponge, there is a danger that this process, gradually growing inwards from the healthy skin towards the sponge, may spread *beneath* the sponge instead of *over* it, and by its constricting power may gradually strangulate the young tissue forming in the sponge, and cause finally the whole piece to slough off. This we have several times observed to take place, and this we believe to be the explanation why sometimes, in the practice of others, "sponge-grafting" has failed.

Dr. D. J. Hamilton has recently[1] advised the surgeon to apply successive thin layers of sponge over a wound, instead of the thick slices which he had formerly advocated. Our observations entirely agree with this change. We have frequently found it necessary to pare down a thick piece of sponge, so as to leave nothing but the thin layer which has become infiltrated with organising tissue. Our object has been twofold; first, to prevent the sponge transgressing the level of the skin around, which it has a great tendency to do; and, secondly, to remove a framework which gets filled with pus, and which may become a fertile soil for putrefactive changes.

We have never found in any of our cases any evidence of the entry of nerve fibres into the sponge. Of course it is possible that such may occur, as is illustrated in the case recently reported by Mr. Ferguson.[2]

The portions of sponge excised were in all cases hardened for about a fortnight in Müller's fluid, and subsequently in alcohol. The sections were cut by means of Williams' freezing microtome, and stained with picro-carmine and hæmatoxylin. It was found that the thinnest sections were difficult to manage,

[1] *Brit. Med. Jour.*, Jan. 6, 1883, p. 7.

[2] *Brit. Med. Jour.*, Dec. 16, 1882, p. 1202.

portions of the sponge not infiltrated with growing tissue being brittle and crumbling away; some of the slices were therefore stained, dehydrated, and cleared *on* the slide. In other cases staining was effected in the mass. Most of the sections were mounted in Canada-balsam, a few in glycerine. Those which were most successful were taken from the sponges of case I., which had been in the ulcer for eight, fourteen, and thirty days respectively. Others were taken from the sponge of case II., which was in the process of being pushed out after lying in the wound for twenty-four days. They all present certain characters in common, the base of the new growth being composed of an embryonic, more or less developed, connective tissue, which in the deeper parts has quite replaced the horny sponge skeleton. Above this deep part the new tissue occupies merely the interstices of the sponge, while more distally still there is to be seen the unaltered sponge containing only blood, or sometimes fibrinous deposit, with scattered blood corpuscles. In the act of cutting out the pieces of sponge for examination hæmorrhage always took place, the porous sponge and new growth becoming more or less filled with blood. Thus we may account for many of the apparent extravasations seen in the sections, and for much of the clot in the unchanged sponge.

Wherever the tissue has infiltrated, the horny fibres of the sponge are evidently fewer in number, and, as Dr. Hamilton has described, the presence of numerous giant-cells in their immediate neighbourhood is a striking feature. Broadly speaking, these sections bear out Dr. Hamilton's descriptions in many respects; but, as will soon be seen, their close examination reveals several material differences. Under a low power the most noticeable elements are the blood-vessels, which pass up from the base, sometimes with little sinuosity, and giving off but few branches; at other times with tortuous course, and inosculating freely. Their course is often at once indicated by a closely surrounding area of small cells, with darkly stained nuclei resembling leucocytes. When they approach the periphery, the branching and anastomosing is very marked (fig. 1), and the curves, whenever they appear, seem to be as often synclinal as anti-clinal. The distal parts of the new tissue are thus the most vascular; and considering, moreover, the facts

