ANATOMICAL AND PATHOLOGICAL OBSERVATIONS.

BY

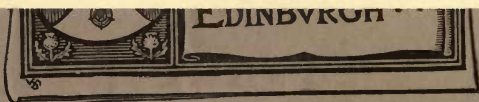
JOHN GOODSIR, F.R.S.E.,
Demonstrator of Anatomy in the University of Edinburgh,

AND

HARRY D. S. GOODSIR, M.W.S.,
Conservator of the Museum of the Royal College of Surgeons, Edinburgh.

EDINBURGH:
MYLES MACPHAIL.
LONDON: SIMPKIN, MARSHALL, AND CO.
1845.


Ex-libris
Charles Atwood
Kofoid
BMC


EDINBVRGH

ANATOMICAL

AND

PATHOLOGICAL OBSERVATIONS,

BY

JOHN GOODSIR, F.R.S.E.,

DEMONSTRATOR OF ANATOMY IN THE UNIVERSITY OF EDINBURGH,

AND

HARRY D. S. GOODSIR, M.W.S.,

CONSERVATOR OF THE MUSEUM OF THE ROYAL COLLEGE OF SURGEONS, EDINBURGH.

EDINBURGH:

MYLES MACPHAIL.

LONDON: SIMPKIN, MARSHALL, AND COMPANY.

1845.

WILLIAM MACPHAIL,
PRINTER,
2 GREENSIDE PLACE, EDINBURGH.

"*Although it shew not the agent, yet it sheweth a rule and analogy in nature, to say, that the solid parts of animals are endued with attractive powers, whereby from contiguous fluids, they draw like to like; and that glands have peculiar powers attractive of peculiar juices.*"

BERKELEY.

"*Even herein consists the essential difference, the contra-distinction, of an organ from a machine; that not only the characteristic shape is evolved from the invisible central power, but the material mass itself is acquired by assimilation. The germinal power of the plant transmutes the fixed air and the elementary base of water into grass or leaves; and on these the organific principle in the ox or the elephant exercises an alchemy still more stupendous. As the unseen agency weaves its magic eddies, the foliage becomes indifferently the bone and its marrow, the pulpy brain, or the solid ivory.*"

COLERIDGE.

PREFACE.

The greater part of my share of these Anatomical and Pathological Observations will be already, to a certain extent, familiar to those who attended my lectures, in the theatre of the Royal College of Surgeons, in Summer 1842, and Winter 1842–3.

The Memoir on the Secreting Structures is reprinted in a modified form from the Transactions of the Royal Society of Edinburgh for 1842, and that on the Intestinal Villi from the Edinburgh Philosophical Journal of the same year. Those on the Placenta and Lymphatic Glands were read in the Royal Society of Edinburgh in 1843, but were not submitted for publication. Abstracts of some of the others have also appeared from time to time in the reports of various Societies.

The observations on the healthy Structure and Economy of Bone are, with the exception of those on the contents of the corpuscules, an abstract of my lectures on this subject in the College of Surgeons in Winter 1842–3. I have considered this explanation necessary, in consequence of the resemblance between certain parts of my description, and those in the admirable chapter on the same subject in Todd and Bowman's Physiological Anatomy, drawn up from the observations of Mr. Tomes.

My brother has added some of his own zoological, anatomical, and pathological observations, as confirmatory of the doctrines of centres of Nutrition, and of Secretion.

To such as may be inclined to object to the theoretical views which run through and connect these anatomical details, I would only say, that we shall be quite satisfied, if on finding the latter correct, they will allow us to retain the former for future use: feeling assured, that "there is a certain analogy, constancy, and uniformity in the phenomena or appearances of nature, which are a foundation for general rules": and that "these are a grammar for the understanding of nature, or that series of effects in the visible world, whereby we are enabled to foresee what will come to pass in the natural course of things."

JOHN GOODSIR.

Edinburgh, 1845.

CONTENTS.

No. I.

CENTRES OF NUTRITION.

By centres of nutrition, I understand certain minute cellular parts existing in the textures and organs. With many of these centres anatomists have been for some time familiar,* but with a few exceptions have looked upon them as embryonic structures.† I am inclined to believe in the general existence of such centres, for a certain period at least, in all textures and organs, and to this I wish to direct attention at present.

The phenomena presented by these centres incline me to regard them as destined to draw from the capillary vessels, or from other sources, the materials of nutrition, and to distribute them by developement to each organ or texture after its kind. In this way they are to be considered centres of germination; and I have elsewhere named them germinal spots—adopting the latter term from the Embryologists.‡

The centre of nutrition with which we are most familiar, is that from which the whole organism derives its origin—the germinal spot of the ovum. From this all the other centres are derived, either mediately or immediately; and in directions, numbers, and arrangements, which induce the configuration and structure of the being. As the entire organism is formed at first,

* The nuclei of the textures.

† Mr. Bowman in his Paper on Muscle, Philosophical Transactions, 1840, Part I, page 485.—Cyclopedia of Anatomy and Physiology, Art. "*Muscle.*"—Dr. Martin Barry in the Philosophical Transactions, and most explicitly in his Paper "*On the Corpuscles of the Blood,*" 1841, Part I, page 269, paragraph 83.

‡ Trans. Roy. Soc. Ed. 1842. "*On the Secreting Structure, and the Laws of its Functions.*"

not by simultaneous formation of its parts, but by the successive developement of these from one centre, so the various parts arise each from its own centre, this being the original source of all the centres with which the part is ultimately supplied.

From this it follows, not only that the entire organism, as has been stated by the authors of the cellular theory, consists of simple, or developed cells, each having a peculiar independent vitality, but that there is, in addition, a division of the whole into departments, each containing a certain number of simple or developed cells, all of which hold certain relations to one central or capital cell, around which they are grouped. It would appear that from this central cell all the other cells of its department derive their origin. It is the mother of all those within its own territory. It has absorbed materials of nourishment for them while in a state of developement, and has either passed them off after they have been fully formed, or have arrived at a stage of growth when they can be developed by their own powers.

Centres of nutrition are of two kinds: those which are peculiar to the textures, and those which belong to the organs. The nutritive centres of the textures are in general permanent. Those of the organs are in most instances peculiar to their embryonic stage, and either disappear ultimately, or break up into the various centres of the textures of which the organs are composed.

A nutritive centre, anatomically considered, is merely a cell, the nucleus of which is the permanent source of successive broods of young cells, which from time to time fill the cavity of their parent, and carrying with them the cell wall of the parent, pass off in certain directions, and under various forms, according to the texture or organ of which their parent forms a part.*

There is one form in which nutritive centres are arranged, both in healthy and morbid parts, which is frequently alluded to in the following chapters, and which may be named a germinal

* For the first consistent account of the developement of cells from a parent centre, and more especially of the appearance of new centres within the original sphere, we are indebted to the researches of Dr. Martin Barry. Whatever may be said in opposition to Dr. Barry's views regarding the functions of the blood globules, and the structure of muscular fibre, he is yet entitled, above all physiologists of the present day, to the merit of having kept steadily before him in his researches, the principle of the central origin of all organic form.

membrane.* In a germinal membrane, the nutritive or germinal centres are arranged at equal or variable distances, and in certain directions, in the substance of a fine transparent membrane. A germinal membrane is occasionally found to break up into portions of equal size, each of which contains one of the germinal centres. From this it is perceived, that a germinal membrane consists of cells, with their cavities flattened, so that their walls form the membrane, by cohering at their edges, and their nuclei remain in its substance as the germinal centres.

Germinal membranes are only met with on the free surfaces of parts or organs. One surface of the membrane is therefore attached, and is applied upon a layer of areolar texture, intermixed with a more or less rich network of capillary vessels. The other surface is free, and it is on it only that the developed or secondary cells of its germinal spots are attached. These secondary cells are at first contained between the two layers of the membrane, these layers being the opposite walls of each of its component cells. When fully developed, the secondary cells carry forward the anterior layer, which is always the thinnest, leaving the nuclei or germinal centres in the substance of the posterior layer, in close contact with the blood-vessels.

Of the forces which exist in connection with centres of nutrition, nothing very definite can yet be stated. When this branch of inquiry shall have been opened up, we shall expect to have a science of organic forces, bearing direct relations to anatomy, the science of organic forms.—J. G.

* The membranous tubes of glands on which the epithelium is situated, was described by Henle, Müller's "Archiv," 1839. Mr. Bowman (Phil. Trans. 1842) "*On the Structure and Use of the Malpighian Bodies of the Kidney*," &c., has applied to the membrane of these tubes the very appropriate name of Basement Membrane. This membrane I consider to be a primary or germinal membrane. The term, basement membrane, is good as involving no hypothesis ; it is therefore a most appropriate descriptive term. I have always considered the basement membrane, or elementary membrane of glands, as a form of the primary cells of glands, and the source of the secondary or secreting cells, and have therefore been in the habit of naming it primary, or germinal membrane. Mr. Bowman considers it to be simple, or homogeneous. This is true as far as it contains no blood-vessels, and as regards its external or attached layer; but as in its original condition it consists of cells, and when perfect contains nuclei at equal or variable distances, I do not consider it as simply molecular. These nuclei, or germinal spots, may be certain of the epithelial cells, which become mother cells, between the two layers of the membrane ; or cells belonging to the order of the nuclear fibres of Valentin and Henle.

No. II.

THE STRUCTURE AND FUNCTIONS OF THE INTESTINAL VILLI.

Mr. Cruikshank, in treating of the orifices of the Lacteals and Lymphatics,* states that he and Dr. William Hunter observed the openings by which the lacteals communicated with the cavity of the gut in portions of the intestine of a woman who died after eating a hearty supper. The two preparations of the intestine on which these anatomists made their observations, came into the possession of the College of Surgeons in Edinburgh, as part of the collection of the late Sir Charles Bell.

I removed one of the villi from Mr. Cruikshank's preparation, and had no difficulty in recognising what had been described and figured by the original owner of the preparation. With a low power the extremity of the villus appeared bulbous and opaque. With a higher power I observed that this opacity was due to the existence, at the extremity of the villus, of a number of vesicles of different sizes. The larger vesicles were pretty uniform in size, and about twenty in number. The smaller were of different sizes, and more numerous, and appeared gradually to pass into the granular texture of the attached extremity of the villus. No blood-vessels could be detected, but along the neck of the villus distinct traces of two or more opaque lacteals were visible. The vesicles

* William Cruikshank. The Anatomy of the Absorbing Vessels of the Human Body, 2d Ed., 1790, page 56.

and the lacteals, when viewed by transmitted light, were of a light brown colour; but when examined as opaque objects, they stood out of a dead white appearance, contrasting strongly with the semi-transparency of the surrounding texture. Repeated examinations of these preparations satisfied me that Dr. William Hunter and Mr. Cruikshank were quite correct in describing and figuring radiating lacteals within the villi, but that they were led into error in describing those vessels as opening on the free surface of the gut, partly by imperfect instruments and methods of observation, partly by the general prejudice of the period in favour of absorbent orifices. I also satisfied myself of what appeared highly probable from the commencement of the observations, that the villi, when turgid with chyle, were destitute of their ordinary epithelial covering. This circumstance I could not avoid connecting with the fact of the stomach throwing off its epithelia during the process of digestion. I determined, therefore, to investigate the process of absorption of chyle in fresh subjects, as the facts exhibited in Mr. Cruikshank's preparations indicated the probable existence of complicated processes going on in villi during digestion. The analogy of the vesicular bulbous extremity of the villus, to the spongiole of the vegetable, forced itself upon me, and the existence of milky chyle, within closed cells, led me to anticipate an explanation of some of the phenomena of digestion.

A dog was fed. Three hours afterwards he was killed. The lacteals were turgid, and the gut was found to be full of milky chyme, with an admixture of thin brownish fluid of a bilious appearance. The milky matter was situated principally towards the mucous membrane; the brown fluid occupied the cavity of the gut.

The white matter consisted of a transparent fluid, with a few oil globules, and numerous epithelia.

Some of the epithelia I recognised as those which cover the villi. They were pointed at their attached extremities, flat at the other. Many of them were single, others were united in bundles, adhering principally by their flat or free extremities, as if a fine membrane passed over and connected the edges of their extreme surfaces. Occasionally these epithelia presented a distinct nucleus; but generally, and whether single or in bundles, they exhibited in their interior a group or mass of oil-like globules, which, when viewed as opaque objects, had a peculiar semi-opaque or opalescent appearance.* Others of the epithelia, contained in the chyme, were prismatic, single, or in columns. They were the lining epithelia of the follicles of Lieberkühn, and presented the usual nuclei.

The mucous membrane displayed the villi turgid, as if in a state of erection, and, as I had anticipated, naked or destitute of epithelia, except at their bases where a few still adhered. Each villus was covered by a very fine smooth membrane, which from its free bulbous extremity, passed on to its sides, and became continuous with the germinal membrane of the follicles of Lieberkühn. These villi, when removed from the mucous membrane, and examined with a low power, were semi-transparent, except at their free or bulbous extremities, which appeared both by direct or transmitted light white and opaque. Under higher powers the summit of the villus, somewhat flattened, was observed to be crowded, immediately under the membrane before mentioned, with a number of perfectly spherical vesicles. These vesicles varied in size from 1000 to less than 2000 of an inch. The matter in their interior had an opalescent milky appearance. Towards the body of the villus, on the edges of the vesicular mass, minute granular or oily particles were situated in great numbers, and gradually passed into the granular texture of the substance of the villus.

The trunks of two lacteals could be easily traced up the centre of the villus, and as they approached the vesicular mass they subdivided and looped. In no instance could one of these lacteals be traced to any of the spherical vesicles, nor could any direct communication between the structures be detected.† The blood-vessels and capillaries, with their columns of tawny blood disks, could be seen passing in radiating lines and in loops across the villus, immediately under the fine membrane already mentioned. This membrane, perceptible on the body and neck of the villus only by the smooth surface it presented, was most distinctly

* Is this appearance due to a partial absorption of chyle by these protective epithelia?

† See Gulliver's translation of Gerber's General Anatomy, page 272 and 273.

traced at the free extremity of the villus, as it passed from the surface of one vesicle on to that of another.* The vesicles pushing the membrane forward, and grouped together in masses on its attached surface, gave the extremity of the villus the appearance of a mulberry. When viewed on a dark ground as an opaque object, the point directed to the light, a villus in this condition is remarkably beautiful, the play of the light on the surface of the highly refractive semi-opaque and opalescent vesicles, giving them the appearance of a group of pearls.

In villi turgid with chyle, which have been kept for some time in spirits, the contents of the vesicles are opaque, the albumen having become coagulated.

To understand the part which the vesicles of the villus play in digestion, it is necessary to be aware of certain of the functions of the cell, with which physiologists are yet unacquainted. Not only are these bodies the germs of all the tissues, as determined by the labours of Schleiden and Schwann, but are also the immediate agents of secretion. A primitive cell absorbs from the blood in the capillaries, the matters necessary to enable it to form, in one set of instances, nerve, muscle, bone, if nutrition be its function; milk, bile, urine, in another set of instances, if secretion be the duty assigned to it. The only difference between the two functions being, that in the first, the cell dissolves and disappears among the textures, after having performed its part; in the other, it dissolves, disappears, and throws out its contents on a free surface. Now, it will be perceived, that before a cell can perform its function as a nutritive cell, or as a secreting cell, it must have acted as an absorbing cell. This absorption, too, must necessarily be of a peculiar and specific nature. It is in virtue of it that the nutritive cell selects and absorbs from the liquor sanguinis those parts of the latter necessary for building up the peculiar texture of which the cell is the germ. It is in virtue of this peculiar force that the secreting cell not only selects and absorbs, but also in some instances elaborates, from the same common material, the particular secretion of which it is the immediate organ. And it is by the same force that the cell

* Mr. Bowman in the Article "*Mucous Membrane*," Cyclopedia of Anatomy, does not admit this portion of the membrane. It certainly cannot be detached as a separate membrane.

becomes the immediate agent of absorption in certain morbid processes.

"Absorption,"* says Professor Müller, "seems to depend on an attraction, the nature of which is at present unknown, but of which the very counterpart, as it were, takes place in secretion; the fluids altered by the secreting action being impelled towards the free surface only of the secreting membranes, and then pressed onwards by the successive portions of fluid secreted. In many organs, for instance in those invested with mucous membranes — absorption by the lymphatics and secretion by the secreting organs, are going on at the same time on the same surface." It appears, however, from what is stated in the present chapter, and in the Trans. Roy. Soc. Edin.† that Prof. Müller, and indeed all the physiologists hitherto, have been in error in supposing the forces of secretion and absorption as of different and opposite tendencies—the one attractive, the other repulsive. They are both attractive, absorption being but the first stage in the process of secretion. Secretion, in fact, differs from absorption, not physiologically, but morphologically.

What has been stated in the present paper explains also how, in the mucous membranes, "absorption by lymphatics and secretion by secreting organs are going on at the same time on the same surface." There is no physiological mystery in this. It depends on a morphological circumstance. The absorbing chyle cells are on the attached surface of the germinal membrane—the secreting epithelia are on its free surface; the former are interstitial cells—the latter peripheral; the former cast their contents into the substance of the organism—the latter into the surrounding medium.

The primitive cell, then, is primarily an organ of specific absorption, and secondarily of nutrition, growth, and secretion.

As the chyme begins to pass along the small intestine, an increased quantity of blood circulates in the capillaries of the gut. In consequence of this increased flow of blood, or from some

* Müller's Physiology, page 30.—Baly's Translation.

† Trans. Royal Society, Edin. 1842, "*On the Secreting Structure, and Laws of its Function.*"

other cause with which I am not yet acquainted, the internal surface of the gut throws off its epithelium, which is intermixed with the chyme in the cavity of the gut. The cast-off epithelium is of two kinds,—that which covers the villi, and which, from the duty it performs, may be named protective epithelium, and that which lines the follicles, and is endowed with secreting functions. The same action, then, which, in removing the protective epithelia from the villi, prepares the latter for their peculiar function of absorption, throws out the secreting epithelia from the follicles, and thus conduces towards the performance of the function of these follicles.

The villi, being now turgid with blood, erected, and naked, are covered or coated by the whitish-grey matter already described. This matter consists of chyme, of cast-off epithelia of the villi, and of the secreting epithelia of the follicles. The function of the villi now commences. The minute vesicles which are interspersed among the terminal loops of the lacteals of the villus, increase in size by drawing materials from the blood through the coats of the capillary vessels, which ramify at this spot in great abundance. While this increase in their capacity is in progress, the growing vesicles are continually exerting their absorbing function, and draw into their cavities that portion of the chyme in the gut necessary to supply materials for the chyle. When the vesicles respectively attain in succession their specific size, they burst or dissolve, their contents being cast into the texture of the villus, as in the case of any other species of interstitial cell.

The debris, and the contents of the dissolved chyle cells, as well as the other matters which have already subserved the nutrition of the villus, pass into the looped network of lacteals, which, like other lymphatics, are continually employed in this peculiar function. As long as the cavity of the gut contains chyme, the vesicles of the terminal extremity of the villi continue to develope, to absorb chyle, and to burst, and their remains and contents to be removed along the lacteals.

When the gut contains no more chyme, the flow of blood to the mucous membrane diminishes, the developement of new vesicles ceases, the lacteals empty themselves, and the villi become flaccid.

The function of the villi now ceases till they are again roused into action by another flow of chyme along the gut.

During the intervals of absorption, it becomes necessary to protect the delicate villi from the matters contained in the bowel. They had thrown off their protective epithelium when required to perform their functions, just as the stomach had done to afford gastric juice, and the intestinal follicles to supply their peculiar secretions. In the intervals of digestion, the epithelium is rapidly reproduced.

The germinal membrane, which, as I have stated, not only forms the outer membrane of the follicles, under the epithelia, but also the under-lying membrane of the villi, contains in its substance germinal centres of an oval form, situated at pretty regular distances. From these the epithelium appears to be reproduced during the intervals of absorption, as stated in the first chapter.

During this process of developement, the primary membrane appears to split into two laminæ, the epithelia passing out from its nuclei between these. This would account for the epithelia, particularly the prismatic and conical, adhering by their free extremities.

Such are the processes which would appear to take place in the villi of the intestinal tube during digestion and absorption. When considered in relation to the functions of digestion and absorption of chyle, these processes are highly interesting.

The labours of the chemist have now so far simplified the theory of digestion, as to deprive the stomach of their vitalizing or organizing powers so long ascribed to it.

Every step in this chemico-physiological inquiry leads to the conclusion, that the changes which the food undergoes while in the cavity of the gut are entirely of a chemical nature.

If we continue, then, to apply the term digestion to that series of processes by which the aliment is assimilated to the matter of which the body is composed, we must divide the series into two groups. The first group will include all those changes which take place within the digestive tube, but exterior to the organism. The second will include those which present themselves after the alimentary matter is taken up into the animal body, and becomes buried in its substance. The first group of processes are mechanical and chemical in their nature. They may be considered in a great measure as peculiar to the animal, although even vegetables throw out from their roots matter which, acting on some of the materials of the surrounding soil, prepare these for absorption.

The second group of processes is common to animals and vegetables. In these, for the first time, are alimentary substances taken into the tissues of the organism. In animals, as in plants, as I have already pointed out, these alimentary substances are drawn by a peculiar force into the interior of the cells, after escaping from which they pass on by the absorbent system. The chemist has not yet informed us of the change which the matter has undergone during its passage from the cavity of the gut, or from the soil, into the afferent lacteals and the sap-vessels; but if in vegetables, as in animals, this matter passes into the cavities of the cells of the spongiole before it passes on to the sap-vessels, then it is highly probable that the organizing and vitalizing part of the function of digestion commences in the cells of the spongiole and of the extremity of the villus.

The extremity of the fibril of the root of a plant elongates by the cells added to its tissue by the germinating spongiole. The spongiole is, therefore, an active organ of growth as well as of absorption. It is to the fibril of the root, what I have denominated in the animal tissues, the nutritive centre. I conceive it to be probable, therefore, although as to this I have made no observations, that absorption by, and elongation of, the febril of the root, vary inversely as one another. This supposition is founded on the assumption, that the cells of the spongiole do not absorb by transmission but by growth and solution.

In the villi of the intestines of animals, my own observations lead me to believe that absorption by growth and solution is the process which actually takes place.

The vesicular extremity, like the spongiole of the root fibril, is the primitive nutritive centre of the villus. The villus originates in a cell. During the developement of the villus, this spot or cell was employed only in procuring materials for the growth of the organ. In the perfect animal the formative function of the spot ceases; its action becomes periodical, active during digestion, at rest during the intervals of that process. The same function is performed, the same force is in action, and the same organ, the cell, is provided for absorption of alimentary matters in the embyro, and in the adult, in the plant, and in the animal. The spongioles of the root, the vesicles of the villus, the last layer of cells on the internal membrane of the included yelk, or the cells which cover the vasa lutea of the dependent yelk, and the cells which cover the tufts of the placenta, are the parts of the organism in which the alimentary matters first form a part of that organism, and undergo the first steps of the organizing process.

J. G.

No. III.

ABSORPTION, ULCERATION, AND THE STRUCTURES ENGAGED IN THESE PROCESSES.

Every organic cell, the most simple, as well as the most complicated, when a separate organism, or when a part of a more highly organized being, existing as a mere magazine of matter, or performing some of the more striking of the vital functions, invariably exhibits a phenomenon which is antecedent to all others, absorption from without of materials for its own growth.

The various kinds of cells in any organism differ from one another in this respect, that they have the power, each after its kind, of selecting and procuring from the circulating medium, or from other sources, the sort of matter necessary for their own growth: or they have the power of elaborating, or of conducing to the chemical change of the matter which is absorbed by them. In this respect, the component cells of animals and vegetables resemble the various species of beings of which they form parts: they have not only the power of selecting food, but the various species out of the same kind of food are formed of matter and of parts which are specifically different.

A most important circumstance in the history of cellular phenomena is the duration of existence of a cell. Like the various species of animals and vegetables, each species of cell has its own average term of existence, each after its kind. This average term is nevertheless contingent on the amount of action which each species may, by peculiar circumstances in the organism to which it belongs, be called on to perform. This variableness in the average age of each species of cell, is dependent on those circumstances which have been named "nervous agency," "peculiarity of constitution," "irritability of the parts," "morbid action," but may be studied independently of these agencies. The variableness in the term of existence of cells can no more be explained at present, than the variety in the duration of the lives of species of animals and vegetables: but the fact being known, its laws ascertained will afford a clue to the explanation of many organic phenomena and processes.

In the study of absorption, nutrition, and secretion, attention has been directed to the vessels, as the active agents in the performance of these processes. It is only a short time since we have been willing to admit that the new matter which is constantly replacing the old materials of the frame, is selected and laid down, not by the ultimate vessels, but by the non-vascular portions of the textures. It is only now that we are beginning to know that secretion differs from nutrition in its anatomical relations, and not in its intimate nature. We still, however, retain in full force the old belief in the active obsorbent powers of the vessels, and in the agency of the capillary and lymphatic vessels in removing parts and modelling the forms.

It is not my intention to question entirely the active agency of the veins and lymphatics in absorption and ulceration, but merely to direct attention to the subject; and to point out, in some of the following chapters, a few organic processes in which these actions appear to be functions independent of the vessels, the latter to be passive agents, mere ducts for conveying away the products of action.

A rapidly extending ulcerated surface appears as if the textures were scooped out by a sharp instrument. The textures are separated from the external medium by a thin film. This film is cellular in its constitution, and so far it is analogous to the epidermis or epithelium. It is a peculiarly endowed cellular layer, which takes up progressively the place of the subjacent textures, these being prepared for dissolution, either by the state of the system, the condition of the part, or by some influence induced by the contiguity of the new formation. Carrying out, therefore, the principles at present regarded as regulating the reciprocal functions of textures and vessels, the subjacent textures disappear in consequence of a disturbance of their own forces, consequent upon the appearance of new forces residing in the cellular layer. The disturbance and gradual annihilation of the natural forces residing in the subjacent textures, is indicated by the gradual disappearance of these. That new forces, not formerly existing in the part, are developed, appears from the formation of the cells of the cellular layer. As these appear in rapid succession, and disappear as rapidly, the subjacent textures also disappear, either by previous solution and subsequent absorption by the properties and powers of the former; or under the peculiar circumstances of inflammatory action by the more vigorous growth of the former, monopolizing the resources of the part, the latter dissolving and disappearing by the usual channels of the returning circulation, more rapidly, but according to ordinary laws.

From this view of the process, it appears that so far from consisting in a diminution of the formative powers of the part, such a progressive ulceration is actually an increase of it. The apparent diminution, is a consequence of the extremely limited duration of existence of the cells of the absorbent layer, which die as rapidly as they are formed, disappearing after dissolution, partly as a discharge from the surface, but principally through the natural channels by which the debris of parts, which have already performed their allotted functions, are taken up into the organism.

When a portion of dead or dying bone is about to be separated from the living, the process which occurs is essentially the same as that which has now been described. The haversian canals which immediately bound the dead or dying bone, are enlarged cotemporaneously with the filling of their cavities with a cellular growth. As this proceeds, contiguous canals are thrown into one another. At last, the dead or dying bone is connected to the living by the cellular mass alone. It is now loose, and has become so in consequence of the cellular layer which surrounds it presenting a free surface and throwing off pus.

In this process, the veins and absorbents act on the osseous texture of the walls of the haversian canals in no otherwise than in the natural state of the part. They are mediate, not immediate instruments of absorption. It is the cells of the newly formed cellular mass, contained in the haversian canals, which are the immediate cause of the removal of the bone, either by taking it up as nourishment, and substituting themselves in its stead; the bone being prepared for this absorption in a manner analogous to that which occurs in the digestion of food previously to absorption of it by the cells of the gut:* or by the active formation of the cells of the new substance monopolizing the resources of the part, and so inducing the disappearance of the osseous texture by the natural channels of the returning circulation.

