6-1937

The Gross Anatomy and Histology of the Brain of the Frog

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THE GROSS ANATOMY AND HISTOLOGY OF THE BRAIN OF THE FROG

By

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A Thesis submitted to the Faculty
of the
College of Liberal Arts of Marquette University
in
Partial Fulfillment of the Requirements
for the
Degree of Bachelor of Science

Milwaukee, Wisconsin

June 1937

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ACKNOWLEDGEMENT

Before entering upon the discussion of the subject I wish to express my gratitude to the Reverend Paul L. Carrol S.J., who as Professor of Zoology of Marquette was my mentor in this work. He placed the resources of the entire department at my disposal, and was a constant guide and critic during the writing of this work. I would also like to thank the Reverend Francis A. Bautsch S.J., Assistant Professor of Zoology, for his invaluable help in photomicrography, and James Russel Neidhoefer, a student in the department, for the use of his fine slides on the brain of the frog, without which many hours would have been necessarily spent in the mechanics of technique, that is, running up, sectioning, and staining the material.

INTRODUCTION

The histology of the frog brain has been discussed at length in many sources, thus this work will be in the nature of a review of the previous material. However, all the work will be done on the actual sections of the frog brain, and the histological discussion will be preceded by a discussion of the gross anatomy, both internal and external; and the whole will be preceded by a short historical preface.

MATERIALS AND METHODS

The sections used were transverse sections taken from an average size, normal, healthy frog (Rana pipiens), and were stained by the usual methods of technique using Methylene Blue as the stain. For the transverse sections photomicrography was employed throughout. The low power was used. Drawings accompany the photomicrographs to show the cell structure at a much greater magnification. Specifications of the photomicrographs will appear under each one. The other photos of transverse sections are diagrams from Ludwig Stieda's "Studien über das centrale Nervensystem der Wirbelthiere," the outline of the diagram is magnified thirty times, while the details are magnified eighty times. These magnifications, however, have been changed in re-photographing. For viewing the sections and determining the sizes of the various cells, a Leitz microscope (ocular 8x, objectives 10x and 45x, low and high power respectively) was used. For determining magnification and size and diameter of cells a No.3 Mikrometer eyepiece was used and this was calibrated to the microscope by means of a stage micrometer.

Calibrating the Micrometer Eyepiece

1. The stage micrometer was placed in position again and the scale was brought into a sharp focus.

2. The ocular micrometer was placed with the etched scale uppermost into the ocular of the microscope.

3. As many divisions as possible on the ocular micrometer were made to coincide with those on the stage micrometer.

4. Size of space in ocular micrometer:
   25 spaces on ocular = 7.9 spaces on stage.

   25 spaces = 7.9 spaces

   25 spaces = $\frac{7.9}{100}$ mm.

   1 space = $\frac{7.9}{2500}$ mm.

   1 space = $\frac{79\cancel{000}}{25\cancel{000}}$ = 3.2 microns.

Thus:

One eyepiece unit is equal to 2.3 micra when used with No. 5 objective. Magnification 288x. A Siebert microscope was used.

Historical Preface

The introduction of the microscope in the seventeenth century, through the work of Grew(1628-1711), Hooke(1635-1703), Malpighi(1628-1694), and Leeuwenhoek(1632-1723), opened a vast new field to the anatomist--the field of histology. Now the anatomist could see, not only those parts visible to the naked eye or visible to the hand lens, but the minute and complex cellular structure of an organism.

The first man to attract our attention is Franciscus Sylvius(1614-1672)of Holland. He made investigations on the brain, and the fissure or Aqueduct, and the artery of Sylvius were named in his honor. He described these parts for the first time, about 1641, and they bear his name.

The next man of importance is Marcello Malpighi(1628-1694)who first described a species fully. Thus he studied and made drawings of the gross anatomy of the nervous system as did Jan Swammerdam(1637-1680)of Holland, who wrote on insects, and in his Biblia Naturae described the gross anatomy of the nervous system in the bees and mayflies. Lyonet(1707-1789), a Frenchman, and Straus-Dürckheim, a German, lifted these studies to a more exact plane, while Franz Leydig(1821-1908), a German, introduced histology and physiology.

