Fig. 1.

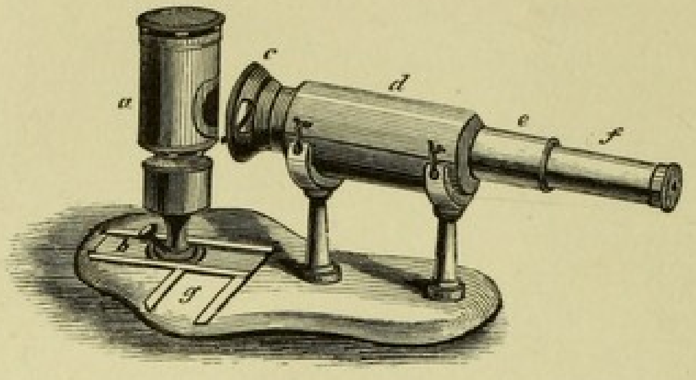


Fig. 2.

Fig. 3.

GERMINAL MATTER AND FORMED MATERIAL.

To illustrate the supposed structure of germinal matter, and the mode of deposition of formed material in elementary parts of different tissues.

Fig. 4.

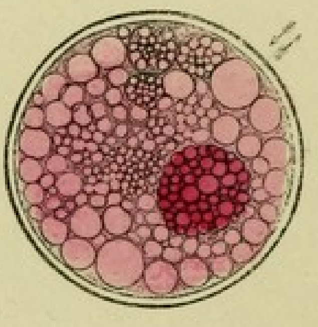


Fig. 5.

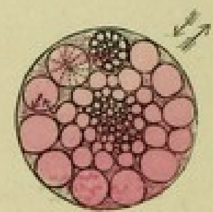


Fig. 6.

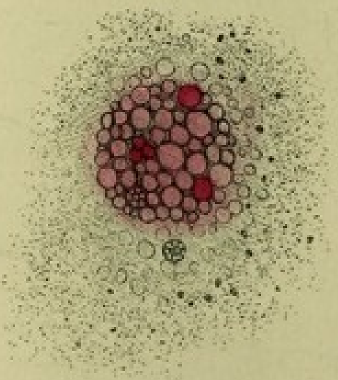


Fig. 7.

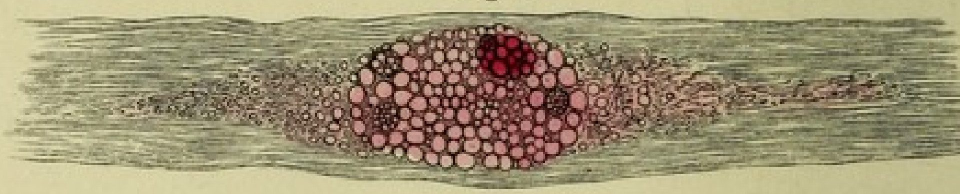


Fig. 8.

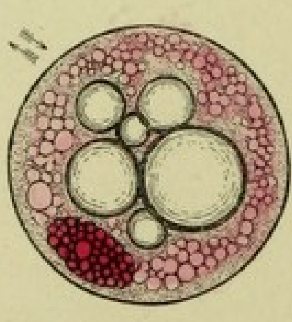


Fig. 9.

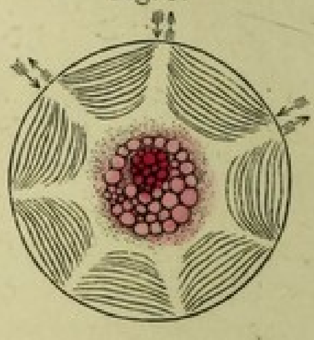


Fig. 1.—The Microscope. Fig. 2.—The Lamp. Fig. 3.—Mirror for use in day-time. Fig. 4.—An elementary part. Spherical particles of germinal matter composed of smaller spherules. The smaller spherules are only represented in one or two instances. The quiescent portion of the germinal matter (nucleus) is indicated by the dark outline of the spherules. Fig. 5.—Supposed structure of one of the smallest component spherules of Fig. 4, very highly magnified. Fig. 6.—Germinal matter and formed material of a structure like the liver cell. At the outer part the formed material is gradually being resolved into biliary, and other constituents. Fig. 7.—Germinal matter and formed material of ordinary tendon. Fig. 8.—Diagram to show the manner in which fatty matter and other substances resulting from changes occurring in the germinal matter, accumulate in its central part. The germinal matter at last forms a very thin layer between these particles and the formed material of which the investing membrane or cell wall is composed. Fig. 9.—Diagram to show the manner in which the pores in certain vegetable cells, and the canaliculi of bone are left during the deposition of hard matter from without inwards.

MICROSCOPICAL SPECIMENS,

ILLUSTRATING

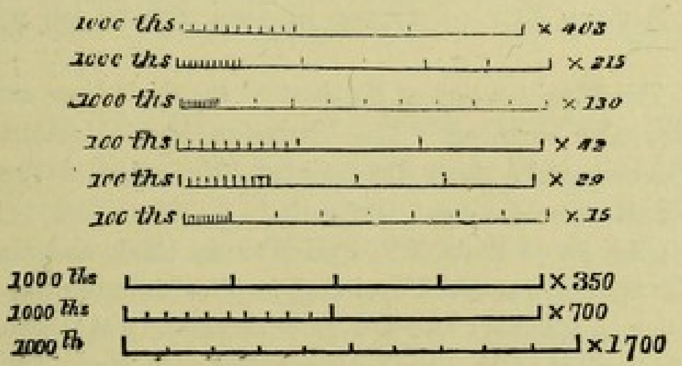
DR. BEALE'S LECTURES

AT THE

ROYAL COLLEGE OF PHYSICIANS,

1861.

SCALES OF MEASUREMENT MAGNIFIED BY DIFFERENT POWERS.



LECTURE I.

APRIL 8TH.

Prep. 1. *Three simple papillæ from the tongue of a child,* 10 *years of age.* The epithelium has been removed. The capillaries are filled with *Prussian blue* injection. Numerous small oval bodies are seen connected with the walls of the vessels, and others pass over them in different directions. Many similar nuclei are seen between the walls of the capillaries and the surface of the papilla, from which the epithelium has been removed. They are connected with the nerve fibres, which cannot be seen with a power of 130. × 130.