The process by which a slough in the soft parts is separated from the living textures, is similar to that which occurs in bone.

In this view of ulceration, there is substituted for the hypothetical active, or aggressive power of absorption ascribed to the veins and the lymphatics, a power which is known to exist in the organic cell during the progress of its growth; and the ultimate removal of the matter from the scene of action is ascribed, partly to the formation of discharge, partly to the yet unexplained, but at the same time undoubted, and in all probability passive agency of the returning circulation.

J. G.

* "Hence, the digestive process, instead of being confined to the stomach and duodenum, is actually carried on without intermission, in all parts of a living animal body."—*Prout's Bridgewater Treatise*, page 534.

No. IV.

THE PROCESS OF ULCERATION IN ARTICULAR CARTILAGES.

The question as to the vascularity of cartilages cannot now excite much interest, when we know that all the textures are in themselves destitute of blood-vessels, which are accessary parts, carriers of nourishment, not active agents in its deposition. We do not consider cartilage as a texture into which no blood-vessels pass, but only as less vascular than some of the others. In a large mass of cartilage, as in those of the bulky mammals, or in the thick cartilages of the fœtal skeleton, canals containing blood-vessels are found here and there; but in the thin articular cartilages of the adult human subject few or no vessels can be detected.

It is evident, therefore, that in the process of ulceration in cartilage, it cannot be the usual blood-vessels of the part which are the active agents.* Still less likely is it, that lymphatics, the existence of which has never been asserted in this texture, are the absorbing instruments.

If a thin section, at right angles, be made through the articular cartilage of a joint, at any part where it is covered by gelatinous membrane in scrofulous disease, or by false membrane in simple inflammatory condition of the joint, and if this section be examined, it will be found to present the following appearances.

* *See* Mr. Aston Key's Paper in the London Med. Chir. Trans., Vol. xviii., Part. I., "*On the Ulcerative Process in Joints.*"

On one edge of the section is the cartilage unaltered, with its corpuscules natural in position and size. On the opposite edge, is the gelatinous, or false membrane, both consisting essentially of nucleated particles, intermixed, especially in the latter, with fibres and blood-vessels; and, in the former, with tubercular granular matter. In the immediate vicinity, and on both sides of the irregular edge of the section of cartilage, where it is connected to the membrane, certain remarkable appearances are seen. These consist, on the side of the cartilage, of a change in the shape and size of the cartilage corpuscules. Instead of being of their usual form, they are larger, rounded, or oviform; and instead of two or three nucleated cells in their interior, contain a mass of them. At the very edge of the ulcerated cartilage, the cellular contents of the enlarged cartilage corpuscules communicate with the diseased membrane by openings more or less extended. Some of the ovoidal masses in the enlarged corpuscules may be seen half released from their cavities by the removal of the cartilage; and others of them may be observed in the substance of the false membrane, close to the cartilage, where they have been left by the entire removal of the cartilage which originally surrounded them.

If a portion of the false membrane be gradually torn off the cartilage, the latter will appear rough and honey-combed. Into each depression on its surface a nipple-like projection of the false membrane penetrates. The cavities of the enlarged corpuscules of the cartilage, open on the ulcerated surface by orifices of a size proportional to the extent of absorption of the walls of the corpuscule, and of the free surface of the cartilage.

The texture of the cartilage does not exhibit, during the progress of the ulceration, any trace of vascularity. The false membrane is vascular, and loops of capillary vessels dip into the substance of the nipple-like projections which fill the depressions on the ulcerated surface of the cartilage;* but, with the exception of the enlargement of the corpuscules, and the peculiar development of their contents, no change has occurred in it. A layer of

* The vascular loops described and figured by Mr. Liston, are not vessels in the cartilage, but the vessels described in the text.—Liston. Lond. Med. Chir. Trans.

nucleated particles always exists between the loops of capillaries and the ulcerated surface.

The cartilage, where it is not covered by the false membrane, is unchanged in structure. The membrane generally adheres with some firmness to the ulcerating surface; in other instances it is loosely applied to it; but in all, the latter is accurately moulded to the former.

In scrofulous disease of the cancellated texture of the heads of bones, or in cases where the joint only is affected, but to the extent of total destruction of the cartilage over part or the whole of its extent, the latter is, during the progress of the ulceration, attacked from its attached surface. Nipple-shaped processes of vascular cellular texture pass from the bone into the attached surface of the cartilage, the latter undergoing the change already described. The processes from the two surfaces may thus meet half way in the substance of the cartilage, or they may pass from the attached, and project through a sound portion of the surface of the cartilage, like little vascular nipples or granulations. The cartilage may thus be riddled, or it may be broken up into scales of varying size and thickness, or it may be undermined for a greater or less extent, or be thrown into the fluid of the cavity of the joint in small detached portions, or it may entirely disappear.

On the principles already laid down, if absorbents exist, as we have reason to believe they do in the false membrane, neither they nor the veins are to be considered as the active or immediate agents in the absorption of the cartilage. They certainly are not so in the absorption of the walls of the corpuscules, and this, as well as the analogy of similar processes, gives weight to the opinion to which I have come, that they are not the immediate instruments in the absorption of the free surface. The cells of new formation appear to be the immediate agents in this action. They absorb into their substance the hyaline matter of the cartilage, the latter probably not being removed at once from the spot, but merely converted into soft cellular texture; the process being one of transformation rather than removal.

J. G.

No. V.

SECRETING STRUCTURES.

Malpighi was the first to announce that all secreting glands are essentially composed of tubes, with blind extremities.* Müller, by his laborious researches, has brought this department of the anatomy of glands to its present comparatively perfect condition.† Purkinje announced his hypothesis of the secreting function of the nucleated epithelium of the gland ducts, but made no statement to show that he had verified it by observation.‡ Schwann suggested that the epithelium of the mucous membranes might be the secreting organ of these surfaces.§ Henle described minutely the epithelium cells which line the ducts of the principal glands and follicles, but did not prove that these are the secreting organs. The same anatomist has stated, that the terminal extremities of certain gland ducts are closed vesicles, within which the secretion is formed, and which contain nucleated cells. Henle has not, therefore, verified the hypothesis of Purkinje, although he is correct in stating that the terminal vesicles of certain gland ducts are closed.|| It will be shewn, that the secretion is not formed, as Henle has asserted, in the closed vesicles, but in the nucleated cells themselves.

* *Exercitationes de Structura Vicerum*, 1665.

† J. Müller, *De Gland. Struct. Penit.* 1830.

‡ Isis, 1838.

§ Froriep. Notiz., 1838.

|| Müller's "*Archiv.*" 1838, 1839.

The discrepant observation of Boehm* and Krause† on the glands of Peyer, were in some measure reconciled by Henle, who referred them to the same class of structures as the closed vesicular extremities of the ducts of compound glands. Dr. Allen Thomson has observed, that the primitive condition of the gastric and intestinal gland is a closed vesicle.‡ Wasmann described the structure of the gastric glands in the pig ; and his description will be fully explained by the following observations and views..§ Hallman has given a detailed account of the testicle of the ray, which closely resembles that of the *Squalus cornubicus*, as described in another part of this chapter.‖ None of the recent observations on the developement of the spermatozoa, have proved, that the vesicles, in which they are formed, are the epithelium cells of the ducts of the testicle. I am indebted to Dr. Allen Thomson for directing my attention to a notice in Valentin's Repertorium, 1841, of a Dissertation by Erdl,** in which he describes, in the kidney of that mollusk, cells, the nuclei of which pass out by the duct of the gland. It does not appear, however, that Erdl had discovered the uric acid within the cell.††

If the membrane, which lines the secreting portion of the internal surface of the ink-bag of *Loligo sagittata* (Lamark) be carefully freed from adhering secretion by washing, it will be found to consist almost entirely of nucleated cells, of a dark brown or black colour. These cells are spherical or ovoidal. Their nuclei consist of cells, grouped together in a mass. Between these composite nuclei, and the walls of their containing cells, is a fluid of a dark brown colour. This fluid resembles, in every respect, the secretion of the ink-bag itself.

* *De Gland. Intestin. Struct. Penit.*, 1835.

† Müller's "*Archiv.*" 1837.

‡ Proceedings of British Association, 1840.

§ *De Digestione Nonnulla*, Diss. manq. Berol, 1839.

‖ Müller's "*Archiv.*" 1840.

** *De Helicis Algiræ vasis sanguiferis*, 1840.

†† Mr. Bowman has shown that the fat in the fatty liver is contained in the secreting cells.—"*Observations on the Minute Structure of the Fatty Degeneration of the Liver.*" *Jan.* 1842.

It renders each cell prominent and turgid, and is the cause of its dark colour.

The dilated terminal extremities of the ducts in the liver of *Helix aspersa* (Müller) contain a mass of cells. If one of these cells be isolated, and examined, it presents a nucleus, consisting of one or more cells. Between the nucleus and the wall of the containing cell, is a fluid of an amber tint, and floating in this fluid are a few oil globules. This fluid differs in no respect from the bile, as found in the ducts of the gland.

If a portion of the ramified glandular organ, which opens into the fundus of the stomach of *Uraster rubens* (Agassiz) be examined, its internal surface is found to be lined with cells ; between the nucleus of each of which, and the wall of the cell itself, a dark brown fluid is situated. The organ secretes a fluid, supposed to be of the nature of bile.

The dark brown ramified cæca of the same animal exhibit on their internal surfaces an arrangement of nucleated cells, the cavities of which contain a brown fluid. These cæca are also supposed to perform, or to assist in the performance of the function of the liver.

The liver of *Modiola vulgaris* (Fleming) contains masses of spherical cells. Between the nucleus and the wall of each of these cells, a light brown fluid is situated, bearing a close resemblance to the bile in the gastro-hepatic pouches.

The nucleated cells, which are arranged around the gastro-hepatic pouches of the *Pecten opercularis*, are irregular in shape, and distended, with a fluid resembling the bile.

The hepatic organ, which is situated in the loop of intestine of *Pirena prunum* (Fleming), consists of a mass of nucleated cells. These cells are collected in groups, in the interior of larger cells or vesicles. These nucleated cells are filled with a light brown bilious fluid.

The hepatic organ, situated in the midst of the reproductive apparatus, and in the loop of the intestine of *Phallusia vulgaris* (Forbes and Goodsir), consists of a number of vesicles, and each vesicle contains a mass of nucleated cells. These cells contain a dark brown bilious fluid.

The hepatic organ, in the neighbourhood of the stomach, in each of the individuals of the compound mollusk, the *Alpidium Ficus* (Linnæus), consists of nucleated cells, which contain in their cavities a reddish brown fluid.

The liver of *Loligo sagittata* (Lamark), contains a number of nucleated cells, ovoidal and kidney shaped. These cells are distended with a brown bilious fluid.

The nucleated cells in the liver of *Aplysia punctata* (Cuvier), are full of a dark brown fluid.

The ultimate vesicular cæca of the liver of *Buccinum undatum*, contain ovoidal vesicles of various sizes. These vesicles contain more or less numerous nucleated cells. The cells are full of a dark brown fluid.

The hepatic cæca in the liver of *Patella vulgata*. Each of these vesicles encloses a body, which consists of a number of nucleated cells, full of a dark fluid resembling the bile.

The simple biliary apparatus, which surrounds the gastric portion of the intestinal tube of *Nereis*, contains nucleated cells, full of a light brown fluid.

The hepatic cæca of *Carcinus Mœnas* contains cells full of a fluid of an ochrey colour, along with numerous oil globules.

The hepatic cæca of *Carabus catenulatus* (Fabricius) contain cells attached to their internal surfaces. Between the nuclei and the cell walls, a brown liquid containing numerous granules is situated.

The kidney of *Helix aspersa* (Müller) is principally composed of numerous transparent vesicles. In the centre of each vesicle is situated a cell full of a dead white granular mass. This gland secretes pure uric acid.

The ultimate elements of the human liver are nucleated cells. Between the nucleus and the cell wall is a light brown fluid, with one or two oil globules floating in it.

The vesicular cæca, in the testicle of *Squalus cornubicus*, contain nucleated cells which ultimately exhibit in their interior bundles of spermatozoa.

The generative cæca of *Echiurus vulgaris* (Lamark) contain cells full of minute spermatozoa.

Aplysia punctata secretes from the edge and internal surface of its mantle a quantity of purple fluid. The secreting surface of the mantle consists of an arrangement of spherical nucleated cells. These cells are distended with a dark purple matter.

The edge and internal surface of the mantle of *Janthina fragilis* (Lamark), the animal which supplied the Tyrian dye, secretes a deep bluish purple fluid. The secreting surface consists of a layer of nucleated cells, distended with a dark purple matter.

If an ultimate acinus of the mammary gland of the bitch be examined during lactation, it is seen to contain a mass of nucleated cells. These cells are generally ovoidal, and rather transparent. Between the nucleus and the cell wall of each, a quantity of fluid is contained, and in this fluid float one, two, three or more oil-like globules, exactly resembling those of the milk.

In addition to the series of examples already given, I might adduce many others to prove that secretion is a function of the nucleated cell. Some secretions, indeed, are so transparent and colourless, as to render ocular proof of their original formation within cells impossible; and we are not yet in possession of chemical tests sufficiently delicate for the detection of such minute quantities. The examples I have selected, however, show that the most important and most striking secretions are formed in this manner. The proof of the universality of the fact, in reference to the glandular structures which produce colourless secretions, can only rest at present on the identity of the anatomical changes which occur in their cellular elements. This part of the proof I shall enter upon in another part of this chapter.

The secretion within a primitive cell is always situated between the nucleus and the cell wall, and would appear to be a product of the nucleus.*

* In the original Memoir the cell wall is stated to be the probable secreting structure. "Now, as we know that the nucleus is the reproductive organ of the cell, that it is from it, as from a germinal spot, that new cells are formed, I am inclined to believe that it has nothing to do with the formation of the secretion. I believe that the cell wall itself is the structure, by the organic action of which each cell becomes distended with its peculiar secretion, at the expense of the ordinary nutritive medium which surrounds it."—*Trans. Roy. Soc., Edin.* 1842.

The ultimate secreting structure, then, is the primitive cell, endowed with a peculiar organic agency, according to the secretion it is destined to produce. I shall henceforward name it the primary secreting cell. It consists, like other primitive cells, of three parts—the nucleus, the cell wall, and the cavity. The nucleus is its generative organ, and may or may not, according to circumstances, become developed into young cells. The cavity is the receptacle in which the secretion is retained till the quantity has reached its proper limit, and till the period has arrived for its discharge.

Each primary secreting cell is endowed with its own peculiar property, according to the organ in which it is situated. In the liver it secretes bile—in the mamma, milk, &c.

The primary secreting cells of some glands have merely to separate from the nutritive medium a greater or less number of matters already existing in it. Other primary secreting cells are endowed with the more exalted property of elaborating from the nutritive medium matters which do not exist in it.

The discovery of the secreting agency of the primitive cell does not remove the principal mystery in which this function has always been involved. One cell secretes bile, another milk; yet the one cell does not differ more in structure from the other than the lining membrane of the duct of one gland from the lining membrane of the duct of another. The general fact, however, that the primitive cell is the ultimate secreting structure, is of great value in physiological science, inasmuch as it connects secretion with growth, as phenomena regulated by the same laws. The force, of whatever kind it may be, which enables one primary formative cell to produce nerve and another muscle, by an arrangement within itself of the common materials of nutrition, is identical with that force which enables one primary secreting cell to distend itself with bile, and another with milk.

Instead of growth being a species of imbibing force, and secretion on the the contrary a repulsive, the one centripetal, the other centrifugal, they are both centripetal. Even in their later stages the two processes, growth and secretion, do not differ. The primary formative cell, after becoming distended with its peculiar nutritive matter, in some instances changes its form according to certain laws, and then, after a longer or shorter period, dissolves and disappears in the inter-cellular space in which it is situated, its materials passing into the circulating system, if it be an internal, and being merely thrown off if it be an external cell. The primary secreting cell, again, after distention with its secretion, does not change its form so much as certain of the formative cells, but the subsequent stages are identical with those of the latter. It bursts or dissolves, and throws out its contents either into ducts or gland cavities, both of which, as I shall afterwards show, are inter-cellular spaces, or from the free surface of the body.

The general fact of every secretion being formed within cells, explains a difficulty which has hitherto puzzled physiologists, viz., why a secretion should only be poured out on the free surface of a gland-duct or secreting membrane.

"Why," says Professor Müller, "does not the mucus collect as readily between the coats of the intestine as exude from the inner surface? Why does not the bile permeate the walls of the biliary ducts, and escape on the surface of the liver, as readily as it forces its way outwards in the course of the ducts? Why does the semen collect on the inner surface only of the tubuli seminiferi, and not on their exterior, in their interstices? The elimination of the secreted fluid on one side only of the secreting membrane, viz., on the interior of the canals, is one of the greatest enigmas in physiology." Müller proceeds to explain this enigma by certain hypotheses; but the difficulty disappears, the mystery is removed, when we know that the secretion only exists in the interior of the ripe cells of the free surface of the ducts or membrane, and is poured out or eliminated simply by the bursting and solution of these superficial cells.

I have hitherto confined my observations to the structure and function of the ultimate secreting element, the primary secreting cell. I now proceed to state the laws which I have observed to regulate the original formation, the developement, and the disappearance of the primary organ. This subject neccessarily involves the description of the various minute arrangements of glands and other secreting structures.

If the testicle of *Squalus cornubicus* (Gmelin) be examined when the animal is in a state of sexual vigour, the following arrangements of structure present themselves.

The gland consists of a number of lobes separated, and at the same time connected by a web of filamentous texture, in which ramify the principal blood-vessels.

The lobes, when freed from this tunic, present on their surface a number of vesicles. When the gland is dissected under water, and one of the lobes is raised out of its capsule, an extremely delicate duct is observed to pass from it into the substance of the capsule, to join the ducts of the other lobes.

When a section is made through one of the lobes, it becomes evident that the vesicles are situated principally on its exterior.

If a small portion be macerated in water for a few hours, and dissected with a couple of needles, there are observed attached to the delicate ducts which ramify through the lobe vesicles in all stages of developement. These stages are the following:—1*st*, A single nucleated cell attached to the side of the duct, and protruding, as it were, its outer membrane.

2*d*, A cell containing a few young cells grouped in a mass within it; the parent cell presenting itself more prominently on the side of the duct.

3*d*, A cell attached by a pedicle to the duct, the pedicle being tubular, and communicating with the duct; the cell itself being pyriform, but closed and full of nucleated cells.

4*th*, Cells larger than the last, assuming more of a globular form, still closed, full of nucleated cells, and situated more towards the surface of the lobe.

5*th*, The full-sized vesicles already described as situated at the surface of the lobe. These vesicles are spherical, perfectly closed; that part of the wall of each which is attached to the hollow pedicle forms a diaphragm across the passage, so that the vesicle has no communication with the ducts of the gland. The contents of the vesicles are in various stages of developement Those least advanced are full of simple nucleated cells; in others, the included cells contain young cells in their interior, so that they appear granular under low powers; in others, the included cells have begun at a certain part of the vesicle to elongate into cylinders, with slightly rounded extremities. In others the cylindrical elongation has taken place in all the included cells, with the exception of a few, which still retain the rounded form, at a spot opposite to that part of the vesicle in which the change commenced, and at the same time it may be observed, that the cylindrical cells have become arranged in a spiral direction within the parent vesicle. Lastly, Vesicles exist in which all the cells are cylindrical, and are arranged within its cavity in a spiral direction.

The changes which occur in the included nucleated cells of the vesicle are highly interesting. After the nucleus of each has become developed into a mass of cells, the parent cell becomes, as has been stated, cylindrical. The change in the shape of the cell is contemporaneous with the appearance of a spiral arrangement of the included mass of cells. This spiral arrangement is also contemporaneous with an elongation of each cell in the mass, in the direction of the axis of the parent cell. When the elongation has reached its maximum, the original mass of included cells has assumed the appearance of a bunch of spirals, like cork-screws arranged one with another, spiral to spiral. In particular lights the cylindrical cell presents alternate spots of light and shade, but by management of the illumination, the included spiral filaments become evident; the light and shade is seen to arise from the alternate convexities and concavities of the spiral filaments, combined in a spiral bundle.

In vesicles more advanced, the wall of the cylindrical cells have become attenuated.

In other vesicles the diaphragms across their necks have dissolved or burst, the bundles of spiral filaments float along the ducts of the gland, or separate into individual spiral filaments. These filaments are completely developed spermatozoa, pointed and filamentous at both extremities, thicker and spiral in the middle.

In the centre of the lobe where the smaller ducts meet to form the principal duct, there is a mass of grey gelatinous matter through which the ducts pass. This gelatinous matter consists of a number of cells lying between the converging ducts, and from their peculiar appearance not presenting the usual nuclei. I am inclined to believe that they are either vesicles which have never become developed on account of the pressure of the surrounding parts, or that they are old vesicles in a state of atrophy after the expulsion of their contents.

Having now described the changes which are constantly taking place in the testicle of this shark when the organ is in a state of functional activity, I must defer till a future occasion an account of similar changes which occur in the parenchyma of an order of glands, of which the one already described may be considered as a type. I may state, however, that I have ascertained the following general facts in reference to glands of this order:—

1*st*, The glandular parenchyma is in a constant state of change, passing through stages of developement, maturity, and atrophy.

2*d*, The state of change is contemporaneous with, and proportional to, the formation of the secretion, being rapid when the latter is profuse, and *vice versa*.

3*d*, There are not, as has hitherto been supposed, two vital processes going on at the same time in the gland, growth and secretion, but only one, viz., growth. The only difference between this kind of growth and that which occurs in other organs being, that a portion of the product is from the anatomical condition of the part thrown out of the system.

4*th*, The vital formative process which goes on in a gland, is regulated by the anatomical laws of other primitive cellular parts.

5*th*, An acinus is at first a single nucleated cell. From the nucleus of this cell others are produced. From these, again, others arise in the same manner. The parent cell, however, does not dissolve away, but remains as a covering to the whole mass, and is appended to the extremity of the duct. Its cavity, therefore, as a consequence of its mode of developement, has no communication with the duct.

The original parent cell now begins to dissolve away, or to burst into the duct at a period when its contents have attained their full maturity. This period varies in different glands, according to a law or laws peculiar to each of them.

6*th*, In the gland there are a number of points from which acini are developed, as from so many centres. These I name the germinal spots of the gland.

7th, The secretion of a gland is not the product of the parent cell of the acinus, but of its included mass of cells. The parent cell or vesicle may be denominated the primary cell; its included nucleated cells, after they have become primary secreting cells, may be named secondary cells of the acinus.

8th, There are three orders of secretions, 1*st*, A true secretion, that is, matter formed in the primary secreting cell cavities; or, 2*d*, A mixture of a fluid formed in these cell cavities with the developed or undeveloped nuclei of the cells themselves; and, 3*d*, It may be a number of secondary cells passing out entire.

In the liver of *Carcinus Mœnas*, and other Crustacea, it may be observed, that each of the follicles of which it consists presents the following structure. The blind extremity of the follicle is slightly pointed, and contains in its interior a mass of perfectly transparent nucleated cells. From the blind extremity downwards, these cells appear in progressive states of developement. At first they are mere primitive nucleated cells; further on they contain young cells; and beyond this they assume the characters of primary secreting cells, being distended with yellow bile, in which float oil globules, the oil in some instances occupying the whole cell. Near the attached extremity of the follicle an irregular passage exists in the midst of the cells, and allows the contents of the cells which bound it to pass on to the branches of the hepatic duct.

This arrangement of the secreting apparatus may be taken as the type of an order of glands, which consist of follicles more or less elongated. Growth in glands of this kind is regulated by the following laws:—

1*st*, Each follicle is virtually permanent, but actually in a constant state of developement and growth.

2*d*, This growth is contemporaneous with the function of the gland, that function being merely a part of the growth, and a consequence of the circumstances under which it occurs.

3*d*, Each follicle possesses a germinal spot situated at its blind extremity.

4*th*, The vital action of some follicles is continuous, the germinal spot in each, never ceasing to develope nucleated cells, which take on the action of, and become primary secreting cells, as they advance along the follicle. The action of other follicles is periodical.

5th, The wall, or germinal menbrane of the follicle, is also in a state of progressive growth, acquiring additions to its length at its blind extremity, and becoming absorbed at its attached extremity. My brother, in a paper on the Developement and Metamorphoses of *Caligus*, read in the Wernerian Society, April 1842, has stated that the wall of the elongated and convoluted follicle, which constitutes the ovary in that genus, grows from its blind to its free extremity, at the same rate as the eggs advance in developement and position. A progressive growth of this kind would account for the steady advance of its attached contents, and would also place the wall of the follicle in the same category with the primary vesicle, germinal membrane, or wall of the acinus in the vesicular glands.

6th, The primary secreting cells of the follicle are not always isolated. They are sometimes arranged in groups, and when they are so, each group is enclosed within its parent cell, the group of cells advancing in developement according to its position in the follicle, but never exceeding a particular size in each follicle.

In my original memoir, I stated my opinion, that there is an order of glands, namely, those with very much elongated ducts, which do not possess germinal spots in particular situations, but in which these spots are diffused more uniformly over the whole internal surface of the ducts. The human kidney is a gland of this order.*

We require renewed observations on the original development of glands in the embryo. From the information we possess, how-

* "I am the more inclined to believe this, from what I have observed in certain secreting membranes. Thus the membranes which secrete the purple in *Aplysia* and *Janthina* are not covered with a continuous layer of purple secreting cells, but over the whole surface, and at regular distances, there are spots, consisting of transparent, colourless nucleated cells, around which the neighbouring cells become coloured. Are these transparent cells the germinal spots of these secreting membranes? And may not the walls of the elongated tubes, and the surfaces of the laminæ within certain glands, have a similar arrangement of germinal spots?"—*Trans. Roy. Soc., Edin.* 1842.

ever, it appears that the process is identical in its nature with the growth of a gland during its state of functional activity.

The blastema, which announces the approaching formation of a gland in the embryo, in some instances precedes, and is in other instances contemporaneous with, the conical blind protrusion of the membrane upon the surface of which the future gland is to pour its secretion.

In certain instances it has been observed that the smaller branches of the duct are not formed by continued protrusion of the original blind sac, but are hollowed out independently in the substance of the blastema, and subsequently communicate with the ducts.

It appears to be highly probable, therefore, that a gland is originally a mass of nucleated cells, the progeny of one or more parent cells; that the membrane in connexion with the embryo gland may or may not, according to the case, send a portion of the membrane, in the form of a hollow cone, into the mass; but whether this happens or not, the extremities of the ducts are formed as closed vesicles, and then nucleated cells are formed within them, and are the parents of the epithelium cells of the perfect organ.

Dr. Allen Thomson has ascertained that the follicles of the stomach and large intestine are originally closed vesicles. This would appear to shew that a nucleated cell is the original form of a follicle, and the source of the germinal spot which plays so important a part in its future actions.

The ducts of glands are therefore inter-cellular passages. This is an important consideration, inasmuch as it ranges them in the same category with the inter-cellular passages and secreting receptacles of vegetables.*

Since the publication of my paper on the secreting structures, in the Transactions of the Royal Society of Edinburgh in 1842, I have satisfied myself that I was in error, in attributing to the cell wall the important function of separating and preparing the secretion contained in the cell cavity. The nucleus is the part

* Henle, in his General Anatomy, has made a similar statement.

which effects this. The secretion contained in the cavity of the cell appears to be the product of the solution of successive developements of the nucleus, which in some instances contains in its component vesicles the peculiar secretion, as in the bile cells of certain mollusca, and in others becomes developed into the secretion itself, as in seminal cells. In every instance, the nucleus is directed towards the source of nutritive matter, the cell wall is opposed to the cavity into which the secretion is cast. This accords with that most important observation of Dr. Martin Barry, on the function of the nucleus in cellular developement.

