The formation commences in the interior of the cellular capsules of the cartilage, and then extends also into the fundamental intercapsular substance.

All these calcareous formations become charged also with organic colouring matters, whether naturally contained in the liquid or purposely dissolved in it. Not only colours of animal origin, but also those from vegetable sources, such as saffron, turnsole, logwood, &c., are absorbed, so that the coloured calcareous formations met with in animals may thus be reproduced.

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On the Peripheral Distribution of Non-medullated Nerve-fibres. By Dr. E. Klein. (With Plate IX.)

PART III.

In the second part of this memoir we have described, among other subjects, the distribution of fine non-medullated nerve-fibres on the capillaries of the nictitating membrane as well as of the mesentery of the frog.

We there saw how from the large non-medullated nerve-fibres still provided with a nucleated sheath, which accompany the vessel for a longer or a shorter distance, finer nerve-fibres spring off and join to form a plexus round the capillary vessel; further, we were able to follow from this plexus still finer nerve-fibres which partly run in the wall of the vessel itself, in which wall they divide and join by their lateral branches so as to form a network.

What I am going to treat of in this third part will concern first the relation of the non-medullated nerve-fibres to small arteries, small veins, and to capillary vessels, in the muscular substance of the frog's tongue; and secondly, the termination of nerve-fibres in the already mentioned ciliated duct in the tail of the rabbit.

A. Nerves of the Blood-vessels in the Frog's Tongue.

The preparations figured in Pl. IX, figs. 1, 2, and 3, were obtained by the following process:—The whole tongue of the living frog is cut out. It is then pinned out on a piece of flat cork, from which it is raised slightly like a tent so as completely to remove its lower surface from the cork, and immersed in half per cent. solution of chloride of gold for
one hour; after that time the tongue is rinsed in distilled water, taken off from the cork and exposed in distilled water to the light until it becomes dark. The tongue is then placed in common alcohol for twenty-four or forty-eight hours, a sufficient time to harden it so far as to be able to make horizontal sections. The sections after they have been washed in water are mounted in glycerine. The preparations which I am going to describe belong to the deeper muscular portions of the tongue. The muscular fibres appear here grayish violet, the connective-tissue-corpuscles, well known by their bizarre shape, are, except the nucleus, dark coloured, the non-medullated nerve-fibres appear dark violet, and the blood-vessels more or less a grayish violet colour. In the intermuscular connective-tissue, which contains a great number of connective-tissue-corpuscles, we find some isolated medullated nerve-fibres provided with a thick nucleated sheath of Schwann. From these spring off more or less numerous non-medullated nerve-fibres which are also provided with nuclei. These nerve-fibres join so as to make a not very dense plexus. If we follow a very small artery (fig. 1), we find a broad non-medullated nucleated nerve-fibre approaching the vessel and accompanying it either without branching, or else dividing into two nucleated branches which are still to be regarded as coarse nerve-fibres.

The two branches accompany the artery for a shorter or longer distance on opposite sides, and bend round the vessel once or twice. Or we see a coarse non-medullated nucleated nerve-fibre crossing the artery, and while doing so giving off two branches which bear the same relation to the vessel as above.

Besides these coarser nerve-fibres which accompany the artery we find a great number of finer fibres which accompany the vessel. They bend round the vessel several times, and join by lateral branches together, forming a plexus which surrounds the artery like a sheath. There cannot be any doubt that the fibres just mentioned are nerve-fibres. First of all they can be traced with the greatest certainty to the above-mentioned coarser nucleated non-medullated nerve-fibres; and secondly, many of them exhibit in their course here and there a nucleated swelling.

To recapitulate, we see that from the coarser nucleated non-medullated nerve-fibres which accompany an artery, there spring off a number of finer nerve-fibres still provided with rare nuclei, which finer fibres form a rather dense plexus like a perivascular sheath. Where this perivascular nervous sheath is very richly developed, and the wall of the artery
is not too much coloured, we are able to follow from this nervous sheath finer fibrillæ which no longer exhibit nuclei, and these fibrillæ can be traced in the wall of the vessel itself, where one or other of them divides into two branches.