Prep. 2. *Muscular fibres with capillaries and nerve fibres from the tongue of the white mouse* (not clearly demonstrable by a power of 215). The great majority of the very numerous oval bodies belong to the capillaries and nerve fibres. × 215.

Prep. 3. *Thin section from the central part of the tongue of a mouse recently killed.* It is immersed in very weak glycerine. *The vessels and* *smaller nerve fibres cannot be seen, and very few of the oval bodies are observable.* The greater part of the tissue about the muscular fibres appears to consist of *fibrous or connective tissue,* and no one would believe that the capillaries so clearly seen in the last specimen, are actually present here. × 30.

Prep. 4. *A thin section from the same part of the tongue of a mouse injected with Prussian blue, and soaked in carmine.* The "indefinite connective tissue" of the last specimen is seen to contain an immense number of *capillaries* and *fine nerve fibres,* and the connection of the *oval bodies* (binde-gewebs-körperchen, areolar tissue corpuscles), with capillaries and nerve fibres is clearly demonstrated. × 215.

These specimens illustrate the general appearance of the capillaries when injected with *Prussian blue,* and those parts of the tissues which are in an active state (the nuclei of some authors, cells of others) which appear as little oval bodies when stained with *carmine,* prepared according to the plan I have alluded to. The importance of careful preparation is proved by the two last specimens. The relations of the oval bodies cannot be demonstrated without the use of coloring matters, and in Prep. 3 very few of these bodies are to be made out.

Prep. 5. *Terminal portion of the duct of the pig's liver and its continuity with the cell-containing network.* The *Prussian blue* injection has filled the finest ducts and penetrated a short distance into the tubes of the cell-containing network, where it is seen amongst the cells. × 215. This is the preparation which is copied in fig. 28 of Plate XV, Phil. Trans., 1856, and fig. 229, page 478, Vol. II, of Todd and Bowman's Physiology. The drawing has been curiously distorted by Budge in Reichert and Du Bois Raymond's Archives, plate XVIII, page 642, to suit his view of the arrangement of the ducts.

Prep. 6. *A corresponding preparation from the human liver.* × 130.

Prep. 7. *Thin section from the human liver.* The *capillaries* of the lobule have been injected with *Prussian blue,* and in many places the walls of the capillaries can be seen to be distinct from the tubes of the cell-containing network. Here and there a slight interval is observable. × 215.

Preps. 5 and 6 show that the *ducts of the liver* are continuous with the *tubes of a network containing the liver cells,* which alternates with the capillary network, and Prep. 7 proves that these networks are *distinct in the centre, as well as at the circumference of the lobule.* The relation of the capillaries to the glandular elements is the same as in other glands, and the liver may be included in the same category as the other glands with permanent ducts,—and it is of all, the most perfect type of gland structure.

LECTURE II.

April 15th.

Prep. 8. *Section of a healthy liver. Portal vein injected with carmine, hepatic vein with Prussian blue.* Observe the narrow interlobular fissures and the numerous points at which the capillaries of contiguous lobules are continuous. Each blue space, with half the intervening red space, constitutes a lobule. × 42.

Prep. 9. *Section of a cirrhose liver.* The disease is not very advanced. *Portal vein* injected with *Prussian blue.* The lobules are much shrunk and appear to be separated by a wide interlobular space, but of this the greater portion was once *lobular.* The lobule shrinks from *circumference* to *centre;* numerous altered vessels and shrunken tubes of the network remaining. × 42.

Prep. 10. *Another specimen of a cirrhose liver,* soaked in *carmine,* showing the shrunken tubes of the network, containing numerous wasted liver cells. × 130.

Prep. 11. *A specimen from the same liver immersed in water.* The tissue between the lobules, which is shown by Preps. 9 and 10 to be occupied with altered vessels, and secreting tubes, exhibits merely a fibrous appearance, and there is not the slightest indication of the above important structures. × 215.

Preps. 8, 9, 10, 11, prove that careful preparation is necessary to enable us to ascertain the true nature of morbid conditions of the liver. The tissue in the cirrhose liver which is usually considered as *inflammatory lymph* or *fibrous tissue,* resulting from an inflammation of *Glisson's capsule or areolar tissue between the lobules,* mainly consists of the altered structure of the lobule. The alteration depends principally on a wasting of the secreting structure, which commences at the circumference and gradually extends towards the centre of the lobule.

Prep. 8 demonstrates that this so-called *interlobular fibrous tissue or Glisson's capsule does not exist between the lobules of the human liver.*

In *cirrhosis,* as the cells shrink and become altered in a direction proceeding from the circumference towards the centre of the lobule, much of what now appears to be *interlobular* really formed part of the lobule when the organ was healthy.

Prep. 12. *Mildew, in various stages of growth, stained with carmine.* The *germinal matter* within, is in all cases tinged red, while the *formed material* outside is colorless. × 700.

Prep. 13. *Mildew, showing that the germinal matter is composed of numerous spherical particles, varying much in size.* The largest of these may be seen to be composed of *still smaller spherical particles.* In some specimens, pores are seen in the *formed material.* × 1700.

Preps. 12 and 13 illustrate the view that an elementary part consists of matter in two states,—active, as *germinal matter*,—passive, as *formed material,* which was once in the state of germinal matter.

LECTURE III.

APRIL 22ND.

Prep. 14. *Shows the appearance of elementary parts (cells) from the liver of the mouse.* Many contain two of the so-called nuclei, and some contain three or four. Nuclei are observed of all sizes, and the amount of formed material is very different in the different masses. In some elementary parts the outline is sharp and well-defined; in others it is rough and angular, and in some the outer part seems to be undergoing disintegration. No cell wall is to be demonstrated around these masses; some of them are very irregular in shape, having projections, and often much elongated, as if they consisted of soft material which had been moulded in a tube. × 215.

Prep. 15. *Shows the appearance of elementary parts from the liver of an old man, aged* 74. The liver appeared healthy. The elementary parts are for the most part small, and there is not that very distinct line of demarcation between the germinal matter and the formed material which was seen in the last specimen, and which is in part due to the method of preparation. Oil globules and particles of colouring matter have been precipitated amongst the formed material. × 215.

Prep. 16. *Contains elementary parts from a cirrhose liver.* The quantity of formed material here is much greater than in the last specimen, depending probably on the changes which lead to the conversion of the formed material into bile, and other substances being interfered with. × 215.