I have also had an opportunity of verifying, and to an extent which I did not at the time fully anticipate, the remarkable vital properties of the third order of secretions, referred to in the memoir to which I have just alluded. The distinctive character of secretions of the third order is, that when thrown into the cavity of the gland, they consist of entire cells, instead of being the result of the partial or entire dissolution of the secreting cells. It is the most remarkable peculiarity of this order of secretions that, after the secreting cells have been separated from the gland, and cast into the duct or cavity, and therefore no longer a component part of the organism, they retain so much individuality of life, as to proceed in their developement to a greater or less extent in their course along the canal or duct, before they arrive at their full extent of elimination.

The most remarkable instance of this peculiarity of secretions of this order, is that discovered by my brother, and recorded by him in a succeeding chapter.* He has observed that the seminal secretion of the decapodous crustaceans undergoes successive developements in its progress down the duct of the testis, but that it only becomes developed into spermatozoa after coitus, and in the spermatheca of the female. He has also ascertained, that apparently for the nourishment of the component cells of a secretion of this kind, a quantity of albuminous matter floats among them, by absorbing which they derive materials for developement after separation from the walls of the gland.

This albuminous matter he compares to the substance which,

* *See* Page 39.

according to Dr. Martin Barry's researches, results from the solution of certain cells of a brood, and affords nourishment to their survivors. It is one of other instances in which cells do not derive their nourishment from the blood, but from parts in their neighbourhood which have undergone solution; and it involves a principle which serves to explain many processes in health and disease, some of which have been referred to in other parts of this work.

I conclude, therefore, from the observations which I have made—1*st*, That all the true secretions are formed or selected by a vital action of the nucleated cell, and that they are first contained in the cavity of that cell; 2*d*, That growth and secretion are identical—the same vital process, under different circumstances.*

J. G.

* In Mr. Bowman's elaborate Paper "*On the Structure and Use of the Malphigian Bodies of the Kidney*," read in the Royal Society of London, 17th Feb. 1842, and in his Article "*Mucous Membrane*," in the Cyclopedia of Anatomy, written in Dec. 1841, certain parts of the theory of secretion are well elucidated by a reference to human structure. In my own Memoir, read in the Royal Society of Edinburgh, 30th March, 1842, I endeavoured, by an appeal to facts in comparative anatomy, to establish secretion as a function of the nucleated cell, and to shew that glandular phenomena are only the changes which the cellular elements of these organs undergo. Mr. Bowman's own observation on the secretion of fat by the cells of the human liver in a state of disease, was an important and positive result; and Professor John Reid, with whom I had frequent conversations on the subject of secretion, and to whom I had communicated my views on the subject, a year before the pnblication of my Paper, was in the habit of supporting Purkinje and Schwann's hypothesis, by an appeal to the structure of *Molluscum contagiosum*, as described by Professor Henderson and Dr. Paterson in the Edinburgh Medical and Surgical Journal, 1841.

No. VI.

THE TESTIS AND ITS SECRETION IN THE DECAPODOUS CRUSTACEANS.

The organs of generation in the male crustacean consist of testes, vasa deferentia, and external or intromittent organs.

In no class of animals do these parts vary so much as in that now under consideration. In every family, and almost in every genus, they afford generic, and in some even specific characters. This variableness of configuration and structure is not peculiar to the organs of reproduction, but exists also in the other systems —the vascular and respiratory, the nervous and locomotive. Such a variableness is to be looked for in a class, the forms in which pass from that of the annelids, through the articulata, to the mollusk. Throughout all this range of form the organs and functions vary in accordance with those in the group of animals to which the crustaceans presenting them are analogous.

In all the higher, or brachyurous crustaceans, the internal organs of generation are comparatively most highly developed. These organs exhibit the greatest complexity of form and structure among the *Triangulares*, but in the next order, the *Cyclometopa*, they are of great size. These crustaceans are accordingly the most prolific, and in greatest demand as articles of diet. The *Catometopa*, or rather the higher forms of that family, have these organs also very large; this family containing the land-crabs of tropical climates, which are used as food.

As we descend towards the *Anomoura* the internal organs of generation are found to give way gradually to others, which have apparently a more important part to play in the economy, and in the lowest forms of the *Oxystoma* they are in a minimum state of developement.

In this division (*Brachyura*) they occupy both sides of the shell, lying upon the liver, and sometimes entering the folds of that organ, and separated with difficulty from it. In others, as *Cancer* and *Carcinus*, when in an active state, they completely cover and conceal the liver.

In *Leptopodium* and *Hyas* the testis is a body of considerable size, lying upon the upper surface of the liver, and consisting of irregular masses, formed by the twistings of its constituent duct. It is covered by a delicate membrane, which is much stronger on the body of the testis than elsewhere, and is analogous to the tunica albuginea in the higher animals. The gland extending forward, gradually enlarges, and when it has arrived in a line with the stomach, curves slightly inwards to the mesial plane, and terminates in a large tube on each side, which is its duct much dilated. This large tube, making a number of convolutions, proceeds inwards and downwards until it meets and forms a junction with that of the opposite side. The anastomosis is incomplete in this division of the class. After running in contact for some distance the two ducts again separate, and each becoming much smaller, terminates by opening at the base of the external organs.

In the *Anomoura*, instead of being situated in the thorax, as in the *Brachyura*, the testes are contained in the abdominal segment of the body, lying on and above the liver. They are very small in all the animals of this section, the tubuli semeniferi being large, and after making a few convulutions, ending in the vas deferens, which opens on the base of the 5th pair of legs, without the intervention of an intromittent organ. The elongated acini are confined to the lower part, and are contained within the external tunic of the gland.

In the *Macroura* the testes commence on each side of the stomach, and extend down to the middle parts of the abdomen. In almost all the species of the section, these organs are narrow ribbon-shaped organs, connected with one another immediately behind the stomach by a narrow commissure; the vasa deferentia come off behind this commissure, and are more distinct than in any other of the sections. In *Galathea* these organs are more complicated, the tube being more convoluted.

The ultimate structure of the testis consists of a germinal membrane, covered externally by the common tunic of the organ, or by processes from it. The germinal membrane in the upper or first part of its course, developes from germinal spots in its substance formative cells of a spherical shape and of small size, which will be afterwards described. In the lower part of the tube, the formative cells assume a peculiar linear or spindle-shape, attached by one of their extremities to the germinal membrane, and projecting either into the cavity of the gland duct, as in *Pagurus*, or from its external surface as in *Galathea*, and therefore in this case covered by the common enveloping tunic of the gland, or by processes of it which correspond to the areolar vascular matrix of the glands in the higher animals.

When the animal is getting into season, numerous small cells are found, as just described, on the internal surface of the seminal tube, and more particularly from that portion of the gland which lies on the surface of the liver. As the animal becomes stronger, these cells increase in size from the formation of young in their interior. That these young or secondary cells are produced from the germinal spots on the germinal membrane of the seminal tube, from which the primary cells took its origin, appeared highly probable among other circumstances, from this, that after the latter had burst, its cell wall was smooth and regular, not broken up or rough, as might have been expected, had the secondary cells been formed from it. After these primary cells have burst, the secondary cells contained in them pass down the seminal tube, to undergo the changes to be afterwards described.

The spindle-shaped cells in the lower part of the seminal tube are large primary cells, two or three generally arising from a disk or spot in the germinal membrane. They correspond in every respect, except in shape and size, to the spherical primary cells further up the tube, and like them form in their interior young or secondary cells. These secondary cells originate in a germinal spot or nucleus, situated about a third from the attached extremity of the cell. In such of the spindle-shaped cells as are quite full of secondary cells, this nucleus cannot be seen, so that it probably disappears after the primary cells have become fully developed, that is, have become full of young. In such of these elongated cells, again, as are not quite developed, with cavities not entirely occupied by their progeny, the nucleus may be occasionally seen in various stages of developement, with a brood of young cells surrounding it, and enclosed in a membrane carried off by them from the nucleus. (*Pagurus.*)

These spindle-shaped primary cells of the lower part of the seminal duct differ from the spherical primary cells of the upper part of the same tube, principally in this, that whereas the latter contain only a limited number of secondary cells, formed probably by a single act of nuclear developement, the former are filled by successive broods from the nucleus.

In *Hyas*, when these spindle-shaped cells project from the external surface of the seminal duct, instead of into its cavity, the secondary cells pass off by a narrow valvular orifice in its attached extremity, and replaced by others from the nucleus. The cell in this case has become a secreting follicle, with an active germinal spot.

The passage downwards of the secondary cells, both of the superior spherical, and the lower spindle-shaped primary cells, is retarded in the neighbourhood of the latter by long slips or bands, which run up the cavity of the duct and terminate by free edges; the direction of these bands being opposed to the flow of the seminal fluid downwards.

These peculiar spindle-shaped cells or acini, although present in all the orders, are most apparent in the *Anomoura* and cuirassed *Macroura*. In the *Triangulares* and succeeding families of *Brachyura*, also in lower families of *Macroura*, from the *Cryptobranchiate* genera and downwards, they are by no means so elongated, resembling rather widened and contracted portions of the seminal duct. The arrangement is similar in the lower orders—as in *Stomapoda*, *Amphipoda*, and *Isopoda* — the *Læmodipoda* being apparently exceptions to the rule. Neither is this structure found in *Branchiopoda*, *Entomostraca*, *Siphonostoma*, and *Xip-*

hosura, in which orders the structure of the testis would require for elucidation a separate inquiry.

The secondary cells, as has already been stated, continue to be developed in their progress along the seminal tube. At the spot where they are retarded by the folds at the necks of the spindle-shaped cells, they increase much in size, from the increased number and size of their contained cells. After this no great change takes place, with the exception of a thinning of the walls. In this state they pass along the narrow part of the duct, or vas deferens, and are thrown during coitus into the spermatheca of the female, there to undergo the essential change which is to fit them for fertilization of the ova.

That this final change can only take place in the spermatheca of the female does not appear to be the case, for precocious secondary cells may occasionally be found bursting in the lower part of the seminal tube, and even as high up as the spindle-shaped cells. The greater number, indeed, with a few exceptions the whole of them, are introduced into the female before bursting.

After lying in the spermatheca for some time, the wall of the secondary cell becomes so thin that it bursts, and allows the young cells to escape. These tertiary cells contain, and are the formative cells of the spermatozoa. In the higher crustacea, *Brachyura*, they each contain one or more spermatozoa, in the *Macroura* one only. The spermatozoal cells are nucleated when they first burst from the secondary cells, and shortly the head of the spermatozoa is found to correspond to the nucleus.

The seminal fluid in all the species of *Macroura* is very peculiar, the tertiary cells being in all cases armed with three long slender setæ.* They are oblong, and dilated at the armed extremity. They are developed singly within their parent cells; sometimes, however, two may be observed in one cell. These parent or secondary cells are oblong, and bulge slightly in the middle. After they have remained for some time in the spindle-shaped cæca (*Galathea*), the three setæ of the tertiary cell expand, and the cells begin their descent. In the progress downwards, the unarmed extremity acquires a small nucleated spot,

* Von Siebold in Müller's "*Archiv.*," 1836.

and in many instances small spherical cells are thrown off from this, which are quaternary, and probably spermatozoal cells. In the cuirassed and digging *Macroura* these tertiary cells are all armed with three setæ, many times longer than the body of the cell. In the prawn these setæ are short and truncated.

Throughout the whole course of the lower part of the seminal tube there may be observed during the active state of the gland, and while the seminal cells are being produced, a large quantity of albuminous matter in small irregular masses floating among the cells in an aqueous fluid. I am induced to believe that the cells derive their nourishment from this matter.

In the upper part of the tube, where the cells are small and comparatively few in number, this matter is in small quantity; but in the lower part of the tube, where the cells are more numerous, more developed, and in a more active condition, it exists in the greatest abundance. Still lower down in the vas deferens, where the cells are in a state of satiety, and are in fact absorbing principally their own external wall, preparatory to bursting, it again diminishes in quantity, and disappears.

This albuminous matter would appear to result from the debris of dissolved cells. It is more abundant in the *Brachyura* than in the other forms of crustacea, in accordance with the greater abundance of seminal cells.*

H. D. S. G.

* An abstract of more extended observations on the subject of this chapter was published in the Ed. Phil. Journal, Oct. 1843.

No. VII.

THE STRUCTURE OF THE SEROUS MEMBRANES.

A portion of the human pleura or peritoneum will be found to consist, from its free surface inwards, of a layer of nucleated scales, of a germinal membrane,* and of the sub-serous areolar texture intermixed with occasional elastic fibres. The blood-vessels of the serous membrane ramify in the areolar texture.

There is one stratum only of the nucleated scales in the superficial layer of the serous membrane. This layer conceals the germinal membrane, which can only be detected after the removal of the scales.

The germinal membrane does not in general shew the lines of junction of its component flattened cells. These appear to be elongated in the form of ribbons, their nuclei, or the germinal spots of the membrane being elongated, expanded at one extremity, pointed at the other, and somewhat bent upon themselves. The direction of these flattened cells and nuclei is the same in any one part of the membrane, this direction being in general parallel to the subjacent blood-vessels, in the neighbourhood of which they exist in greatest numbers. The germinal spots are bright and crystalline, and may, or may not, according to their condition, contain smaller cells in their interior. They

* I stated this fact in my Paper on the Intestinal Villi, in the Ed. Phil. Journal, July 1822. Dr. Todd and Mr. Bowman, in their "Physiology of Man," have described the same membrane in the serous texture.

are not to be confounded with the fibres of the areolar texture, or with elastic filaments, or with the nuclei of the capillary vessels of the sub-serous texture, or with paler, ovoidal, somewhat indistinct cells, scattered throughout that texture, and which appear to be connected with the common areolar fibres.

These flattened ribbon-shaped scales, and bright crystalline nuclei, which from the germinal or basement membrane of the serous coat appear to be identical with the objects described by Valentin,* Pappenheim,† and Henle,‡ and named by the latter nucleated fibres.

In inflamed or aged serous membranes, I have found it impossible to detect this membrane, or even the super-imposed scales. The germinal membrane in such instances appears to break up into areolar texture, and to assimilate itself to the bursæ mucosæ, or the ordinary enlarged areolæ of the areolar texture.

If these germinal centres be the sources of all the scales of the superficial layer, each centre being the source of the scales of its own compartment, then the matter necessary for the formation of these during their developement must pass from the capillary vessels to each of the centres, acted on by forces whose centres of action are the germinal spots; each of the scales, after being detached from its parent centre, deriving its nourishment by its own inherent powers.

I have been in the habit of considering the highly vascular fringes and processes of the synovial membranes as more active in the formation of epithelium, and therefore more closely allied to the secreting organs than other portions of these membranes. If this be the case, Clopton Havers§ was not mistaken in his ideas regarding the functions of these vascular fringes. They are situated where they cannot interfere with the motions of the joint. They hang into those parts of the cavity best fitted for containing and acting as reservoirs of synovia; and their high

* Valentin. "*Repertorium*," 1838.

† Pappenheim. "*Zur Kentniss der Verdauung*," 1839.

‡ Henle. "*Anatomie Allgemeine.*"

§ Clopton Havers. "*Osteologia Nova*," 1691.

vascularity, and the pulpy nature of their serous covering, tend to strengthen this opinion.

The phenomena attending inflammatory action of the membranes are highly interesting. The capillaries are all on one side of the membrane, and yet the serum and lymph are on the other. The capillary vessels in healthy action have no power in themselves of throwing out any of their contents. They do not secrete in virtue of any power inherent in themselves. Do they acquire this power during inflammation? Or will any of the hypotheses of effusion account for the lymph and serum being on the free surface of the serous membranes, and so little, if any, in the subserous textures?

I do not see how we can, in the present state of the science, account for phenomena of this kind, by referring them to actions of the extreme vessels. We must look for an explanation, I am inclined to believe, in a disturbance of the forces which naturally exist in the extra-vascular portions of the inflamed part.*

J. G.

* "The primary change," in inflammation, "is in the *vital affinities*, common to the solids and fluids, and acting chiefly in that part of the system where the solids and fluids are most intimately mixed, and are continually interchanging particles."—*Alison's Outlines of Physiology and Pathology*, page 437.

No. VIII.

STRUCTURE OF THE LYMPHATIC GLANDS.

It is now generally admitted, that the afferent communicate in the interior of the lymphatic glands with the efferent vessels. These glands, indeed, consist of a dense network of lymphatics, in the meshes of which, the arteries, veins, and nerves, ramify. Much difference of opinion still exists, however, as to the nature of the communication between the afferent and efferent vessels, and no definite idea is entertained regarding the parenchyma of these organs.

We know that an efferent lymphatic, before it enters a gland, consists of an external tunic of filamentous texture, a middle tunic of fibrous texture, and an internal layer of epithelium.

Immediately after the branches, into which the afferent vessel divides, have penetrated the capsule of the gland, they lose their external tunic. For a short distance, indeed, until they have begun to anastomose with one another, a very thin external tunic, accompanied by a little fat, is still observable. This fat is continuous with the layer of adipose texture, which generally exists immediately under the capsule of the gland, and through which the lymphatics must pass to and from the organ.

The branches of the extra-glandular lymphatics, then, which pass to and from the glands, possess a very thin internal tunic; but the network of intra-glandular lymphatics which enter into the structure of the gland itself, present no external coat. The external tunic of the extra-glandular lymphatics—the afferent and efferent vessels—appears to leave them almost entirely at their entrance and exit from the organ, and by passing on to the surface of the gland form its capsule.

This capsule is moderately strong, somewhat smooth on its free, more filamentous on its attached surface, sending inwards from the latter the processes already described, which not only support the larger branches of the vessels before they anastomose, but also bind together and strengthen the substance of the organ. The larger trunks of the arteries and veins, as they pass through the capsule, and plunge into the substance of the gland, carry along with them also a certain quantity of filamentous texture, which is derived from the internal surface of the capsule, and is continuous with the processes which surround the larger lymphatic branches.

The middle, or fibrous tunic of the extra-glandular lymphatics, also begins to disappear after these vessels have penetrated the capsule of the gland. It is still sufficiently apparent on the lymphatics near the surface of the organ, but is met with sparingly towards the centre. Different glands, however, differ in this respect; the human intra-glandular lymphatics appearing to me to retain more of their fibrous tunic, than those in the more granular and developed mesenteric glands of the dog and seal.

It is, however, to the changes which the internal tunic of the intra-glandular lymphatics undergoes, that I shall now more particularly direct attention, as these have hitherto escaped observation, and as upon them depend those appearances and peculiarities which are yet unexplained.

I shall first describe the internal tunic, and afterwards its arrangement.

If this tunic be traced from the afferent lymphatics, in which it presents the usual structure, into the branches immediately after they have penetrated the capsule of the gland, it is found to become thicker and more opaque. In the short dilated anastomosing branches which form the intra-glandular network, this tunic has become so thick and opaque, that the vessels will no longer transmit the light, and appear as if they were stuffed full of a granular matter. When these thickened and dilated vessels are cut, torn, or broken, so as to display their structure, it may be observed that two parts enter into their composition ; an extremely fine external membrane, and a thick granular substance, which lines the membrane.

The external membrane is extremely thin and transparent. In its substance there are arranged, at regular distances, ovoidal bodies, so placed that their long diameters are all in the same direction. The distance of these bodies from one another is somewhat greater than their long diameters. They are embedded in the substance, and form a part of the membrane. They are hollow, and contain one or more rounded vesicles grouped together in their interior. I have seen portions of this membrane after it has been acted upon by acetic acid, present an appearance of being broken up into flat semi-transparent scales, united by their edges, each scale consisting of one of the nucleated ovoidal bodies, and a portion of the surrounding membrane.

The thick granular substance which is attached to the internal surface of the membrane just described, is composed entirely of nucleated particles, closely packed together, and cohering to one another. The thickness of this layer of granular substance is so considerable as to render the vessel, of which it is a part, almost opaque, encroaching on its cavity, and leaving a comparatively narrow canal for the passage of the lymph and chyle. This canal appears to be somewhat irregular, in consequence of the greater exuberance of the granular substance in some spots, and its deficiency in others. This circumstance also accounts for the greater transparency of the vessels at certain parts of their extent. The canal is not lined by a membrane, but appears to me to be irregularly pierced through the granular substance, the projections and hollows of which, as well as the superficial layer of its nucleated particles, being freely bathed by the lymph and chyle.

The nucleated particles are on an average about the 5000 of an inch in diameter. They are spherical, and contain a nucleus, which consists of one or more particles. Their walls are very distinct, especially after being treated with acetic acid, which reduces their size somewhat, without dissolving or breaking them up.

The layer of particles which has now been described is thickest in the lymphatics towards the centre of the gland. If it be examined in either direction towards the afferent or efferent branches, it will be found to become thinner, and, at last, to be continuous with the layer of flat epithelium scales of the extra-glandular lymphatics.

The anatomical relations of the membrane, and its layer of nucleated particles, are identical with those which characterize the primary cells or membrane, and the secondary or secreting cells of certain glands. The oval vesicles in the substance of the membrane are germinal spots or centres of nutrition, and the membrane is a germinal membrane. I am inclined to believe the spots on the membrane to be the sources from which the germs of the nucleated particles of the thick layer are derived. These spots are doubtless in a state of constant activity in all lymphatic glands, but must be called into much more vigorous action periodically in the mesenteric glands, during the passage of the chyle. If this be the case, these spots must exert a force by which matter is abstracted from the blood which circulates in the neighbouring capillaries, for the purpose of developing a steady succession of nucleated particles.

The arrangement in the substance of the lymphatic glands of this highly developed portion of the lymphatic system of vessels, or, in other words, the mode in which the afferent communicate with the efferent lymphatics, I have found to coincide with the account usually given of it. The terminal branches of the afferent form a more or less dense network with the radicals of the efferent lymphatics. The question which has been so often agitated, as to whether cavities exist, intermediate between the two sets of lymphatics, is not one of much importance. Some lymphatic glands, as has frequently been stated, exhibit, after injection with mercury, nothing but a mass of lymphatic vessels; others, again, a mass of apparently intermediate cells, and Cruikshank correctly remarks, that occasionally, when the mercury first passes through a gland, cells only may appear, but after the injection has been pushed a little further, vessels full of mercury may suddenly present themselves.*

* Cruikshank. "*The Anatomy of the Absorbing Vessels of the Human Body*," page 82.

These various appearances may be explained by the following facts. In some lymphatic glands the meshes are elongated, in which case no force short of what is sufficient to burst the vessels can obliterate the vascular appearance. The intra-glandular lymphatics, like those in other parts, are liable to be over-distended with injections, or by their own contents, so that short vessels or rounded meshes, more especially after great distention, assume the appearance of globular cavities.

There is another apparently cellular appearance, which is not met with in the human lymphatic glands, but in some of the lower mammals, which is produced by another cause, the partial or entire obliteration of some of the meshes, so as to produce cavities more or less extended, with bars or threads passing from wall to wall, the lymphatics opening into them. This is the conversion of a network of lymphatics into cavities and connecting threads, by a process of absorption similar to that which I have to describe as occurring in the placental decidua.*

The external surfaces of the intra-glandular lymphatics are closely applied to one another. They are strengthened here and there by fibrous bundles, the remains of the middle tunic. These fibres are most distinct towards the surface of the glands, and at the angles formed by the junction of one lymphatic with another; and when viewed in thin sections, seem to form arches inclosing circular or oval spaces, like the fibrous matrix of the human kidney.

The description usually given of the arrangement of the blood-vessels in the lymphatic glands is sufficiently correct. The ultimate capillaries, as I have observed, do not ramify in the substance of the germinal membrane of the intra-glandular lymphatics but are merely in contact with its external surface. In this respect they resemble the ultimate ducts of the true secreting glands.

The capillary network which surrounds the intra-glandular lymphatics is as fine as that which supplies the ultimate secreting ducts, and for the same purpose in both, to afford matter for the continued formation of secreting epithelium on the internal susface of the germinal membrane.

* *See* Page 61.

The structure I have described affords, in my opinion, satisfactory evidence—

1. That the lymphatic glands are merely networks of lymphatic vessels, deprived of all their tunics but the internal, the epithelium of which is highly developed for the performance of particular functions.

2. That these peculiar lymphatics are supplied with a fine capillary network, to supply matter for the continual renovation of the epithelium.

J. G.

No. IX.

THE STRUCTURE OF THE HUMAN PLACENTA.

I.—OF THE STRUCTURE OF THE TUFTS AND VILLI OF THE PLACENTA.

1.—*Of the Configuration of the Tufts.*

A placental tuft resembles a tree. It consists of a trunk, of primary branches, and of secondary branches or terminal villi, which are attached as solitary villi to the sides of the primary branches, and to the extremities of the latter, in which case they generally present a digitated arrangement. The villus, when solitary, is cylindrical, or slightly flattened, or somewhat club-shaped; when digitated, each division may be much flattened, or is then generally heart-shaped. The digitated villi are only solitary villi grouped together at the extremity of a primary branch.

2.—*Of the External Membrane of the Tufts.*

The trunk, the primary branches, and the terminal villi of the tuft are covered by a very fine transparent membrane, apparently devoid of any structure. This membrane may be described as bounding the whole tuft, passing from the trunk to the branches, and from these to the villi, the free extremities of which it closely covers. Its free surface is smooth and glistening,—its attached surface is somewhat rough.*

3. *Of the External Cells of the Villi.*

Immediately under the membrane just described is a layer of cells.† They are flattened spheroids, slightly quadrilateral in outline, from the manner in which they are packed together. When a tuft is viewed in profile, under compression, its edges exhibit the appearance of a double line, which leads the observer to suppose that its bounding membrane is double, with the cells just described situated between the two laminæ. In the space between the two lines, the nuclei of the cells may be seen in the form of dark oval spots, and the septa formed by the walls of contiguous cells are also visible.

At variable distances the space between the two lines widens out into a triangular form, the base towards the external membrane, the apex towards the centre of the villus. This wider space is produced by a larger group of cells, which appear to be passing off from a spot in the centre of the mass. The groups of cells I am now describing are germinal spots. They are the centres from which new cells are constantly passing off, to supply the loss of those which have disappeared in the performance of their important function.

As in the case of the intestinal epithelium, I am inclined to believe that a fine membrane lines the internal aspect of the layer of cells. I have not been able to isolate it; but the very sharp outline in a profile view of a villus confirms me in my belief of the existence of such a membrane.

* Professor Reid, "*On the Anatomical Relations of the Blood-Vessels of the Mother to those of the Fœtus in the Human Species.*" Ed. Med. Surg. Journal, 1841, page 7.

† Mr. Dalrymple, "*On the Structure of the Placenta.*" Med. Chir. Trans. London, Vol. xxv., pages 23, 24.

4. *Of the Internal Membrane of the Villus.*

When a villus, under gentle compression, is viewed by transmitted light, there is perceived under the structures already described, and immediately bounding the blood-vessels, and other parts to be afterwards examined, a membrane finer and more transparent than the external membrane, but strong and firm in its texture. This membrane is most distinctly seen when it passes from one loop or coil of the blood-vessel of the villus on to another. It separates very easily from the internal surface of the layer of external cells. I am not disposed to believe that it is attached to this layer, but am of opinion that the spaces which frequently exist between them, even in villi which have undergone no violence, are due to the presence of a fluid matter, the nature of which will be afterwards considered. Be this as it may, pressure very easily separates this membrane from the external cells, the latter invariably remaining attached to the external membrane, the former continuing in every instance closely rolled round the internal structures of the villus, and following them in all their changes of position.

