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THE FINER ANATOMY OF THE INFUNDIBULAR REGION OF THE CEREBRUM INCLUDING THE PITUITARY GLAND.

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Anatomy.—The material used in this study was obtained from the brains of twelve dogs of various races, and six mice of the gray variety. The results obtained from the dog were on the whole more satisfactory than those from the rodent, though, in some instances, the tingeing of the nerve elements was finer with the smaller animal. All examples of both species were *adults*, and some of our best preparations of the neuroglia elements were had from the infundibulum of a very old dog of the setter breed.

The region examined, began anteriorly at the posterior margin of the chiasma opticorum, and included in the first sections some of the fibres of the optic nerves, then passing dorsally, the anterior portion of the infundibulum, the infundibulum proper, the tuber cinerium, the anterior and posterior lobes of the pituitary gland, and the corpora mamillaria as far as their posterior border.

All sections were made vertical to the surface of the brain, it being found that these gave the best results; and in the central region of the infundibulum, where it opens

into the third ventricle, the sections took in an area as high as five millimetres above the floor of the inferior surface of the cerebrum. Laterally, the area of the sections was confined to the margins of the gray matter of the temporal convolutions, but did not extend into their substance. In all, about 2,500 sections were examined.

The staining agents used were the rapid silver method for the nerve elements, and my picric acid modification of the same, for the neuroglia elements and nerve cells. The magenta method of Nissl, eosin-hæmatoxylin, and a number of the aniline dyes were used for confirmatory purposes only.

I.—THE PITUITARY GLAND.

Our work commenced by a study of the pituitary body, as it is best seen in vertical section after it has been removed from the basis cerebri with a portion of the tuber cinerium attached. Sections were also made of the inter-thalamic region with the hypophysis connected, in order to ascertain the relations of the nerve elements of the infundibulum and those of the nervous portion of the gland, and to preserve as far as possible the landmarks, as the Golgi method, owing to its characteristic action in staining only a portion of the nerve fibres and cells, also owing to the overlapping of the white and gray substances, renders it very difficult to keep track of the intermingling ganglionic regions.

In the mouse, the pituitary body proved to be too small to obtain satisfactory sections, not being larger than the point of a good-sized pin. In the dog it is about the size and shape of a small cherry, and is divided into two unequal portions by a closed ventricle. The posterior portion, the *lobus infundibuli*, which is directly attached to the infundibulum, is a rounded oval in form, and varies both in shape and size but slightly in the various animals used. This lobe is so strongly adherent to the dura that it pulls out of the rest of the pituitary body in removing this with the brain, unless the membrane is dissected with it from the base of the skull.

The second half of the organ, the anterior or glandular portion, is attached loosely to the rounded base of the infundibulum, by connective tissue and a large number of vessels, both veins and arteries, that directly pass into it from the substance of the infundibulum, and to the *lobus infundibuli*, by connective tissue and large vessels. This glandular portion of the body may be roughly divided into two rounded lateral thicker portions, united by a central thinner portion, into which the lobus infundibuli is pressed. Between the anterior and posterior lobes, is a constant closed cavity. The wings of the main cavity have horns, which pass far outward toward the inferior and lower margins of the lateral thickenings of this lobe. These cavities are lined throughout their extent by cylindrical epithelium. Besides the main cavity, a number of smaller cavities are to be found, both in the nervous and glandular portions of the organ, usually lined with cylindrical epithelium, but sometimes, especially along the margin of the body, other cavities of a different nature are to be observed, evidently formed by the coalescence of two or more follicles, and are commonly filled with a colloid material.

For the general histological features of the glandular elements of the anterior lobe, I must make reference to the text book of W. Krause,¹ the monographs of Lothringer,² Schönemann,³ and Stieda,⁴ and for histology and development, to the very excellent work of W. Müller,⁵ as our researches only concern the intimate nerve distribution.

The Glandular Portion of the Hypophysis.—In the glandular portion of the body, nerves, other than those belonging to the sympathetic system, are not found. They are very fine varicose fibres, with numerous ramifications and ultimate branchlets coming off from the main stems at a right or slightly obtuse angle. As in all the other secretory organs we have studied, bundles of small nerves are to be

¹ W. Krause, *Handbuch der Anatomie*.

² Lothringer, *Arch. für Mik. Anat.*, Bd. xviii.

³ Schönemann, *Virchow's Arch.*, Bd. cxxix.

⁴ Stieda, *Inaug. Dis. Königsberg*, 1889.

⁵ W. Müller, *Jenasche Zeitschrift*, Bd. vi., 1871.

seen following the course of the arteries, and in the present instance these vascular bundles do not seem to be unusually numerous. From them come off, at irregular intervals, single fibres, or branches from the main stems, which pursue a very irregular course through the glandular substance, crossing over or accompanying the large venous channels in the septa, and finally being distributed upon the coils of the epithelial cells forming the follicles. As in the illustration (fig. 1), single nerve fibres may frequently be seen coming from some considerable distance over the surfaces of the follicles, across veins and septa, and finally breaking up into a terminal figure, with quite numerous ball-shaped endings, which appear to lie in the inter-cellular substance; the whole arrangement being very similar to that of the adrenal gland. No nerve cells are to be found in the substance of the organ, and all nerves belonging to it appear to be derived from branches of the carotid sympathetic plexus.

The Infundibular Lobe of the Pituitary Gland.—The microscopic appearances of the very numerous sections we have made of this portion of the organ are somewhat at variance with the ideas received from the text books, in respect to its histological characters. Both the sections stained with eosin-hæmatoxylin, and with aniline dyes, and those simply hardened in the osmium-bichromate mixture, without further process of staining, give a separation of the organ into three portions; all of which are microscopically dissimilar in appearance. There is first an outer lamina of slightly irregular ependymal cells (*a*, fig. 2), three or four deep, arranged after the manner of the cuticular epithelium, separated into divisions by thin processes extending from the fibres of the surrounding capsule and terminating at a definite line, where a separation from the more internally lying elements occurs; then follows a more internal zone of varying depth containing epithelial cells of a secretory type, which in places along the posterior and inferior border of the lobe, as well as occasionally in the more central regions, are arranged into distinct closed acini, lined with a low variety of cylindrical epithelial cell, and often hold in

their lumen collections of a colloid substance. Occasionally, several of the acini are seen coalesced, forming cavities of small size. The follicles vary very greatly in numbers in the several sections, but are always more numerous along the posterior border than elsewhere, though they may be present quite up to the mid-region of the lobe when invaginations of the outer epithelial layer occur. Intermingled with the acini are numbers of smaller cells, not so distinctly epithelial in appearance, which become predominant in the central and more anterior regions.

The alveoli are separated by trabeculæ of connective tissue, bearing blood-vessels, which are not of such large dimensions as are found in the anterior lobe.