Prep. 17. *Epithelium from the tongue of a girl, aged* 10. The youngest particles are seen upon the surface of a papilla, and are separated from each other by a very thin layer of formed material. The proportion of the germinal matter to the formed material gradually becomes less as we proceed outwards, until in the largest elementary parts seen in this specimen, which are by no means the outermost, the formed material is four or five times as wide as the germinal matter. The small dark red bodies crowded together are the deep elementary parts, and those above them and to the left are more superficial; the latter correspond to the side of the papilla. × 700.

The last four Preps. are intended to show that the structure external to, and resulting from, the changes occurring in the germinal matter, does not always take the form of a cell wall. The form of many of the elementary parts in Preps. 14, 15, and 16, is incompatible with the existence of an external investing membrane. In Prep. 17, the gradual growth of the formed material which, according to the theory entertained, may be considered *either as cell membrane and cell contents,* or *intercellular substance* or *internuclear substance,* is well seen.

Prep. 18. *Perpendicular section through the mucous membrane of the tongue of a fœtus at the 7th month.* Above is the mucous membrane with its epithelium. The papillæ are already formed, and their epithelial covering can be seen. At the lower part of the specimen the muscular fibres of the tongue are observed quite distinctly. Between the insertion of the muscular fibres and the deep surface of the mucous membrane is the corium, which seems to consist almost entirely of small oval particles of *germinal matter,* which are entirely colored by the carmine. Large bundles of nerve fibres and some vessels may with difficulty be discerned. There is only a trace of fibrous structure. × 130.

Prep. 19. *A corresponding section from the tongue of a girl,* 10 *years of age.* Parts of two large compound papillæ are seen, and the corium has increased so much in thickness, that a very small part of it, with only a few of the pointed insertions of the muscular fibres are included in the field. The masses of germinal matter are very numerous in the papillæ, but in the corium they are fewer in number. These are the so-called nuclei of the areolar tissue (binde-gewebs-körperchen). × 130.

These two specimens are intended to illustrate the fact, that in a given bulk of young tissue there is a much larger proportion of germinal matter than in the fully developed tissue. In the fœtus there is comparatively little fibrous tissue to be detected in the corium. In the adult the corium seems to be composed entirely of this substance, the bundles of which are separated by yellow elastic fibres and corpuscles which are generally known as the areolar tissue corpuscles.

LECTURE IV.

April 29th.

Prep. 20. *Deep surface of the cuticle from a blister on rising.* The germinal matter occupies a much larger space than in the normal elementary part from the same situation. Several masses of germinal matter are dividing into two, and numerous constituent spherical particles are seen at the outer part of each mass of germinal matter. These are increasing, and exhibit a tendency to spread into the softened formed material. × 550.

Prep. 21. *From the same blister* 24 *hours after rising.* Numerous large spherical masses of germinal matter are seen now invested with but a very thin layer of formed material. These are very slightly removed from pus, and elementary parts of every shade of difference between the normal one from this part of the cuticle, in which the germinal matter bears a small proportion to the formed material, to the pus corpuscle, have been demonstrated in these preparations. × 215.

Prep. 22. *Ordinary pus corpuscles tinged with carmine.* The majority have escaped the action of the coloring matter. If the pus be allowed to remain long in the ammoniacal solution the corpuscles are entirely disintegrated. × 700.

Preps. 20, 21, 22, prove that the germinal matter of epithelium,—the formed material which surrounds it, being softened so as to allow it to be freely supplied with nutrient matter,—will increase very rapidly, and if the conditions favourable to its growth last long enough, will assume the form of small spherical masses (pus), surrounded with, and separated from, each other, by a thin layer of soft formed material.

Prep. 23. *Spherical masses of very actively growing germinal matter, closely resembling the pus in general characters.* The specimen was obtained from a very simple form of fungus, which grew to the size of a small pear in a single night. Here it is impossible to detect any formed material forming an external envelope to each elementary part. × 215.

This preparation, like the last one of pus, exhibits numerous spherical masses of germinal matter with the smallest quantity of formed material, and is intended to illustrate the fact, that germinal matter, in the highest and in the lowest living structures, possesses the same general appearances, grows in the same manner, and may be stained with carmine. A small portion of the germinal matter from this rapidly growing fungus could not be distinguished under the microscope from that obtained from an elementary part of one of the highest animals. Germinal matter everywhere possesses the same character, and is always colored by carmine, but it differs widely in *power*.

Prep. 24. *Tendon from the leg of a kitten, one day old,* showing the very large proportion of germinal matter to the formed material.. The proportion diminishes as the tendon grows. × 215.

Prep. 25. *Ridges and furrows of the skin from the tip of the finger*, showing the formation of the papillæ, and the *orderly* arrangement of the elementary parts, composed almost entirely of germinal matter, from which the tissues are formed. The capillaries are injected with Prussian blue. Fœtus 7th month. × 130.

Prep. 26. *Bulbs of the hairs of a kitten.* The capillary loop in the papilla is injected blue. Observe the quantity of germinal matter and the small amount of formed material at the lower growing part of the hair, and compare the appearance here with that existing higher up. × 215.

Preps. 25 and 26 illustrate the fact that even in young tissues, before any textural peculiarities are manifested, the separate portions of germinal matter grow in a regular and orderly manner, and do not multiply beyond the boundaries assigned to them.

LECTURE V.

May 6th.

Prep. 27. *Section from a large tumour from the back of a boy, aged* 12 *years.* It grew from three to twenty-seven inches in circumference in about six months. The boy died eleven months after the tumour first appeared, from exhaustion consequent on hemorrhage. The tumour weighed 12 lbs. It probably originated in the periosteum, at the inferior angle of the scapula. × 130. (Case reported by Dr. Elin, of Hertford.)

Prep. 28. *Cancerous tumour from the parotid.* The remains of some of the follicles of the gland can be seen. These being dead, and in a state of disintegration, are not colored by carmine, but, in the actively growing tissue, the proportion of living germinal matter to the formed material is very great. So active is the power of increase that the elementary parts insinuate themselves between tissues in every direction, causing their death, and appropriating the material of which they were composed. × 130.