5. *Of the Blood-vessels of the Tufts.*

Within the internal membrane, and imbedded in structures to be afterwards described, are situated the blood-vessels of the tuft. These vessels are branches of the umbilical arteries and veins.

In the trunk of the tuft, the artery gradually diminishes and the vein increases in size. In some of the primary branches the same rotation holds. In others of the primary branches, and in all the villi, the vessel retains the same mean diameter throughout. This species of blood-vessel, although it cannot be considered as either artery or vein, cannot nevertheless be denominated in precise anatomical language, a capillary. It differs from artery and vein in retaining throughout the same mean diameter; and from the capillary, properly so called, in its greater calibre, containing four or six blood disks abreast. It is also peculiar in exhibiting sudden constrictions and dilatations, like an intestine.

These changes in form are most remarkable at the spots where the vessel makes sudden turns, coils, or convolutions. Like a capillary, however, this vessel may divide and again become single, and may send off a division to a vessel of the same kind. All such divisions and anastomosing vessels, however, preserve the same mean diameter, and are in this respect distinguishable from arterial and veinous branches.

As regards the general arrangement of the vessels, it may be observed, that—

1. One vessel may enter a villus, and returning on itself, leave it again.

2. Two vessels may enter a villus, may anastomose, and leave it in one or two divisions.

3. One, or more may enter, may each separate into two or more divisions, which may reunite and leave the villus as they entered.

Many other modifications occur, but the general rule is, that one vessel enters, and leaves the villus without dividing.

As regards the particular arrangements of the vessels within the villus, we recognize those leading varieties: —

1. The simple loop, a vessel turning closely on itself.

2. The open loop, a vessel turning on itself, but leaving a space within the loop.

3. The wavy loop, resembling the first, except that the vessel is wavy instead of being direct.

4. The wavy open loops.

5. The contorted loop, the contortion being generally at the extremity or sling of the loop; the limbs of the loop being straight or wavy as the case may be.

6. The various modifications which arise from combinations of the five foregoing forms, in single, double, triple, or quadruple or anastomosing loops. The most common forms are the simple and contorted loop. The simple loop, and the wavy loop, are found in cylindrical villi. The open loop, and the wavy open loop, occur in the flattened and heart-shaped villi. The contorted

and other varieties of loops exist in the club-shaped and tuberose villi.*

Lastly, It must be stated as a fact first recorded and represented by Professor Weber, confirmed by the observations of Mr. John Dalrymple, and to the accuracy of which I can testify, that the same peculiar vessel, or umbilical capillary, may enter and retire from two or more villi before it becomes continuous with a vein.

6.—*Of the internal Cells of the Villus.*

Within the internal membrane, and on the external surface of the umbilical capillaries, are cells which I have named the internal cells of the tuft. When the vessels are engorged, these cells are seen with difficulty. When the vessels are moderately distended, and the internal membrane separated from the external cells by moderate pressure, the cells now under consideration come into view. They are best seen in the spaces left between the internal membrane and the retiring angles formed by the coils and loops of the vessels, and in the vacant spaces formed by these loops. These cells are egg-shaped, highly transparent, and are defined by the instrument with difficulty; but their nuclei are easily perceived. They appear to be filled with a transparent highly refractive matter. This system of cells fills the whole space which intervenes between the internal membrane of the villus and the vessels, and gives to this part of the organ a mottled appearance.

* Mr. Dalrymple, in his Paper on the Placenta, in the Med. Chir. Trans., has described with great accuracy the manner in which the fœtal vessels ramify and coil in the tufts of the placenta. I am indebted to Mr. Dalrymple for specimens of his injections of the placenta; and to Dr. John Reid, for a portion of a placenta injected by Professor Weber of Leipsic, and have satisfied myself of the accuracy of the descriptions given by these anatomists. My own observations have been made on the unprepared placenta. The drawings of the fœtal vessels in Dr. Reid's Paper are plans, as the only point he was anxious to establish was, that the villi terminated in blunt extremities unconnected by cellular or other textures, the fœtal vessels returning upon themselves.—Reid, in Edinburgh Medical and Surgical Journal.

II.—OF THE VILLI OF THE CHORION.

Without entering at present into the question as to the manner in which the villi of the chorion take their origin, I may state, that as soon as they are distinctly formed, they present a structure which has to a certain extent been represented and described by Raspail,* Seiler,† and others.

The substance of the tufts consists of nucleated cells. These cells are of different sizes. The smaller are situated, some in the interior, others in the spaces between the latter. The cavities of the larger cells are full of a granular fluid. The surface of the tufts is bounded by a fine, but very distinct membrane, which, when minutely examined, is seen to consist of flattened cells united by their edges.

The free extremity of each villus of the tuft is bulbous. The cells which constitute this swelling are arranged round a central spot. They are transparent and refractive, apparently from not containing the same granular matter as the cells of the rest of the villus and tuft. However short a villus may be, it invariably presents a bulbous extremity, with the peculiar cellular arrangement already described. Here and there, on the sides of the stems of the tufts, swellings of a similar structure may be seen. Each of these swellings is the commencement of a new villus or stem, which, as it elongates, carries forward on its extremity the swelling from which it arose.

These groups of cells in the bulbous extremities of the villi of the chorion, and in the swellings on the sides of their stems, are the germinal spots of the villi. They are the active agents in the formation of these parts. The villus elongates by the addition of cells to its extremity, the cells passing off from the germinal spot, and the spot receding on the extremity of the villus, as the latter elongates by the additions which it receives from it.

The bulbous extremities of the villi of the chorion, are not only the formative agents of these parts, but are also all along,

* Raspail. "*Chemie Organique.*"

† Seiler. "*Gebärmutter und das Ei des Menschen in den ersten Schwangerschaftsmonaten.*"

but principally after the villi have become well developed, their functional agents also. They are to the ovum what the spongeoles are to the plant—they supply it with nourishment from the soil in which it is planted.

Up to a certain period of gestation, the chorion and its villi contain no blood-vessels. Blood-vessels first appear in these parts when the allantois reaches and applies itself to a certain portion of the internal surface of the chorion. The umbilical vessels then communicate with the substance of the villi, and become continuous with loops in their interior. Those villi in which the blood-vessels do not undergo any further developement, as the ovum increases in size, become more widely separated, and lose their importance in the economy. The villi, again, in which vessels form, in connection with the umbilical vessels, increase in number, and undergo certain changes in the arrangement of their constituent elements, so as to become the internal structures of the tufts of the placenta, as described in the first part of this Memoir. The villi of the chorion always retain their cellular structure. As the blood-vessels increase in size the cells diminish in number; but are always found surrounding the terminal loop of vessels in the situation of the germinal spot. The fine membrane, which was formerly described as bounding the villus of the chorion, always remains at the free extremities of the villi of the placenta; but on the stems and branches of the latter it coalesces with the contained cells.

The conversion into fibrous texture of the membrane and cells of the stems and branches of the tuft of the chorion, forms the tough white fibrous trunk and branches of the tufts of the fœtal portion of the placenta; in each of which runs a branch of the umbilical arteries and vein; and the fine membrane of the villi of the chorion, with its contained cells and terminal blood-loops, still persistant at the extremities of the villi, are the internal membrane, the internal cells, and the blood-loops described in the first part of this memoir.

III.—OF THE MATERNAL PORTION OF THE PLACENTA.

The mucous membrane of the uterus presents on its free surface the orifices of numerous cylindrical follicles arranged parallel to one another, and at right angles to the surface. In the spaces between these follicles the blood-vessels form a dense capillary network.

From the observations of Professors Weber and Sharpey,* it has now been ascertained, that when impregnation has taken place, the mucous membrane of the uterus swells, and becomes lax, that its follicles increase in size, and secrete a granular matter, and that the capillaries increase in a proportional degree. "In a uterus," says Dr. Sharpey, "supposed to have been recently impregnated, and in which the vessels had been minutely injected with vermilion, the lining membrane, or commencing decidua, appeared everywhere pervaded by a network of blood-vessels, in the midst of which the tubular glands were seen, their white epithelium strongly contrasting with the surrounding redness." It must have been from a uterus in this condition that Baer took the sketch of the structure of the commencing decidua, which has been copied by Wagner in his *Icones Physiologicæ.* Baer and Wagner, however, have mistaken the enlarged follicles for papillæ, and have represented the capillary loops in a manner much too formal. I have examined a uterus which was in a state described by Dr. Sharpey. There was a well formed corpus luteum in one of the ovaries; the decidua had appeared on its internal surface, and presented in the most distinct and beautiful manner the orifices of the follicles, and the vascularity of the inter-follicular spaces. The follicles, bounded by their germinal membrane, were turgid with their epithelial contents. The inter-follicular spaces in which the capillaries formed a network with polygonal or rounded meshes, was occupied by a texture which consisted entirely of nucleated particles. This is the tissue represented by Baer and Wagner, described by them as surrounding what they supposed to be uterine papillæ, and considered by them as decidua. The free surface of the uterine mucous membrane was covered by a membrane, which appeared to me to be continuous with the germinal membrane of the follicles.

* Müller's Physiology, page 1574.

Dr. Sharpey has not described this inter-follicular substance, as his attention appears to have been chiefly directed to the follicles. As, however, it is to this inter-follicular substance, as much as to the enlargement of the follicles themselves, that the mucous membrane owes its increased thickness, it appears to me worthy of being recorded.

A uterus in the condition which has just been described, is said to be lined with the decidua, consisting, as has been stated, of an inter-follicular cellular substance, and of an extended network of capillary blood-vessels.

About the time at which the ovum reaches the uterus, the developed mucous membrane or decidua begins to secrete, the os uteri becomes plugged up by this secretion, where it assumes the form of elongated epithelial cells; the cavity of the uterus becomes filled with a fluid secretion, the "hydroperione" of Breschet, and in the immediate neighbourhood of the ovum, the secretion consists of cells of a spherical form. The cells which are separated in the neighbourhood of the ovum I consider as a secretion of the third order. They have passed off from the uterine glands entire, and possess a power peculiar to the third order of secretions, the power of undergoing further developement after being detached from the germinal spots or membrane of the secreting organ.

From what has now been stated, it appears, that the decidua consists of two distinct elements: the mucous membrane of the uterus thickened by a peculiar developement, and of a non-vascular cellular substance, the product of the uterine follicles. The former constitutes at a later period the greater part of the decidua vera, the latter, the decidua reflexa. This view of the constitution of the decidua, clears up the doubts which were entertained regarding the arrangement of these membranes at the os uteri and entrances of the fallopian tubes. It is evident that these orifices will be open or closed, just as the cellular secretion is more or less plentiful, or in a state of more or less vigorous developement. It also removes the difficulty of explaining how the decidua covers the ovum, a difficulty which cannot be reconciled with the views of Dr. Sharpey, who is obliged to suppose the deposition of lymph, which is only the old view of the constitution of the decidua.

When the ovum enters the cavity of the uterus, the cellular decidua surrounds it, and becomes what has been named the decidua reflexa, by a continuation of the same action by which it had been increasing in quantity before the arrival of the ovum. The cellular decidua grows around the ovum by the formation of new cells, the product of those in whose vicinity the ovum happens to be situated.

At this stage of its growth, the ovum with its external membrane, the chorion, covered by tufts, the structure and functions of which, have been described in the second part of this Memoir, is embedded in a substance which consists entirely of active nucleated cells. The absorbing cells of the tufts are constantly taking up either the matter resulting from the solution of the cells of the cellular decidua, or the fluid contained in these cells. The ovum is now deriving its nourishment, not from the supply which it took along with it when it left the ovary, but from a matter supplied by the uterus. I am, therefore, inclined to look upon the cellular decidua, as representing in the gestation of the mammal the albumen of the egg of the oviparous animal. They are both supplied by a certain portion of the oviduct, and they are both brought into play after the nourishment supplied by the ovary is exhausted, or in the course of being exhausted. The difference between them consists in this, that in the mammal the albumen is applied to use as quickly as it is absorbed; whereas, in the oviparous animal, after being absorbed, it is kept in reserve within the chorion till required. I have also been in the habit of considering the uterine colyledons of the ruminant and other mammalia as a permanent decidua vera, and the milky secretion interposed between them and the fœtal colyledons as decidua reflexa in its primitive and simplest form.

I have been thus particular in the explanation of what I believe to be the nutritive function performed respectively by the chorion and decidua, as upon it I shall have to found my views regarding the actions of nutrition in the fully developed placenta.

When the ovum has arrived at a certain stage of its growth, the absorption and circulation of nutritive matter by the agency of cells alone is no longer sufficient. At this period, the ovum has approached the thickened mucous membrane, or that portion usually described as decidua serotina. About the same time, the allantois bearing the umbilical vessels applies itself to the internal surface of that portion of the chorion opposed to the decidua serotina, and the villi of that portion become vascular, as formerly described. The vessels of the decidua enlarge, and assume the appearance of sinuses encroaching on the space formerly occupied by the cellular decidua, in the midst of which the villi of the chorion are embedded. This increase in the calibre of the decidual capillaries, goes on to such an extent, that finally the villi are completely bound up or covered by the membrane which constitutes the walls of the vessels, this membrane following the contour of all the villi, and even passing to a certain extent over the branches and stems of the tufts. Between this membrane, or wall of the enlarged decidual vessels, and the internal membrane of the villi, there still remains a layer of the cells of the decidua.

From this period, up to the full time, all that portion of decidua in connection with the group of enlarged capillaries, and vascular tufts of the chorion, and which may now be called a placenta, is divided into two portions. The first portion of the decidua, in connection with the placenta, or forming a part of it, is situated between that organ and the wall of the uterus. This is the only portion of the placental decidua with which anatomists have been hitherto acquainted, and I shall name it the parietal portion. It has a gelatinous appearance, and consists of rounded or oval cells. Two sets of vessels pass into it from the uterus. The first set includes vessels of large size which pass through it for the purpose of supplying the placenta with maternal blood for the use of the fœtus. These may be named the maternal functional vessels of the placenta. The second set are capillary vessels, and pass into this portion of the decidua for the purpose of nourishing it. These are the nutritive vessels of the placenta.

The account given by Mr. Hunter of the manner in which the functional vessels of the placenta pass through this portion of the placental decidua is still doubted by many, notwithstanding the more recent of Mr. Owen's* dissections, and the observations of

* Owen. Palmer's Edition of John Hunter's Works, Vol. iv.

Dr. Reid.* I have dissected the vessels of an unopened uterus at the full time in the manner adopted by Mr. Owen, by opening one of the large veins over the spot to which the placenta was attached. Introducing a probe as a guide, I slit open the vein with a pair of scissors, and repeated the same process with the probe and scissors whenever a branch entered the vein already opened. I gradually passed through the wall of the uterus. In my progress, I occasionally found, that when the probe was pushed along an unopened vein, its point appeared at another opening; and as I approached the internal surface of the wall of the uterus, these anastomoses of the veins became more numerous, the spaces which they inclosed presenting the appearance of narrow flat bands. At last, in introducing the probe under the falciform edges of the veinous orifices, it was found to have arrived at the placental tufts, which could be seen by raising the edges of the falciform edges. Having passed over the falciform edges, the veinous membrane suddenly passed to each side to line the great cavity of the placenta. The flat bands which I have just described as the spaces inclosed by anastomosing veinous sinuses, became smaller, and, on entering the cavity itself, the bands were seen to have assumed the appearance of threads, which passed in great numbers from the vascular edges of the veinous openings, and from the walls of the cavity of the placenta on to the extremities and sides of the villi and tufts of the placenta. The whole mass of spongy substance, that is the whole mass of tufts, were in this manner perceived to be attached by innumerable threads of veinous membrane to that surface of the parietal decidua of the placenta which was covered by the veinous membrane. On proceeding deeper into the substance of the placenta, I perceived that, throughout its whole extent, villus was connected to villus, and tuft to tuft, by similar threads of veinous membrane. Sometimes the apex of one villus was connected to the apex of another. In other instances the threads connected the sides of the villi. On minute examination these threads were found to be tubular, and the membrane of which they were formed was seen to be continuous in one direction with the lining membrane of the vascular system of the

* Reid. Edinburgh Medical and Surgical Journal, *loc. cit.*

mother, and in the other with the external membrane of the tufts of the placenta, and passing from one tuft, or set of tufts, on to another, so as to form the central containing membrane of the bag of the placenta. These threads, as well as their cavities, are somewhat funnel-shaped at each extremity. The funnel-shaped portions of the cavities of threads, and, in some instances, the whole length of the tube, were found to be full of cells, which were continuous in the one direction with the parietal decidua of the placenta, and in the other with the external cells of the placental villi.*

This observation led me at once to perceive the real signification of the external cells of the placental tufts. I saw that this great system of cells was a portion of the decidua, all but cut off from the principal mass by the enormous developement of the decidual vascular network, but still connected with it by the minute files of cells, which fill the cavities of the placental threads.

This system of cells, the external cells of the villus, with the external membrane, are portions of the decidua, and, unlike the other elements of the placental tufts, belong to the organism of the mother. These cells, with their membrane, I name the central division of the placental decidua, to distinguish it from the other portion formerly described, and which I have already called the parietal division of the placental decidua.

1. My observations have confirmed the statements of Professors Weber and Sharpey as to the mode of formation of the decidua vera; but have led me to attach more importance to the interfollicular substance, and to the secreted or non-vascular portion of the decidua.

2. The placenta, as has long been admitted, consists of a fœtal and of a maternal portion intermixed. But the maternal portion, instead of consisting of a part of the vascular system of the mother only, includes the whole of the external cells of the villi.

3. The external membrane of the placental villi is a portion of the wall of the vascular system of the mother, continuous with the rest of that wall, through the medium of the placental threads and lining membrane of the placental cavity.

4. The system of the external cells of the placental villi be-

* These are the reflections of the veinous membrane of the mother, described by Dr. Reid.

longs to the decidua, and is continuous with the parietal division through the medium of the cavities of the placental threads. This portion of decidua has been named the central division of the placental decidua, and the threads decidual bars.

5. The function of the external cells of the placental villi is to separate from the blood of the mother the matter destined for the blood of the fœtus. They are, therefore, secreting cells, and are the remains of the secreting mucous membrane of the uterus.

6. Immediately within the external cells of the placental villi there is a membrane which I have named the internal membrane of the villi. This membrane belongs to the system of the fœtus, and is the external or bounding membrane of the villi of the chorion.

7. Inclosed within the internal membrane of the placental villi is a system of cells, which belong to the system of the fœtus, and are the cells of the villi of the chorion. These are the internal cells of the placental villus.

8. The function of the internal cells of the placental villi is to absorb through the internal membrane the matter secreted by the agency of the external cells of the villi.

9. The external cells of the placental villi perform, during intra-uterine existence, a function for which is substituted in extra-uterine life the digestive action of the gastro-intestinal mucous membrane.

10. The internal cells of the placental villi perform during intra-uterine existence a function, for which is substituted in extra-uterine life the action of the absorbing chyle cells of the intestinal villi.

11. The placenta, therefore, not only performs, as has been always admitted, the function of a lung, but also the function of an intestinal tube.

J. G.

No. X.

THE STRUCTURE AND ECONOMY OF BONE.

A texture may be considered either by itself, or in connection with the parts which usually accompany it. These subsidiary parts may be entirely removed without interfering with the anatomical constitution of the texture. It is essentially non-vascular, neither vessels nor nerves entering into its intimate structure. It possesses in itself those powers by which it is nourished, produces its kind, and performs the actions for which it is destined, the subsidiary or superadded parts supplying it with materials which it appropriates by its own inherent powers, or connecting it in sympathetic and harmonious action with other parts of the organism to which it belongs.

In none of the textures are these characters more distinctly seen than in the osseous. A well macerated bone is one of the most easily made, and, at the same time, one of the most curious anatomical preparations. It is a perfect example of a texture completely isolated, the vessels, nerves, membranes and fat, are all separated, and nothing is left but the non-vascular osseous substance.

The osseous texture of a fresh bone, considered in this way, consists of two parts, a hard and a soft. The hard part, composed of earthy salts, deposited in a cartilaginous matrix, has already been carefully examined by anatomists. The soft has not yet attracted attention, in consequence of the manner in which it is isolated, divided into small portions, and concealed in the cavities of the osseous corpuscules.

The hard part of the osseous texture, considered in a long bone, presents four surfaces, all communicating with one another, a periosteal or external, a medullary or internal, a haversian or intermediary, and a corpuscular or canalicular. The periosteal surface communicates with the haversian in three ways: by those haversian canals which open in it; by the canal for the medullary artery gradually subdividing and diminishing till it breaks up into arterial haversian canals; and by the more numerous canals for the veins, principally met with at the extremities of the bone. The medullary surface is to be considered as a portion of the haversian, having been formed by the enlargement, and subsequent blending of neighbouring haversian canals into medullary cavities and cancelli. The canalicular or corpuscular surface forms the walls of the innumerable corpuscules and canaliculi, and communicates by the latter with the haversian, medullary, and less freely with the periosteal surface.

The compact osseous substance, in which the corpuscules and their canaliculi are situated, is not homogenious in texture. It consists, of cells filled with bony substance, ossified or calcified primordial cells.

The soft part of the true osseous texture is not continuous like the hard, but is divided, as has been stated, into as many portions as there are corpuscules in the bone. Each of these portions consists of a little mass of nucleated cells of great transparency. They do not appear to extend along the canaliculi, but to be confined to the cavity of the corpuscule.

These two parts, the hard and the soft combined, constitute the true osseous texture. They differ from one another only in this, that the cells of the one are ossified, those of the other retain their original delicacy and softness. The masses of soft cells in the corpuscules, I am inclined to consider as the nutritive centres, germinal centres, or germinal spots of the texture. These centres are the source of all the hardened cells, each of them being the centre of all those comprehended within the range of its own canaliculi. Each of these soft germinal masses is the centre of attraction for the proper nutriment of bone, and is the active agent in withdrawing this from the vessels, and appropriating it, partly for the nourishment of the hard cells, each of which has a centre of attraction within itself, but more probably for the formation of new calcigerous cells, as the old cells dissolve and their debris falls back into the returning circulation. The canaliculi are undoubtedly the principal channels for the passage of nutriment from the capillaries to the calcigerous cells and germinal centres. They are necessary in a hard texture, and like similar canals and fissures in certain hard cells in vegetables, only appear at a late stage in the developement of bone. Each osseous corpuscule has its own system of canaliculi, these extending, for the purpose of communicating with others, to the confines of its own territory; that is, to the boundaries of the space which was at one time contained within the sphere of the primary cell of which it was the nucleus.

The accessory parts of the osseous texture, are the vessels nerves, membranes, and oil. For my present purpose it is only necessary for me to allude to the membranes, as one of them, the periosteum, has been held to play a most important part in the formation and economy of bone.

The periosteum is not so important an element in the constitution of a bone as has usually been supposed. In the adult bone, it is nothing more than the fibrous sheath of the organ, similar to the bounding or limiting membrane of other organs, and in which the vessels ramify sufficiently to anastomose with those of the comparatively few haversian canals which open on the external surface. In the fœtus it is much more vascular, the external surface of the bone being at that period actively engaged in growth.

There exists in every true bone, a membrane or layer of much greater importance, and infinitely more extended than the periosteum. Between the blood-vessels and the walls of the haversian canals, there is a layer of cellular substance. This cellular substance is the product, its cells being the descendants of the corpuscules of the cartilage or matrix in which the bone was originally formed. It forms a blastema, originally produced round each cartilage corpuscule by developement into a linear series perpendicular to the ossifying surface: each of the secondary cartilage corpuscules remaining as centres, or the sources of new centres of nutrition, of the future bone, their progeny forming the cellular mass which becomes enclosed in the capsules of compact primary bone. When these capsules have opened into one another to form the haversian canals, a process similar to the mode of developement of gland ducts, and capillaries, the cellular mass surrounds the vessels in their course, and separates them from the walls of the canals.

That this cellular layer plays an important part in the economy of bone, appears probable from the prominent position it holds in its developement, and from the intimate connection of the haversian canals with all the morbid changes of bone. Its existence, great extent, and probable powers, cannot be overlooked in any question regarding the economy of bone in health or disease.

The cellular mass, just described, fills the cancelli, or enlarged haversian chambers, of fœtal bones, and, in this situation, has not been overlooked by former observers. In adult bones, it is in the medullary cavity, cancelli, and, to a certain extent, in the larger haversian canals, replaced by fat cells.

On the surface of young and vigorous bones I have observed numerous cells, flattened, elongated, and more or less turgid, belonging doubtless to the system of haversian cells.

J. G.

No. XI.

THE MODE OF REPRODUCTION AFTER DEATH OF THE SHAFT OF A LONG BONE.

The question at issue regarding the source of the new osseous substance in regeneration of the shaft of a long bone, is thus stated by Professor Syme.* "Whether the periosteum, or membrane that covers the surface of the bones, possesses the power of forming new osseous substance independently of any assistance from the bone itself?" and the Professor has detailed some very ingenious experiments, which satisfied him that this membrane does possess the power of producing new osseous texture.

The first experiment consisted in exposing the radius of a dog, and removing an inch and three quarters of it along with the periosteum; and in the other leg removing a corresponding portion without the periosteum. In six weeks the cut extremities of the radius, from which a portion had been taken, together with the periosteum, had only extended towards one another in a conical form, with a great deficiency of bone between them, and in its place merely a small band of tough ligamentous texture. In the other, where the periosteum had been allowed to remain, there was a compact mass of bone, not only occupying the space left by the portion removed, but rather exceeding it.

The objection to this experiment is, that it cannot be performed

* Trans. Roy. Soc. Edin., Vol. xiv., page 158. "*On the Power of the Periosteum to form New Bone.*"

accurately. I have satisfied myself, that it is impossible to separate the periosteum from a dog's radius without removing along with it minute longitudinal, filamentary, or ribbon-shaped portions of the surface of the bone, more particularly, as may be conceived, when performed in the manner which under the circumstances would be adopted, by slitting it up in front, and detaching it transversely before separating the portion of bone. It remains to be proved that it is not from these minute shreds of bone that the regenerated portion of the shaft has derived its origin.*

In the other part of the experiment, in which the periosteum as well as the bone was removed, it was not to be expected that complete regeneration should have taken place, inasmuch as the bounding or limiting membrane of the organ had been removed, and the surrounding textures were allowed to collapse and unite. Even under these unfavourable circumstances, the cut extremities of the bone had lengthened themselves out in a conical form.

The two subsequent experiments, by the insertion of tin plates, though highly ingenious, differ in no essential particular from the first, and are liable to the same objections. If a section had been made through the denuded shafts, new bone would have been found deposited in their interior, just as it had been at the cut extremities in the first experiments.

The careful examination of numerous bones, the shafts of which had died, and were in progress of replacement by a substitute in the form of a shell, has satisfied me that in no instance do we ever see a new shaft, without at the same time observing portions of the old shaft ulcerated to a greater or less extent — the ulcerated portions invariably corresponding in the early stages to the scales of new bone in the periosteum. Whenever the old shaft is entire, its periosteal surface presenting the natural appearance of a macerated bone, the part corresponding to this in the new shaft is formed of bone which is seen to be shooting, in the manner peculiar to this mode of regeneration, from a point corresponding to an ulcerated portion of the old shaft. So

* Baly. Note in his Translation of Müller's Physiology, page 471.

striking is this peculiarity, that it will at once recur to those who have had an opportunity of observing new shafts in an early stage of formation; as well as the remarkable contrast between the smooth hard portions of the dead or dying bone and the nodulated scales lying in the separated periosteum, alternating with the former, and concealing from direct view the rough or ulcerated portions of the dead shaft. In those instances in which the shaft has died, with the exception of a ring or small portion at each or one end, close to the epiphysis, the new bone shoots in stalactitic masses in the longitudinal direction, their course, direction and magnitude corresponding to the forms of the rings or portions of ulcerated bone in the old shaft. This is an unfavourable form of necrosis, in consequence of the difficulty encountered by the extremities of the new shell in meeting in the centre, and the length of time required for the process of regeneration. This form has also given rise to a mistaken view of the source of the new bone in necrosis, a belief that it is derived from the epiphysis. I have never seen an instance in which the epiphysis supplied the new shaft, and I have had occasion to point out that the specimens on which such opinions were founded are in fact exemplifications of the formation of the new, from a ring or portion of the old shaft close to the epiphysis. An epiphysis is a distinct part, and has no greater tendency to supply the losses of the principal mass of the bone to which it belongs than the femur, fibula, or astragalus to supply the loss of a tibia.