that the branches vary in diameter, and that the anastomoses take place in the meshes of a sponge, it is difficult to understand how they could have been pushed up as loops from below. Their formation *in situ*, or at any rate their growth upwards and subsequent anastomosis, appears to be more probable; and indeed there seems to be abundant evidence of the new formation of the branches at least, in most of the sections examined (fig. 2). In the older parts of the new tissue, the larger blood-vessels, when cut longitudinally or transversely, are seen to be surrounded by a finely granular, homogeneous area, sometimes almost hyaline, which passes on the one side into the cells which make up the inner wall of the vessel; and on the other, into the matrix, and into the cell substance of the cells of the tissue around—forming, in fact, an adventitia. No such differentiation has taken place in the youngest growth, where the wall appears to be formed by a condensation of the surrounding cellular tissue. The cells nearest to the lumen are more closely packed, but they seem to pass gradually, and without much change of form or character, into the larger cells of the neighbourhood. The cross section of these capillaries sometimes shows the lumen to be more or less occupied by a collection of cells other than blood-corpuscles, which are united by processes to the cells of the capillary wall, and which show signs of multiplication and division of their nuclei. The smaller of these cells appear identical with colourless blood-corpuscles, the larger with the cells of the wall and of the surrounding tissue. Do these facts not suggest another possible mode of capillary formation? The formation of capillary branches is frequently to be observed in the younger as well as in the older growths. Sometimes a heaping-up of the cells forming the wall is seen, from which the new branch is evidently sprouting (fig. 2, *a*); or a line of cells may be seen springing from the wall and uniting with cells of the general tissue, or stretching across to a neighbouring capillary.[1]

In the sponges which had been but a comparatively short time in the wound, the deeper portion of the new tissue consists mostly of rounded, cuboid, or irregularly-shaped cells, which

[1] Figures illustrating some of the above points are given in a paper "Notes on the Vessels of New Growths," in the *Transactions of the Academy of Medicine of Ireland* for this year.—P. S. A.

vary also in size and in the relative amount of nucleus and cell substance. The prolongations which the latter sends out, and which join with processes from neighbouring cells and with the tissue matrix, are usually less developed than in the case of the older growths. Some of the smaller cells have a large, darkly-staining nucleus, and are hardly distinguishable from ordinary leucocytes or pus-corpuscles; others have the nucleus more faintly coloured, and there are various gradations of division of the nucleus. With high objectives, the reticular structure of the cell substance, and particularly of the paler nuclei, is quite apparent. The cells of the older tissue also present innumerable differences in size, formation, and structure. The fibrillation of the cell substance, and its passage by processes into the substance of other cells, and into the material between these, is still better seen in the highly magnified older parts (fig. 3).

At the distal or youngest part of the new growth, the cells are so closely packed, and their nuclei for the most part stained so deeply, that there is generally formed a more or less distinct bordering area, which looks under a low power like a layer of leucocytes. There may be a few of the latter present, but with a high power and in thin sections the cells are seen to be rapidly multiplying connective tissue cells, identical with those above described.

Even with an enlargement of forty diameters, the giant-cells can be easily made out. They often occupy the angles between the branching keratode fibres, wrapping around them, or lying closely apposed along their sides. Now and then they are to be observed capping the end of a fibre, and fitting into irregular cavities, which the extremity may show (figs. 4 to 9). In one or two cases only could any indentation be found on the side of the fibre (fig. 5, *c*). The thinning and pointing of the fibres which Dr. Hamilton mentions is not as a rule so evident in these sections (see, however, fig. 8); nor is there any special striation of the fibre.

That these giant-cells act as "spongo-clasts" is probably as well supported by the appearances observed as in the case of the "osteo-clasts" of bone. It seems likely, however, that if they be the active eroders, the erosion is mainly effected at the ends of the fibres. Occasionally a fibre appears to be softening and

breaking down at its extremity, but even then a giant-cell is always to be found in the immediate neighbourhood.