Prep. 29. *Elementary parts (cancer cells) passed in the urine in a case of cancer of the uterus.* The germinal matter is very abundant and well colored. (Sent by Dr. Arthur Farre.) × 215.

Preps. 27, 28, and 29 show that cancerous growths, like healthy structures, are composed of elementary parts, each consisting of germinal matter within, and soft formed-material externally. An elementary part from a cancer (cancer cell) sometimes cannot be distinguished by any microscopical characters from the elementary part of a healthy tissue, but it differs from it in the irregularity and greater rapidity of its growth, and in the continual repetition of the same processes, leading to the indiscriminate destruction of higher tissues. In the normal state, growth occurs under certain restrictions, and in adult tissues the *removal of the old elementary parts* is exactly counterbalanced by the *orderly* development of new ones. In certain morbid states, these restrictions are almost entirely removed, and the formation of new tissue, which goes on uninterruptedly, is only limited by the supply of nutrient material.

Prep. 30. *Old and young elementary parts from the common potatoe, close to the point at which a bud is being formed.* The germinal matter (primordial utricle) is well colored, and can be distinguished from the formed material external to it (cell wall, intercellular substance), and from the secondary deposit in its central part (starch globules, in the present case). × 215.

Prep. 31. *Portion of the young leaf of the common mignionette,* showing the elementary parts, composed externally of *formed material* and of *germinal matter* within. The nucleus is observed to be very darkly stained with carmine.

Prep. 32. *A portion of the epidermis from the leaf of the common mignionette,* showing the germinal matter and formed material.

Prep. 33. *A small piece of a rootlet of the common mignionette,* showing that the elementary parts of which it is composed, like those in the leaves, consist of germinal matter and formed material. A small portion of the germinal matter (nucleus) is seen of a much darker color than the rest, as in many of the animal tissues.

Prep. 30 shows the manner in which products resulting from changes in the *formed* material, secondary deposits, may be deposited amongst the germinal matter and this, with Preps. 31, 32, and 33, prove that the vegetable elementary part, like all others, may be considered to consist of *germinal matter* and *formed material.*

LECTURE VI.

May 13th.

Prep. 34. *Tendon of child at birth,* showing elongated masses of germinal matter colored with carmine, and the intervening formed material (intercellular substance) colourless. In parts of the specimen, the continuity of the fibrous matter, or formed material, with the germinal matter can be most distinctly seen. The germinal matter passes into the formed material. × 215.

Prep. 35. *Vessels of Tendo Achillis; kitten, one day old.* The vessels are seen to be very numerous in this preparation. × 215.

Prep. 36. *Tendon from the finger of an old man, aged 74.* The relation of the germinal matter to the formed material is the same as in the other specimens, but its proportion to the latter is very much less. When the fibres are stretched in a longitudinal direction, the oval masses of germinal matter appear as very narrow red stripes, which communicate with each other by a narrower and much fainter line (nuclear fibres, kern-fasern). On the other hand, when the fibres are stretched laterally, the oval masses become very broad, and may be made, by stretching, almost circular. In this state, longitudinal cracks or creasings are observed, and the lines of germinal matter can be seen most distinctly to be continuous with the formed material. × 215.

Prep. 37. *Fascia from the frog,* showing the connection of the oval masses of germinal matter (nuclei) with the formed material (fibrous tissue, intercellular substance). × 550.

Preps. 34 to 37 are intended to show that the fibrous tissue of the tendon, or formed material, is in immediate connection with the masses of germinal matter, and the constant variation in the relative proportion of the germinal matter to the formed material in the young and old tendon in all animals establishes a definite relation between the two structures. The whole of the fibrous tissue, or formed material, was once in the state of germinal matter. The masses of germinal matter, which are colored red in all these specimens, and which exactly correspond to those in other tissues, have been looked upon by Virchow as cells which communicate with each other by tubes, and thus it is supposed that a special system of channels for distributing nutrient matter throughout the tendon is formed.

Prep. 38. *Cartilage, Mouse,* showing germinal matter and intervening formed material. In the upper part of the specimen, the immediate continuity of the formed material of the cartilage with that of the tendon is most distinctly seen, and the oval or circular masses of germinal matter of the cartilage are seen gradually to shade into the elongated masses of the tendon. Muscular fibres are seen to be connected with the tendon at various points. × 130.

Prep. 39. *Cartilage of os Calcis and tendo Achillis.* Kitten, one day old. Some injected vessels divide the cartilage from the tendon, otherwise the two structures would seem to shade gradually the one into the other. Both grow in opposite directions from the line of the vessels. × 215.

Prep. 40. *A small piece of the amnion of a fœtus at the 7th month.* It is seen to be composed of many-sided elementary parts, which adhere to each other at the margins. The germinal matter (nucleus) and formed material (cell-wall and cell-contents) are very distinctly seen. × 130.

Preps. 38 and 39 show the structure of cartilage contrasted with that of the perichondrium, periosteum, and fibrous tissue. In the cartilage the germinal matter of the elementary parts soon separates into distinct portions, which are surrounded with formed material; but in the other structures the masses of germinal matter remain continuous with each other for some time.

Prep. 41. *Soft spongy fibrous tissue from the umbilical cord of a fœtus at the 7th month.* This is the so-called mucous tissue, which is considered by Virchow to consist of a system of anastomosing tubes for the distribution of nutrient matter.* If the specimen be compared with those of the tendon, it will be seen that the structure is composed of a network of fibres, and that the relation of the germinal matter (cells or nuclei) to the formed material (fibres) is precisely the same as in other tissues. × 130.

Prep. 42. *The same as the last under a much higher power,* showing the numerous fibres and their continuity with the germinal matter. Tubes cannot be demonstrated. The wavy fibres, much resembling, in their general appearance, the finest fibrous bands of white fibrous tissue, are perfectly colourless, while the germinal matter (considered as spaces) are darkly colored by the carmine. × 700.

Preps. 40 and 41 are intended to prove that the so-called mucous tissue of the cord possesses the ordinary structure of other varieties of fibrous tissue, and that the structure considered to be tubular by Virchow is really fibrous. No anastomosing tube system can be made out in the above specimens.

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* Cellular Pathology, translated by Dr. Chance, p. 99. The illustrations introduced (figs. 41, 42) differ materially from the appearances seen in the specimens sent round.

LECTURE VII.

MAY 20TH.