Another remarkable peculiarity, arising from the circumstance of the new bone invariably shooting from spots corresponding to ulcerated portions of the dead shaft, is met with in instances where one side of a dead shaft is not ulcerated, and the other side, or a portion of it, has undergone that process. In such instances, the new bone proceeds from points corresponding to the ulcerations, and shoots in the form of arches across the smooth portion of the old bone, meeting from either side, and giving rise to new processes which ultimately enclose the whole. In instances of this sort regeneration is effected with difficulty, and there is a tendency in the old shaft to ulcerate out on the side on which it has supplied no osseous centres of regeneration.

The death of the entire shaft of a long bone must be a very rare occurrence. In a case of this kind, the shaft would be found lying loose in a cavity formed by the epiphysis at each end, and the separated periosteum on the sides. The bone itself, although its surface might be opened up by inflammation, would present no ulceration or actual deficiency of substance. In a case of this kind, I believe no regeneration whatever would take place. The epiphysis have no tendency to assist; and the periosteum has separated without a single portion of the shaft from which new bone might be produced.

In the majority of instances of what is incorrectly named death of the entire shaft, ulcerated portions or deficiences of the surface will be met with; and in the periosteal sheath scales of new bone corresponding to these will be perceived. I have observed the process by which these ulcerations are produced, and have already described it in the chapter on ulceration.

The first appreciable inflammatory changes in bone occur within the haversian canals. These passages dilate or become opened up, as may be seen on the surface of an inflamed bone, or better in a section. The result of this enlargement of the canals is the conversion of the contiguous canals into one cavity, and the consequent removal or absorption of all the osseous texture of the part. This removal of the substance of the walls of the haversian canals is not to be explained by pressure arising from effused lymph, understood either in a mechanical sense, which is inapplicable to actions of this kind, or in the Hunterian sense in which it is employed, as a mode of expression for an action, the details of which have not been recognised.

By the enlargement of neighbouring haversian canals, and the consequent removal of all the osseous substance of a portion of bone, an ulceration is produced, or a piece of dead or dying bone is separated from the living organ. A stratum of what, in the language of surgical pathologists, is named granulations, divides the dead from the living, and ultimately casts the dead off, by assuming a free surface towards it, throwing pus into the interspace.

When the entire shaft of a bone is attacked by violent inflammation, there is generally time before death of the bone takes place, for the separation, by the process just described, of more or less numerous portions of its surface. When the entire periosteum has separated from the shaft, it carries with it those minute portions of the surface of the bone. Each of these is covered on its external surface by the periosteum, on its internal by a layer of granulations, the result of the organised matter which originally filled the inflamed haversian canals; the gradual enlargement and subsequent blending of which ultimately allowed their contained vascular contents to combine with the layer of granulations just described; and to form the separating medium between the dead shaft and its minute living remnants. These minute separated portions, after having advanced somewhat in developement, appear, when carelessly examined, particularly in dried specimens, to be situated in the substance of the periosteum, and have been adduced by the advocates of the agency of that membrane in forming new bone as evidences of the truth of their opinions.

In proportion to the equal manner in which these living portions of the old shaft are arranged over the whole internal surface of the periosteum, will be the facility and consequent rapidity in the formation of the new shaft. The shape of the new bone will also depend very much upon the same circumstances; for, if the centres of formation of the new shaft are separated from one side only of the old bone, then an unshapely mass of new bone is thrown out on the same side, for the purpose of strengthening the part during the time necessary for shooting across the bridges of bone which are to supply that side of the new shaft, for the formation of which no osseous centres had been separated. Every possible modification, resulting from these principles, may be observed in looking over series of necrosed long bones.

A remarkable fact in connection with cloacæ is, that they are almost invariably opposite a smooth or unaltered portion of the surface of the dead shaft. They result from the pus thrown off from the granulating internal surface of the new shaft making its way to the exterior, by those parts not yet closed, in consequence of having been opposite to portions of the old shaft, which had not afforded separated osseous centres. After the new shell has gained its full strength, the cloacæ, like sinuses of the soft parts, are prevented from closing by the continued flow of the pus. The situation of cloacæ is determined by circumstances in the death of the old, and kept open by the continued flow of the secretions of the new shaft.

As, therefore, it has been found impossible to separate the periosteum in living animals, without detaching shreds of bone along with it; as in necrosis of the shafts of long bones, portions of the old osseous texture may be detected in the periosteal sheath opposite ulcerations of the dead shaft; and as consistent with what is at present held regarding the powers of capillary vessels, and the origin of the textures, we are compelled to assent to the doctrine that periosteum does not possess an independent power of forming osseous substance.

The participation of the periosteum in the office of regeneration—an important principle in surgery—is not denied in this conclusion.

J. G.

No. XII.

THF MODE OF REPRODUCTION OF LOST PARTS IN THE CRUSTACEA.

That all the species of crustacea have the power of regenerating parts of their body which have been accidentally lost, is a fact which has been long known. The particular manner in which these new parts are developed, and also the organ from which the germ of the new part is derived, has never yet been sufficiently examined, or properly explained.

If one or more of the last phalanges of the leg of a common crab be seriously injured, the animal instantly throws off the remaining parts of the limb close to the body. It has the power of doing so, apparently for two purposes; to save the excessive flow of blood which always takes place at the first wound, and to lay bare the organ which is to reproduce the future limb. As soon as the injured limb has been thrown off the bleeding stops, the reason of which will be explained hereafter; but if the animal is unable, from weakness or other causes, to effect this, the hæmorrhage proceeds to a fatal termination.

It is apparently in the organs of locomotion only that the power of reproduction resides. That it does not do so in all parts of the body—in the higher crustacea, at least—is proved by experiment, and is also apparent from the circumstance of many species being obtained with the body and other parts very much maimed, and which have to all appearance been so for a considerable period. Wounds of the body in general prove speedily fatal, if they penetrate deeply, but if otherwise, a cicatrix only is formed, which remains until the casting of the shell, when the new shell takes on all the characters and appearance of the old one, before it met with the injury. When the animal is weak and unhealthy, and in that state meets with any severe injury of a limb, it is unable to throw it off at the usual place, and consequently very soon dies from loss of blood; but when strong and vigorous, it is enabled to throw the injured limb off with little apparent pain or exertion. It is a well known fact, that these animals can throw off their limbs when seized by them, and also from several other causes, to which it is unnecessary to allude at present.

When the crustacean does throw off a limb voluntarily, it will be found on examination that this is always effected at one spot only, near to the basal extremity of the first phalanx. This part of the phalanx is very much contracted for the length of half an inch, or a little more, in the common edible crab. The whole of this portion is filled with a fibrous, gelatinous, glandular looking mass; the organ which supplies the germs for future limbs. On looking closely into the surface of this body, we find that it is divided into two unequal parts, by means of a transverse line. The basal or proximal part of this body is the smallest. On tracing this line towards the shell, we find that it runs into it, as it were, and forms, instead of one line, two, by which means a very thin ring is formed, and this ring is also found to run completely round the limb, being marked externally by means of a thin band of small scattered hairs. By dissection this line can be traced into the substance of the organ of reproduction, and is found in this way to be the exact spot where the limb is generally thrown off. Through the long axis of this, and near to one edge, a small foramen exists for the transmission of the blood-vessels and nerve. The microscopic structure of this gland or organ is extremely beautiful. When a thin transverse section is made, and placed under the microscope, it is found to present the following appearances:—The foramen, for the transmission of the vessels and nerves, which was distinctly seen with the naked eye, is obscured on account of the pressure arising from the glass plates, but its situation can be still distinctly made out near to one edge of the section, and also within a thick fibrous looking band, which, when traced, is found to surround a considerable extent of surface. The space contained within this band is also found upon examination to be much more transparent than that beyond it, and to contain numerous small cells, all of which have nuclei or nucleoli within them. These cells appear to be suspended in a thickish transparent liquid. The thick fibrous band, mentioned above, is composed of a great many fibres, all of which run almost parallel to one another. Beyond this band, and occupying the remaining space between it and the shell, lies a confused mass of large primitive cells or blastema. The shell membrane, covered by the shell, encircles this,—thus the whole structure of the leg at this part consists of, 1*st*, the foramen for the transmission of the vessels and nerves; the fibrous band, with the semi-liquid mass containing small cells; the blastema of larger nucleated cells; and, lastly, the shell membrane, covered by the shell.

In reference to the fibrous band here mentioned, farther observations have proved it to belong to a very peculiar system of vessels, which are very generally distributed throughout the body of the animal. They ramify very freely over the membrane lining the carapace, throughout the ovaries, liver, intestinal canal, and on the blood-vessels of the organs of locomotion. In the latter, they are arranged at regular intervals, and run parallel to one another. They run in this manner, until that part of the leg is reached about half an inch beyond the reproductive gland, when they terminate by means of blind extremities. I have not yet made out the exact relative anatomy of this very peculiar system of vessels, or in what manner those running in the longitudinal direction of the leg are connected with the circular one which surrounds the foramen at the point of fracture, but immediately after the animal has thrown of the injured limb, the raw surface becomes covered with these vessels. Before the separation, the vessels had been partially empty; but immediately on the separation taking place, they became so distended as to become visible to the naked eye. In all the observations made, it was generally found that these vessels presented a radiated appearance on the newly made surface, running from the circumference to the circular one surrounding the situation of the germ. The greater number also appeared to terminate at the circumference by means of blind extremities. A dark circular disc was seen at the extremity of many of these cul-de-sacs, which had all the appearance of a germinal spot. When these vessels were first seen, they were thought to be connected with the reproductive gland alone, but after farther observations, this appeared to be incorrect; and, as already mentioned, their relations are so extensive and complicated, as to require much more time for their elucidation than I have had since they came under my observation. It is evident, however, they perform some important function in the economy of the animal, but whether it is connected with the reproduction of lost parts or not, is a question to be decided by future observation.

Immediately on the limb being thrown off, a quantity of blood escapes, which is soon stopped by the retraction of the vessels. After this takes place, we see the small open foramen for the passage of the artery and nerve, which becomes closed almost immediately by means of a slight film which spreads over the whole of the exposed surface. When this surface is examined some hours after the loss, we find that the small cavity of the foramen is slightly filled up with a body resembling a nucleated cell. This cell is the germ of the future leg, and very shortly encreases in size, so as gradually to push out the film alluded to above, which is now become a thick strong cicatrix. During the time that this is going on, the whole of the exposed surface had become tense and bulging, but this gradually decreases round the circumference as the central nucleus encreases in size, which it does at first longitudinally, and then transversely. As it encreases in size, the cicatrix, which still surrounds it as a sac, becomes thinner and thinner, until it bursts, when the limb, which has hitherto been bent upon itself, becomes stretched out, and has all the appearance of a perfect limb, except in size.

In the lower crustacea, and even in the lower Macroura, we find the power of regeneration more extended;—a limb broken off at any part of its phalanges will grow. The mode of reproduction in the lobster is peculiar, and differs from the higher crustacea. Instead of the young limb being folded upon itself, as we found it in the Brachyura, it is quite extended, although apparently enclosed in a sac.

As far as my observations have yet gone, it appears to me that the germinal cell is derived from one of those which are nearest the central opening on the raw surface. This cell, following the ordinary course of developement, by the nucleus breaking up into nucleoli, which in time become parent cells, each of which again undergo the same process. This proceeds for several stages, all the less important cells dissolving and serving as nourishment to the central or more important ones, until the number of centres are reduced to five, the number of joints required, which, by a constant process of a similar nature, assume the form of the future leg.

H. D. S. G.

No. XIII.

OF THE ANATOMY AND DEVELOPEMENT OF THE CYSTIC ENTOZOA.*

I.—OF THE ACEPHALOCYST.

The acephalocyst, or simple hydatid, consists of a vesicle composed of several membranes, containing a quantity of fluid, in which the young hydatids float, and from which they apparently derive nourishment.

Although found in all parts of the body, these animals are nevertheless more strictly confined to the liver, which appear to be their natural habitat.

In examining an acephalocyst from without inwards, there is met with, first, the natural tissues of the infested being, slightly condensed, the condensation being greatest near the hydatid, and becoming gradually less as the distance encreases. The next part met with in the dissection inwards, is a strong fibrous membrane, of considerable thickness, with numerous blood-vessels. This forms a sac for the hydatid. During the earlier stages of growth, hardly a vestige of this can be seen; for being formed of the condensed tissues of the infested animal, it becomes perceptible only after the parasite has attained some size. It is highly

* Read before the York Meeting of the British Association, 1844.

vascular, and forms a cushion, to which the external surface of the hydatid is applied. In this way, a steady supply of the blood, or of debris of the textures of the infested animal is close at hand, from which the hydatid may extract nourishment. This membrane is best seen in aged hydatids, or in those in which the process of obliteration has commenced, and in such can easily be demonstrated by dissection. In such aged individuals also it is found to be so intimately attached to the external membrane of the hydatid, as to appear to form one membrane with it; whereas in younger individuals, a considerable space intervenes.

The external coat of the hydatid is gelatinous and slightly fibrous in appearance, and presents no structure.

The middle membrane appears to be of the nature of a germinal membrane, is much thinner, and more delicate than the external membrane. In this membrane numerous cells, in various stages of growth, take their rise, and project inwards into the cavity of the hydatid, carrying the next membrane along with them.

The internal membrane does not appear to be continuous over the whole internal surface; but observed only where it is reflected, as has been just stated, over the surface of the germinal cells. It may, therefore, be considered as that portion of the middle or germinal membrane which has been carried inwards by the rise of the germinal cells in the substance of the former membrane.

A small clear cell, or vesicle, jutting from the internal surface of the second membrane, is the first vestige of the young hydatid. At first this vesicle is colourless, but as it encreases slightly in size, it becomes opaque, and also carries the internal membrane inwards before it, which in time, as the young hydatid becomes more pedunculated, before becoming free, almost covers it entirely. Vestiges of this membrane may be seen attached in shreds to the vesicle even after it has attained a considerable size.

In all the hydatids which have already become independent animals, with their external coat still gelatinous, and are still enclosed within the cyst of the original acephalocyst, it may be observed that one side presents shreds of membrane attached to it; but that the other is quite free and almost transparent. This transparent part was that originally attached to the parent or germinal membrane; and the shreds are consequently the remains of the internal membrane of the parent. Shortly before the young hydatid separates from the germinal membrane of the parent, smaller cells are seen within it, which increase in size along with it. These are another generation of hydatids, and the fourth in the series I have been describing.

About this period in the process of developement, there may be seen in some forms of hydatids of the tertiary growth, a dark irregular flat nucleated spot, which always occupies the same place, immediately opposite that of attachment. This spot is visible only before the separation. I am inclined to consider this spot as the first appearance of the pedicle, or what is generally termed a head in the class. This species I denominate *Acephalocystis armatus*. This appearance is merely the nucleus or central cell, from which all the others are produced; thus illustrating that the pedicles of Cænurus and Cysticercus are analogous to this nucleus, both being reproductive organs;—in the acephalocyst being a reproductive organ only, in Cænurus and Cysticercus being chiefly a reproductive organ with a slight adaption for the purposes of prehension.

If the small cells which are seen in the tertiary hydatids are the young, they must be the first of those which are afterwards seen attached to the germinal membrane, for I have not met with secondary hydatids enclosing separated young individuals. It is only after the hydatid has obtained a nidus, or separate habitat of its own, that it begins to throw off its young from the germinal membrane, and those only which had been formed during the tertiary and secondary periods. Thus, if the original hydatid is buried deep in the textures of the infested being, or from other causes is prevented giving exit to its young, (for it is by the dilatation caused by the young within it that the parent sac gives way,) it soon becomes unable to extract proper nourishment from the infested being, the young within it become decomposed, and the whole animal degenerates either into a firm cicatrix, or, as is most general, into a fatty cretaceous matter.

I have in many instances found this matter forming upon the external coats of young secondary hydatids, which were confined, as above stated, in old and degenerating parent sacs. In general this cretaceous matter originates in the internal and germinal membrane of the parent sac; these two membranes in old hytadids being always thick, gelatinous, and homogeneous, like pure gelatine. This thick gelatinous membrane presents no trace of the two membranes of which it originally consisted; it is generally about the eighth of an inch in thickness; and lies in the most dependant part of the cavity, quite loose and detached from the external coat. It presents no trace of young vesicles or hydatids, but has upon its internal surface a number of white, opaque, fatty looking spots of all sizes. Similar spots, but of much smaller size, are also to be seen in the substance of the membrane, and when examined by the microscope, present a peculiar cellular network. As these spots become larger, they from being quite smooth, become rough and nodulated, each of the cells being apparently filled with the peculiar fatty substance. As this mass encreases in size, it becomes more cretaceous, and sends out branches in all directions, so as in time to fill the whole cavity of the hydatid, which, as this process is going on, shrinks up very much, so that it meets the fatty matter, and enables the process of filling up to be more speedily completed. Shortly before the cavity is completely filled up, the fatty matter begins to lessen in quantity, being probably absorbed by the cretaceous matter gaining the preponderance. In this way more or less of the whole mass is absorbed, so that ultimately nothing is left but a small quantity of cretaceous matter which becomes very much condensed.

The middle membrane then appears to play the most important part in the economy of the hydatid; the external membrane acting only as an organ of defence.

Of this peculiar form of animal three species have been determined, the characters of which are derived from the structure and appearance of the germinal membrane. In *Acephalocystis simplex*, the lowest of these forms, the whole structure of the animal is much more homogeneous, transparent, and gelatinous than that of the two higher forms; the cyst is not divided into separate parts, and the young are developed promiscuously throughout its internal surface.

In *Acephalocystis armatus*, the young are developed from a true germinal membrane, each of the young arising as a separate cell, and afterwards throwing off internally successive broods of young independently. It is also distinguished from the other species by the teeth which it possesses during the period of its attachment to the parent germinal membrane. These teeth are generally exactly opposite the spot of attachment, are quite straight, barbless, and form an irregular circlet, somewhat similar to that of Cænurus and Cysticercus. They are lost as soon as the animal leaves the germinal membrane and becomes free, and not the slightest vestige of them can be seen, even upon the shreds of membrane alluded to above, which at one period formed the internal membrane of the parent sac.

In the Medical Gazette for Nov. 22, 1844, p. 268, there is an abstract of a Paper read before the Royal Medical and Chirurgical Society of London, by Erasmus Wilson, on the classification, &c., of *Echinococcus hominis*. There can be no doubt that the *Echinococcus* here described by Mr. Wilson, and the *Acephalocystis armatus* are both one and the same species. The bodies described by Mr. Wilson as the echinococci, and which are attached to the internal surface of the membrane, are merely the young acephalocysts either of the secondary or tertiary stages of developement. They will be, as already fully described in this paper, of the secondary generation, if found growing from the walls of the original containing sac, and tertiary if found growing from the walls of those sacs floating free in the fluid contained within the original sac. This animal is an acephalocyst, and not an echinococcus. Bremser, in the atlas of his work, On the Intestinal Worms of Man, calls it an echinococcus, but upon false grounds, for the proper definition of echinococcus, he says, at p. 294 of his work alluded to:*—" M. Rudolphi distingue les hydatides en vivantes et en non vivantes; il regarde

* Traité Zoologique et Physiologique sur les Vers Intestinaux de l'Homme, par M. Bremser. Traduit de l'Allemand par M. Grundler. Revu et augmenté de Notes par M. de Blainville.

l'echinocoque provenant des intestins des bisulques (*Echinococcus veterinorum*) comme une hydatide vivante, par la raison que l'on trouve dans le liquide qu'elle contient les echinocoques, proprement dits, c'est-à-dire, des petits corps microscopiques, pourvus de quatre suçoirs et d'une couronne de crochets." The animal described by Mr. Wilson is also referred to in the same abstract by Dr. Budd, "who examined seven hydatid tumors which had been for many years in the Museum of King's College," when he found appearances exactly similar to those described by Mr. Wilson. It is more than probable that the animals here alluded to by Dr. Budd, are similar to that I have called *Acephalocystis armatus*, which, if the case, from the want of suckers, cannot be an Echinococcus, being merely a transitory stage of the acephalocyst. For I have examined great numbers of these animals, preserved in the Museum of the Royal College of Surgeons in Edinburgh—a Collection particularly rich in preparations of these animals—and in no instance have I been able to make out the slightest vestige of suckers. I had made out the existence of teeth, and was anxious to determine whether or not the animal was allied to the cephaloid hydatids.

The next form of Acephalocystis is one presenting a structure peculiar to itself, and which at once distinguishes it from the others. The external membrane is gelatinous and delicate; the germinal one is more fibrous, and is so slightly attached to the external one, as to float in the contained fluid. When a small portion of this germinal membrane is placed under the microscope, its free or internal surface presents the following appearances:—1*st*, A fibrous texture forming the basis of the membrane; 2*d*, A series of large irregular ovoid vesicles, arranged in irregular rows. The fibrous texture surrounds the vesicles, and thus presents a peculiar appearance of ramification of a very regular form. Each of the vesicles contains one or more dark spots containing nucleoli—these spots are the young hydatids.*

* This species I have named *Acephalocystis Monroii*, after Dr Monro, to whom I am indebted for the opportunity of examining the species, and from whom also I have received much valuable information regarding hydatids generally. A very beautiful figure of *A Monroii* is given in Dr. Monro's work on "*The Morbid Anatomy of the Stomach and Gullet.*"

II.—OF ASTOMA.

Astoma acephalocystis is an animal very nearly allied to Acephalocystis.* It was found attached to the peritoneum of an old subject, generally by means of a broad basis, but very often by a slender pedicle. The sac, composed of three membranes, of more or less delicacy, was very strong, and the membranes were easily separable from one another. They were all more or less composed of fibrous texture, and as in the Acephalocystis the external appeared to serve as a means of defence, while the two inner were devoted to nutrition and generation. The young cells, after acting for a time as the organs of nutrition, become free and independent animals after having thrown off young cells internally, which in their turn act as organs of nutrition to their parent, until they are fit to become independent animals themselves. The particulars relative to the peculiar mode of developement of this animal will be adverted to more at length, when we come to treat of that function in Diskostoma, in the meantime a few remarks on the external character of the animal may be useful.

It was of a greenish yellow colour when taken from its habitat, and varied in size from a millet seed to that of a middle-sized orange. The smaller specimens were all spherical, and very much corrugated; the larger were quite smooth and botryoidal—the first of which appearances arose apparently from the distention caused by the young; the second, from the young within it encreasing irregularly in size. When a section was made of an adult specimen, the interior was found to consist of an immense number of young in various stages of advancement, and all of them apparently having their origin from the enclosing sac, either immediately or mediately. Along with these the interstices contained a great quantity of gelatinous matter, which appeared to be the assimilated food, analogous to the pabulum of the seminal cells, already spoken of in another paper.

* Edinburgh Medical and Surgical Journal, No. clxi., p. 14.

III.—OF DISKOSTOMA.*

Diskostoma acephalocystis is another animal belonging to the Cystic Entozoa, and very similar in many respects to the preceding genera; it is, however, more complicated in its structure than either.

Diskostoma was met with in great numbers in the peritoneal cavity of a middle-aged man. About six or eight gallons were taken out of the abdomen after death, all of which had been apparently generated in the course of a few months.† Like Astoma they varied very much in size, but with very few exceptions were all regularly globular, and of a bright straw colour, hanging, when undisturbed, from the surface of the abdominal cavity, like the ova in the active ovarium of the common fowl. The sac consisted of two demonstrable membranes, the most external of which was rather complicated.

The basis of the membrane itself was fibro-gelatinous, and having a number of discs scattered at irregular intervals over its surface; these discs were connected with one another by means of numerous tubuli, which also ramified freely through the membrane. These were probably the organs of nutrition. The next membrane was much more delicate, and was that from which the gemmules arose. In some instances there was the appearance of a third membrane, but it was most difficult of detection. The greater mass of the body was composed of the gelatinous matter already alluded to as occurring in Astoma.

The function of generation in all these lower Acephalocysts is very interesting. In all of them the young cells, or gemmules, arise from the middle membrane of the sac. In Acephalocystis and Astoma the young cells act at first as organs of nutrition, and after a time become themselves independent animals. This is probably the case in Diskostoma also, but it could not be determined with certainty. The mode of devolopement of the young in Astoma and Diskostoma is somewhat different from that

* Transactions of the Royal Society, Edinburgh, Vol. xv. p. 564.

† *See* Edinburgh Medical and Surgical Journal for October 1844, page 1.

already described as taking place in Acephalocystis. There appears to be two modes of generation, namely, one for the enlargement of the original group, and another for the formation of new groups in other parts of the peritoneum. The first of these modes proceeds in the Astoma, from the animal becoming so distended, in consequence of the increased size and number of the young within it, that it bursts when the young are exposed, and the parent sac, which is now useless, absorbed, the progeny in the meantime becoming attached to the peritoneum.* The external membranes in Diskostoma spread over the as yet uninfested portions of the peritoneum, and give origin to a number of cells from the attached surface, each of which, becoming parents, gradually increase in size, from the addition of new matter within the young cells. These young cells are the germs of the future animals. The other mode of developement or that intended for the formation of new groups is similar in both animals. The young or secondary cells, bursting from their formative cell, by some means escape from the parent sac, and so gain a situation at some distance from the original group, where they become attached, in time throw off young cells, and thus become the origin of a new set.

Relative to the mode of reproduction in these animals, it is found that in Astoma, and the higher cystic entozoa, the numbers proceeding from one parent may be unlimited, whereas in acephalocystis generation ceases with the quaternary series of young, unless this series, or the gemmules of some of the preceding, escape from the original sac, and are able to form a nidus in any portion of the liver, or other organ yet uninfested. For it appears necessary to the existence of the common hydatid that it be completely enveloped in the tissues of the infested being. To ensure this normal habitat, then, the animal must escape during the period of its gemmule existence from the parent; but, as most generally happens, if the parent hydatid be so deeply buried as not to allow free rupture of its coats within a certain period, decomposition ensues as already described, and so existence is terminated;—if, on the contrary, the parent hydatid be so near

* *See* Preparation in Museum of Royal College of Surgeons, Edinburgh, No. 2244.

a surface, or from other causes, as during its increase in size to rupture, then the young escape, and so form new and altogether independent animals. As the hydatid is by no means of unfrequent occurrence in the liver and other internal organs, this limitation of the increase appears to be a beneficent law of nature, for the purpose of preventing the fatal termination which the rapid increase of these animals would infallibly produce. In Diskostoma we have an instance of this rapidity of reproduction, which happily appears to be of rare occurrence.