This secretory region gradually merges into a central region of small rounded and polygonal cells, separated by extensive connective tissue partitions, carrying blood-vessels, and scattered widely among these cells are others of larger dimensions. Among the scattered cells may be distinguished some of spindle form, others of pear or rounded shape, and still others of very irregular form, with their borders ill defined; all having a finely granular appearance, with here and there larger granules scattered among them, that are tinged by osmic acid a blackish colour. The nuclei of the cells, when they can be determined, are rounded, have a nucleus and adnuclear particles, and are moderately large in size. Along the anterior border of the lobe, the epithelial elements, except the outer ependymal row, retreat a little in prominence, especially along the anterior margin adjacent to the region, where in the lower orders of animal life the infundibular duct is present (now represented in the dog, only by blood-vessels and connective tissue bundles), they become segregated into groups of mainly oval and pear-shaped cells, separated by a fine stroma, with small nuclei here and there in it, and are now easily recognised as nerve cells. A certain number of the spindle cells are very long as well as broad, and probably correspond to those described by Krause, as spindle cells of uncertain function, but are undoubtedly nerve cells.

It has been shown by Andriezen,¹ that the pituitary in *amphioxus* and *amocætes*, is of three-fold structure, namely, a sub-neural glandular organ; a duct lined by ciliated epithelium, which affords a communication between the buccal and neural cavities; and a group of nerve cells, around and at the back of the upper opening, where the duct widens into the ventricular cavity. He has further shown that particles of carmine, suspended in the water surrounding the animals, will be taken up with the water passing through the infundibular duct, and carried by ciliary action into the ventricle, and thence into the central canal of the cord, finally the particles of carmine may be traced right up to the free end of the canal, where the spinal cord opens into the exterior by the blastopore; therefore, it is made manifest, that the infundibular duct carries a stream of oxygen-bearing water, for the nutrition of the tissues, and the carrying off of their effete products.

It is quite curious to find essentially the same structures preserved in as high a vertebrate as the dog, and descending to so low a zoological order as *amphioxus*, though as Müller remarks, the pituitary is practically the same from *myxine* to man. The epithelial structures surrounding the proper nervous portion of the pituitary, are hardly to be accounted for, except on the supposition that they originally enclosed a group of nerve cells, whose processes, probably, through a connection with peculiar neuro-epithelial cells, had the function of testing the water entering the infundibular canal (Herdman, Andriezen), and that after this function had become lost in the gradual ascent in animal life, these cells became metamorphosed into cells having a secretory function, in part, homologous to those of the anterior lobe, and probably originated from an offshoot of the same buccal epithelium that formed the substance of the anterior lobe. The nerve cells of the ganglion likewise underwent partial changes, a group of them remaining near their former situation, and retaining somewhat of their old characteristics, while the deeper ones became more scattered, through

¹ Andriezen, *British Medical Journal*, Jan., 1894.

the infiltration of new cellular elements between them, even to the extent of producing a partial loss of function, and consequent prevention of their further and higher organization.

We have been so fortunate in a number of specimens as to obtain good staining of the nerves and neuroglia elements of the nervous lobe of the pituitary, but unfortunately the nerve and neuroglia cells, and the nerve fibres, do not stain well in the same sections, the fibres being better influenced by the plain Golgi, the neuroglia and nerve cells coming out with greater clearness and frequency in the picric acid preparations, hence, the connections between the two portions of the nervous structures are in some measure difficult to ascertain.

The Supporting Tissues.—At the outermost margin of the body, there are seen extending from the thin capsule surrounding it, numbers of rather thick varicose threads, all unbranched, and invariably ending when their terminations can be discovered, in a ball-shaped figure, at a definite line in the substance of the body, usually at the inward ending of the first layer of epithelial cells, at the line of separation from the more centrally situated elements. These knobby threads strongly resemble the ependymal glia cells of embryonic life, and possibly may be related to them, but as their basal end is shrouded in a blackened aggregation of cellular masses, their histological origin must remain a matter of some uncertainty. Throughout the remaining portions of the lobe, connective tissue trabeculæ, are everywhere met with, separating the cellular elements, and bearing the blood-vessels.

In the posterior two-thirds of the body, glia cells are not stained, but as we approach the anterior edge, that is in all portions of the anterior third of the lobe, where the nerve cells are thickly strewn, we find moderately numerous neuroglia cells of different types, principally a mossy cell of varied form (fig. 3), lying between the groups of nerve cells; and the usual spider element, with its single very prominent tentacle (fig. 4), but their bodies are a little different from those seen in the purely cerebral tissues,

being much larger in proportion to the extent of their tentacles. In the superior portion of the organ, adjacent to the infundibulum, these spider cells are in moderate numbers, to the exclusion of every other variety, though nowhere in the substance of the lobe are very numerous glia cells of either type stained.

The Nerve Cells.—It is only here and there through the anterior two-thirds of the lobe, that the silver stain affords examples of the varieties of nerve cells of the body. At the extreme base a small group of cells may quite constantly be seen stained (*g. fig 2*), but this is the only example of groups of nerve cells stained by the silver salt, elsewhere they are only tinged in singles and in collections of twos and threes. In some respects this defect in the reception of the silver salt is a drawback, in others it is a decided advantage, as the full figure of the tinged cell stands prominently forth among the unstained elements, with their exceedingly beautiful and massive neurodendrites.¹ It is hardly to be supposed that any varieties of the nerve cells have escaped impregnation at some time in all of our sections, as the isolated cells are pretty thoroughly scattered among the regions occupied in the unstained sections, by visible nerve cells. All the ganglionic elements of the gland may be considered as belonging to the multipolar type, no exception to the rule being determined by the method of staining.

For the sake of distinction the nerve cells may be divided into two principal classes, cells with one neuraxôn, and cells with two or more neuraxôns.¹ These varieties may be further subdivided into large irregularly pyramidal and oval cells having large numbers of neurodendrites and a single neuraxôn (*figs. 5 and 6*); medium-sized multipolar cells of very irregular shape with many dendrites, among which may be distinguished one very prominent one directed towards the upper and anterior margin of the lobe (*fig. 7*); irregular pyramidal cells with the same characteristics (*fig. 8*); flasked-shaped cells of about the same size with numerous processes,

¹ I have throughout this article used the word neurodendrites, and dendritic and protoplasmic extensions or processes, also neuraxôn and axis cylinder, as synonymous.

from which come off at different points on the dendrites, two or more axis-cylinder processes (fig. 9); very small pyramidal and flasked-shaped cells, having an enormous length for their apical processes (figs. 10 and 11); rounded cells of equally small dimensions with very strong processes, among which may be distinguished a single axis-cylinder extension (fig. 12); lastly, cells of very small size, situated along the extreme upper and inner edge of the lobe, with an apical tuft of smooth protoplasmic processes, and an axis-cylinder extending downward toward the centre of the lobe (fig. 13).

(1) The first variety (figs. 5 and 6), the largest pyramidal and oval cells, are possessed of many and strong dendrites, which come off from the thickened points at the extremities, and along the margin of the cellular body, and gradually break up into finer and finer ramifications, which eventually terminate in filaments of feathery tenuity, giving the cell a very beautiful appearance. The axis-cylinder processes of these cells, which is always one to each cell, throw off very few collaterals near the cell body, but later break up into numerous branches, some of which terminate upon other cells, while the main thread continues upward, toward the upper periphery, to end in a very complex network among the epithelial cells along the border of the lobe. These larger multipolar cells are principally found among groups of unstained cells along the anterior and inferior margin of the lobe.