Prep. 43. *A very thin piece torn from the circular coat of the aorta* of a man who died in consequence of an opening occurring in a dilated arch. The specimen was taken from a point about half an inch above the orifice, where the coats *appeared* healthy, but they were readily torn by employing very slight force. The elementary parts are very large, and are stellate. The central part is very darkly colored by carmine; external to this the structure is colored, but the color becomes fainter in the most external portions, and the outermost part of each fibre and its prolongations are perfectly colorless. It is hardly necessary to state that these are fibres and not tubes. × 215.

Prep. 44. *Muscular fibre cells of the uterus of the mouse.* The bundles in the field are quite at the upper margin of the organ, and the muscular fibre cells are seen gradually to pass into those from which fibrous tissue is produced. The fibrous tissue is arranged so as to form the boundary of spaces which are more or less circular in form, and the manner in which the fibres are produced is well demonstrated in some parts of this specimen. × 700.

Prep. 43 shows the fibrous nature of the prolongations of a certain form of "connective tissue corpuscle," and clearly establishes the fact that these are not tubes. Prep. 44 proves that the elementary part at the margin of a bundle of muscular fibre cells may shade off into those of fibrous tissue. Here the 'connective tissue' seems to be composed of elementary parts which, up to a certain period of their existence, might have been developed into a much higher form of tissue.

Prep. 45. *Cancellated structure near the articular cartilage of the first phalanx of the toe* of a girl about 16 years of age. Several of the so-called marrow, or myeloid, cells are seen, and two of these are much elongated and bent in two or three different directions. These form the basis of some of the spiculæ of bone which at length form the imperfect septa between the cancelli. They are seen to be separated by a considerable quantity of soft material in which nuclei are also very abundant. In some places this tissue has a fibrous appearance, but the majority of the nuclei seen in it probably ultimately become the fat-cells of the medullary tissue. It is very interesting to contrast the dark red color of the tissue, which is actively growing and about to become impregnated with calcareous matter and converted into bone, with the very faintly tinted intervening substance.

Prep. 46. *Femur of Kitten,* 1 *day old, showing ossifying cartilage, temporary spongy bone,* and the formation of *true bone with lacunæ.* The latter is gradually encroaching on the soft spongy structure and growing at its expense. The original nuclei of the cartilage cells imbedded in the matrix now impregnated with calcareous matter are well seen and are tinged red with the carmine. It would appear that these afterwards grow, absorb the cartilaginous and calcareous matter in which they lie, and gradually give rise to the formation of true bone. At the periosteal surface several lacunæ may be seen.

Prep. 47. *Young lacunæ from the femur of a kitten at birth.* Observe the oval mass of germinal matter (nucleus) alone tinged with carmine. The majority of these are oval but some are slightly irregular in form. The lacunæ are very large and angular. Numerous funnel-shaped spaces lead from them to the canaliculi.

The last three preparations illustrate the formation of lacunæ. Lacunal-cells, consisting of germinal matter and formed material, are seen in contact with each other, and arranged in the general form which the bone tissue is ultimately to assume. The deposition of calcareous matter commences in the oldest, that is, the outermost part of the formed material, and as it is deposited, little spaces are left between the globules through which nutrient matter passes to the germinal matter within. The deposition continues from without inwards until the germinal matter remains enclosed in a comparatively small space. The canaliculi are channels which are left, not tubes which are formed, and they correspond to the intervals between portions of formed material, where this is fibrous.

Prep. 48. *Portion of the compact tissue of the shaft of the femur of a kitten at birth, showing the formation of the first series of Haversian systems.* These are much narrower than those in the adult bone. The capillaries in the interior of the wide Haversian canals are seen, and between them and the walls of the canal is a quantity of a soft tissue consisting of minute oval elementary parts, the most external of which are becoming impregnated with calcareous matter.

Prep. 49 *is a thin transverse section of the dentine and the surface of the pulp of an incisor tooth.* The dentinal tubes are seen to be occupied with a solid substance which is tinged red with carmine, and each of these is continuous with an oval mass of germinal matter situated on the surface of the pulp. A thin layer of dentinal tissue is observed close to the pulp, in which calcareous matter is not yet deposited, and this tissue lies between the oval masses of germinal matter with their prolongations, above alluded to. It is the formed material of the germinal matter of dentine prior to its impregnation with calcareous matter.

Prep. 50. *In this specimen the solid prolongations into the dentinal tubes have been torn out, and the tubes in which they were situated are also seen.* These prolongations are immediately continuous with the oval masses of germinal matter on the surface of the pulp. The matrix, which is afterwards calcified, is the formed material of these oval masses of germinal matter. Some of the tubes are still seen occupied with solid material, colored bright red with carmine. The deposition of calcareous matter in separate globular masses is also seen in this preparation.

Prep. 51. *A transverse section of the inner part of the dentine, showing the same point as the last two specimens,* but the innermost layers of the matrix are very clearly shown, and the globules of calcareous matter and their gradual coalescence are very distinct. Sometimes in consequence of several adjacent globules coming into contact, the precipitation of the calcareous matter ceases, and thus these globules enclose a portion of uncalcified matrix, which remains in this state because it is not possible that fresh calcareous matter can be supplied to the space enclosed. In the dry tooth this matrix dries up, and air rushes in and fills the spaces which lie between the globules (globular dentine).

These specimens seem to prove that the manner in which the dentinal tubes are formed is much more simple than is usually believed. The elongated masses of germinal matter which occupy the cavity of the tubes, are surrounded with formed material which, as in other cases, increases at the surface of the germinal matter, and this gradually shrinks. The formed material of the several adjacent elementary parts is of course in contact, and gradually calcareous matter is precipitated in the oldest part of the formed material. Globules are formed, and gradually the formed material becomes impregnated with calcareous matter. These globules at length coalesce, and the calcification of the matrix is so far complete; but the germinal matter still slowly undergoes conversion into formed material, and it diminishes in extent from the outer part of the dentine (which was first formed) towards the pulp cavity. The pulp cavity of a tooth, and the dentinal tubes gradually diminish in diameter as age advances. The dentinal tubes gradually increase in length as the pulp diminishes, while their calibre diminishes by the slow formation of new formed material and its calcification. The narrowest part of the dentinal tubes is that at the circumference of the dentine, and this part first appeared; the widest part is that which is in contact with the pulp, and this was most recently formed.