Severinus(1580-1656)began the work on comparative anatomy. His work was followed later by Camper(1722-1789), a German; John Hunter(1728-1793)a Scotchman; Vicq' D' Azyr

(1748-1794)a Frenchman; Leopold-Christian-Frederic-Dagobert Cuvier(1769-1832) a Frenchman. His intellectual heirs in France were H. Milne-Edwards(1800-1885), and Henri de Lacaze-Duthiers(1821-1901). In England Richard Owen(1804-1892) carried on the work of Cuvier. Richard Owen was succeeded by Thomas Henry Huxley(1825-1895) who defended the theory of Darwin, and spread the doctrine of organic evolution. He was a pioneer in the laboratory teaching of biology, and also a great investigator in anatomy. He used a special terminology of his own in naming the parts of the brain(Fig.5)and did much in naming its developmental parts. In Germany J. Fr. Meckel(1781-1833) stood at the head of the school of comparative anatomy just Cuvier did in France. He was followed in Germany by Martin Henry Rathke(1793-1860), and Johannes Müller(1801-1858), and they were followed by Karl Gegenbaur (1826-1903) who brought scientific anatomy to its climax. The contemporary German anatomists Furbinger, Waldeyer, Wiedersheim, and Ecker must be mentioned. In America the greatest comparative anatomist was E. D. Cope(1840-1897).

Marie Francois Xavier Bichat(1771-1801) laid a foundation in histology for the work of Theodor Schwann(1810-1882), a German, who with the help of Schleiden, propounded the cell theory; Albrecht Von Kölliker(1817-1905), a German, who helped in the establishment of the cell theory, and demonstrated the continuity between the nerve fibres and nerve cells of vertebrates. Von Kölliker was one of the greatest histologists of the nineteenth century. Max Schultze(1825-1874) made some fine observations on nerves, and Rudolph Virchow(1821-1903), also a German, extended Bichat's work in the field of abnormal histology, and another German Franz Leydig studied the histology of insect tissues. One of the greatest contemporary workers on the histology of the nervous system is S. Ramon y Cajal(1850-), a Spaniard, who cleared up many questions about the complicated relations between the nervous elements.

Francis Maitland Balfour(1851-1882) reviewed the periodicals, monographs, and transactions; which made up a mass of information on Embryology. He digested, organized, and finally published it in two volumes of almost priceless value with the title Comparative Embryology. He also produced a large number of technical researches. His book was also a powerful defense of Darwinian morphology in its classical form. Balfour maintains that phylogeny is the goal of evolution. He was the younger brother of the famous English statesman, Lord Balfour. He went to Switzerland for recuperation after his prodigious work on the Comparative Embryology, and was killed, with his guide, when they slipped from an Alpine height into a chasm in July, 1882. He describes the pineal body in Chapter IX. The Development of the Elasmobranch Fishes.

Wilhelm His(1831-1904), a Swiss scientist, did a good deal of work on the development of the nervous system, and tracing the origin of nerve fibres. The'bundle of His' in the heart is named in his honor.

Roux, Herbst, Jacques Loeb, Morgan, and E. B. Wilson contributed to the growth of experimental embryology. Jacques Loeb, a contemporary Portugese scientise, who sorked in America; studied the artificial fertilization of the ovum of the frog, and also did a great deal of work on the comparative physiology and psychology of the brain..

Purkinje(1787-1869), a Bohemian sceentist, was the first to use the name protoplasm for living matter. The 'cells of Purkinje' in the brain were named by G. Denissenko in his honor.

Since a great deal of the work in this thesis is based upon Ecker's '<u>Anatomie des Frosches</u>' which was translated from the German by George Haslam, and read and corrected by Professor A. Milnes Marshall, of the Owens College, and which work was subsequently accepted by the Delegates of the Clarendon Press, as one of the series of 'Foreign Biological Memoirs', published by them; I will devote a paragraph to Robert Wiedersheim, the great German anatomist and histologist who wrote that portion of Ecker which discusses the nervous system.

