I shall give no account to the Royal Society unless expressly requested by the Council to do so, and assured that my communication shall receive that treatment which I consider the importance of the subject to demand.

II. "Further Observations on the Distribution of Nerves to the Elementary Fibres of Striped Muscle." By Lionel S. Beale, M.B., F.R.S., Professor of Physiology and of General and Morbid Anatomy in King's College, London; Physician to King's College Hospital. Received June 19, 1862.

(Abstract.)

After referring to the views entertained on the mode of termination of the nerves in the tissues generally, the author proceeds to consider the arrangement of the nerves in muscle. The old view was that nerves terminate in loops or networks which are external to the sarcolemma. More recent researches had proved that these loops and networks are composed of coarse dark-bordered fibres, and from them finer fibres had been followed to the surface of the elementary fibres, and it was concluded that these terminate upon the sarcolemma in *free ends*. In the Philosophical Transactions for 1860, a paper by the author was published, in which it was shown that the distribution of nerve-fibres to the muscles of the mouse was much more extensive than was generally supposed, and that to each muscular fibre, pale nerve-fibres with nuclei are distributed throughout its entire length; that numerous fibres cross the elementary fibres at various angles, and thus the appearance of a network of nerve-fibres is produced. This network is upon the same plane as the capillaries, and can be stripped off the surface of the sarcolemma with these vessels. Last year Kühne published a memoir on the termination of the nerves upon the elementary muscular fibres of the frog, and supported his view expressed in previous papers, that the nerves penetrate the sarcolemma and terminate in close relation to the contractile tissue*. Kühne endeavoured to show that the white substance of the nerve ceases at the sarcolemma, and that a pale nucleated fibre, the continuation of

* Ueber die peripherischen Endorgane der motorischen Nerven, 1862.

the axis-cylinder of the nerve, perforates the sarcolemma and terminates in free extremities beneath. In connexion with these pale fibres he described special organs of an oval form and containing a nucleus. In the Croonian Lecture for the present year, Professor Kölliker stated that he had failed to demonstrate the peculiar organs described by Kühne, that Kühne's pale fibres are outside the sarcolemma, and that the nerves terminate in free ends, the sheath of the nerve being continued for some distance over the pale fibre*. He also described some nerve-fibres, which for the most part ramify over the surface of the muscle. These he regarded as sensitive fibres. Kölliker and Kühne agree that the muscle receives but a small supply of nerves, that their supply is limited to one part of the muscle, and that a comparatively very small portion of each elementary fibre is brought into relation with the nerves at all. The author's conclusions are quite at variance with these views. Although in many cases the fine pale nerve-fibres could not be followed for any great distance from their origin, in some instances this had been done. The pale fibres consist of a bundle of very fine fibres, which divides and subdivides into smaller bundles, and these, after being followed to the edge of the muscular fibres, can often be traced a long way amongst the fibres of connective tissue, and can sometimes even be followed to other trunks. The author had seen many fibres less than the $\frac{1}{50,000}$th of an inch in diameter, which had been proved to consist of at least two fibres. Many of the so-called connective tissue corpuscles, close to the sarcolemma, are really the nuclei of very fine pale nerve-fibres, which form, as in the mouse, networks on the surface of the muscular fibre; but the meshes are larger and the fibres much finer in the frog than in the mammal or bird.

The author showed that the distribution of the dark-bordered fibres to many muscles of the frog is by no means so limited as is generally supposed. The elementary fibres of the inferior muscle of the eye of the frog are crossed by dark-bordered fibres at intervals of the $\frac{1}{50}$th of an inch. The author showed that what appears to be the outline of a dark-bordered fibre *near its peripheral distribution*, really consists of a finer nerve-fibre in many instances.

* See Kölliker's 'Handbuch der Gewebelehre des Menschen.' Vierte Auflage, 1862, pp. 203, 286, 287, figs. 111, 157, 158. Also the Croonian Lecture delivered May 1st, 1862.

Fine nerve-fibres run in the same sheath with the dark-bordered fibres. Some of these fibres are the direct continuation of dark-bordered fibres. There are often also fine fibres to be demonstrated external to what appears to be the sheath of the fibre. Nuclei are connected with the dark-bordered fibre, with the fine fibres in, and with those external to the sheath. The pale fibres of Kühne and Kölliker are always compound, and consist of—

1. A very fine fibre prolonged from the dark-bordered fibre.

2. Very fine fibres continuous with those in the sheath of the nerves, or external to it.

The author concludes, from numerous observations upon the distribution of nerves in many different tissues, that the general disposition of the finest fibres is the same as that of the coarser trunks and fibres. In passing from the trunks towards the ultimate distribution of the nerves, it might be said we meet with finer and still finer networks and plexuses; the finest fibres visible with the highest powers (1700 diameters) being composed of more than a single fibre. It is therefore probable that in all cases complete circuits exist. The author maintains that the really important part of the peripheral nerve-fibres only commences at the point where the dark-bordered nerve-fibre seems to cease. Beyond this there is a most elaborate network, the fibres of which are compound and composed of very fine fibres. The meshes of this network and the fibres differ much in size in different tissues. The active elements of the tissues lie in or upon the meshes of this network.

The author then discusses the relation of the terminal branches of the nerve-fibres to connective tissue. His views are briefly expressed in the conclusions given below. In order to see the appearances described by the author, the tissue must be mounted in some fluid which reflects highly, like syrup or glycerine. The fine fibres he has seen cannot be demonstrated in specimens mounted in fluids composed mainly of water.

The paper is accompanied with upwards of forty figures copied from specimens magnified by a twelfth or by a twenty-sixth of an inch object-glass made by Messrs. Powell and Lealand, and magnifying respectively 700 and 1700 diameters linear.