It may be well to state here also the opinions to be deduced from the changes which take place in the germinal membrane of Acephalocystis, and the other acephalic entozoa. It has been already fully described in what manner the function of reproduction in these animals is stopped, namely, in consequence of the thickening of the germinal membrane. After having made out this fact, I was led to infer that many instances of the stoppage of cellular formations at certain periods of life might be traced to similar changes taking place in the germinal membrane of the formative organ, and, with the view of determining this point, examined the testes of several old men, after the fecundating power had in all probability passed away, when the germinal membrane in almost all cases had become thicker and quite different from what is generally seen in young males, a change which (as we have attempted to describe) had taken place in the germinal membrane of hydatids.*

IV.—OF SPHAIRIDION.†

Sphairidion acephalocystis is an animal allied to Acephalocystis, chiefly from its acephalic character, but also from its reproductive organ being enclosed within the centre of its sac. This reproductive body or membrane is exactly similar to the pedicle of the

* The stoppage here alluded to, in the function of reproduction of these animals, may be also greatly assisted, and the degenerating process made more active, in consequence of the thickening of the external membrane preventing the absorbing cells extracting from it a sufficient supply of nourishment.

† Σφαιρίδιον, a globule.

Cysticercus, with the exception of its being entirely buried in the body of the animal, consequently also it is neither furnished with teeth nor suckers. There is no separate absorbent apparatus in the sac of the animal, and this part of its body appears to be composed of one membrane only, which is analogous to the external membrane of the sac of Acephalocystis. The cyst of this animal at first appears to be composed of three membranes, but a little examination proves the outermost to consist of peritoneum only, the two others being similar to the analogous membranes of the cyst of *Cysticercus rattus*, namely, an external for defence, and an internal for absorption of nourishment.

This animal was found attached to the intestines of the Balearic Crested Crane (*Balearica pavonia*, Vigors) beneath the peritoneum.

V.—OF CÆNURUS.*

The next animal we have to describe is Cænurus. It is in the species belonging to this genus that the first vestiges of extremities are perceived, to which form of structure we are led through Diskostoma—the discs described in the latter being without doubt analogous to the pedicles of the Cænurus.

Cœnurus cerebralis, an animal frequently found in the brain of the sheep and other ruminants, has been long known to naturalists. This animal is composed of a double sac, from the external surface of which proceed a number of small bodies, termed pedicles. These pedicles are contained between the two membranes of the sac, project at right angles from its surface, and are armed at the extremity with a double circle of teeth.

The sac of the Cænurus is composed of two membranes, the outermost of which acts as an organ of defence, the internal, containing a layer of absorbent cells, acts along with the larger cells contained in the pedicles as organs of nutrition. The natural size of the pedicles is about the one-eighth of an inch in length. It is divided into two parts, the basal and distal. The former contains the absorbing cells already spoken of, which,

* Transactions of the Royal Society, Edinburgh, Vol. xv. p. 564.

after a time become themselves independent pedicles. The cells within the pedicle are arranged regularly in the form of concentric circles, each cell as it becomes a parent forming a centre. The latter, or distal portion of the pedicle, contains very few, if any, of these cells, but bears on its extremity a double series of bent barbed teeth, which enable the animal to attach itself firmly to the infested body. Four suckers are also placed at regular intervals round the sides of this portion of the pedicle.

When one of the smaller cells escape from the pedicles, and obtains a situation between the layers of the parent sac, it shortly commences to take on a new action, the nucleus enlarges and presents a clear spot in the centre. As this spot encreases in size, the nucleus becomes irregular on its edges, and shortly becomes nodulated, each of which nodules after a time are thrown off as separate cells, a central cell occupying the place of the clear central spot.*

This is the termination of the first stage of the developement of the ovum, after which the nucleus of the central cell undergoes a similar process, the cells proceeding from it pushing out nearer to the circumference those of the previous generation. Thus we have a great series of centres, round which all the other cells are arranged in circles. This I have termed the discoidal period of developement.

After numerous circles have been thus formed, the cells nearest the circumference, and, of course, those first formed, become parents, and consequently centres ; but a few of these gaining the advantage, dissolve the more peripheral cells and absorb them, thus becoming principal centres. As soon as this change in the developement has taken place, the mode of growth, hitherto discoidal, becomes vertical, or at right angles to the sac, and so proceeds until the pedicle becomes perfect.

There is still another animal belonging to this series, and which requires to be noticed in this place. It is nondescript, and its characters resemble so much both those of Acephalocystis and Cænurus that I have not yet been able to decide with precision to which

* It will be noticed by all observers, the great similarity which exists between the developement of this animal and the mammiferous ovum, as described by Dr. Martin Barry.

genus it belongs. It has certainly more of the characters of the Cænurus than Acephalocystis, although many also connect it most intimately with the latter. In the meantime, however, I have placed it along with Cænurus, and from its habitat called it C. hepaticus. In all its more important characters, it is very similar to the C. cerebralis.

VI.—OF CYSTICERCUS.

Cysticercus is distinguished from Cænurus by its sac having only one pedicle; it is also always contained in a cyst, which, in some cases, is formed from the compressed textures of the infested animal, while in others it consists of two membranes, viz., one similar to that mentioned, and another, *sui generis*, and belonging entirely to the parasite. The pedicle of the Cysticercus, is exactly similar in its structure to that of the Cænurus, with the exception of the cells, which are not arranged so regularly. The sac is also composed of two membranes, each having structures exactly similar to that of the Cænurus.

I have divided the animals composing this genus of Entozoa into two classes, in consequence of the difference of structures met with in the cyst. Those species, in which the cyst is only composed of one membrane, derived from the compressed tissues of the infested being, have been placed near to the Acephalocysts; and those in which the cyst consists of two membranes already described, compose the other division.

The *Cysticercus cellulosæ* is an example of the first of these divisions. In this animal, the cyst is very vascular, *i. e.* more so than the surrounding textures, so that in this respect it is quite similar to the analogous structure in Acephalocystis. As an example of the animals belonging to this division of the genus, there is another species which appears to be nondescript. This Cysticercus was found in the Museum of the Royal College of Surgeons, but unfortunately the jar was not labelled, so that I am uncertain from what animal it was got. It is enclosed in a cyst formed by the omentum alone; these cysts are pedunculated, and although quite continuous with the healthy portion of the membrane, it is so puckered and constricted at the pedunculated portion, as to be quite impermeable, so that the enclosed animal can obtain no nourishment from without, except through the portion of omentum forming the cyst. The cyst is very vascular, and generally contains a quantity of thin granular looking matter, (probably the matter intended for the food of the enclosed animal). The double circlet of teeth in this species is remarkable for their great length. In many specimens which came under my notice numerous small globular bodies were observed, surrounded externally with hooked spines, and attached to the internal surface of the cyst, apparently by means of the spines. These bodies, although the intermediate stages between them and the young gemmules could not be seen, I considered the young Cysticerci in an advanced stage of growth, and I was led to do so, because they were often observed on the free surface of the omentum, attracting and puckering it together in folds, evidently the commencement of the process for the formation of a cyst, and in many instances they had completely enveloped themselves. It has not yet been decidedly made out, in what manner the gemmules escape from the body of the Cysticercus, but from the observations I have made, it appears that they must first escape from the pedicle where they are formed into the sac, and then from the sac to the cyst. I am led to this supposition in consequence of having observed on several occasions the sac of the animal ruptured, and great numbers of the globular spined bodies attached to the inner surface of the cyst. How they escape from the cyst I have not been able to determine.

Those Cysticerci having the cyst composed of a double membrane, do not differ in any other particular from those of the preceding division of the genus. The best example of this peculiarity of structure, exists in a species found in the liver of the rat, and which I have denominated *Cysticercus Rattus*. The specific characters are given in the synopsis at the end of the Paper.

In all the details, then, we find a great similarity between Cænurus and Cysticercus, with this exception, that the latter is simple, whereas the former, like all the other Acephalocysts, is a compound animal. Why the pedicles of Cænurus should all become attached to the same sac, is a fact, the cause of which it will be impossible to determine with any degree of certainty; probably, however, it arises from the difference of strength in the sacs of the two animals;—the greater strength of that of Cænurus preventing the escape of the young gemmule from between its membranes. The mode of formation of the sac is also a point interesting to the physiologist, and one deserving consideration. In Acephalocystis and the other allied genera, the original gemmule, shortly after it has become an independent animal, begins to swell out and be distended from the accumulation of new matter within it. This new matter is drawn into it by means of the young internal cells, which have just been formed, and which have a power, inherent in themselves, of attracting and assimilating nourishment from without. The cells referred to here, are the young germs of future hydatids, and which afterwards, as already explained, become independent animals; but, at the same time, there is in many cases also another series of cells, whose only function is to act in this way, and throughout the term of their existence: these have been termed absorbent cells. Now, these cells drawing in the nourishment in this way, cause the expansion of the original cell wall, so that the enlargement of these bodies resembles a process of dilatation. This, then, appears to be the explanation of the peculiar forms assumed by the Cænurus and Cysticercus, as well as the different species of acephalocysts; that it is so, can be proved from *Sphairidion acephalocystis*, an animal very nearly allied to Cænurus, and being a connecting link between the acephalic and cephalic hydatids; for in this animal we find that portion of its body analogous to the pedicle of Cysticercus, not exserted, as in the latter animal, but situated in the centre of the body, where it forms the attracting point for the nourishment absorbed, which accordingly dilates the external and containing sac.

What I wish to be inferred from this is, that the sac of Acephalocystis, Cænurus, and Cysticercus, are analogous organs; and that the pedicles of these two latter animals are analogous to the reproductive nucleus, which may be observed during certain early stages of the developement of Acephalocystis, as well as the reproductive and absorbing nucleus of Sphairidion.

Species of Cysticercus have been found in almost every part and cavity of the human body. In the brain, eye, lungs, liver, in the walls of the intestines, and in the muscles. In the present state of our knowledge, it is impossible to say how these animals gain such habitats as the eye, &c. This is a question, however, which has been the cause of much discussion.

VII.—OF THE HIGHER CYSTIC ENTOZOA.

Besides those already described, there are many other forms of entozoa of the higher orders, which are inhabitants of cysts similar to these of Cysticercus; we have examples of this occurring in the Nematoidea, Cestoidea, and Acanthacephala, &c. As examples of the worms alluded to, I may instance *Trichina spiralis*, *Gymnorhynchus horridus*, and a small filaria inhabiting the livers of some fish, but, as far as can be made out, not hitherto described by any author. As another example, too, of these peculiar forms, may be mentioned, a very interesting animal which will be afterwards described, namely, *Neuronaia Monroii.*

The cysts of all these worms have similar structures to those of Cysticercus, namely, an external membrane composed of compressed cellular texture, and an internal membrane containing absorbing cells, through which the contained animal obtains nourishment.

In the descriptions of the acephalocysts already given, it will be remembered how the animal died in consequence of the thickening and hardening of the external membrane of the cyst, preventing the absorption of nourishment from or through it; so in like manner do these higher Cystic Entozoa—Trichina—die from a similar cause. In many cases where the subject is infested with Trichina, it is found on examination, that with few exceptions almost every specimen is converted into the hard cretaceous matter spoken of, many, at the same time, presenting all the intermediate stages of decay. Gymnorhynchus presents us with a very curious habit dependant upon this mode of structure, and which enables the animal to avoid the death from which all its co-geners suffer. This species which I have fortunately had an opportunity of examining in its natural habitat, but which has been already described by my brother (Edinburgh Philosophical Journal, Vol. 31) inhabits the liver of the sun-fish in great numbers, and from its peculiar structure is enabled to move slowly through the organ it infests. If the cyst of this worm is carefully examined, it will be found that the inner membrane, containing the absorbent cells, is covered anteriorly with a very thin layer only of the external membrane, so that it is enabled to absorb the nourishment from the external textures in great abundance, which thus enables the animal to move forward, as well as obtain a supply of food; as we trace the cyst backwards, the external membrane will be found to become thicker and thicker, as also more impermeable, until we reach the tail of the animal, after which it becomes a mere cord. This cord can be traced for a great distance, becoming less and less perceptible, until it is lost altogether, and the course only marked by a simple line of a darker colour than the rest of the textures. It will be observed that the external membrane of this animal presents analogies similar to that of acephalocystis; for instance, the cephalic portion of the membrane is so thin as to be hardly distinguishable, being thus analogous to the young hydatid.

In regard to the cyst of these worms, it has been long a question how far it is a part of the enclosed animal. Professor Owen* holds, that it is merely condensed textures of the infested being, and Dr. Knox† again, that it belongs essentially to the parasite. My brother, in the Paper already alluded to, says, regarding the cyst—"May we not suppose them to be parts of the original ovum, within which the animal was formed, and within which it passes its term of existence." From observations made on the developement of the acephalocystic entozoa, it may be safely stated, I think, that the above statement is correct, for acephalocystis must be considered as an enlarged ovum; but Sphairidion perhaps is the best example of this peculiar mode of formation,

* Owen. "*Description of a Microscopic Entozoon infesting the Muscles of the Human Body.*" Transactions of the Zoological Society, Vol. I., page 322.

† Knox, Edinburgh Medical and Surgical Journal.

the "inserted pedicle" being analogous to the confined Trichina or Gymnorhynchus—for we must look upon the inserted pedicle as the active animal. In Cænurus, also, the pedicles are contained within the external membrane of the sac.

I shall finish these observations on the Cystic Entozoa, with the following account by my brother, of *Neuronaia Monroii.**

The observations of Pacini† on the peculiar bodies which are appended to the digital nerves, induced me to direct my attention to the "spheroidal bodies," described by the second Monro, as existing on the surfaces of the brain and nerves of the gadidæ. I accordingly examined the "spheroidal bodies" in the haddock, and found that they were entozoa, referrible to the family Distoma, and enclosed in cysts. I described these curious parasites at a meeting of the Anatomical and Pathological Society, and a short abstract was published in the monthly Journal of Medical Science. Till lately, I had supposed that I was the first to observe the true nature of these "spheroidal bodies," when Dr. Allen Thomson ascertained that Dr. Sharpey was in the habit of mentioning them in his courses of lectures in the University College. I accordingly wrote Dr. Sharpey on the subject, and I am indebted to that gentleman for the following interesting account of what has been already recorded regarding this entozoon:—

"When I was in Berlin some years ago, the late Professor Rudolphi remarked to me in conversation, that he thought it not unlikely the little bodies discovered by Dr. Monro 2d, on the nerves of the cod, haddock, and other allied fish, would turn out on examination to be entozoa; and he suggested that I should take an opportunity of inquiring into the point on my return to Scotland. Accordingly, in the autumn of 1836, I examined these bodies in the haddock or whiting, I really forget which, but I think it was the former, and found that each of them was a little cyst, containing a Distoma, which could be easily turned out from

* Monro. "*Observations on the Structure and Functions of the Nervous System,*" p. 59.

† Pacini. "*Nuovo Giornale dei Letterate,*" March and April 1836, page 109. J. Henle and Kölliker. "*Ueber die Pacinischen Körperchen an den Nerven des Menschen und der Säugethiere.*"

its enclosure alive. The specimens I examined were from the membranes of the brain.

"This observation was made in Edinburgh, and, on going to London soon after, I mentioned the fact to Mr. Owen; and I have been accustomed to take notice of it in my lectures ever since, suggesting at the same time that it would be well to search for them, or for analogous parasites, in the nerves of other animals, as it was not likely that the gadus tribe of fishes should be the only example. Indeed, unless my memory deceives me, some one has met with something of the same kind in the nerves of the frog; and Valentin has seen the eggs of Distoma in the vertebral canal of a fœtal sheep. When I learned that the oval bodies, which all must have seen in the cellular tissue of the palm of the hand and fingers, were connected with the nerves, I at first imagined they might be entozoa, (having been led to make just the converse of your conjecture,) but Mr. Marshall, formerly of our Museum, having examined these "Pacinian" bodies two or three years ago, (quite independently of any suggestion from me,) I found nothing to confirm this conjecture on his showing me their structure. I have since seen Henle and Kölliker's memoir, which includes the substance of Pacini's observations.

"Rudolphi, as far as I know, never examined the structure of the spheroidal bodies of Monro; and the only notice of them which I have met with in his writings (to which he did not refer me) is in his *Historia Naturalis Entozoarum*, Vol. ii. Part 2, page 277, when, under the head of Dubious Entozoa, he enumerates an object described and figured by J. Rathke, under the name of "Hydatula Gadorum," which that observer found in the *pia mater* of the Gadus Morrhua and G. Virens, often in great numbers, and which appeared to be a vesicle containing a worm. The nature of the parasite was doubtful, but supposed in some degree to resemble that of a cysticercus, and hence the name applied to it by Rathke, but Rudolphi denies that it is a cysticercus, though he does not know to what genus to refer it, he adds 'an Cucullanus.'"

This entozoon, as stated by Monro, is found in great numbers in the gelatinous substance which surrounds the brain, spinal cord, and semicircular canals, in the cod, haddock, and whiting.

They are also very numerous in the larger branches of the nerves, and particularly on those of the pectoral and caudal fins. In the former situation they are suspended in the gelatinous fluid by fibres of areolar texture and by blood-vessels; in the latter they lie embedded in the substance of the nerve, the ultimate fibres of which are spread in bundles over the surface of the cysts.

The cysts are produced spheroids, somewhat flattened ; their long axis measures about one-fourth of a line.

They consist of three tunics; an external, which appears to be derived from the areolar texture of the infested animal, and of a middle and internal, belonging to the parasite.

Upon the surface, and in the substance of the external tunic, the blood-vessels of the nerve can occasionally be seen, and recognised by their contents. One or two vessels may thus be observed coasting along the cyst, accompanied by single nerve tubes, or by bundles of these, or by a mass which completely encloses and conceals the cyst. The second tunic is a fine transparent membrane, which lines the first, and has in its turn its internal surface covered by an epithelial layer, which is the third tunic of the cyst. The epithelia are flat, irregular in shape, and somewhat opaque. The third, or internal layer, formed by them, breaks up under the pressure of the glass plates, so as to present rents or fissures passing in various directions over it.

The cyst, in addition to the worm, contains a small quantity of fluid, in which oil-like globules of various sizes float.

The worm is a Distoma, oblong, dilated in front, tapering slightly towards its posterior extremity. The mouth longitudinally oval, and rather pointed posteriorly, is surrounded by the usual suctorial disc. The acctabulum is situated at the junction of the anterior and middle third of the animal, and can be protruded from the surface of the body.

On the anterior edge of the acctabulum a minute pore is situated, and communicates with a sac, to be afterwards described.

At the posterior extremity of the animal another orifice is placed, which forms the outlet of the large chyle sac, and apparently also of another sac, to be afterwards alluded to.

The integument of the two anterior thirds of the body, is closely covered with short slightly curved spines, directed backwards. These spines are largest round the suctorial mouth, and on the posterior part of the body are gradually replaced by minute tubercles or dots. Under this spiny or cuticular layer, the integument is muscular, the fibres being principally transverse, and so arranged that the animal appears to be made up of a series of rings, as may be observed along its edges, when examined by transmitted light.

From the anterior extremity to the acetabulum the integuments are so opaque, from the dense covering of spines, that the internal structure of the animal cannot be detected. It is probable, however, that the œsophagus terminates as in the family Distoma generally, in two blind intestinal tubes. I have failed in detecting an arrangement of this kind; but I have observed about the middle of the animal, and along the sides of its posterior half, a sort of cellular structure, which may probably belong to the digestive system, as in *Distoma clavatum* described by Professor Owen.*

A large sac, evidently connected with the digestive system, opens externally by the minute orifice, at the posterior part of the animal. This sac, in every individual, is full of a matter, which by reflected light is of a chalky whiteness, and described by Monro, and conjectured by him to be of a cretaceous nature. Examined by transmitted light, it is seen to consist of numerous spherical globules of variable size, and resembling the matter which fills the chyle cells of the intestinal villi. The larger sac in which this matter is contained varies in shape, but it generally passes up from its outlet for about a third of the length of the body of the animal, then takes an acute bend to the other side, and passing forwards in a curved direction, ends in a dilated blind extremity between the acetabulum and the mouth. It is the "sigmoidal" or "serpentine body" of Monro. This sac is evidently the "cisterna chyli."

It does not communicate directly with the digestive system, as in the apparently analogous receptacles in *Distoma clavatum*, nor, as far as I could see, with the vascular system; but I have seen it

* Owen. "*On the Anatomy of Distoma Clavatum*," Trans. Roy. Soc., Vol. I.

discharge its contents by the posterior orifice, in the manner described by Nordman in *Diplostomum Volvens.**

From the movements of the walls of this receptacle, or from contractions of the animal itself, an active motion of the particles of its contents is occasionally observed. The movements occasionally resemble very much those produced by cilia. This sac is apparently a secreting organ, and is probably the only arrangement by which feculent matter is removed from the body of the animal. The food of an animal, living as this does, in a cyst, is already digested by the walls of its cyst. Its food, therefore, yields no mechanical feculent matter, and its intestinal tube requires no anus. The only outlet which such an animal requires, is for chemical feculent matter, which in all animals is the product of secretion, and principally of the lung, gill, or kidney. This sac may, therefore, be considered as a respiratory organ, or kidney.

There is another sac, very uniform in shape and size, situated at the posterior part of the body. This sac is elongated, extending from near the outlet of the " cisterna chyli," forward about a fourth of the length of the animal. Its posterior extremity is funnel-shaped, and appears to me, although I have failed in tracing it distinctly, to open externally along with the " cisterna chyli." It appears to possess circular fibres, which constrict it slightly at regular distances. The three anterior fourths of its wall are so thick that the cavity appears linear. This thick part of the wall exhibits an arrangement of fibres or particles perpendicular to its surface. The thick portion terminates by forming a curved projection into the thin posterior part of the organ, the whole arrangement resembling the projection of the human os uteri into the vagina. This organ in its relations and structure appears to be the analogue of the cavity described by Professor Owen, as opening into the posterior orifice of *Distoma clavatum*, and supposed by him to be a respiratory organ.

A pyriform sac, communicating with the exterior, by the pore in front of the acetabulum; and two large, with occasionally two smaller globular masses, would appear to be the analogues of the

* Nordman. "*Micrographische Beiträge*," page 38, hft. 1.

reproductive organs. The pyriform sac always contains highly refractive oil-like globules, but larger than those in the chyle receptacle. The two larger globular masses are very constant, and as well as the two smaller contain a mass of particles apparently nucleated. From the two larger, I have only been able to see faint traces of what appeared to be ducts passing in the direction of the smaller masses, and towards the neck of the pyriform sac. Whether these convoluted bodies be ovaries or convoluted oviducts, and the pyriform sac a uterus; or whether the former be the testes, and the latter the female organ, as in the arrangement described in the other Distomas; or whether they be reproductive organs at all, I have failed in satisfying myself, in consequence of the delicacy of their texture, and the comparatively dense integument of this part of the animal.

This Distoma possesses a vascular system forming a network throughout the body. The two principal trunks, as in the other genera, passing along the sides of the body and being most apparent at its posterior third.

I.—ACEPHALOCYSTIS.

Completely buried in the textures of the infested animal; young only consisting of three membranes; adult of four, the external one belonging originally to the infested being. Nourished by epithelial cells, which are contained in one of the membranes composing the sac. Generated by means of cells arising from a germinal membrane. Internal cavity filled with a watery fluid.

1.—*Acephalocystis Simplex (Mihi).*

Parent sac quite transparent, with the membranes indivisible and the germinal cells very minute.

2.—*Acephalocystis Monroii (Mihi).*

Parent sac transparent and gelatinous; germinal membrane intersected by membranous bands, which form flattened compartments, in which are large cells containing unequal numbers of young cells. Each of the young are marked with one or more dark spots.

3.—*Acephalocystis armatus (Mihi).*

Parent sac opaque, membranes distinct, germinal membrane composed of a soft granular matter, in which the germs are arranged irregularly; they are globular and armed with an irregular circlet of teeth at the part opposite that of attachment.

II.—ASTOMA (MIHI).

Not buried, but attached by means of a pedicle, which becomes very slender as the animal increases in size. Young, globular and corrugated ; adult, botryoidal and smooth ; epithelial cells; with some appearance of tubuli in external coat. Young remain and increase in size within the membranes of the parent, till she bursts, when they become attached to the peritoneum.

4.—*Astoma acephalocystis (Mihi).*

Botryoidal, that part of the interior not occupied with the young, filled with a yellowish gelatinous matter.

III.—DISKOSTOMA (MIHI).

Peduncular. Whole group covered by a disk bearing tubular membrane.

5.—*Diskostoma acephalocystis (Mihi).*

Globular interior filled with gelatinous matter, of a transparent greenish yellow colour.

IV.—SPHAIRIDION (MIHI.)

S. Animal enclosed within a cyst which is composed of two membranes. Sac single, containing the pedicle or reproductive body in its centre, and presenting a number of concentric coloured rings. Hab. Peritoneum of Crested Balearic Crane.

V.—CÆNURUS RUDOLPHI.

Sac double, armed with numerous clusters of toothed pedicles. Epithelial cells in the sac. Germinal cells in the pedicles. Buried.

6.—*Cœnurus Hepaticus (Mihi).*

Sac botryoidal, opaque and thick; pedicles internal, small, suckers obsolete; teeth barbless, small, irregularly bent, and forming one irregular series. Gregarious. Infests the liver of man.

7.—*C. Cerebralis (Rudolphi).*

Sac globular, transparent, thin, pedicles with four or five acetabula. Teeth thirteen, about three times as long as the breadth of the disc from which they arise. Infests the brain of sheep and other ruminants.

VI.—CYSTICERCUS.

Animal enclosed within a cyst provided with a single pedicle.

1. Cyst formed from the infested animal.

8.—*C. Neglectus (Mihi).*

Cyst formed from omentum of infested animal. Pedicle about three times the length of sac, head rounded, teeth twenty-one in number, very long, slender, and bent at the extremity, barbed on bent edge. Hab. unknown.

2. Cyst formed by parasite, as well as from textures of infested being.

9.—*C. Rattus (Mihi).*

Cyst small, globular, and transparent pedicle, not very long, teeth short, sickle-shaped, being curved throughout their whole length.

VII.—ECHINOCOCCUS.

H. D. S. G.

DESCRIPTION OF THE PLATES.

DESCRIPTION OF THE PLATES.

CENTRES OF NUTRITION.

PLATE I. Fig. 1. A portion of the middle and internal membranes of a large encysted tumour situated under the tongue, and removed by Professor Syme.

a The middle or second membrane, which is a germinal membrane, consisting of flattened cells, the lines of junction of which are faintly visible, the nuclei remaining as the germinal spots of the membrane.

b The internal membrane, a layer of small cells, somewhat spherical, with slightly granular contents.

The external membrane of the cyst, consisting of areolar and elastic fibres, contained the blood-vessels of the morbid growth.

The cyst contained a soft mass resembling thick honey in consistence. The outer layer of this mass was white, and consisted of large, flat transparent cells or scales, with few or no traces of nuclei. The larger internal part of the mass was reddish grey, and consisted of ovoidal cells, resembling those of the external layer, except that they were turgid with a transparent oily-like fluid, and contained nuclei in various stages of developement.

PLATE I. Fig. 2. *a*, PLATE I. Fig. 3. *a*, Cells of the meliceritous mass—those without nuclei being those of the white external layer, the others belonging to the reddish grey part of the mass, presenting nuclei in various stages of developement.

b b Some of the latter cells, in which the nuclei have become so much developed as to distend their cells beyond the average size. In these enlarged cells, it will be remarked, that the nuclei, instead of remaining as single germinal spots for each cell, have broken up into numerous spots, or centres of nutrition.

In a tumour of this kind, the cyst and its contents are two distinct parts, and perform two distinct actions. The cyst is the active agent in withdrawing materials of nutrition for itself and its contents from the vessels which ramify in its outer tunic. The organs which accomplish this are the germinal spots in its middle tunic, which in virtue of forces of attraction in each, select and remove from the capillary vessels the matter necessary for the formation of the cells of the internal layer. These after solution pass in succession into the cavity of the cyst, to serve as nutriment for the contained cellular mass.