Dr. Ecker says in the preface to the first part, "I would apply to it the words with which Sömmering prefaced his anatomy, "Ich wünſchte ein Handbuch zu liefern und ſeine Einrichtung ſo zu treffen, daſſ man künftig an ihm alſ einer Baſiſ nach Erforderniſſ leicht ändern, wegnehmen und zuſetzen könnte.'"

i.e.-('I wished to furnish a manual so arranged that it might serve as a basis easily altered, pruned, or enlarged as the future might need.')

Dr. Ecker then continues in the preface to the second part, "Sixteen years have elapsed since the first portion of this anatomy of the frog appeared; this second portion, therefore, requires a somewhat apologetic introduction.

The nervous and vascular systems have, in substance, been known for some years; still, certain points required a thorough revision: this seemed especially necessary with regard to the cranial nerves. In consequence of my anthropological investigations, and particularly through undertaking the editorship of the '<u>Archiv für Anthropologie</u>', my attention was drawn into another channel, and I found it impossible to work out this chapter: consequently the whole was deferred, and would have been still longer delayed had I not received assistance.

At my request Professor Wiedersheim undertook to investigate afresh the cranial nerves, the brain, the spinal cord, and the sympathetic system; and the descriptions of these parts are the result of his work alone. I regard it as most advantageous to this second part that so experienced an investigator in the anatomy of Amphibia should have given me his help.

The remaining portions appear almost unaltered as written several years ago; and the majority of illustrations date from the same period. I had neither the time nor the zeal necessary to re-examine the whole; besides, it is doubtful whether eyes some twenty years older would improve matters.

This somewhat neglected book is therefore commended to the indulgence of my fellow-workers, with the hope that it may at least form a basis upon which further work may easily be done; to proffer more than this, as I stated, with a quotation from Sömmering, in the preface to the first part, I have never even hoped.

The final part on the viscera and sense-organs, has been undertaken by Professor Wiedersheim, and will appear in the spring of 1882. Freiburg, August, 1881."

Thus the material on the nervous system is that of Professor Robert Wiedersheim(1848-1923). The book Wiedersheim and Ecker has been translated and altered many times. Robert Wiedersheim was a disciple of Leydig.

The Brain of the Frog.

Gross Anatomy--Dorsal surface

In the anterior portion of the brain are the olfactory lobes, and posterior to them are the cerebral hemispheres, the thalamencephalon, the optic lobes, the cerebellum, and the medulla oblongata. The olfactory lobes(Fig.1,2,3,5-L, ol) are anterior prolongations of the cerebral hemispheres. They are slightly elongated egg-shaped bodies, separated by a dorsal longitudinal fissure(Fig.1-Lf). The point at which they meet the cerebral hemispheres is marked by a very faint transverse indentation(Fig.1-f). The olfactory lobes fuse posteriorly into the larger and wider cerebral hemispheres (Fig.1,2,3,5-Hc). In general the cerebral hemispheres resemble the olfactory lobes, being also ovoid, but they are much larger and diverge posteriorly. Taken together they form the greatest portion of the brain. They are also separated along a mid-dorsal longitudinal line by a fissure (Fig.1-Lf), but internally their cavities are joined forming a common cavity, the Foramen of Monroe(Fig.4-MF), which joins the lateral cavities or ventricles(Fig.4-Sv; Fig.5-I & II). It forms a common cavity with the third ventricle(Fig.4-Dv; Fig.5-III)posteriorly, and with the fissure between the cerebral hemispheres anteriorly. Between the two cerebral hemispheres is the choroid plexus(Fig.1,3,5,-Ad)and posterior to them the thalamencephalon(Fig.1,3,5-Tho). The choroid plexus is a thick membrane of vascular material, and through it passes the stalk of the pineal body(Fig.1,3-Gp). Under the choroid plexus is a small opening in the roof of the thalamencephalon which connects the hollow stalk of the pineal body with the third ventricle, which lies along the median line being bordered by the optic thalami. Lying anteriorly and deep in the opening of the third ventricle is the posterior commissure(Fig.5-Po). The choroid plexus (Fig.8,9,10,11-r)continues anteriorly between the two cerebral hemispheres, ending in a fine thread of connective tissue. The pineal body or gland occupies a median position on the thalamencephalon. The thalamencephalon itself lies between the posterior ends of the cerebral hemispheres, and extends posteriorly as far as the optic lobes. The optic lobes(Fig.1,3,5-L,op)are two symmetrical ovoid bodies which at their anterior ends form the widest portion of the brain. They narrow toward their posterior ends and are the most heavily pigmented of all the central nervous tissue.