In some cases I was able to convince myself of the fact that these very fine fibrillæ join by their branches, as I have already described in the second part. The number of fine nerve-fibres surrounding the vessels in some places, where a small artery divides into two branches, which very soon after that are not easily to be distinguished from capillary vessels, is most striking. This is especially the case when we have to do with arteries so small that only here and there can we distinguish a very limited number of smooth muscular fibres, while, on the other hand, in the larger arteries which possess a distinct middle coat of smooth muscular fibres, the number of the accompanying nerve-fibres can be by no means compared with those mentioned above. As regards the finer nerve-fibres of the capillary vessels I need not trouble the reader with a long description, as I have dealt with this question already in the second part. On the capillaries of the muscular tissue of the frog's tongue I have seen these relations with such distinctness and so plainly that I do not hesitate one moment to adhere to every point I have maintained. I refer to the fig. 3 of this third part:—

(a) represents a capillary vessel, (b) the coarse nucleated nerve-fibres which, as may be seen, have a parallel course with the vessel, and bend round the latter in opposite direction. From these spring off (c) finer nerve-fibres which are scarcely provided with nuclei, and which form a plexus round the vessel like a sheath. From this plexus spring off (d) still finer fibrillæ which belong partly to the wall of the vessel itself.  

1 If we compare our Fig. 3 with the figures given by Dr. Beale in his last paper on this subject ('Monthly Microscopical Journal,' Jan., 1872, Plate IV, fig. 3 and 4), the substance of which had already been published by the same investigator, who really was the first to mention non-medullated nerves on the capillary vessels several years since ('Philosoph. Transact.,' 1863, pl. lx, fig. 44; 'Philosopli. Transact.,' 1865, pl. xxii, fig. 15; 'How to Work with the Microscope,' 4th edit., 1868, pl. xxix, fig. 192), everybody, even if not thoroughly acquainted with this subject, will, I think, agree with me that the difference between the results which Beale has obtained and my own is not a small one. This difference consists chiefly in the fact that Beale's "ultimate nerve-fibres" correspond to my coarser non-medullated nerve fibres, as regards which I perfectly agree with Beale that they accompany the vessel in a nearly parallel course and bend round it once or twice. These nerve-fibres have been seen also by Kessel and Tomsa, as I have already mentioned in the second part. What Beale has not seen at any time in his preparations, and therefore doubts, is the great number of finer nerve-
B. The Ciliated Duct in the Rabbit's Tail.

I am unable at present to add much to what I have already published on this subject in my preliminary communication in the 'Centralblatt für Medicin. Wissenschaften,' 1871, No. 38.

If we cut off the tail of young or middle-sized rabbits near the root, strip off the skin, and then tear off the joints nearest the root from the rest of the tail (a well-known method of isolating the delicate tendons of the tail), we often succeed in isolating also what appears to the naked eye as a yellowish cord, extending for nearly the whole length of the tail.

Under the microscope this is seen to be a duct, forming, in all probability, a prolongation of the central canal of the fibres which spring off from the coarser ones, and which make a perivascular plexus, and further, the still finer fibres which spring off from this plexus. If Beale with his "ultimate nerve-fibres," which I regard, as I have just now stated, only as coarser nerve-fibres, deduces conclusions about the action of nerves on the blood-vessels; if Beale, while building theories, sets aside all the most accomplished and laborious physiological researches of foreign observers, I must pass that over, because I cannot follow him without coming into collision with what has really been found to be the result of experiments. Neither shall I discuss what Beale states about the structure of the capillary vessels; if Beale still adheres, only in a more refined sense, to the description first given by Henle, 1841 ('Allgemeine Anatomic,' p. 491), that also I pass by with great equanimity, the more so as our knowledge of the structure of the capillary vessels has been brought by the numerous researches of German histologists to such a point that the old view of Henle must be regarded as a complete anachronism. Further, if Beale with his method is not able to show anything more about the anatomical relations of the finer nerve-fibres than what he was already acquainted with several years ago, and if he confesses that he is not able by his own method to form any opinion about the assertions of other investigators obtained by a different method—viz. by chloride of gold—and, therefore, doubts them; I should be the last to make any objection except by putting the facts obtained by one method against the results of the other. If Beale, when expressing these doubts, both orally and in writing, calls attention to the fact that the non-medullated nerves of the capillaries have been until lately entirely passed over, I can only perfectly agree with him, especially since Beale, as I stated above, many years since on several occasions described and illustrated them by very beautiful figures. But, on the other hand, I must allow myself to contradict Beale if he asserts that the doctrine of terminal networks of non-medullated nerve-fibres in general was, before him, unknown in Germany, and that the networks of non-medullated nerve-fibres which he has described are now accepted, as I have been able to convince myself that, although the doctrine of networks of non-medullated nerve-fibres has been advanced by his researches in a very high and remarkable degree, our knowledge of networks of non-medullated nerve-fibres in many organs has had a different source than he has stated. (See my memoir in the 'Month. Micr. Journ.,' April.)
spinal cord. The wall of this duct consists of the following parts:

a. A pale epithelium, occupying about two thirds of the thickness of the wall, consisting of an internal superficial layer, turned towards the lumen of the duct, of pale, thin, conical, cylindrical cells, and a deeper layer of smaller, apparently round cells, in which there is often only a very narrow zone of protoplasm surrounding the relatively large nucleus. The cells of the superficial layer are all provided with bundles of cilia, which I have seen continue in lively motion for more than three hours in specimens examined in fresh serum.