(2) The medium-sized pyramidal and irregularly oval cells (figs. 7 and 8), are found in numerous locations, both along the borders of the organ, and in the more central regions, quite as far back as the nerve cells extend. Their bodies are usually well stained, but the dendrites are quite short, with the exception of one very long one, which may arise from either the apex or side of the cell. These dendrites exhibit none of the extensive ramifications and arborizations of the larger variety, but on the contrary are often distinguished by the presence of numerous hairy processes, extending but a little distance from the ramus. These hair-like processes may also come off from the margin of the cellular body itself (fig. 8). Clubbed endings to the dendrites

are also more frequent than with the larger variety. Always among the dendrites may be distinguished a single one that does not diminish in calibre as rapidly as the others, and extends for a long distance from the cell, with a general direction upwards and forwards. The neuraxons are not very easy to distinguish from the other processes, and appear to originate by a gradual diminution of the calibre of the process. Each cell seems to possess only a single neuraxon.

(3) The flask-shaped cells (fig. 9) are to be found over a wide territory, and while covering a considerable space with their branches, never show the fine feathery arrangement of the largest cells, but finally pass by a gradual diminution of their calibre into finer and finer neurodendrites, ending free among the tissues, frequently with a small knob-like arrangement. From two to four neuraxons have been found coming off from this variety of cell, and though it is difficult to trace them for any great distance, they would appear to break up into a fine meshwork which surrounds unstained cells.

(4) The small flask-shaped and pyramidal cells (figs. 10 and 11) are moderately numerous, and are found chiefly in the central regions of the organ. They do not show many basal, and these are only stained for short distances, but on the contrary they have exceedingly strong apical processes, which may run almost through the long diameter of the body, giving off lateral processes as they extend upwards, and these processes have at times a tendency to form a complex brush-like figure at their terminations. No axis cylinder process is to be made out, coming off from these small cells, but the appearance of some of the basal processes would indicate that the origin of the neuraxon was from that extremity. The singular endings of some of the apical processes would indicate a peculiar function for these cells.

(5) Our next variety is an interesting type of cell, of which the drawing hardly gives a complete idea. The body is small and of a rounded form, from which strong dendrites come off, and sub-dividing, cover a large space around the body of the cell. These ramifications have exceedingly numerous thorny and knotty extensions from them, giving the dendrites a prickly appearance. The axis-cylinder

process comes off at some variable point from one of the thickest arms, and is fine, and shows collaterals here and there, though they are not very numerous. This cell is only stained near the upper border of the body, and the axis-cylinders soon disappear among the thick-set arrangement of the nerve fibres found in this region. It is very probable that this cell belongs to the intermediary (second type of Golgi) type, though, as already mentioned, but one neuraxon is to be found belonging to it. This cell is peculiar to the region, and to the lobe, so far as I have been able to determine, not having met with a similar variety of ganglionic body in any other portion of the central or peripheral nervous system.

(6) The last variety is a cell of rather smaller size than than those of sub-class four, and is quite numerous along the upper and anterior border of the lobe, and is distinguished by a strong tuft of fine wavy prolongations from the upper apical portion, which extends almost, but not quite, to the inner free margin (fig. 13, also fig. 2), where they are intermingled with the network of varicose nerve fibres, that are so thickly set in this region, along the space formerly occupied by the infundibular duct. The basal processes are inconsiderable in numbers, at the most two or three, and do not give off lateral branches over considerable distances. They are directed downward, and finally intermingle with, and are lost among, the haze of nerve fibres in this region.

The chief protoplasmic extensions of all the larger and medium-sized nerve cells are distinguished either by their extreme length, or by the extent of territory over which they spread. The extensions themselves are either knotty, prickly, or have a feathery arborescence developed upon their branches, which is simply the breaking up of the finest protoplasmic prolongations, into exceedingly numerous fine short ramuscles.

One of the peculiarities of the cells of the lobe is the development at the final ramifications of the dendrites, of complex tufts of various forms, which, under low powers, show only as irregularly blackened objects, lying among the thickly set protoplasmic extensions. These tufted objects

are frequently seen among the processes of the lowermost group of cells (fig. 2, also fig. 14, in which one of the developments more highly enlarged is reproduced). Into it, two varicose fine processes are seen entering, which sub-divide and form figures of peculiar shape, with numerous irregularly blackened points and knotty knobbed endings, extending from and scattered among them. Tufted developments of more simple form are occasionally seen among the extensions of the larger cells, situated in the mid-region of the gland.

The ramifications of the smaller cells, all of which, with one exception, are of moderate length, may be divided into four groups: (1) Those that branch at numerous rectangular and obliquely angled points, but whose finer dendrites do not sub-divide to any extent (fig. 9); (2) cells whose processes sub-divide at numerous rectangular and obtuse angles, and are covered with a multitude of feathery and spicular projections (fig. 12); and (3) cells of irregularly oval form, with tufts of thin non-varicose processes; lastly, cells with very long, not frequently divided apical processes, and short basal ones (figs. 10 and 11). None of these cells show other than a usual development of the dendrites, with the exception of the last variety, where we again find tufted endings, though of more simple form than those appertaining to the larger pyramidal and irregular cells. These tufts are scattered widely in the central regions of the lobe, and as certain of the nerve fibres, as will presently be seen, also develop bushy end-figures, it is sometimes difficult to distinguish between termination of axis-cylinder, and termination of dendritic extension.

The Neuraxôns.—The majority of the axis-cylinder extensions of all the numerous varieties of cells belonging to the organ, are by their finer calibre, and the constant presence of small characteristic varicosities and thickenings, readily distinguishable from the dendrons; but in certain localities, notably in the mid-region of the lobe where the finer lateral extensions of the pyramidal and flask-shaped cells are moderately numerous, we find ourselves between the horns of a dilemma to decide which is axis-cylinder or nerve fibre and which is protoplasmic extension, and it is only by following

them to their terminations, when such may happily be found, that we are definitely able to determine the difference.

The axis-cylinder extensions of all the cells in the inferior portion of the lobe turn upwards; the direction of those belonging to the smaller pyramidal and flask-shaped cells, I have not been able to determine. Those belonging to the larger proportion of the smaller cells of the superior border turn upwards, and intermingle with the marginal fibre network, and but a few belonging to the tufted cells of the higher regions probably turn downwards toward the central regions, and are soon lost in the maze of fibres.

All through the middle and anterior portions of the lobe, the intermingling of the neuraxons and neurodendrites forms an exceedingly complex arrangement, in which it is difficult to pick out the individual fibre belonging to one particular cell, and trace it for any considerable distance. All the axis-cylinder processes, and the long dendrites, have a general tendency upwards and forwards, both dendrites and neuraxons branching as they proceed onward, but all traces of the dendrites of the inferior and median cells of the lobe are lost some little distance below the superior edge, and then the neurons only are intermingled with the extensions of the smaller superficial cells, passing them, however, before the border is finally reached, where they spread out into a most extensive felt-work of fine varicose fibres, still retaining something of their previous longitudinal arrangement from the threads of the uptending fibres being coarser than the lateral and intermingling branches. It is doubtful whether any of these fibres pass beyond the limit of the lobe into the infundibulum, our sections giving no evidence of such an arrangement; while, on the other hand, the nerve fibres accompanying the larger arteries are sometimes distinctly seen coming from the infundibular tract into the body of the posterior lobe of the gland, and ramifying through it. It is probable, too, that some portion of the nerve threads in the posterior secretory portion of the lobe are also derived from these vascular filaments, but connections between the fibres of the vascular supply and the nerve cells of the organ we have never been able to observe.