The optic lobes are separated posteriorly from the medulla oblongata by a narrow vertical sheet of nervous matter, the cerebellum(Fig.1,3,5-C). The base of the cerebellum covers the anterior portion of the fourth ventrical(Fig.1-Sr; Fig. 4-Vv; Fig.5-IV). The valvula cerebelli is a thin sheet of tissue which connects the anterior surface of the cerebellum with the optic lobes. The medulla oblongata(Fig.1,2,3,5-Mo) is the most posterior portion of the brain. It fuses posteriorly with the spinal cord, narrowing toward the point of fusion.

The medulla ends with the origin of the first pair of spinal nerves, at which point is sometimes found a very faint constriction. Anteriorly it fuses with the cerebellum, and at this point a very shallow fissure is formed. On the dorsal surface of the medulla oblongata is a deep, triangular cavity which has as its base anteriorly, the posterior surface of the cerebellum, the sides of the triangle as they run posteriorly are not straight but converge slightly toward the median line. This triangular cavity or fossa is the fourth ventricle, and in reality the cerebellum is not its base for it runs anteriorly under the cerebellum opening into the aqueduct of Sylvius(Fig.4,5-Aq). The fourth ventricle runs posteriorly merging with the central canal of the spinal cord. On the dorsal surface of the base of the medulla oblongata or the floor of the fourth ventricle is a deep, median, longitudinal fissure, the sulcus centralis(Fig.1-SO);and the ventricle is roofed by a membrane of vascular material which is called the choroid plexus of the fourth ventricle (Fig.5-AdP).

Gross Anatomy--Ventral surface

From anterior to posterior on the ventral surface lie the olfactory lobes, the cerebral hemispheres, the lamina terminalis, the tuber cinereum, the optic chiasma, the crura cerebri, and the medulla oblongata, and beneath the brain, just posterior to the tuber cinereum and continuous through the infundibulum with it, is the pituitary body. On the ventral surface of the olfactory lobes and cerebral hemispheres there is also a medial longitudinal fissure, but both the dorsal and ventral fissures are shallow except in one place, between the cerebral hemispheres, where they meet piercing the brain(Fig.4-lt). The cerebral hemispheres diverge more widely at their posterior ends on the ventral surface than they do dorsally, and the space formed by this divergence is called the lamina terminalis(Fig.4-Lt). The optic nerves(Fig.2,3,5-To)run from the optic lobes and cross beneath the thalamencephalon, forming the optic chiasma(Fig. 2-Cho). This chiasma divides the lower surface of the thalamencephalon into two parts, the anterior lamina terminalis and the posterior tuber cinereum(Fig.2,3,5-Tuc). The lamina terminalis has been described previously as a space, bounded on either side by the cerebral hemispheres, and formed by the piercing of these hemispheres by the dorsal and ventral longitudinal fissures. The tuber cinereum is a mid-ventral diverticulum or ramification of the third ventricle when it depresses to form the infundibulum(Fig.5-Inf).

Stieda(1870)says, "The Crura cerebri(Fig.13,14,15,16, 17,18,19.20,21-c)are two columns of white matter, placed beneath the optic lobes, and partly hidden by the pituitary gland(Fig.2,3,5-Hy). At their junction with the medulla oblongata, or rather with the pars commissuralis(Fig.5-Pc), is a very slight transverse fissure; at the same point the ventral longitudinal fissure is interrupted by an extremely small grey tubercle."