Prep. 52. *Tissue with beautiful stellate cells, covering the fangs of the teeth, and in immediate contact with the cementum.* The angular masses of germinal matter of the different elementary parts communicate freely with each other. This arrangement is thus produced. At first the masses are close together, and the formed material covering each remains in continuity with that of its neighbours at numerous points; or, in other words, the cavities of the cells communicate through the intervention of prolongations. Gradually, as the elementary parts become separated from each other, these communicating tubes become longer and narrower, and the germinal matter within them slowly undergoes conversion into formed material. In the specimen, some stellate masses of germinal matter, coloured red, are seen connected with each other by prolongations of germinal matter, which is covered with a layer of formed material. In other places colorless cords alone seem to intervene between, or to connect the separate masses. It is quite clear that the latter originally contained germinal matter. Are these colourless prolongations, which are now seen, tubular or solid? At the upper part of the specimen many of them are seen to shade off nto the matrix, and in several places the stellate mass itself seems to have gradually undergone conversion into formed material. Ultimately the whole would have disappeared. Thus, at first there are tubes containing germinal matter; but as this substance undergoes conversion into formed material, the tube gradually diminishes and a cord exists where there was a tube, and slowly this cord shades off into the rest of the formed material, and cannot be distinguished as a separate structure. Globules of calcareous matter are deposited here and there in the matrix. It would not be possible to trace the changes occurring in this tissue without the use of carmine. × 215.

The tubes containing germinal matter at an early period and becoming afterwards converted into formed material in Prep. 52, may be said to correspond very closely with the dentinal tubes. In both cases, however, they are no more tubes than the space filled with germinal matter in an elementary part--say of the cuticle—is a cavity. Spaces remain if the germinal matter is removed; but during life these so-called tubes and spaces are occupied with the most important part of the whole structure,—the living active growing germinal matter. The canaliculi of bone, therefore, do not correspond to the above tubes or spaces; they do not contain at any period of their formation germinal matter. They are mere channels left during the deposition of calcareous particles in the formed material, and correspond to the spaces left during the deposition of secondary deposits within the vegetable cell. In each case the hard material is deposited from without inwards.

Prep. 53. *The skin of the white mouse seen from below.* The bulbs of the hairs and the sebaceous glands are readily distinguished, and a most intricate plexus of nerves exist in every part of the specimen. By altering the focus, the fibres may be seen in numerous planes. They can be traced amongst the hair bulbs, which are entirely surrounded by them at different levels. Numerous capillaries can also be distinguished. In this specimen, oval corpuscles are seen to be very numerous in the nerve fibres, others are in connection with the capillaries, and some are isolated: these last are probably young fat-cells. × 215.

Prep. 54. *Mucous membrane of the epiglottis of an old man, aged 74.* The epithelium has been removed. Nerve fibres are seen crossing the field in every direction, and bundles, consisting of from two to five or six fibres, can be followed for some distance. Some of the nerve fibres are of very large size, while some of the bands are composed of fibres not larger than the gelatinous fibres. Capillary vessels can also be distinguished. Below this wonderful nervous net-work, which forms a very thin layer just beneath the epithelium, is seen a considerable quantity of yellow elastic tissue. Microscopic ganglia exist in some places in connexion with certain branches of the nerves. Oval masses of germinal matter are seen in connexion with all the nerve fibres, and in some they are more numerous. These nuclei must not be mistaken for areolar tissue corpuscles. They are situated just beneath the epithelium. × 215.

Prep. 55. *Another portion of the same specimen as* 54, *showing a simple papilla projecting from the surface of the mucous membrane.* This papilla contains three or four nerve fibres, the trunks of which form tortuous and highly convoluted loops. The fibres contain numerous oval corpuscles, and divide, but the points of division cannot be satisfactorily demonstrated in this particular specimen. × 700.

The nuclei seen in such number in connexion with the nerve fibres in Prep. 53 would have appeared, if the specimen had been examined in water, or weak glycerine, as the nuclei of connective tissue. When spindle-shaped cells are demonstrated in the cutis by boiling, it is not easy to say to what tissue they originally belonged; and considering the very important structures in this situation they cannot be dismissed simply as the nuclei of the connective tissue. Such rough processes of investigation can only lead to erroneous conclusions when employed in investigating a delicate question of this sort. Prep. 54 demonstrates the vast number of nerve fibres and the nuclei (germinal matter) in connexion with them. If a little water be added to such a specimen, the definiteness of the appearance is lost, and the amorphous matter which remains, might be termed indefinite connective tissue. The fibres of yellow elastic tissue beneath the nerve fibres are almost free from germinal matter (nuclei). It is probable that they are the remains of structures which were in a state of functional activity at an earlier period.

It is quite certain that most important and distinct structures which have not been recognized owing to the imperfect processes employed in the investigation, have been included under the head of 'connective tissue.'

Prep. 56. *Pericardium of the fœtus at the seventh month, in its entire thickness.* The capillaries are injected with Prussian blue. Numerous bundles of nerve fibres can be distinguished, and these compound trunks are seen to divide and subdivide, forming a plexus with wide meshes. × 215. The proportion of connective tissue is small, but fibres of white and yellow fibrous tissue can be detected without difficulty upon the external surface, and nuclei are seen in connection with a very few of these, while the number of oval nuclei observed in different parts of the structure is very great.

Prep. 57. *Ganglion cells and gelatinous nerve fibres from the pericardium of the ox.* Each is seen to be surrounded with nerve fibres in which nuclei are very numerous and situated at very short distances from each other. × 215. The bundle contains no nerve fibres with the white substance of Schwann, and the preparation proves that the nerve fibres grow from the ganglion cells.

Several fibres are connected with each cell. In fact the structure which is usually described as the connective tissue capsule of the ganglion cell, consists solely of nerve fibres.

Prep. 58. *Microscopic ganglion imbedded in the areolar tissue, just outside the base of the aorta at its origin, from the heart of the human subject.* × 215.

Prep. 59. *Ganglion imbedded in the adipose tissue from the left ventricle of the heart of the pig.* These microscopic ganglia are very numerous amongst the adipose tissue between the auricles and ventricles. × 215.