Conclusions.

1. In certain muscles of the frog the distribution of dark-bordered nerve-fibres is pretty uniform in every part. Although in the case of the pectoral a greater number of nerve-fibres is distributed to the central part of the muscle, fibres may be traced from the large bundle almost to the extremities of some of the muscular fibres. Many branches which easily escape observation pass between the muscular fibres, and their subdivisions supply neighbouring fibres, or are gradually lost in the connective tissue.

2. Fine nerve-fibres are most easily demonstrated on the external surface of the sarcolemma near the nerve-trunks; but reasons have been advanced in favour of the conclusion that every elementary muscular fibre is more or less freely supplied with nerve-fibres throughout its entire length. Many of the fine nerve-fibres on the surface of the muscular fibres become gradually very faint, until from their extreme tenuity we are no longer able to follow them.

3. Fine nerve-fibres in direct continuation with the dark-bordered fibres, and less than the $\frac{1}{30,000}$th of an inch in diameter, have been seen to divide into finer branches which have nuclei in connexion with them.

4. The pale fibres delineated by Kühne and Kölliker, and by them considered terminal, consist of—

a. Fibres about the $\frac{1}{30,000}$th of an inch in diameter, or less, resulting from the subdivision of the dark-bordered fibre.

b. Fibres resulting from the subdivision of fine nerve-fibres ramifying in the sheath of the dark-bordered fibre, or situated external to it.

5. Nuclei are found in connexion with—

a. The dark-bordered fibre itself, near its terminal ramifications.

b. The fine fibres which are the direct continuation of the dark-bordered fibres.

c. The fine fibres in the sheath, or external to it.

6. The nuclei and delicate fibres above referred to are arranged so as to form networks, the meshes of which vary much in size, situated with the capillaries on the external surface of the sarcolemma. The fibres of this network are compound, and consist of finer fibres which are distinct from, and do not anastomose with, each other. The fine fibres continued from some of the dark-bordered fibres, as well as

those ramifying in the sheath of the nerves, may sometimes be followed over six or more elementary muscular fibres, and form, with other fine branches, networks, many of the meshes being as wide as a muscular fibre.

7. Fine nerve-fibres with nuclei connected with them exist (not unfrequently to the number of four or five) in the sheath of the dark-bordered nerve-fibres near their distribution; and some are also found external to what appears to be the outline of the sheath. Some of these result from the subdivision of a dark-bordered fibre.

These fine fibres and their nuclei have been hitherto included under the head of 'connective tissue.'

8. The connective tissue around the elementary muscular fibres, and in connexion with the nerve-fibres, is composed of—

a. Nuclei which might have taken part in the formation of the nerve-fibres, but which have degenerated, and a low form of fibrous tissue has alone been produced.

b. Fibres and nuclei which were once active, and formed an integral part of the nervous system, but which have grown old, and have been replaced by new nuclei and fibres.

c. The remains of altered and wasted vessels and nerve-fibres distributed to them, and wasted muscular fibres themselves.

9. The nerves distributed to the voluntary muscles of the frog do not terminate in free ends, but there is reason for believing that complete nervous circuits exist. In all cases the fibres resulting from the division of the ordinary nerve-fibres are so fine that many cannot be seen with a power magnifying less than 1000 diameters, and there is evidence of the existence of fibres which could only be demonstrated by employing a much higher magnifying power. It is by these very fine fibres alone, and their nuclei, that the tissues are influenced. The ordinary nerve-fibres are only the cords which connect this extensive peripheral system, which has been traced in different tissues far beyond the point to which the dark-bordered nerve-fibres can be followed, with the central organs of the nervous system.

10. The facts and conclusions above stated, with reference to the distribution of nerve-fibres to the voluntary muscles of the frog, are in accordance with the arrangement of the finest nerve-fibres demonstrated in many other tissues of the same animal, and agree with

many appearances observed by the author in connexion with the peripheral distribution of the nerves, not only in certain tissues of man and the higher mammalia, but also in invertebrate animals.

11. The distribution of the finest branches of the nerve-fibres can only be demonstrated in tissues which have been immersed in fluids which refract highly, as syrup or glycerine.

III. "Researches on the Development of the Spinal Cord in Man, Mammalia, and Birds." By JACOB LOCKHART CLARKE, Esq., F.R.S. Received May 20, 1862.

(Abstract.)

In the first stage of development the spinal cord consists simply of a canal surrounded by a single layer of small cells or nuclei, which are not distinguishable from each other in regard to size or structure, and are so closely aggregated as to appear in actual contact. After a time this homogeneous layer, while it increases in depth, separates irregularly into two strata, the inner stratum forming the epithelium, and the outer the grey substance. This differentiation of structure proceeds gradually, and is not at first marked by any definite line of separation, nor by any apparent difference in the structure of the component cells. At the same time there is gradually formed around the walls of the nuclei a granular substance, which unites into processes or fibres, and constitutes a continuous network, by which all the nuclei or cells of both layers are uninterruptedly connected. In the grey layer there is at first no apparent difference between the nuclei or cells of the anterior and posterior portion, although in each portion dark or more closely aggregated groups may be observed in connexion with roots of the nerves. As development advances, however, while the nuclei of the posterior grey substance remain for a long time but little altered, those of the anterior substance increase in size, become more granular, and are connected by thicker fibres united in a coarser network. At the same time, in the separate groups of the anterior grey substance, the granular network around the nuclei assumes a coarser and sponge-like structure, until it constitutes a number of large roundish or irregular and adjacent cells with thickening and nucleated walls. While these are in course of development, the contained nuclei are forming