A small number of the nerve fibres originating in the lobe have thickenings of some size in their course, and more rarely a pear-shaped diverticulum of small diameter is seen extending from a fibre, the appearance being similar to certain cells of the spinal ganglia having T-shaped extensions, only they are much smaller.

In the central regions of the lobe certain rounded or oval bodies are observed (*v.v.*, fig. 2), which in the chrome silver preparations have a likeness to closed follicles, but have no visible structure, and only appear as oval bodies of a yellowish colour with a sharply marked line of differentiation from the surrounding structures. A careful search through a number of eosin-hematoxylin preparations failed to reveal any similar rounded bodies in the central regions of the lobe, though in several instances the follicles pressed far inward. Around these bodies the axis-cylinder processes coil with an intricate arrangement, the main fibres in their upward course diverging around them, but from the same fibres arise others, that, after passing to the bodies having the outline of follicles, develop upon themselves very extraordinary figures (15 and 16, also fig. 2, *v.v.*). These fibres twist and coil (fig. 16) upon themselves, develop irregular thickenings, the most common being an irregular, comb-like figure, with knobs set on the end of the blades. There is also a tufted form, and sometimes only a development of intricate knobs is observed, extending from a blackened mass, having a nerve fibre passing into it.

With the exception of the ones present among these peculiar endings, there do not appear to be anastomoses among any of the fibres of the lobe; they branch repeatedly, cross each other, their lateral and even main stems develop arborizations around other cells, especially clearly seen around those that are not stained, but nowhere, even in the situations along the anterior border where the nerve threads are sufficiently dense to form a feltwork, do they ever anastomose.

In the posterior third of the lobe, among the epithelial structures, the nerve arrangement, owing to the greater though comparative rarity of the stained elements, is seen

with exceeding clearness and distinctness. Here varicose fibres come in numbers from the median portion of the organ, branching repeatedly as they wander through the tissues, becoming finer and finer in calibre, and finally end with free minute branches apparently without end-knobs, though this may be a defect in the staining.

Numbers of these nerve threads cross the line separating the follicles (fig. 2) from the outer layers of epithelial cells, and form outspread arborizational figures of considerable extent. Anastomoses between these filaments do not occur. Here also no end-knobs are to be found, though the staining of the fibres is very clear.

The silver method shows the pituitary gland to have retained, in one of the highest orders of vertebrates, its double rôle of secretory and nervous function, intact; the former perhaps modified, the latter, the original special sense organ, probably simply lying quiescent, not atrophied, and only changed in so far as to admit of a slightly different arrangement of its constituent elements.

It is exceedingly difficult to interpret the meaning of the peculiar comb-like figures and nerve tufts upon the central nerve endings. If the rounded bodies are follicles, their nerve endings are certainly very dissimilar to the endings upon the acini of the salivary or thyroid glands, or even the adrenal capsules; very much more strongly do they resemble the endings of the mitral cells of the olfactory bulbs, the so-called olfactory glomeruli, and it is more plausible to refer them to some organ of special sense existing fully developed in the lower forms of animal life, than to endings upon secretory epithelium.

II.—THE INFUNDIBULAR REGION.

Those portions of the inter-brain of embryonic life, represented in the adult by the floor of the middle ventricle, may, for the purposes of this study, be divided into three tracts; the regions anterior and posterior to the central opening of the ventricle, and the funnel-shaped extension downward, the infundibulum proper: the component parts

being united by the rounded walls of the infundibulum, and fused together at its base without a distinct line of differentiation between them.

The Infundibulum.—In eosin-hæmatoxylin preparations of this lowermost portion of the walls of the third ventricle, we find a moderately thin lamina of fibrillated tissue containing a multitude of nuclei of rounded or angular form, a few nerve cells of pear or rounded shape, and a number of large blood-vessels; the whole tract being divided, somewhat unequally, into two parts, by differences in the reception of the staining agents by the tissues. The outer half of the lamina has fewer nuclei, and a finer as well as more complicated arrangement of the glia fibrils than the inner, where the component fibrillæ are coarser and less complicated, and the nuclei more abundant. The central point of the most inferior region of the infundibulum is united to the apex of the posterior lobe of the hypophysis by a mass of blood-vessels and fine fibrillated tissue, with considerable numbers of nuclei among the bundles; the whole arrangement of the structures of the infundibulum being here altered. Elsewhere it shows no break in the described arrangement, the line of differentiation between hypophysis and infundibulum being sharply drawn, a layer of coarse connective tissue bundles being placed between, and separating the glandular and other structures of the pituitary from the tissues of the infundibulum. The staining of the infundibular tissues by chrome-silver, shows an exceptionally complicated mass of interlacing glia elements of a distinctly embryonal type, which is so dense, that in fully impregnated sections, it is impossible to see more than a complicated mass of rods, without differentiation into cellular forms.

In less thoroughly stained specimens we may readily distinguish two principal types of neuroglia cells (1 and 2, fig. 17) and several sub-varieties. In all portions of the organ up to its fusion with the tuber cinerium, we find glia cells passing from the internal edge of the ventricular portion of the lamina to the extreme outer margin of the infundibulum, resembling in every respect the earliest ependymal glia cells of embryonal life, and corresponding to those

arising from the ependyma of the lateral ventricles and penetrating through the cerebral tissues. At the edge of the ventricular cavity we see small pyramidal and elongated cell-like bodies (1, 1, fig. 17) with a slight projection into the cavity of the ventricle, each cell giving origin to a single thick stem, often slightly roughened, which, after reaching as a single twig the middle or even superior third of the lamina, breaks up into several branches, bearing upon themselves small numbers of rounded thickenings. Finally these branches end at the epi-infundibular limit in large rounded or flattened knobs, the latter form often having the aspect of being cup-shaped at their outer extremities. This variety of cell is sometimes stained to the exclusion of every other ependymal form, and then occupies the whole infundibular tract to the beginning of the substance of the tuber cinereum.

The first sub-variety (2, fig. 17) consists of straight, very rough fibres, arising from the edge of the ventricle, only here and there showing cell-like forms at their bases, and running almost to the edge of the outer limit before ramifying. There they sub-divide into a few rather fine branches, only occasionally having knob-shaped terminations upon their extremities. Sub-variety two (3, fig. 17) comprises exceedingly coarse fibres arising from ependymal cells, often of quite irregular form, and almost immediately break up into ramifications after their origin from the cellular protoplasm, finally terminating beneath the outer limit. When the border is reached the knob-like ending is always apparent, consequently the other form, where they end below the margin without a swelling, is probably an imperfection in the staining. These cells are very numerous, especially in the lateral portions of the body, and supplant the primary form (type I) of ependymal cells. Sub-class three (4, 4, fig. 17) is only stained in the outer half of the infundibular lamina. Their stems are sometimes very thick, and sometimes very thin, but always at a certain point they develop an irregular or triangular thickening, out of which sprouts a variable number of fine threads to make a brush-like figure. The threads, when they reach the periphery, are so fine and closely set together that they look like a blackened spot

along the outer margin. None of the branches of the ependymal cells ever anastomose.

The second, and only other type of glia cell (12, fig. 17) that is stained by the silver salt, is a rounded cell of quite large dimensions, having a multitude of exceedingly delicate varicose processes extending from the body, that never branch or anastomose with one another, and give to the cell a burr-like appearance. This type of cell is but sparingly stained, and is present in all portions of the body, most frequently within the inner half, though occasionally they may be found quite close to the outer limit.