Prep. 60. Ganglion cells from the pericardium of the ox, showing their connexion with the nerve fibres which are broken short off, but some of the nuclei are seen in the portion of the fibres left, and others of the same appearance in the very substance of the ganglion cell itself. × 550.

The pericardium contains numerous very fine bundles of nerve fibres which form a network situated at the deep aspect of the fibrous pericardium, and on the surface of the muscular fibres. The branches are much more numerous in and near the longitudinal groove, and the grooves between auricles and ventricles, but many can be demonstrated over the general surface of the ventricles. At short intervals bundles can be seen to dip down in the spaces in which the vessels also pass, and are soon lost amongst the muscular substance. Numerous microscopic ganglia, resembling those of the sympathetic, are connected with many of these fibres. In some cases, collections of ganglion cells are seen at the side of the nerve fibre, and in many instances two or three ganglion cells can be made out in the very substance of the trunk. These microscopic ganglia are demonstrated without difficulty and in immense number, in properly prepared hearts, but from the fact that most of them are imbedded in adipose tissue, they are very liable to be overlooked.

In the muscular substance of the heart, the fine branches of the nerves may be followed. Their general disposition resembles that in voluntary muscle, and, as the nuclei of the muscular fibres of the heart are in the very centre of the fibre, there is no fear of mistaking these for the nuclei of the nerve fibre. Many nerve fibres are distributed to the vessels, but by far the greater number certainly ramify on the surface of the muscular fibres. It is impossible to demonstrate these latter points unless the vessels have been, in the first instance, carefully injected with transparent fluid.

Prep. 61. *Muscular fibres from the diaphragm of a young white mouse, showing nerves and capillary vessels with their numerous nuclei.* This specimen demonstrates that all the nuclei seen, are in connexion with the nerve fibres, capillaries, or with the muscular fibres. There is only a small quantity of a slightly granular 'connective substance,' and there is a total absence of connective tissue corpuscles. In older animals fibres of white fibrous tissue and yellow elastic tissue can sometimes be made out, but it is quite certain that there is no connective tissue developed as a special tissue, since it cannot be demonstrated between the elementary fibres of the voluntary muscles of young animals. ×700.

CONCLUSIONS.

The following general conclusions seem to be justified by the appearances observed in the specimens sent round :—

The elementary parts of the tissues of every living being consist of an active, living, growing substance, *germinal matter*, and of *formed material* resulting from this. The *germinal matter*, in all cases when examined by the highest powers, is seen to be composed of spherical particles, but its powers are wonderfully different in different beings. It possesses in all cases the power of infinite growth. It is always colored red, not merely stained, by an ammoniacal solution of carmine. The *formed material* differs remarkably in characters and properties in various tissues and living beings, and the difference depends mainly upon the powers of the germinal matter which produced it. It may be stained with carmine, but it is not colored like the germinal matter. The whole of the germinal matter is not converted into formed material, but a small portion (nucleus) remains, perhaps, for a very long time in a quiescent state. From this, new centres of growth may proceed infinitely, even if the whole of the germinal matter, undergoing active change, is destroyed.

Development consists essentially in the production of successive elementary parts, the formed material of each series becoming a higher and more perfect tissue than that of its predecessors.

Growth depends upon a greater number of elementary parts being produced than is required merely to make up for those which are removed.

Nutrition is the conversion of pabulum into germinal matter at a rate and in quantity exactly sufficient to replace the amount of germinal matter converted into *formed material*, and this corresponds to the proportion of the latter which is removed, or decays, or is converted into soluble substances.

In decay, the oldest part of the formed material having lost its characteristic properties, and no longer capable of resisting the action of destructive agents, is soon resolved into simpler compounds, which are removed, and in part, at least, again taken up by living particles.

Every living particle comes from a pre-existing living particle. There is reason to believe that independent living particles exist, which are infinitely smaller than the smallest particle which can now be seen by the highest powers yet made (1700 diameters).

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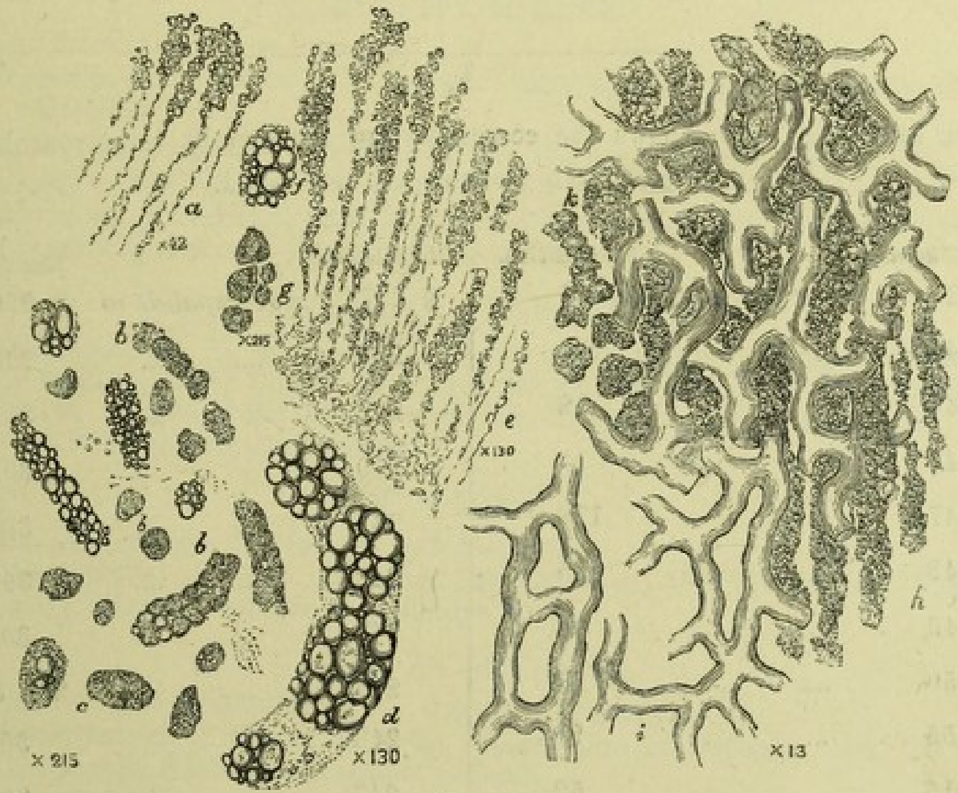