b. The membrana propria, next to the epithelium, consists of connective tissue with numerous elastic fibres.

c. Most externally is a loose adventitia, in which is a network of remarkably large, richly branched pigment-cells, and which contains the large blood-vessels and lymphatics.

The capillary blood-vessels form a network with elongated meshes, in the propria immediately under the epithelium. Near the duct run large nerve-trunks of medullated fibres, which are connected at the root of the tail by smaller branches, and are provided with remarkably distinct ganglia. (ganglia coccygea, *vid. Krause 'Anatomie des Kaninchens'). The ganglionic cells of these latter are mostly unipolar, their processes becoming surrounded by a medullary sheath immediately after their origin. The ganglionic cells are mostly each furnished with a capsule, but occasionally we find two, three, or four, enclosed in a common capsule.

I believe that I have also recognised spiral fibres.

In their further course the nerve-trunks wind spirally around the duct, contain here and there small ganglionic enlargements, and give off numerous small branches, consisting of only a few medullated fibres; these last lie loosely side by side in their sheath, and enter the propria. Here they separate from each other and for a short distance have a course parallel to the longitudinal axis; they show here and there swellings and varicosities of the medulla, giving them the appearance of varicose fibres. They divide freely, the thin branches being still always furnished with a dark border.

Finally, these last divide into several thin pale fibrils, the medulla having just previously ceased quite suddenly.

Of these last pale fibres some are in connection with large cells which lie immediately under the epithelium, and possess a relatively large vesicular nucleus, in which is a shining nucleolus, resembling perfectly the nuclei of those ganglionic
cells which we mentioned as being found in the nerve-trunks.

But in serum preparations and also in those treated with dilute acetic acid we can see that most of the pale fibres pass into a coarse network, in many places widened out into a plate-like formation, in whose oblong or rounded meshes the deep epithelial cells lie imbedded. Whether this network becomes identified with the intercellular substance of the superficial cylindrical cells, or whether it is connected with these cells themselves, as has been described by Exner (38) in the pituitary membrane of the frog, I am not yet in a position to determine.

As regards the relations of the network of pale fibres, I must refer the reader to figs. 4 A, and 4 B.

**Titles of Works and Papers referred to in the foregoing Memoir.**

1. Langerhans, 'Virchow's Archiv,' Bd. xlv.
2. 'Köllicher's Gewebelehre,' 1er Theil, pp. 103—105.
5. Frankenhausen, 'Die Nerven der Gebirnmutter,' &c., 1867.
7. Langerhans, 'Virchow's Archiv,' Bd. xliv.
14. 'Köllicher's Gewebelehre,' 1er Theil., pp. 103—105.
18. Cohnheim, 'Med. Centralblatt,' 1866, No. 26; and 'Virchow's Archiv,' Bd. xxxvii.
20. 'Köllicher's Gewebelehre,' 1er Theil., pp. 103—105.
23. Frankenhausen, 'Die Nerven der Gebirnmutter,' &c., 1867.
On the Structure of Tendon. By J. Mitchell Bruce, M.A., M.B. Lond., Demonstrator of Practical Physiology, Charing Cross Hospital Medical School, &c. (With Plate X.)

The doctrine of the structure of tendon has entered upon a perfectly new phase since the publication of Ranvier's celebrated paper on the subject. In this paper Ranvier describes the tendon of the tail of the rat as consisting of bundles of fibrillar connective tissue, between which regular hollow cylinders are imbedded. These cylinders are built up of quadrilateral nucleated cell-plates, each of which forms an element of the cylinder by being rolled up until its two opposite meet; or, conversely, each element of the cylinder, when opened out, represents a quadrilateral cell-plate. This conception on the part of Ranvier of the arrangement of the cells in tendon is, therefore, completely different from those of former histologists, the majority of whom held that the cellular elements found lying between the bundles of tendon represent spindle-shaped nucleated cells; his description was accordingly very variously received.

Ranvier, 'Arch de Physiologie,' 1869, ii, 471.