The Nerve Elements.—Both the nerve cells and fibres stained by the chrome-silver are quite sparse in numbers when compared with the neuroglia elements. In the unstained osmic acid preparations but a few rounded and pear-shaped cells (5, 5) are to be discovered. The cells of nervous function tinged black in the silver preparations resolve themselves into the usual varieties, cells with one neuraxon, and cells with several neuraxons, all being multipolar.

These types may be sub-divided into four classes: (1) Large multipolar cells with fairly numerous strong processes (6, fig. 17), among which may be distinguished a single one which extends, without branching in a circular direction some considerable distance from the cellular body, and then develops knots and triangular irregularities (10, fig. 17) in its course, from which arise rather thick, right-angled rami, that end, without again branching, at the periphery, in a globular enlargement. The main filament continues in its circular course, and finally disappears before arriving at any definite termination. (2) Smaller pyramidal cells (7, 7, fig. 17) also situated in the long diameter of the body, which gives off one or two apical processes following the direction of the long extension of class 1, though they do not develop lateral processes, except in occasional instances, nor is their protoplasm stained to any definite ending. (3) Cells of pyramidal form (8, 8, fig. 17) but of smaller dimensions, lying transversely or obliquely to the surface, that have an axis-cylinder process coursing among the sparsely stained

longitudinal fibres, and knobbed-endings to their pyramidal processes attached to the outer limit of the infundibulum. (4) Small cells of pyramidal form (9, fig. 17) with a considerable number of basal processes, and a large number of fine, smooth, apical ones, from which arise a number of axis-cylinder extensions, coursing circularly through the long direction of the body, where they are eventually lost.

Nerve Fibres.—The irregular protoplasmic extensions of a number of the largest pyramidal cells found in every portion of the infundibulum, we think should be looked upon as axis-cylinder extensions of probably strictly local function, though from their irregular appearance and the development of triangular thickenings it is improbable that they are provided with a myeline sheath. The other neuraxons, all of which belong to common forms of nerve fibres, are sparingly arranged after a circular fashion entirely in the mid-regions of the body. They are quite fine, possess numerous varicosities, and have the same general appearance as the finer fibres of the cerebrum when stained by chrome-silver. No fibres of nervous origin, apparently, pass to and fro, between the posterior lobe of the hypophysis and the infundibulum besides a few vascular nerves.

In well stained sections, a few thin nerve fibres (11, 11, fig. 17), may always be seen passing beyond the limits proper of the infundibulum into the gray substance of the lateral wall of the third ventricle, along which they ascend for some distance and are finally lost in the haze of nerve and ependymal glia fibrillæ about two millimetres above the opening of the ventricle into the infundibular cavity.

III.—THE NEUROGLIA OF THE VENTRICULAR WALLS.

As we approach the opening of the infundibular cavity into that of the third ventricle, we find the ependymal cells assume a different form from those already described. The cellular mass at the base is now very small (fig. 17, No. 14), the cells closely set together, so closely indeed that they frequently appear to be fused into a single mass, out of which extend long, very infrequently branched rays, studded here

and there with bead-like thickenings. These rays extend through the gray tissues almost incredible distances, passing in the direction of the basal ganglia. There is only a single process to each cellular body.

Proceeding upwards along the borders of the walls of the ventricle, we immediately come upon another and most beautiful variety of ependymal neuroglia cell (fig. 17, Nos. 15, 15). This cell is somewhat different in form from any of the familiar types that have been depicted by Retzius, Kölliker, Cajal, and others. The body is fairly large, of a rounded or flattened form, and is situated along the margin of the ventricular cavity, and very often sends out a short spiked process into the ventricle. Out of the body very numerous lateral rays proceed, extending along the margin of the ventricle for considerable distances. From that portion of the cell body directed towards the cerebral substance, grows a main process which is primarily single, though later it may divide into two or even three main branches. This vertical process has projecting from its sides large numbers of rectangular lateral tentacles, some quite short, others of medium length, similar to those passing from the body of the cell, and taking the same general direction. Some of these extensions are thicker and shorter than the others, and have knotty and prickly projections from their margins, while others are longer and have the prickles, but no knotty thickenings. Subdivisions of the lateral processes are somewhat rare, but do occur. Out of the uppermost portion of these strong vertical processes, we can almost always find a long, smooth, hair-like prolongation, which shortly bends downward toward the floor of the brain, where it meets the up-tending fibres of the sustentacular glia cells along the inferior margin of the floor, as well as the rays from the last described variety of cell, and mingling with them, is soon no longer distinguishable in the dense meshwork; though it is probable from the appearance of a few isolated examples that they all end in a ball-swelling against the pial limit. The general effect given by these ventricular cells reminds one strongly of a lateral view of some of the varieties of conifers, hence we have named them the *fir-tree* ependymal cells.

These very beautiful bodies are thickly set along the margin of the ventricle, and are found in perfection up to a height of several millimetres above the debouchment of the ventricle into the infundibular cavity, above which they become less frequent, and are dislocated from the immediate border of the ventricle, appear to become stunted and lose their long, smooth prolongation. Some of the examples of these cells are very large, others quite small, but together they fill up the whole space along the edge of the ventricle in this region to the exclusion of every other form of neuroglia cell. There are no transitions between these neuroglia cells and the more common varieties in their neighbourhood, and they are stained in no other location than along the immediate border of the ventricle.

A little outward from the ventricular edge we begin to meet with cells approximating the short-rayed Golgi cells in shape, but their bodies are of rather larger size, the tentacles coarse, not reaching to the ventricular border (fig. 17, No. 16), and it is only when we approach a region about 3 mm. from the pial border of the basis cerebri, and some considerable distance from the ventricle, that the distinctly glia cells of the long-rayed type first make their appearance, and are then very numerous and closely placed together, their rays interlacing in all directions. In specimens in which the neuroglia is fully stained, the meshwork formed by the prolongations of these cells is so dense, even without the admixture of nerve filaments, that under low powers this entire portion of the section is stained almost a solid black.

Returning now to the floor of the brain lateral to the ventricular cavity we again see the shapes of the neuroglia cells change completely. The embryonal types have everywhere departed and in their place, ranged along the inferior edge of the brain floor and from thirty to sixty mikra above it, are stout-bodied cells of irregular shape (fig. 17, Nos. 17, 17), with processes extending in all directions, interlacing with each other and forming a grill-work, but never anastomosing. Two chief types of cells may here be differentiated. The first (Nos. 17, 17) are cells with irregular bodies and with a vast number of rays extending from all portions of the

cellular protoplasm, but with several thicker processes extending upward into the cerebral substance, and a number, often very considerable, of shorter ones passing to the pial limit, where they end with ball-like knobs. The lateral rays from these cells are numerous and strong, and help largely to form the interlacing network along the margin of the brain floor.

The second form (fig. 18) is an extremely angular cell, having quantities of hair-like projections from the cellular body and basal portions of the thicker processes. The extensions themselves are not so numerous as those of the former type, and are only notable by arising from the body by thick junctures and then gradually diminishing in calibre. Among the prolongations one may always be distinguished by its stout appearance, which is directed upward toward the central regions of the brain, there to terminate either by a gradual process of attenuation, or by ending in a cone-shaped figure.