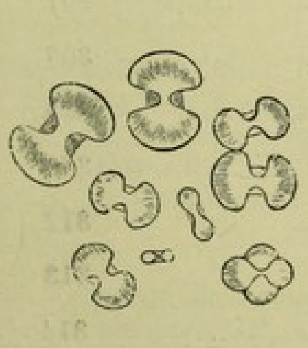

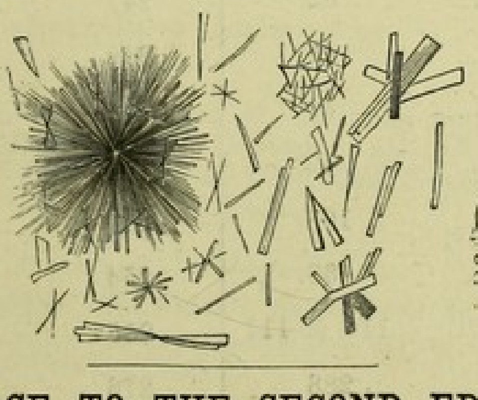

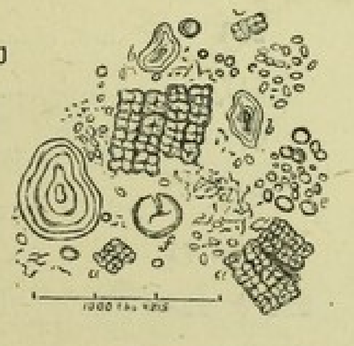

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Old Edition.		*New Edition.*	*Old Edition.*		*New Edition.*
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To be inserted in the "Tables."

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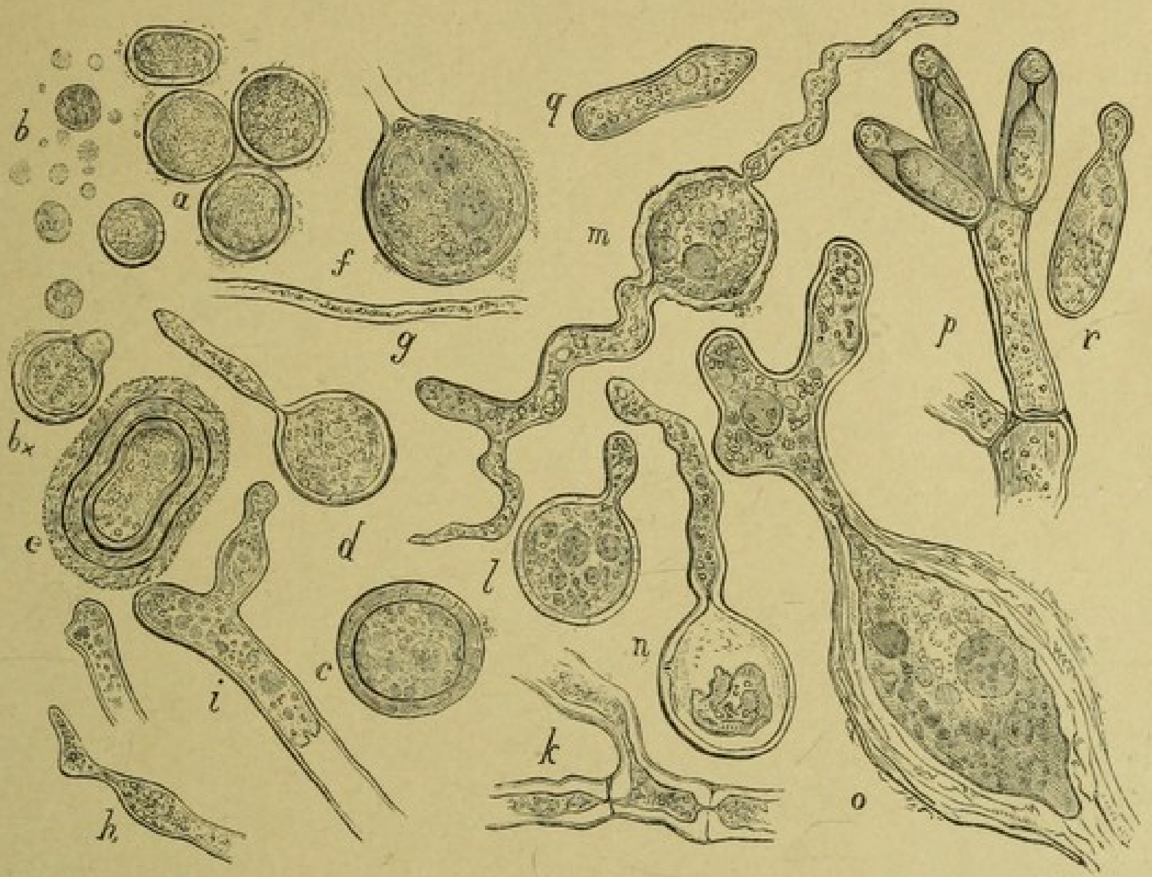
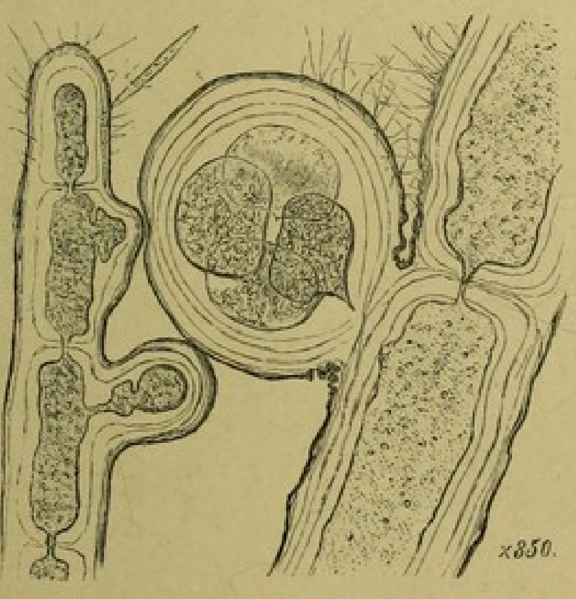
Fig. 1.



×1700

Fig. 2.



a b

Fig. 3.