The giant-cells vary very much in size and shape, and also in construction. The largest ones contain numerous nuclei (figs. 4 and 5) which may be irregularly disposed throughout the mass, or arranged more peripherally; while the smaller sometimes contain but a single nucleus (fig. 5, *d*). Rarely the nuclei are so numerous that but little other substance is left, and then the giant-cell appears as though it were made up of an aggregation of small cells. The texture of the cell in some of them has a more granular appearance than in others, and it is generally better seen in the doubly-stained preparations. With a one-sixth objective and No. 2 eye-piece the granules are not usually resolvable in a network, but with a one-sixteenth oil immersion (Leitz) this structure is plainly indicated. The nuclei are for the most part oval in shape, and they do not stain deeply—thus resembling the larger cells of the neighbouring tissue. Their size is tolerably uniform, but sometimes a few are seen smaller than the rest. The nuclear reticulum is generally distinct, and occasionally there is evidence of a karyokinesis.

In fig. 10 is shown a cell which at one or two points gives off processes, attaching it to neighbouring cells; it is seemingly nothing more than one of the larger connective tissue cells which has increased in size, and has become more apparently granular. Multiplication of its nucleus would give us an ordinary giant-cell; and indeed every stage is to be observed from the common connective tissue corpuscle, up to the largest giant-cell. This fact does not, however, preclude the possibility of other methods of production for giant-cells. As mentioned above, the substance of the cell sometimes passes, without line of division, into the intercellular matrix of the connective tissue around; and it is difficult to resist the conclusion that a portion of this may not assume an individuality, and acquire nuclei perhaps by migration and subsequent multiplication. The appearances, indeed, observed in these cases, as in some others, are not opposed to Stricker's new views on the relation of ground substance and corpuscular elements in tissues.[1]

The skinning over of the sponge has commenced in the piece

[1] Ashhurst's *Encycl. Surg.*, vol. i. part i.

which had been eight days planted, and it has still further proceeded in the older pieces,—generally extending along the top of the granulation tissue irrespective of the sponge fibres, which become imbedded in the new growing skin. The growth of epidermis coming in from the sides can thus be well studied in these sections. Where it is thickest, all the elementary epidermic layers are sometimes present, but generally one or more are imperfectly developed. The uppermost stratum of the youngest epidermis, instead of consisting of horny scales, is generally made of large flattened nucleated cells, the deeper ones being greatly swollen, vacuolated, and containing nuclei showing indirect division. Air spaces are also apparent between the cells. Sometimes the large dividing nucleus is in the middle of an apparently empty space, and occasionally the new nuclei seem to be invested with cell substance,—a process looking like an endogenous formation of cells. The smaller scattered cells with dark nuclei, which are sometimes seen between the larger ones, are possibly thus formed. It is by extension of this layer that the skin appears to grow into the sponge. Whether any of the branching cells of the granulation tissue are transformed into these epidermic cells, cannot be satisfactorily made out in the specimens—but the suspicion of such a possibility has arisen. As a rule, however, the advance of the epidermis appears to be by division of the cells of the layer just alluded to. In the thicker circumferential portion of the epidermis, a well-marked stratum lucidum is shown, which becomes gradually lost above the stratum just described. Just below the lowest columnar cells of the rete Malpighii, a well-defined layer of dark minute granules is to be seen in these sections. They look like finely comminuted "debris;" and in places, and with a high power, they can be made out to be in organic connection with the neighbouring intercellular matrix.

The examination of these sections confirms Dr. Hamilton's observations that a porous antiseptic sponge, placed upon a granulating surface, will become infiltrated with new tissue; and that its own substance gradually disappears. It does not, however, seem to us at all necessary to call in the aid of Dr. Hamilton's ingenious hypothesis as to the pushing out of capillary loops, in order to explain the formation of the granulation

tissue. We very much doubt, indeed, whether the formation is, as he appears to suppose, primarily dependent on the presence of capillaries. It is possible to conceive that, from stimulation or otherwise, a proliferation of the cells of the old tissue takes place; into the new growth so formed branches from the subjacent capillaries may extend, by growth; from these other sproutings and continuations may arise; and in the same new tissue new capillaries may be formed, to become subsequently connected with the others. In short, the appearances observed are not inconsistent with some of the other and more generally received views.

DESCRIPTION OF PLATE XVI.