Along the borders of the optic nerves and among their fibres the neuroglia cells return to the long-rayed Golgi type, but their processes are of far thicker calibre and coarsely but infrequently beaded, and visible among the nerve structures much longer distances than the ordinary long-rayed cells, the two forms being drawn for contrast in figures 21 and 22.

Sixty to eighty mikra above the inferior margin of the brain we first find interesting transition forms between the cells already described and others of probably later development. In fig. 12 of the main figure we find an illustration of an irregular cell with quite large body and numberless rays of considerable length extending in all directions from it. These processes are further subdivided into longer and shorter rays of non-branching character, and stouter short rays with a few short branches, both processes and their branches being covered with minute hair-like projections, giving the arms a shaggy appearance. On the opposite side of the drawing a similar cell is depicted (fig. 17, No. 13) of the same general character, but with few smooth processes of any length, these often bearing at their terminations globular figures. The other extensions of the cell are short and thick and are covered with the fuzzy hairs.

Very numerous forms of similar cells are present all through this region, among them (fig. 19) a cell with pyramidal body, feathery prolongations, and numerous hairy projections from the body and basal portions of the thicker extensions, the type resembling that last described, only being more delicate. These bodies finally give place, higher up in the tissues, to the long-rayed Golgi cells, intermingled with a few of the short-armed variety.

It is at times almost impossible to distinguish between these hairy cells and some of the smaller varieties of nerve cells situated in the circumjacent regions. On the left side of the drawing (No. 20), the same hairy appearance of the body and main arms can be noted, also the globular endings to the processes directed downwards, and when the neuraxon of the nerve cell is not stained, it is utterly impossible to differentiate between these varieties of nerve and similar shaped neuroglia cells.

The last variety of glia cell (fig. 17, Nos. 21, 21), that is present along the borders of the ventricle, though never nearer than 50 to 80 μ . from it, and never very near to the base of the brain, is a cell with a body of variable size as well as irregular shape. Extending from the protoplasmic body are a variable number of stout prolongations, and these extensions, as well as the body of the cell itself, are covered by a vast number of thorny and knobbed processes, generally of short extent, giving to the entire cellular body a very shaggy appearance, comparable to a mass of coarse moss with a central more dense portion, hence the name of mossy cell.

Very similar cells are depicted by Retzius¹ from a preparation of a 26 cm. long human foetus, occurring within the gray columns of the spinal cord; also somewhat similar figures are given by Andriezen² from the cortex of the brain, under the name of protoplasmic glia cells. Some of these cells are of very large size, and stretch between the nerve bodies and fibres, covering an immense territory. Nearly all of them have one or two longer extensions, that eventually

¹ *Biol. Unters. N.F.V.*, 1898.

² *Brit. Med. Jour.*, January, 1894.

lose their mossy appearance, and run as almost straight fibres through considerable areas of the brain substance.

I was at first inclined to think that this mossy appearance was increased by a deposit of silver precipitate in coarse form upon very slight lateral projections from the main arms, but afterwards found numerous equally shaggy bodies in sections entirely free from every trace of deposit.

All the different described forms of neuroglia cells, with the exception of those belonging to the embryonal types, are in close relation to the blood-vessels of their vicinity, the connection being made by the application of their globular endings to the hyaline sheath of the vessel.

Two of the most distinguished, as well as recent writers on the histology of the central nervous system, have stated that, in their opinion, the embryonal supporting substance of the brain and spinal cord—the ependymal neuroglia—almost entirely atrophies and disappears in the adult mammal. To be more exact, Cajal¹ states that in birds and mammals “the epithelial neuroglia retains its embryonal type only in two organs, the olfactory mucous membrane and the retina;” while Kölliker,² speaking of his attempts to obtain a successful staining of the ependymal cells of the spinal cord in full grown animals, adds, after reciting his want of success: “I presume, therefore, that the ependymal fibres are only present in the adult in a very stunted condition, and it is not to be supposed that they run to the outer surface of the cord.”

After reading these statements it was something of a surprise to find the above described beautiful specimens of several types of ependymal neuroglia extending from all portions of the middle and inferior regions of the cavity of the third ventricle, and reaching to the periphery, all portions, bodies, branches, tentacles, and sub-pial endings, being readily distinguishable.

The region examined is therefore very interesting, not only from the great variety of neuroglia cells that may be seen within a very limited area, but from the fact that

¹ Cajal, “Neue Darstellung v. hist. Bau d. Centralnervensystems.” *Arch. f. Anat. u. Phys.*, 1893.

² Kölliker, *Gewebelehre*, 6te. Auflage, 1893.

varieties of the ependymal neuroglia cells, previously supposed to have entirely disappeared from the central nervous system in the adult mammal, are found present in perfect condition in the brain of a very high order of animal, and are not confined, as has previously been supposed, to those of adult reptiles, amphibia, and fishes.

IV.—THE NERVE ELEMENTS OF THE TUBER CINERIUM.

The region lateral and inferior to the descending limb of the cavity of the ventricle, and its anterior and posterior *cul-de-sacs*, presents no important differences between the nerve elements situated in the several departments, and accordingly they will be considered together.

Above the region comprising the floor of the tuber cinerium, containing the layer of interlacing neuroglia cells, lies a zone having comparatively few cellular elements, either stained or unstained, in it, mainly comprising small pyramidal and angular cells with rough processes, intermingling with the filaments of the glia cells. The major part of this region is filled with the dendrites of higher located cells, intermingled with fine branching axis-cylinder processes, the extensions mainly of intermediary cells, of adjacent but over-lying regions.

Situated immediately over the sparsely apportioned pyramidal and irregular cells, and mingling among their upper members, are well stained spindle and angular cells of a number of types and sizes, and above these are pyramidal, globular, quadrate and angular cells intermixed with small numbers of the spindle-shaped cells, this arrangement extending to the limits of our sections. None of the stained cells of this region are large, with the exception of a few pyramidal cells of the upper limit. No large nerve fasciculi are to be seen in the region, with the sole exception of a round bundle lying horizontally and laterally to the ventricular opening, which is better developed in the mouse than in the dog, but numerous small bundles of medullated fibres penetrate from overlying regions, and into them the greater

portion of the axis-cylinder processes of the projection cells appear to pass.

The Spindle-shaped Cells of the Middle and Lower Zones.

—These nerve bodies are the most frequently seen cellular forms stained in the region immediately super-imposed on what we may call the barren zone, and though almost every cell departs somewhat in shape from its neighbour, three principal forms may be described. All these cells lie either vertically or slightly obliquely to the brain surface.