This mass is evidently the principal element of the morbid growth. The cyst is a subsidiary or accessory part, arranged for the protection, and due supply of nourishment for its principal. The cells of which this mass consists have each its own nucleus or germinal centre. These cells would appear to be of two classes—those whose nuclei produce young cells in their interior for their own nutrition, but not for the reproduction of new mother cells; and those which act as reproductive individuals for the whole morbid growth. These latter cells are marked *b b* in Figs. 2 and 3, and contain numerous nutritive centres or germinal spots in their interior. The flat cells of the white external layer appear to be those individuals of the first class, which are about to close their existence, their nuclei having disappeared; their food, therefore, no longer supplied to them, and their position in the mass removed to the exterior by the eccentric developement of the younger and more active neighbouring cells. In a morbid mass of this kind, as in the textures and organs of an animal generally, certain parts are set aside as reproducers, the remaining parts performing the functions of the whole mass, texture, or organ; just as in certain communities of animals certain individuals are set aside to reproduce the swarm, the others are devoted to the duties of the hive.

Plate I. Fig. 4. Two portions of the primary or germinal membrane from the tubes of the tubular portion of the human kidney. The germinal spots of the gland are seen imbedded in the substance of the membrane. The external layer of this membrane, which may occasionally be seen with the nuclei detached from it, is the basement or homegeneous membrane of Mr. Bowman. In other instances, as when the epithelia are but slightly developed, it becomes difficult to decide whether we have merely the germinal membrane, or both the membrane and its epithelia before us.

INTESTINAL VILLI.

Plate I. Fig. 5. Extremity of a villus immediately before absorption of chyle has commenced. It has cast off its protective epithelium, and displays, when compressed, a network of peripheral lacteals. The granular germs of the absorbing vesicles, as yet undeveloped, are seen under its primary membrane.

PLATE I. Fig. 6. Extremity of a villus, with its absorbent vesicles distended with chyle, and the trunks of its lacteals seen through its coats.

Fig. 7. Protective epithelium cells from a villus in the dog.

Fig. 8. Protective epithelium cells cast off preparatory to absorption of chyle; instead of nuclei, they present, in their interior, groups of globules.

Fig. 9. A group of the same cells adhering by their distal extremities.

Fig. 10. Secreting cells thrown out of the follicles of Leiberkühn during digestion.

Fig. 11. Diagram of mucous membrane of jejunum when absorption is not going on. *a* Protective epithelium of a villus. *b* Secreting epithelium of a follicle. *c c c* Primary membrane, with its germinal spots or nuclei, *d d*. *e* Germs of absorbent vesicles. *f* Vessels and lacteals of villus.

Fig. 12. Diagram of mucous membrane during digestion and absorption of chyle. *a* A villus, turgid, erect; its protective epithelia cast off from its free extremity; its absorbent vesicles, its lacteals and blood-vessels turgid. *b* A follicle discharging its secreting epithelia.

PROCESS OF ULCERATION IN ARTICULAR CARTILAGE.

PLATE I. Fig. 13. *a* A section of articular cartilage and absorbent membrane. In the lower part of the section the cartilage corpuscles retain their natural size and appearance; as they approach the rugged ulcerated edge, they increase in size, and contain numerous young cells, apparently the progeny of their nuclei; beyond this edge, rounded masses of cells, originally contained within the cartilage corpuscules, are seen embedded in the cellular absorbent mass.

b Absorbent cells of the false membrane, with two globular masses derived from the cartilage corpuscules.

SECRETING STRUCTURES.

PLATE I. Fig. 14. Four secreting cells from the ink bag of *Loligo sagittata.*

Fig. 15. Five cells from the liver of *Patella vulgata.* In this instance the bile is contained in the cavities of the secondary cells, which constitute the nucleus of the primary cell.

Fig. 16. Three cells from the kidney of *Helix aspersa.* The contained secretion is dead white, and presents a chalky appearance.

Fig. 17. Two cells from the vesicles of the testicle of *Squalus cornubicus.* The contained bundles of spermatozoa are developed from the nucleus,—each spermatozoon being a spiral cell.

PLATE II. Fig. 1. Five cells from the mamma of the bitch. In addition to their nuclei these cells contain milk globules.

Fig. 2. A portion of duct from the testicle of *Squalus cornubicus.* A few nucleated cells, the primary or germinal cells of the future acini are attached to its walls.

Fig. 3. The primary cell of an acinus in a more advanced stage. The nucleus has produced a mass of young cells. The pedicle appears to have been formed by the germinal cell carrying forward the wall of the duct. A diaphragm accordingly presents itself across the neck of the pedicle.

Fig. 4. A primary cell in a more advanced stage.

Fig. 5. A primary cell still more advanced.

Fig. 6. Some of the secondary cells, products of the

nucleus of the primary cell, are cylindrical, and are arranged in a spiral.

Fig. 7. The change into cylinders, and the spiral arrangement completed.

Fig. 8. *a* One of the secondary cells; its nucleus a mass of young cells. *b* A secondary cell elongated into a cylinder, each cell of its composite nucleus elongated into a spiral. *c* The spiral cells, or spermatozoa, free.

Fig. 9. A bunch of acini, in various states of developement, maturity, and atrophy. The four following figures are diagrams, arranged so as to illustrate the intimate nature of the changes which occur in vesicular glands when in a state of functional activity.

Fig. 10. A portion of gland duct with two acini. One of the acini is a simple primary cell: the other is in a state of developement, its nucleus producing young cells.

Fig. 11. Both acini are advancing; the second has almost reached maturity.

Fig. 12. The second acinus is ready to pour out its contents, the first to take its place.

Fig. 13. The second acinus is in a state of atrophy, the first is ripe.

Fig. 14. Two follicles from the liver of *Carcinus mænas*. The colourless germinal spot is at the blind extremity of the follicle. The secreting cells become distended with bile and oil, as they recede from the germinal spot.

THE STRUCTURE OF THE LYMPHATIC GLANDS.

Plate II. Fig. 15. A portion of the germinal membrane of the human intra-glandular lymphatics, with its germinal spots or nutritive centres diffused over it.

PLATE II. Fig. 16. A portion of the same membrane, in which the component flattened cells, with the centres, have been rendered transparent, and are beginning to separate, by the action of acetic acid. Five of the glandular epithelia adhere to the membrane.

Fig. 17. A diagram of a lymphatic gland, showing the intra-glandular network, and the transition from the scale-like epithelia of the extra-glandular to the nucleated cells of the intra-glandular lymphatics.

Fig. 18. A portion of an intra-glandular lymphatic, showing along one edge the thickness of the germinal membrane, and upon it the thick layer of glandular epithelia.

THE STRUCTURE OF THE PLACENTA.

Fig. 19. The extremity of a placental villus.

a The external membrane of the villus, the lining membrane of the vascular system of the mother.

b The external cells of the villus, cells of the central portion of the placental decidua.

c c Germinal centres of the external cells.

d The space between the maternal and fœtal portions of the villus.

e The internal membrane of the villus, the external membrane of the chorion.

f The internal cells of the villus, the cells of the chorion.

g The loop of umbilical vessels.

Fig. 20. This drawing illustrates the same structures as the last, and has been introduced to show the large space which occasionally intervenes between the internal membrane and the external cells. It would appear that into this space, the matter separated from the maternal blood, by the ex-

ternal cells of the villus, is cast, before being absorbed through the internal membrane, by the internal cells. This space, therefore, is the cavity of a secreting follicle, the external cells being the secreting epithelia, and the maternal blood-vessel system the capillaries of supply. This maternal portion of the villus, and its cavity, correspond to the glandular cotyledons of the ruminants, and the matter thrown into the cavity, to the milky secretion of these organs.

PLATE II. Fig. 21. A portion of the external membrane, with external cells of the villus.

a Cells seen through the membrane.

b Cells seen from within the villus.

c Cells seen in profile along the edge of the villus.

Fig. 22. The extremity of a villus treated with acetic acid. All the parts are distinctly visible, and the germinal centres of the internal cells are seen surrounding the umbilical vessel.

Fig. 23. A villus with a terminal decidual bar, along the cavity of which the external cells are seen to be continued, so as to pass forwards in the direction of the parietal decidua.

PLATE III. Fig. 1. A portion of the external membrane of a villus, with a lateral decidual bar. This portion of membrane is seen from its fœtal aspect, and in this three or four germinal centres of the external cells are perceptible.

Fig. 2. A drawing of the extremity of a villus treated with acetic acid. In this villus all the parts described are distinctly seen, and indicated by the same letters, as in Fig. 19. Plate 2.

Fig. 3. The extremity of a villus, with a terminal decidual bar, treated with acetic acid, to show the nuclei of the decidual cells in the cavity of the bar, and on the external membrane of the villus.

Fig. 4. Two tufts connected by a terminal decidual bar.

Fig. 5. A tuft with a lateral bar passing off from its stem.

Fig. 6. A diagram illustrating the arrangement of the placental decidua.

a Parietal decidua.

b A veinous sinus passing obliquely through it by a valvular opening.

c A curling artery passing in the same direction.

d The lining membrane of the maternal vascular system, passing in from the artery and vein lining the bag of the placenta, and covering *e e* the fœtal tufts, passing on to the latter by two routes, first by their stems from the fœtal side of the cavity, and secondly by the terminal decidual bars *f f* from the uterine side, and from one tuft to the other by the lateral bar *g*. Throughout its whole course this membrane is in contact with decidual cells, except along the stems of the tufts, and the fœtal side of the placenta, where the decidual cells have degenerated into fibrous or areolar fibres. All that portion of the decidua which is in connection with the bars, villi, and tufts, is the central or functional portion of the decidua, and along with the lining membrane of the maternal vascular system, or external membrane of the tufts, constitutes the true maternal portion of the placenta.

h h Two diagrams illustrating the fœtal cellular elements of the placental tufts. These are the internal membrane, and the internal cells of the tufts, and along with the loops of umbilical blood-vessels constitute the true fœtal portion of the placenta.

THE TESTIS AND ITS SECRETION IN THE DECAPADOUS CRUSTACEANS.

Plate IV. Fig. 1. Figures of Entozoa from the tubuli semeniferi of *Orchestia littoralis*, probably allied to filaria, and supposed by M. Kölliker to be the spermatozoa. This opinion, however, is incorrect, as may be seen in the accompanying drawings, where figures are given representing all the details of the developement of the true spermatozoa. These are all produced from cells, whereas the entozoa under consideration are never seen within cells, but are in all cases generally seen floating free in the seminal vessels. These filaria have only been seen, so far as I am aware, in Amphipoda and Isopoda. If they are spermatozoa, they must be produced from cells; and from what has been stated in the text, it will be seen that in all the crustacea, these cells, before producing the spermatozoa, undergo several metamorphoses; and that the final changes take place in the spermatheca of the female, where the seminal animalcules are produced. In Amphipoda, and Isopoda, where these supposed filaria exist, we always find them high up in the testicle, and not occasionally, but in great numbers. In the tertiary seminal cells also, which are floating about among them, not the slightest vestige of the worm can be observed. I am inclined to suppose, therefore, that these thread-like worms, supposed by Kölliker to be spermatozoa, are only parasites.

PLATE IV. Fig. 2. Representation of a primary germinal cell projecting from the wall of the seminal tube. It has just burst, and the young secondary cells are escaping and descending the tube; during the descent they increase in size, from their nucleus throwing off nucleoli, the latter forming the tertiary generation. In this figure it will be observed that the cell walls of the parent are quite smooth and unbroken, so that in all probability the young arise from that portion of the cell attached to the seminal tube.

Fig. 3. Is a small quantity of the fluid from the spermatheca of the female crab, showing the tertiary or spermatozoal cells after they have burst from

the secondary. As described in the text, the spermatheca appears to be the organ in which the seminal fluid undergoes the final and essential change which fits it for impregnation.

PLATE IV. Fig. 4. This figure shows the adult seminal secondary cells from the dilated part of the seminal tube. They are full of tertiary cells. The fluid amongst which they are floating is thick and albuminous, much more so than it is higher up or lower down the tube, and the large, clear, transparent looking masses, are the pabulum for the nourishment of the cells. It is much more abundant in this part of the organ than any where else, and accordingly great numbers of the secondary cells in all stages of developement, are constantly found here. If a small quantity of the seminal fluid from that portion of the testicle immediately preceding the dilated part, be placed under the microscope, it will be seen that the nuclei of the secondary cells are just throwing off small nucleoli, and that the parent cell is not very much larger than when it burst from the primary. In the same part also, little or no pabulum is observed. As we proceed downwards, however, we find them increasing rapidly in size; and, at the same time, an immense quantity of pabulum floating about in large masses. The lower part of the tube and the vas deferens are almost destitute of pabulum, the cells being satiated.

Fig. 5. Is the secondary cells of *Hyas araneus* from the vas deferens. The walls of the parent cells, it will be observed, are remarkably thin. The parent secondary cells are of enormous size in this species.

Fig. 6. Represents the testicles of *Carcinus Mænas*, of the natural size, and shortly before they have reached the maximum state of developement. The portion included between *a a* is the tubular or hepatic,

that between *b b* is the dilated or gastric. The vasa deferentia are not seen in this species so well as in *Hyas araneus*, Fig. 8, *c c*. It is in the gastric division that the pabulum lies in such quantities.

PLATE IV. Fig. 7. Is the internal or sheathed portion of the external organs of *Cancer Pagurus*; proximal extremity.

Fig. 8. Testes of *Hyas araneus*. *a a* Tubular portion. *b b* Follicular portion. *c c* Vasa deferentia.

Fig. 9. External organs of *Cancer Pagurus*. *a* Is the internal or sheathed portion *in situ*. *b* Is the sheath or external portion.

Fig. 10. External organs of *Hyas araneus*. *A* Sheath. *B* Sheathed portion.

PLATE V. Fig. 1. First stage of developement of secondary seminal cell of *Galathea strigosa*.

Figs. 2, 3, 4, Second, third, and fourth stages of developement of the secondary cell.

Figs. 5, 6, 7, 8, 9, 10, 11, 12, 13, Various stages of developement of the secondary cell of lobster.

Figs. 14, 15, 16, 17, The same treated with acetic acid.

Fig. 18. Tertiary or spermatozoal cells.

Fig. 19. Secondary cell of lobster seen from armed extremity, to show the three setæ.

Fig. 20. Primary cell, or cœcum of testicle of *Pagurus Bernhardus* full of secondary cells. *c* Attachment, *b* Free extremity. *a* Nucleus.

Fig. 21. Primary seminal cell of *Pagurus Bernhardus* filling with secondary cells. As already described, these cells grow in pairs from discs on the walls of the seminal tubes, and hang free in the cavity of the tube. It has also been described how the secondary cells are produced from the parent nucleus, namely, by means of successive growths, each of which carries off a fold of the nucleus before it.

a Disc from which the primary seminal cells grow.

b b The discs on each side of it.

c c The origins of the primary seminal cells.

d One of the primary cells cut off.
e Nucleus of the primary cell in a state of activity; it has just thrown off a series of young marked
f In the diagram.
g g Are several old walls of former growths.
h Full extremity of primary cell.

PLATE V. Fig. 22. A small portion of the testicle of *Pagurus Bernhardus* magnified, showing the manner in which the cæca hang from the walls of the seminal tube.

Fig. 23. Small drop of seminal fluid of lobster, showing the secondary cells before the armature had expanded.

Fig. 24. Small drop of seminal fluid of lobster from vas deferens. That part of the figure above *a a*, as seen under the microscope, presents one dense mass of secondary cells floating down towards *b*, where a few are seen separate.

Fig. 25. A cœcum from the testicle of *Carcinus Mœnas*, showing a germinal spot at its apex just being filled with secondary cells.

Fig. 26. The germinal spot enlarged.

REPRODUCTION OF LOST PARTS IN THE CRUSTACEA.

PLATE VI. Fig. 1. Represents the raw surface of the proximal or adherent portion of the leg of *Cancer Pagurus*, after the animal has thrown off the distal portion. The figure represents the parts of the natural size, and only a few hours after the separation had taken place.

Fig. 2. Is a representation of the same part, after the young leg had grown to some size. It will be observed, that the cicatrix, which was formed upon the raw surface a few hours after separation, has

now become very strong, covers the young germ, thus acting as a means of defence from external injury.

PLATE VI. Fig. 3, 4, 5, Are the same parts in progressive states of developement. Fig 5. presents a bifurcated character, probably from some accidental cause it thus appears smaller than it is in the normal state.

Fig. 6. Represents the raw surface of the leg, already alluded to, in *Carcinus Mœnas,* some time after separation. A nucleated cell is seen in the centre. This drawing was made from a very small specimen, and was only procured in the stage represented after great difficulty.

Fig. 7. Represents a longitudinal section of a very young germ, for the purpose of showing its mode of developement. The fibrous looking band which surrounds it externally, is a circular canal which belongs to a system of vessels described in the text. The four striated bodies which lie next to this canal are the rudiments of the four joints of the future limb. The striated appearance arises from the muscles already so far developed, and the albuminous matter within, and which they enclose, appears to be pabulum for their farther nourishment. The more defined globules, which may be observed floating amongst the albumen, are oil globules. In the developement of this leg, it will be observed that the external segments, or those which are analogous to the thigh and first tibial joints, are largest, and most fully formed,—a fact we would be led to expect, from the circumstance of their formative cells being the first thrown off from the original parent nucleus, and consequently the first that would take on a central or more independant action. From a similar mode of developement, we see that the second tibial and tarsal joints are the smallest, as they are the last formed of the

centres. The last or distal phalanx is the smallest of the internal segments ; those nearest the circular vessel are the largest, as was to be expected from the centres which formed them, being the oldest and the first formed from the earlier generations of cells ; and those again within them are smaller, being formed from the later generations thrown off by the original parent.

PLATE VI. Fig. 8. Cells from the external series represented by *c* in Fig. 9.

Fig. 9. Transverse section of raw surface of proximal or attached extremity of the reproductive organ in leg of *Cancer Pagurus.* This is the surface and appearance which is seen immediately upon the leg falling off; if it is seen half an hour, or a little more, after the separation, it is covered with a thickish film, which shortly becomes a strong opaque cicatrix hiding every thing beneath it. The vessels seen in Fig. 15 are also omitted, for the purpose of showing the structure of the reproductive body more clearly.

a Is the circular vessel, of the system of vessels mentioned in the text, and it surrounds

b A fluid or semi-fluid mass, containing small nucleated cells, from which the germ is probably derived.

c c Is a large mass of very large cells surrounding the circular vessel, which appear to act as a magazine of nutritive matter for the young germ during its growth.

d Is the shell membrane, which is surrounded externally by the shell.

Fig. 10. A young limb of *Carcinus Mœnas* still enclosed within its original cyst, which is formed probably from the cicatrix mentioned above. Magnified two diameters.

Fig. 11. Is a very young leg of the common lobster. The reproduced leg of this species is not enclosed in a cyst, and it is not folded upon itself, but projects straight forward. Nat. size.

PLATE VI. Fig. 12. Is a figure of the natural size of one of the large claws of *Pagurus Bernhardus*, shortly after it has burst from its containing cyst.

Fig. 13. Enlarged view of Fig. 11.

Fig. 14. One of the large claws of *Carcinus Mœnas* still enclosed within the eyst. From observations made, it appears that these young legs remain within the cyst until their own covering or shell is of sufficient strength to act as a means of defence. They do not obtain a true shell for some time after the cyst has burst.

Fig. 15. Raw surface of proximal extremity of leg in *Cancer Pagurus*, shortly after the animal has thrown off the distal portion. This figure is made for the purpose of shewing the distribution of the peculiar vessels, and their mode of running from the circumference towards the circular vessel in the centre.

Fig. 16. Longitudinal section of young leg still within the cyst.

a a Part of old leg containing the reproductive organ.

b b External cells.

c Smaller nucleated cells.

d d Cyst of young leg.

e Femur of young leg.

f First tibial joint of young leg.

g Second tibial joint.

h Tarsal joint.

Fig. 17. Natural size of young leg.

Fig. 18. Portion of blind extremity of one of the peculiar vessels which are attached to the blood-vessel running to the leg, Plate ix. Fig. 14. The contents are oil globules, but in the figure have somewhat the appearance of nucleated cells.

Fig. 19. An enlarged view, for the purpose of showing the connection of these vessels.

Fig. 20. Two of the blind extremities from raw surface of leg, where they present a clavate appearance.

Fig. 21. View of the extremity, shewing the dark spot supposed to be a germinal spot.

PLATE IX. Fig. 9. Small longitudinal portion of shell from the large claw of *Cancer Pagurus*, showing the thickness of the annulus or ring in it at the point of separation.

Fig. 12. Longitudinal section of one of the legs of *Cancer Pagurus*, shewing the natural position and relations of the reproductive organ.

a a Femur.

b b Reproductive organ.

c Natural appearance of line of separation.

d Coxa.

Fig. 13. Enlarged foramen as it is seen on raw surface after the separation. This has been hardened in boiling water, which gives it a much more defined appearance, and also enlarges it more than it naturally should be.

Fig. 14. Is a small portion of the femoral artery, about half an inch in extent beyond the line of separation, which is covered as represented by the peculiar vessels.

a Distal extremity of blood-vessel.

ON THE ANATOMY AND DEVELOPEMENT OF THE CYSTIC ENTOZOA.

PLATE VII. Fig. 1. Magnified view of one of the young of *Acephalocystis armatus* still attached to the germinal membrane of a secondary parent. It is taken from the group shewn in Fig. 2, and is still in an early stage of developement, the circlet of teeth still being minute and not fully developed. The absorbing series of cells may be seen internally.

Fig. 2. Small portion of the germinal membrane of a secondary parent of *Acephalocystis armatus* highly magnified.

Fig. 3. Small portion of germinal membrane of *Acephalocystis armatus* in a state of degeneration; no-

thing is seen in the membrane, which is quite homogeneous, except the small cells figured *a a*.

b Is the commencement of one of the cretaceous fatty masses described in the text.

PLATE VII. Fig. 4. Several of the stages of developement of Cysticercus.

a First stage represents spines; hardly if at all seen.

b Their first decided appearance.

c Third stage.

d Fourth stage.

Fig. 5. Small portion of the germinal membrane of *Acephalocystis armatus.*

Fig. 6. Small portion, highly magnified, of the granular matter from the cyst of Cysticercus.

Fig. 7. Small portion of the inner surface of the external membrane of *Acephalocystis armatus* while in a state of degeneration.

Fig. 8. Ovum from the pedicle of Cysticercus.

Fig. 9. Small portion of the germinal membrane of *Acephalocystis Monroii*, highly magnified.

a a Fibrous basis.

b b Germinal vesicles.

c c Secondary acephalocysts within the germinal vesicles; this portion was taken from the large parent cyst which is the primary animal, buried in the liver; and each of the smaller vesicles marked *c c c* belong therefore to the secondary generation, their progeny again being the tertiary generation.

Fig. 10. Is a specimen of *Cysticercus neglectus* ruptured at the fundus of the sac, apparently for the escape of the young germs into the cavity of the cyst, where they become attached.

Fig. 11. Small portion of the cyst of *Cysticercus neglectus* magnified, shewing its vascularity, and the mode of attachment of the young Cysticerci to its internal surface.

Fig. 12. View from above the pedicle of Cysticercus, shewing the disposition of the teeth. In all works hitherto published on Helminthology,

there has been a great want of proper figures or descriptions of the true generic and specific characters of these animals, a point of the utmost importance for the obtaining of a proper knowledge of them: with this view the Author has paid scrupulous attention to the leading characters, and these he has placed in the form of a synopsis at the end of the Chapter. All the drawings have been made with the view of illustrating these characters more fully. The disposition of the teeth, and their forms, are perhaps the most certain external characters.

PLATE VIII. Fig. 4. Magnified view of a small portion of the external or tubular membrane of *Diskostoma acephalocystis*.

a Larger disc.

b Smaller one on its surface.

c Tubuli.

d Extremities of tubes.

e e Gemmules, which at this stage of developement may act as absorbents.

Fig. 5. Natural size of *Diskostoma acephalocystis*.

Fig. 6. *Diskostoma acephalocystis* in various stages of developement.

a a a Small cells arising from the attached surface of the tubular membrane. This is the manner in which the original group increases in size.

b More advanced.

c First stage of second mode of developement, or that for the extending of the parasite to as yet uninfested parts of the body, for the purpose of forming new groups.

d Second stage.

e Third stage.

f Root where the original germ became fixed.

g External or tubular membrane.

Fig. 10. Section of *Astoma acephalocystis*, showing its internal structure.

PLATE IX. Fig. 1. Portion of sac of cysticercus, much magnified.

a a Absorbing cells of absorbing membrane.

b b Separate ova, after their escape from the pedicle.

Fig. 2. *Cysticercus neglectus* very much magnified.

Fig. 3. Small portion of omentum containing *Cysticercus neglectus*, showing the bodies considered young Cysticerci attached, the omentum has been folded over, and the young are seen attached to the fold.

Fig. 4. The natural size of the animal supposed to be a new Cænurus. *Cænurus hepaticus*.

Fig. 5. Magnified view of the head of *Acephalocystis armatus* in a more advanced stage than the former figure.

Fig. 6. The germinal membrane from which it was taken.

Fig. 7. The absorbing membrane of cyst of *Cysticercus Rattus* highly magnified.

Fig. 8. Teeth of *Cysticercus Rattus* highly magnified.

Fig. 10. Ovum of *Cysticercus Rattus* highly magnified.

Fig. 11. Ova from pedicle of *Cysticercus Rattus* highly magnified.

PLATE III. Fig. 8. *Gymnorhynchus horridus* within its cyst.

Fig. 9. ——————— exposed.

Fig. 10. First stage of *Cœnürus cerebralis*.

Figs. 11, 12, 13, 14, Second, third, fourth, and fifth stages of the discoidal period of developement of *Cœnurus cerebralis*.

Fig. 15. One of the first stages in the vertical period of developement.

Fig. 16. *Sphairidion acephalocgstis* highly magnified.

Fig. 7. *Neuronaia Monroii.* (J. Goodsir.)

a Suctorial mouth.

b Acetabulum.

c Orifice of organs, supposed to be reproductive.

d Posterior orifice, by which the sigmoidal "cisterna chyli,"

e Opens, and apparently also,

f The thick walled peculiar sac.

g Pyriform sac, a receptacle for the ova.

i Male organs.

The figure also presents the arrangement of the dermal spines, and the general form of the animal.

PLATE VIII. Fig. 2. The anterior extremity and suctorial mouth of *Neuronaia Monroii* more highly magnified.

Fig. 7. The cyst of *Neuronaia Monroii* in a bundle of nervous filaments. The fissured appearance of the cyst, with its epithelia, are represented in this drawing.

I am inclined to believe that the function of the cyst in this and the other Cystic Entozoa is to supply nourishment to the enclosed animal, drawing it from the surrounding parts, and throwing it into the cavity, the structure and action being identical with that in the encysted tumours, as already described.

The bulbous extremities of the cysts of *Trichina spiralis* contain masses of germinating cells, to which I am inclined to attribute the same function.