Fig. 1. Capillaries (*b*) anastomosing among the fibres (*a*) of the sponge skeleton. This is near the surface of the granulation tissue. The sponge had been fourteen days in the wound.

Fig. 2. A capillary in a somewhat older growth, giving off a branch at *a* (about × 400).

Fig. 3. Cells of the new tissue, with processes (about 500).

Fig. 4. Giant-cells at end of a fibre.

Fig. 5. Giant-cells at ends of fibres. At *c* a distinct indentation in a fibre is seen. The smaller giant cell (*d*) has but one nucleus. The cells of the surrounding tissue are approximately of the size of *e*.

Figs. 6, 7, 8, and 9. Giant-cells more or less enveloping fibres.

Fig. 10. A large cell connected by processes with the neighbouring ones.

Fig. 1.

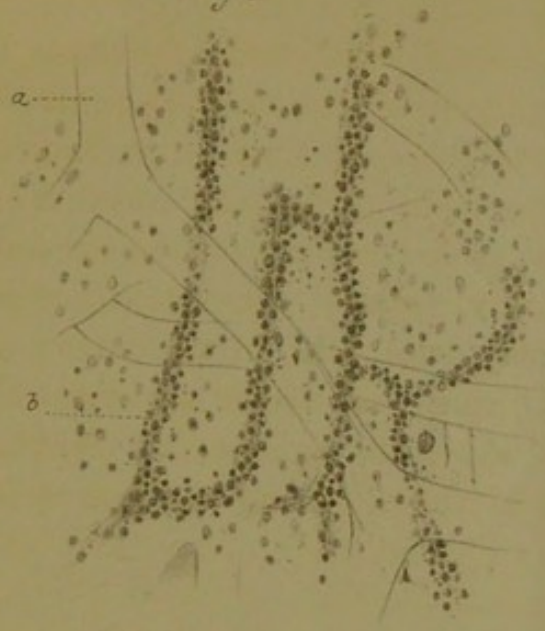

Fig. 2.

Fig. 3.

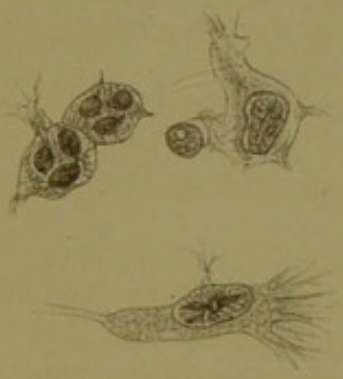

Fig. 4.

Fig. 6.

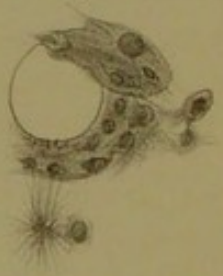

Fig. 7.

Fig. 8.

Fig. 5.

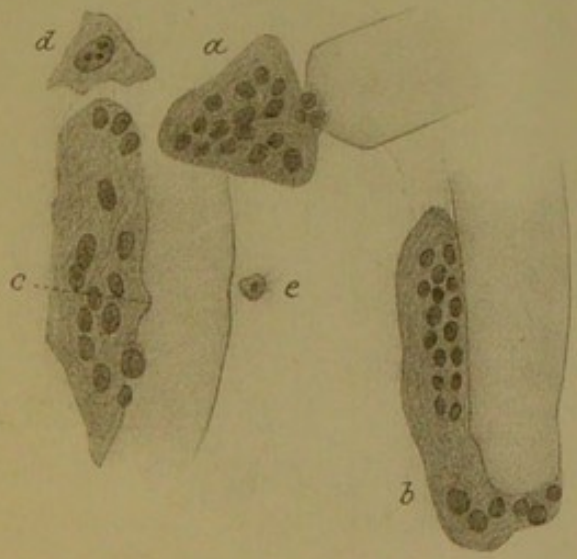

Fig. 9.

Fig. 10.

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