(1) Spindle-shaped cells with short bodies (fig. 22) having regular outlines, and strong processes arising from either extremity, perhaps immediately sub-dividing into two or more divisions which have numerous short lateral spiculæ and knob-ended projections from the sides. The processes directed upward are thick, and, so far as can be determined, do not sub-divide to any extent, though some of them can be traced over long distances from the cell body. There is commonly only one strong process directed downward, which passes, giving off short branchlets on the way, down to the barren zone, there to end, after the development of many beads upon it in a conical termination. Some of these extensions may be traced nearly up to the pial limit. Other downward directed processes are shorter, and terminate in a rather peculiar thickening, from which is thrown off short right-angled fuzzy branches (fig. 22), but among them can sometimes be distinguished a very much finer extension, that turns upwards and is soon lost in the haze of nerve fibrillæ surrounding the cells. The main axis-cylinder process, if so we may speak of a cell that always has several neuraxôns arising from some point of the protoplasmic extensions, is directed upward, waving through the tissues as it proceeds onward, and soon sends out a few collaterals, some directed laterally toward small cells of the locality, while others turn downward toward the lowermost cells, where they divide repeatedly and form wide ramifications with a finely varicose character to the threads (fig. 29), finally encircling the nerve cells and ending upon them. The further course of the uptending neuraxôn is a matter of some uncertainty; a few of them appear to join small nerve bundles and proceed to higher

regions, but the majority are soon lost by a change of course and disappear. The other neuraxons belonging to the cell simply divide between surrounding cellular forms.

The second class of the spindle cells comprises bodies having an irregular outline, but the chief distinction is in the arrangement of the protoplasmic prolongations. Near the cell body they are slightly roughened, a disposition which increases as the distance from the central point lengthens, and when the extremity is reached (fig. 23), they sub-divide into a large number of short branches thickly studded with beads, and forming striking objects under high powers. These cells have several neuraxons, usually directed laterally, but they cannot be traced any great distance among the tissues.

The third variety of spindle cell comprises very small cells, rather long, but of scarcely greater diameter than their immediate neurodendrites. The extensions branch considerably, and extend over considerable areas, but are not so frequently sub-divided or varicose as the last type. Their neuraxons tend upwards.

In the same territory as the spindle cells we find fairly numerous cells of angular form (fig. 24), with a single axis-cylinder process extending upwards and sending off collaterals at frequent intervals, which finally enter some of the small bundles of medullated fibres passing beyond the limits of the section. The dendrites of these cells hardly branch at all, but are oftentimes very long and always roughened by short spiculæ from the sides, the cell body remaining smooth in outline.

In the neighbourhood are very similarly shaped cells with two or more neuraxons, and it is very possible that all of these cells are of the poly-neuric type. An out-spread axis-cylinder prolongation of one of these cells is drawn in fig. 30, where the single nerve thread entering the superior portion divides and re-divides, forming very intricate figures.

Intermingled with the cells of angular form are medium-sized triangular and pyramidal bodies with stout, roughened processes (fig. 25), coming off at the angles of the cellular body. These cells lie with their long processes directed

downward, upward, or laterally, with reference to the surface of the brain. Some of the terminations are of very great length, passing over more than two microscopic fields magnified 500 diameters, but do not ramify to any extent, except at their ultimate portions, where they become knotty and often thickened. Processes from these cells may be found as low as the middle of the barren layer, intermingled with the downward directed processes of the small spindle-shaped cells. There is only a single neuraxon to these pyramidal cells, which follows a course toward a lateral region and joins some of the smaller bundles of uptending nerve fibres. Collaterals are few in number, and are usually short, coursing toward some of the angular cells of the locality, but seldom can be traced with certainty to them.

A little higher upwards we come upon cells of a form not seen in the lower zones, namely, globular or rounded cells (fig. 26), smooth in outline, but having dendrites with the usual projections, including some longer knobbed ones. The neuraxon comes off from one of the thicker arms at some distance from the cell body, and waves through the intervening tissues, without giving off collaterals, for considerable distances. Intermixed with these cells are larger ones of pyramidal form (fig. 27). Their bodies are somewhat irregular in contour, the neurodendrites coming off from apex, base and sides, are stout, and soon branch repeatedly, but their length is short, and they are covered with varicose thickenings of some size, ending commonly in a thin pointed termination beyond the last knot. None of the ramifications show the fine arborizations seen in the dendrites of the smaller cells. The apical dendrites may be directed either laterally or upward.

The last type of cell represented in the drawings (fig. 28) is stained only in the highest region of the sections, is pyramidal in shape and closely approximates the size and form of the larger pyramidal cells of the third layer of the cortex. The body is stout, the arms come off from the sides and base by short conical projections gradually attenuating, the apical process is studded with short, thick, lateral projections, and there is just below the free termination a swelling covered

with minute hairy extensions. Some of the arms after spreading over considerable distances from the cellular body develop a feathery appearance like similar cells of the cortex. There is only a single axis-cylinder process to these cells arising from one of the thick basal processes and eventually directed upward toward the thalamic regions.

The dendrites of the cells of the infundibular tract, may, as has already been seen, be divided into two classes—neurodendrites that develop knots and varicosities in their course, the extensions themselves being sometimes short, sometimes very extended; and dendrites having short spiculæ and knobbed projections from their sides, occasionally to such an extent as to give them a feathery appearance, and in the latter case they are always long.

The neuraxons present at their points of origin a diversity of form; they may arise by thin even threads from the cell body or processes, or they may at first be thickened and have a number of large varicosities, or may have a number of minute transverse projections from the thread, or lastly, they may arise by a gradual process of attenuation from a protoplasmic extension, the protoplasm passing insensibly over into the neuraxon. Some of the axis-cylinder processes of the various cells join the fibres of the nerve bundles by passing into them, and bending into the direction of the run of the fibres at an obtuse angle, or they may, and this is seen with less frequency, join themselves to a fibre of the bundle, the union being made at a T-shaped angle. The very interesting neuraxons of the intermediary cells have so often been described from other regions of the brain that the figure given in the drawings presents a better idea of their appearance than any further verbal description can possibly add. The network formed by the thin axis-cylinder processes of the cells and the fibres entering the region is very dense, and numerous arborizational endings upon the bodies of the nerve cells are seen in all the sections of the tuber cinereum.

V.—THE NERVE CELLS OF THE CORPORA MAMMILLARIA.

Though not properly included in the infundibular region, a number of sections were made transversely through the bodies of the corpora albicantia, but the forms of the cells only were studied; the other nerve elements have precisely the same aspect as in the regions already examined.

A haze of fine nervous filaments fills all portions of the bodies, encircling the protoplasm of the nerve cells, and following their arms so closely that it is extremely difficult to differentiate the neuraxons of the cells for any considerable distance from other fine nerve filaments.

Though the boundaries of the corpora are microscopically well defined, nerve filaments, and even the dendrites of some of the cells pass into the surrounding tissues beyond the limits of the bodies in considerable numbers, and between the two bodies a rather extensive system of single nerve fibrillæ pass from one to the other ganglion. The threads of the networks have extensive branchings, and free terminations at the distal extremity of short rami are not infrequent.

There is distinguishable in the inferior half of the bodies a variety of cellular shapes, among them an extremely large, badly stained nerve cell of rounded form, probably corresponding to the unipolar cells lately mentioned by Golgi¹ as located in this region; secondly, well stained triangular and irregularly pyramidal cells of medium size with thick dendrites, the apical one being directed toward the base of the body. The dendrites are of considerable length, but do not branch extensively. Thirdly, cells of rounded pyramidal form with apical processes directed upward and dendrites similar to the last variety. Fourthly, spindle-shaped cells of various forms lying in all directions with dendrites corresponding to the similarly shaped cells of the tuber cinereum. Fifthly, various forms of angular cells with long but not abundantly branched dendrites.