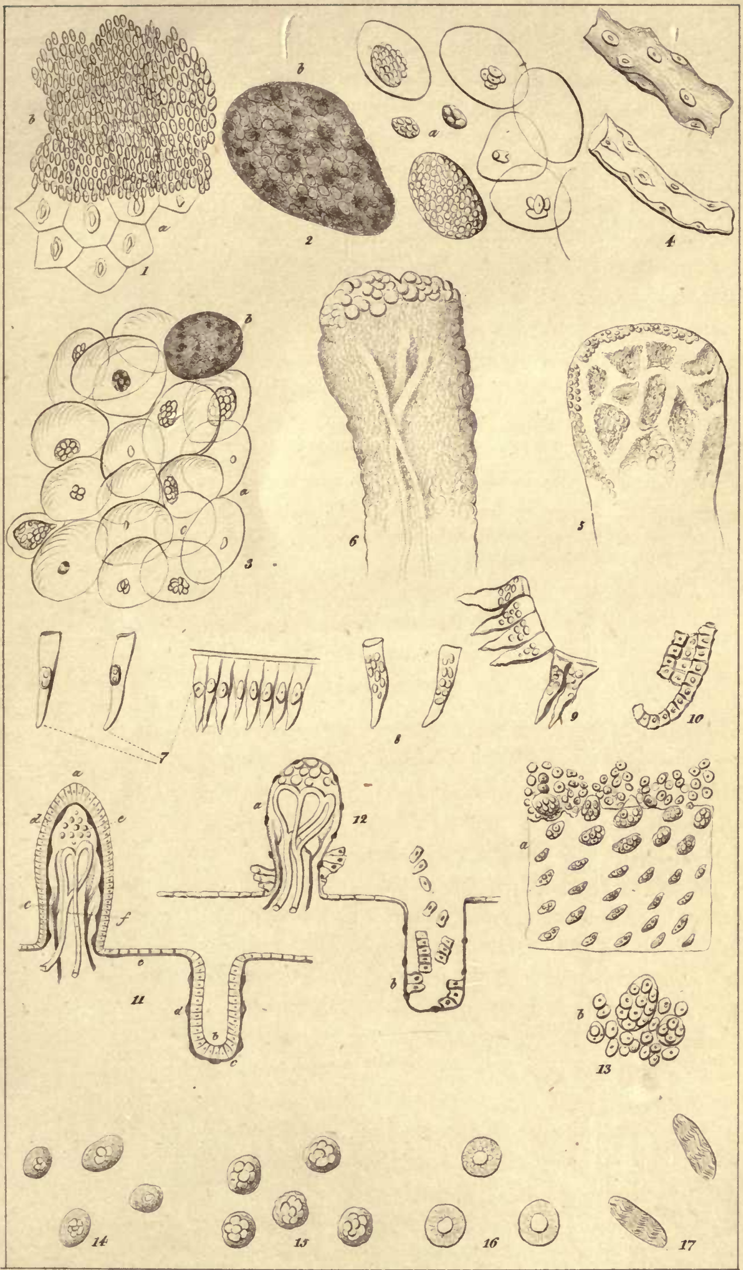
Fig. 8, 9, 11. The clavate extremities of the cysts of *Trichina spiralis*, with their germinating absorbent cells.

The epithelium and absorbent cells of the cysts of the entozoa may be considered as permanent yelk-cells, in the economy of these persistent embryoes.

Figs. 1, and 3. Magnified drawings of *Sarcena Ventriculi* described, but badly figured by me in the Edinburgh Medical and Surgical Journal, No. 151. I am still of opinion, notwithstanding the arguments of Mr. Busk, in the Microscopical Journal, that this body is a vegetable parasite, its sudden occurrence and sudden disappearance being not more extraordinary than the rapid developement of many cellular structures; the glandular epithelium, for instance, during secretion. That it is a Gonium, as has been suspected by Professor Link, appears to me improbable, as would be admitted, I believe, by that great botanist, if he had had an opportunity of observing its peculiar vegetable aspect, so different from that of an infusorial animal.

ERRATA.

Page 11, line 30—for febril, *read* fibril.
Page 14, line 21—for obsorbent, *read* absorbent.
Page 17, line 3—for accessary, *read* accessory.
Page 52, line 24—for rotation, *read* relation.



John Goodsir del.t

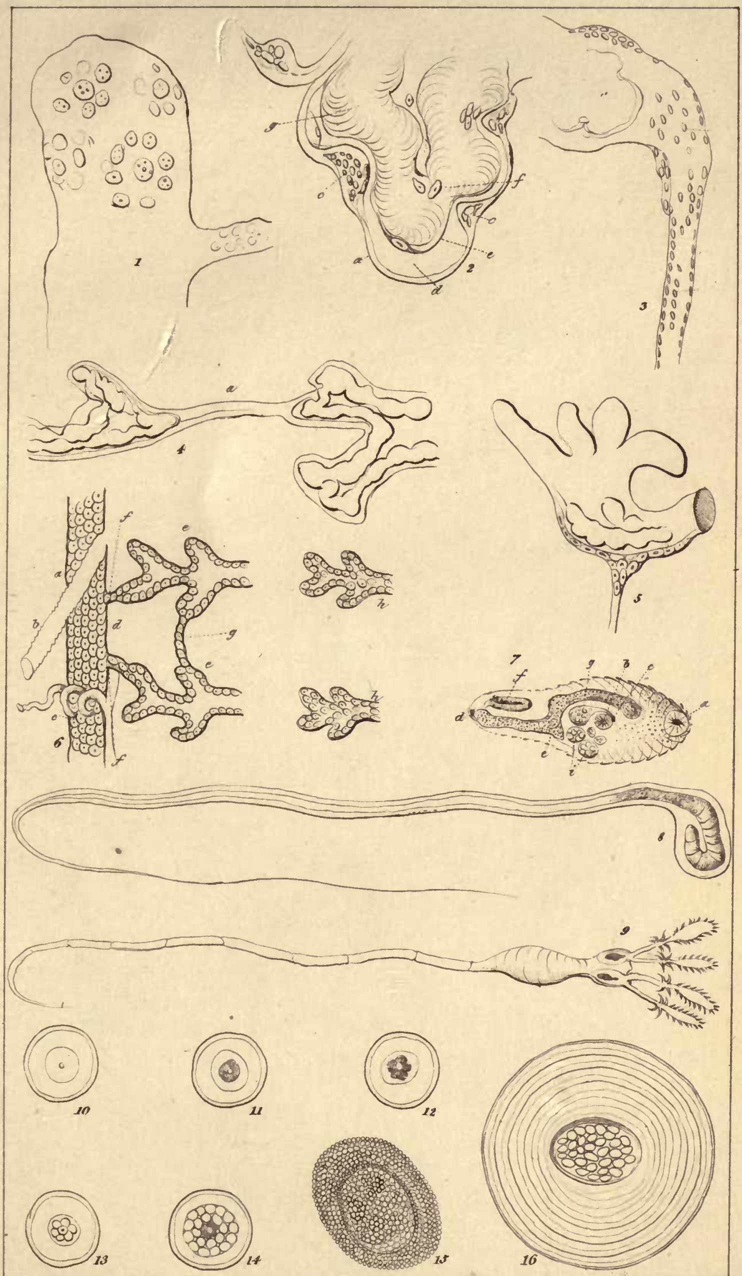
Fr. Schenck, lith. Edin.r

PL. II.

John Goodsir del.

Fr. Schenck, Lith^{r} & Print^{r}

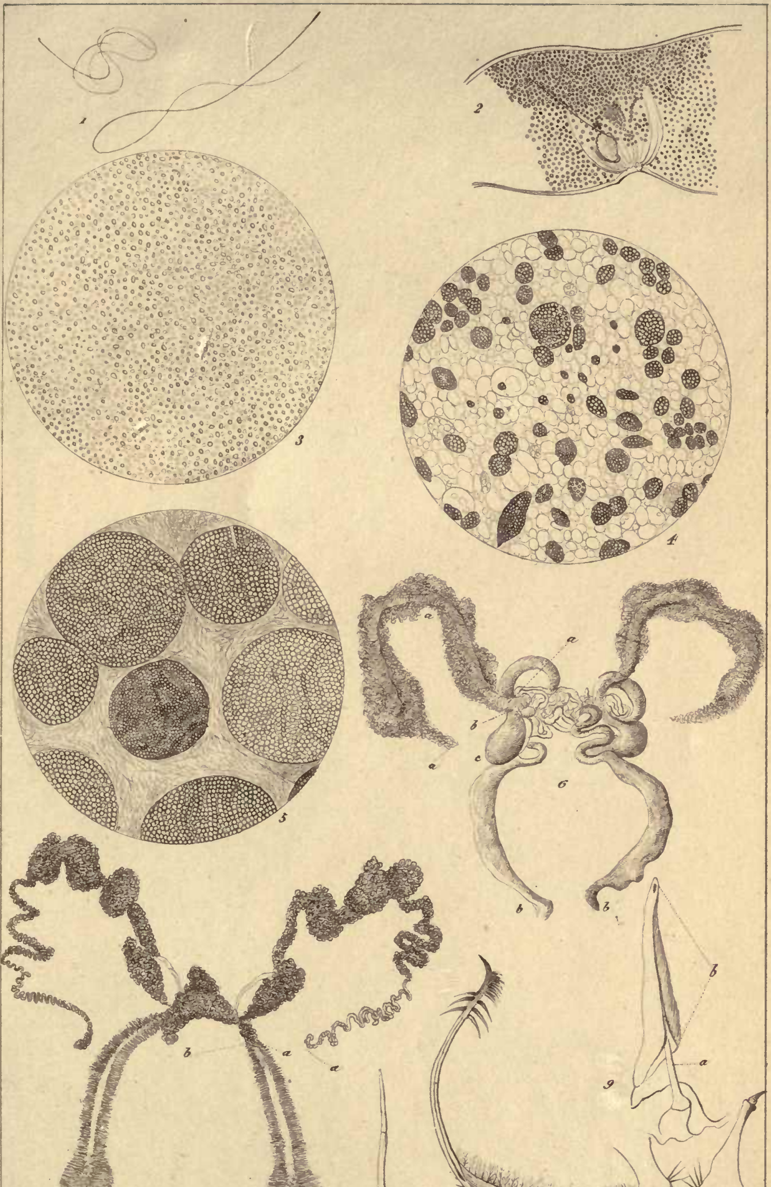
PL. III.



John Goodsir del.t

Fr. Schenck, Lith.

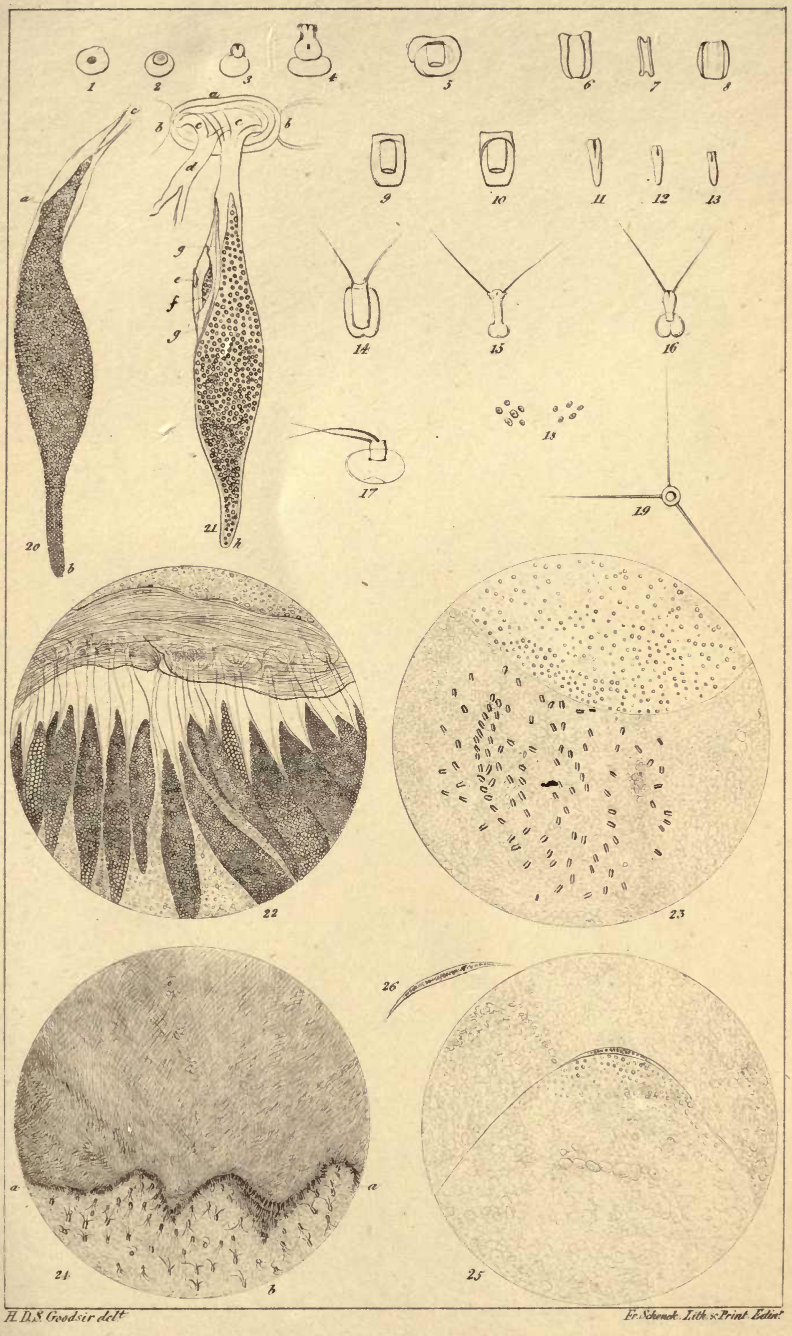
PL. IV.



H. D. S. Goodsir del.t

Fr. Schenck, Lith. & Print. Edin.r

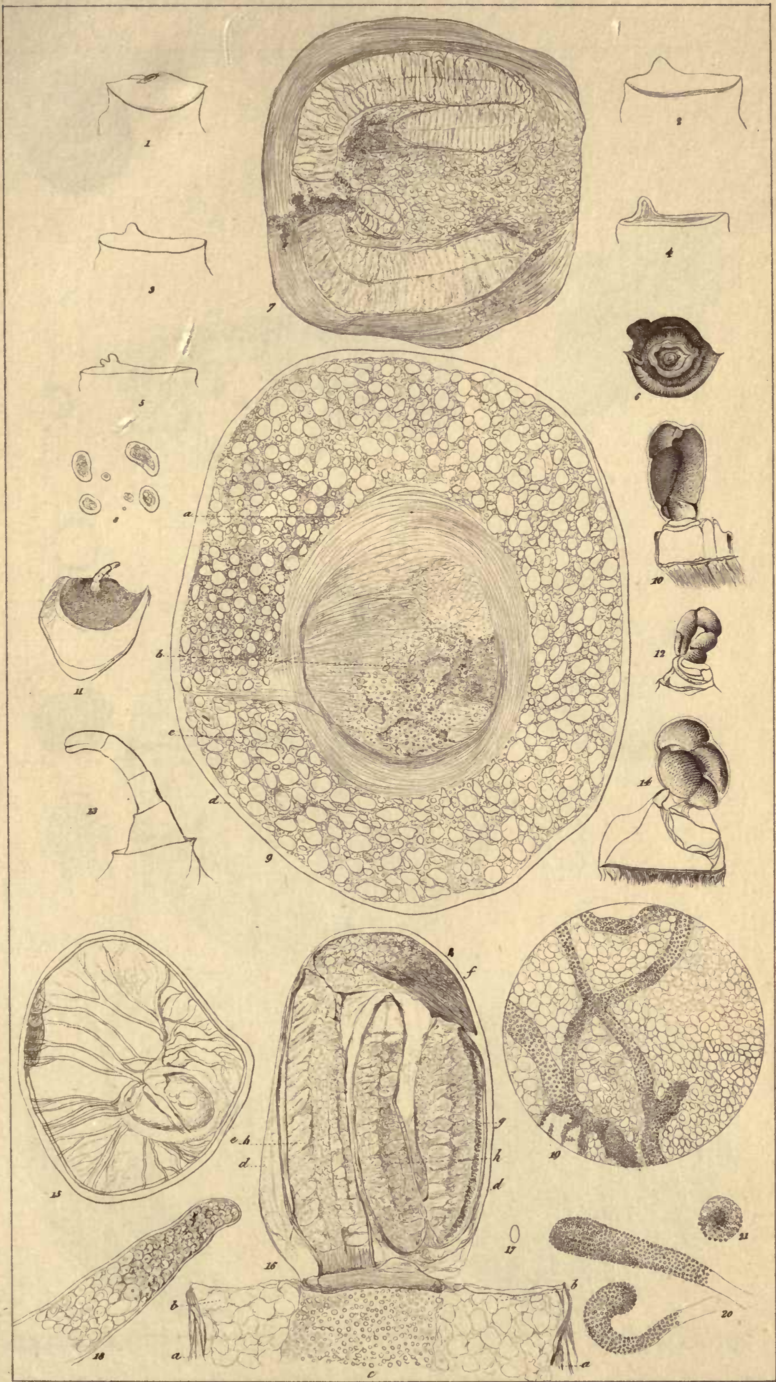
PL. V.



H. D. S. Goodsir delt.

Fr. Schenck. Lith. & Print. Edin.

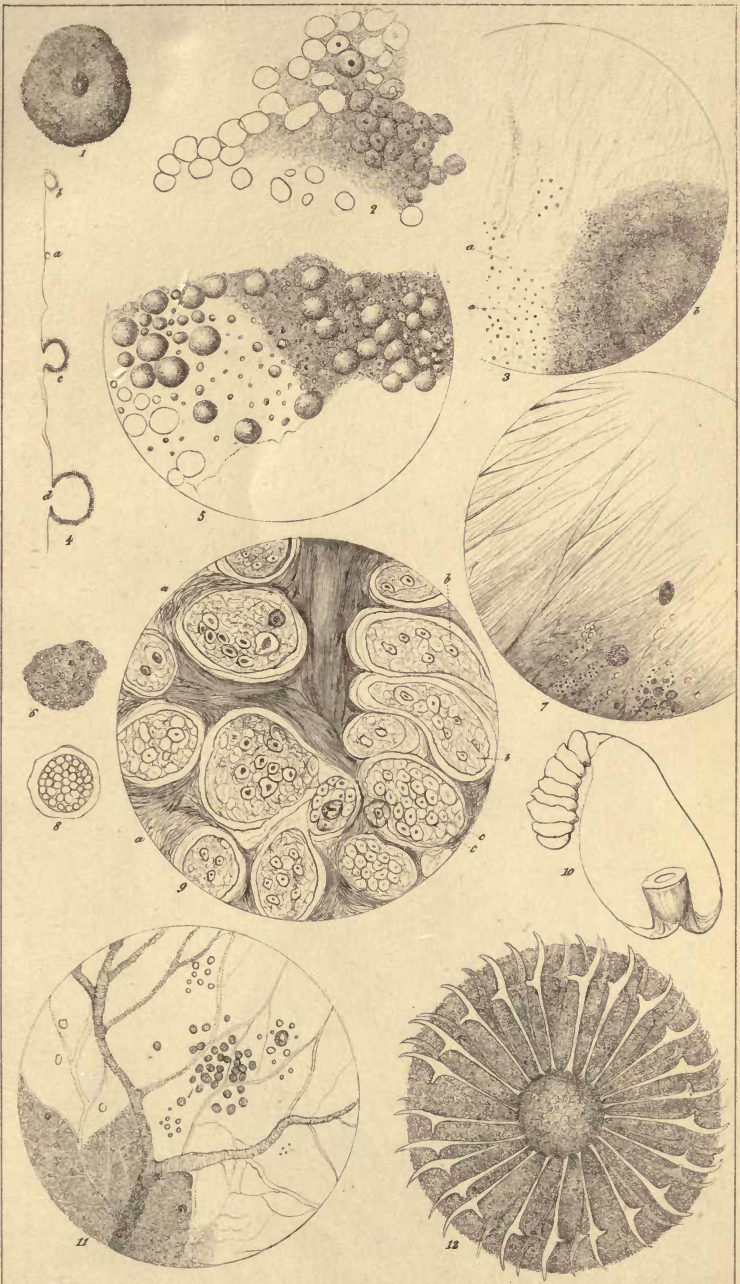
PL. VI.



H. D. S. Goodsir del.t

Lith.r & print.d by F. Schenck Edin.r

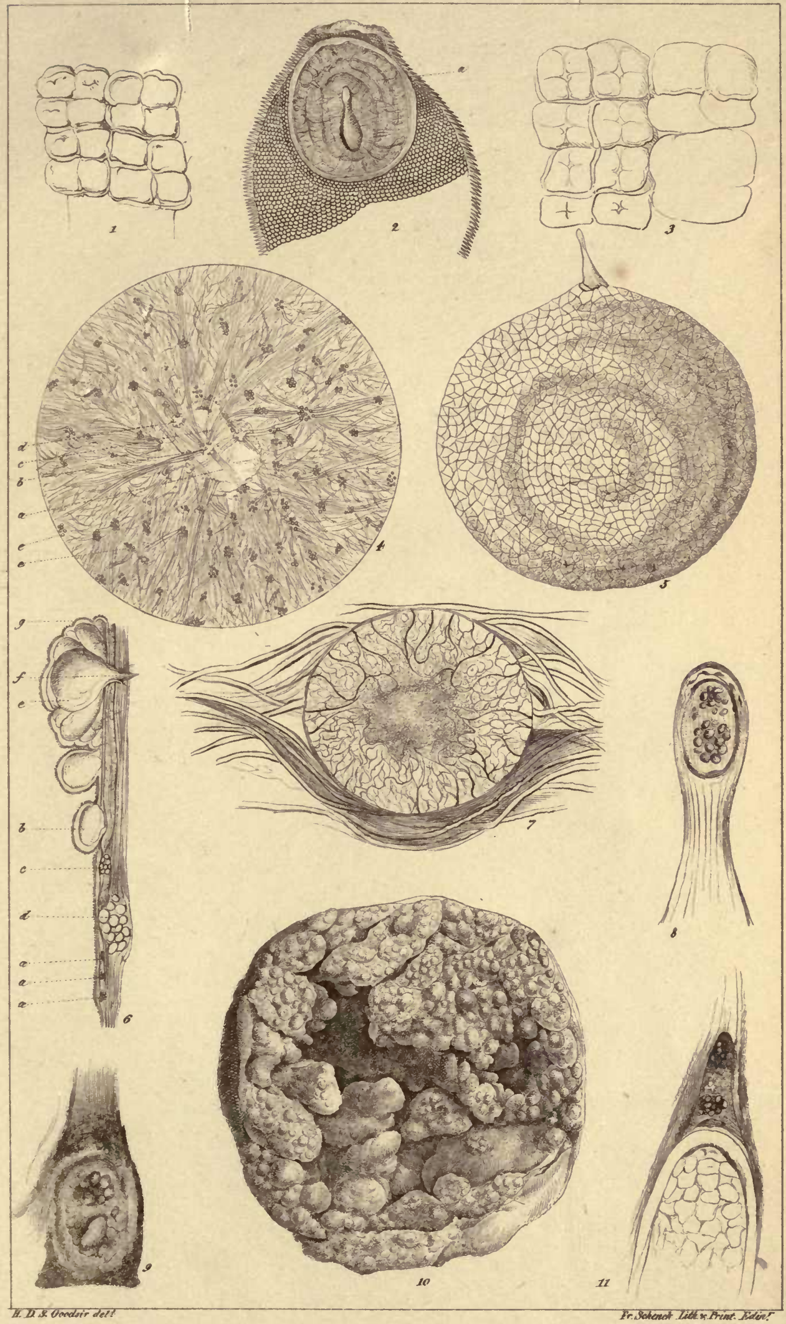
PL. VII.



H. D. S. Goodsir del.t

Lith.d & print. b. Fr. Schenck.

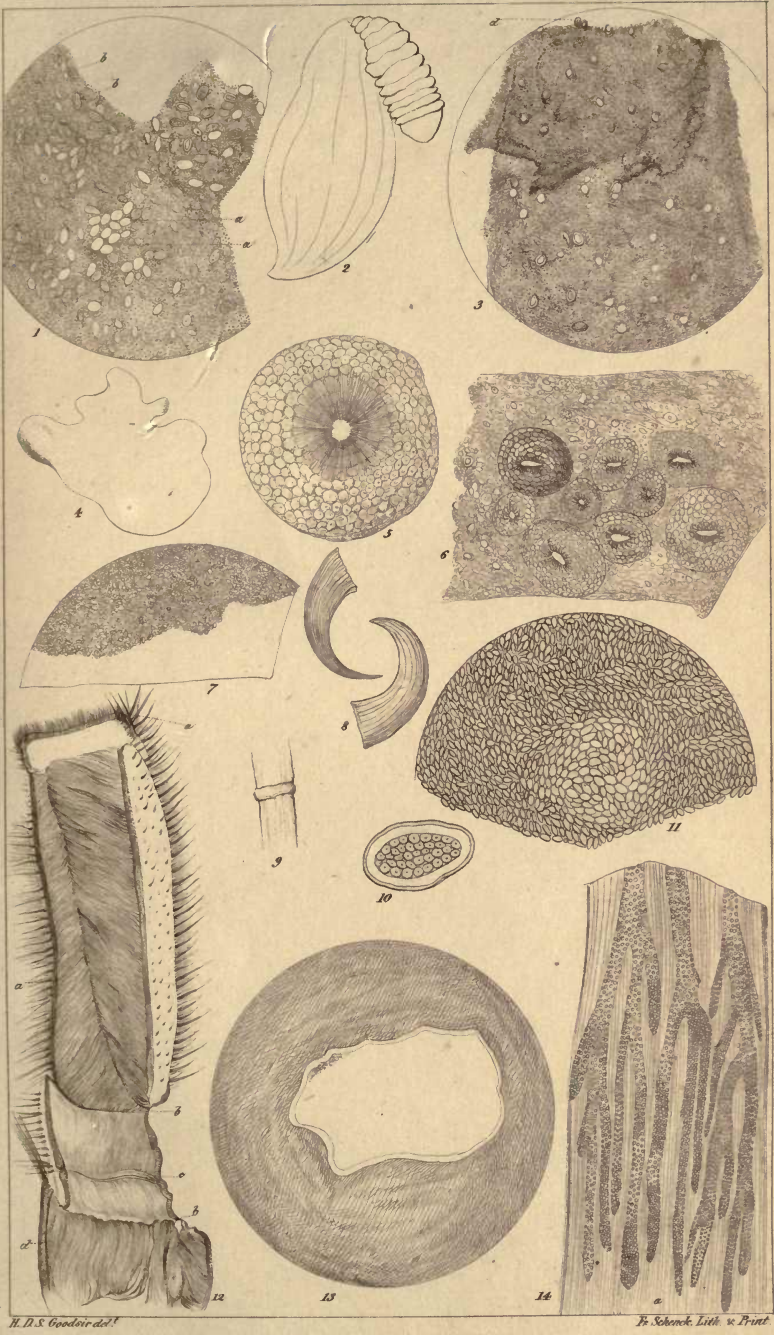
PL. VIII.



H. D. S. Goodsir del.

Fr. Schenck Lith. & Print. Edin.

PL. IX.



H. D. S. Goodsir del.t

Fr. Schenck. Lith. & Print.

IN THE PRESS.

A SYSTEM OF DISSECTIONS,

BY JOHN GOODSIR,

DEMONSTRATOR OF ANATOMY IN THE UNIVERSITY OF EDINBURGH.

This Work will appear in Parts, each of which will be complete in itself.

The first five Parts will comprehend the Dissection of the Human Body, as usually conducted in the Schools, and will form a Dissecting Manual. The succeeding Parts will contain more minute Dissections of particular regions; the Mode of Dissecting and Developing the Structure of the Viscera, with Descriptions of these in their healthy and more important morbid conditions.

Each Part will contain Plans, or simple outline Drawings, arranged so as to serve as Guides in each Stage of Dissection.

The Whole will form a progressive Series of Studies for the Dissecting Room.

CRUSTACEOLOGICAL RESEARCHES,

A Series of Quarto Drawings on Stone,

WITH LETTERPRESS ILLUSTRATIVE OF THE ANATOMY, DEVELOPEMENT, AND ECONOMY OF THE CRUSTACEA, INCLUDING THE CIRRIPEDS.

BY HARRY D. S. GOODSIR.