The upper half of the bodies contain spindle cells, but not in the same proportion as in the lower region, small pyramidal and irregular cells, and a large pyramidal cell, the

¹ *Berliner Klin. Wochensh.*, No. 14, 1894.

largest stained nerve body in the regions studied. This cell is of irregular shape, the protoplasmic processes thick and short, with numbers of thinner dendrites coming off from them, giving a bushy effect to the entire cell. The axis-cylinder processes of these cells are at first directed downward, then laterally and inwardly, and appear to conjoin with the fibres of some of the numerous bundles located along the inner margin of the bodies.

The dendrites of the majority of the cells of the corpora mammillaria are moderately long, knotty, and have the short projections from their sides, but none of the feathery arrangement of the cortical cells and terminate in an attenuated free ending. Occasionally the termination is more complex, and similar to certain of the spindle-shaped cells of the tuber cinerium.

Though the nerve cells of the corpora are fully tinged, no neuroglia cells can be seen stained among them, though in the tissues adjacent to their edges, and along the margin of the tuber the same sustentacular cells of the more anterior region are found, and above them are numerous mossy and long-rayed Golgi cells.

EXPLANATION OF THE DRAWINGS.

FROM THE PITUITARY GLAND.

FIG. 1.—A portion of a follicle from the anterior lobe of the pituitary, with a nerve fibre crossing from the adjacent territory over the vessels surrounding the follicle, and finally branching extensively upon its epithelial cells. The terminations of the branches of the nerve fibre are all in knob-form, and apparently are situated between the epithelial cells.

FIG. 2.—Vertical section of the posterior lobe of the pituitary, the various elements arranged somewhat diagrammatically; *a, a*, capsule of the lobe thickened in places, from which extend threads that end in knobs at an inner line of separation from the more centrally lying cellular elements; *b, b*, rows of epithelial cells arranged after the manner of the cuticle; *c*, inner limiting line; *d, d*, transversely cut follicles of the posterior third of the lobe, lined with cubical epithelium; *e*, connective tissue trabeculae; *f*, epithelial cells of irregular formation; *g*, lowermost group of ganglion cells; *h, h*, unstained groups of nerve cells; *i, i*, terminal dendritic tufts; *k*, medio-anterior nerve cells of irregular pyramidal form; *l, l*, neuroglia cells of the anterior border; *m*, tufted cells; *n*, cells belonging to the fifth group of the text; *o*, nerve cells

of different forms along the superior border; *p, p*, feltwork of fine varicose nerve fibrillæ along the superior border of the lobe; *r*, nerve haze of the central and anterior regions; *s*, free arborizations of fibres coming from the central regions, situated between scattered nerve and other epithelial elements of the region; *t*, rounded thickening in the course of a nerve fibre, near which is also a flask-shaped projection from a fibre; *v, v*, peculiar tufted endings of nerve fibres upon rounded and oval bodies of the central region of the lobe; *w*, smaller pyramidal nerve cells. The lobe is enlarged 94 diameters, the various elements 90 diameters.

FIG. 3.—A mossy neuroglia cell with large body from the anterior portion of the posterior lobe of the pituitary.

FIG. 4.—A long-rayed neuroglia cell from the same locality.

FIGS. 5 and 6.—Cells of the first sub-class of irregularly pyramidal and oval forms, having large numbers of dendrites terminating in feathery arborizations, and a single neuraxon.

FIGS. 7 and 8.—Cells of the second sub-class with a single long protoplasmic extension directed toward the superior border of the lobe.

FIG. 8.—Flask-shaped cell of the third sub-class with smooth dendrites and several neuraxons.

FIGS. 10 and 11.—Small cells of the fourth sub-class, with exceedingly long pyramidal extensions directed upward.

FIG. 12.—Cell of the fifth sub-class, with numerous short hairy and feathery projections from the dendrites.

FIG. 13.—Very small tufted cells of the sixth sub-class, with a bush of smooth wavy apical dendrites.

FIG. 14.—An intricate termination of two dendrites of a cell of group *g*, at the base of the lobe, highly magnified.

FIG. 15.—A portion of one of the peculiar terminations of the neuraxons upon one of the oval bodies situated in the central regions of the posterior lobe, highly magnified.

FIG. 16.—One of the oval bodies from a similar situation surrounded by nerve fibres, which give off lateral branches, ending in peculiar tufts and comb-like figures.

FROM THE INFUNDIBULUM.

FIG. 17.—Semi-diagrammatic drawing of a transverse vertical section of the infundibular region of the brain, at the opening of the cavity of the ventricle into that of the infundibulum; *a*, lumen of ventricle; *a'*, lumen of infundibulum. 1, Primary forms of ependymal neuroglia, the processes extending from a cell-like body at the edge of the ventricular cavity to the sub-pial limit. 2, Coarser and less ramified variety of ependymal cell. 3, Coarse ependymal cells, branching within the inner half of the infundibular wall. 4, Portions of ependymal cells with tufted sub-pial branchings. 5, Unstained nerve cells. 6, Pyramidal cells with long fine processes. 7, Transversely lying cells of small size with knobbed extremities. 8, Pyramidal cells with large numbers of apical processes. 9, Probable axis-cylinder extension of pyramidal cells with thickenings, and rectangular extensions to the sub-pial limit. 10, Nerve fibres passing from the infundibular wall into the tissues along the border of the ventricle. 11, Burr-like cells of the infundibular wall. 12, Line of the floor of the brain. 13, Long-rayed ependymal

Fig 1

Fig 2.

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cells of the juncture of the ventricular and infundibular cavities. 15, 15, Fir-tree ependymal cells of various sizes and forms lining the border of the ventricle. A few of them are seen to have rounded knobs adjusted against the pial limit of the basis cerebri. 16, Neuroglia cell approximating the short-rayed type of Golgi. 17, 17, Sustentacular glia cells of the inferior border of the tuber cinerium. 18, 19, Glia cells with numerous long and stout hairy processes from the bodies and thicker projections, probably transition forms between the sustentacular cells, and cells of later development. 20, Probable nerve cell resembling some of the glia cells. 21, 21, Large mossy cells situated at some distance from the ventricular border. 22, 22, Nerve cells of different forms.

FIG. 18.—A large sustentacular glia cell from the base of the brain, with long, knotty, upward extension.

FIG. 19.—A hairy cell from the floor of the tuber.

FIG. 20.—A stout neuroglia cell with extremely long-beaded rays from the border of the optic nerves.

FIG. 21.—A long-rayed Golgi cell from over-lying regions, drawn for comparison to show the extent of the tentacles.

FIG. 22.—Spindle-shaped nerve cell with smooth body and thick arms. The lower dendrite ends with a peculiar figure having an axis-cylinder process arising from one of the limbs.

FIG. 23.—Spindle-shaped cell of another type having very much beaded dendrites.

FIG. 24.—Angular cell with uptending branched axis-cylinder process.

FIG. 25.—Irregular pyramidal cell with long branched apical process; and single axis-cylinder, coursing laterally.

FIG. 26.—Rounded cells with smooth outlines.

FIG. 27.—Pyramidal cell with short knotty processes, and a single axis-cylinder.

FIG. 28.—Pyramidal cell approximating in shape cells of the third layer of the cortex.

FIG. 29.—Outspread termination of one of the collaterals of a spindle-shaped cell, near the inferior layer of the tuber.

FIG. 30.—A more complex termination of one of the angular cells of the region. At A, a single nerve thread is seen, which breaks up into intricate figures.