On the ventral surface of the medulla oblongata is a median longitudinal fissure which is merely a continuation of the marked ventral fissure of the spinal cord, and on each side of the medulla oblongata are lateral fissures which join the crura cerebri anteriorly.

Internal Anatomy of the Brain

Cavities of the Brain

Concerning the internal structure or cavities of the brain Marshall(1906)says, "The lateral ventricles(Fig.4-Sv; Fig.5-landll)extend through the whole length of the cerebral hemispheres and a short way into the olfactory lobes. The third ventricle(Fig.4-Dv;Fig.5-III)is situated in the thalamencephalon: It opens in front through the foramina of Monroe(Fig.4-MF)into the lateral ventricles: The stalk of the pineal body opens into it above; and in the hinder part of its floor is a conical depression, the infundibulum(Fig.5-Inf.). The aquaeductus Sylvii or iter a tertio ad quartum ventriculum(Fig.4,5-Aq)is a narrow passage leading from the third to the fourth ventricle: It communicates above with the cavities or ventricles of the optic lobes(Fig.4-Aq; Fig. 5-Vop), which are hollow. The fourth ventricle(Fig.1-Sr; Fig.4-Vv; Fig.5-IV)is the large triangular cavity in the medulla, already exposed by removal of the vascular membrane (the choroid plexus of the fourth ventricle(Fig.5-Adp)plexus choroideus ventriculi quarti, Reissner; velum medullare posterius)covering it."

Adams(1933)says, "A series of cavities extend through the brain to aid in the metabolism of the structure. They are filled with lymph and are usually penetrated by the telea choroidea, thin membranous sheets filled with capillaries."

The Cranial Nerves

The most anterior cranial nerve is the olfactory nerve (Fig.2,3-I,I^2). It has its origin in the cerebral hemispheres from whence it proceeds along the lateral surface of the olfactory lobes until it reaches their anterior end, and there it arises from the anterior end of its corresponding olfactory lobe and leaves the brain. The optic nerve(Fig.2,3,5-II) originates from the optic lobe as the optic tract. This optic tract begins laterally and proceeds medially forming a chiasma beneath the brain. The oculo-motor nerve(Fig.2-III) arises on the ventral surface, medially between the crura cerebri, at a point near the anterior portion of the pituitary body. The trochlear nerve(Fig.2,3-IV)arises from the dorsal surface of the brain between the optic lobes and the cerebellum. The trigeminal nerve(Fig.2,3-V)arises from the lateral anterior portion of the medulla oblongata. The abducens nerve(Fig.2-VI)originates on the ventral surface of the medulla oblongata midway between the sulcus centralis and the origin of the vagus and just posterior to the pituitary body. The facial nerve(Fig.2,3-VII)arises just posterior and next to the trigeminal nerve on the lateral anterior portion of the medulla oblongata. The auditory nerve(Fig.2,3-VIII)comprises the third nerve of this group, lying posteriorly and again adjacent to the facial nerve. The glossopharyngeal nerve(Fig.2,3-IX)arises anteriorly but in a group with the more posterior pneumogastric nerve(Fig.2,3-X)and the still more posterior accessory nerves(Fig.2,3-XI), on the mediolateral portion of the medulla oblongata somewhat posterior but in a line with the last group of nerves(the trigeminal, facial, and auditory). The glossopharyngeal, pneumogastric, and accessory nerves form the most posterior group of cranial nerves.

Internal Structure and Histology

Olfactory Lobes and Cerebral Hemispheres

The olfactory lobes and the cerebral hemispheres are hollow, their cavities being termed the lateral ventricles. At a point immediately posterior to the middle of the cerebral hemispheres their cavities are brought together(Fig.9-d) to form a common cavity, the Foramen of Monroe, which opens anterio-laterally into the hollow cavities of the cerebral hemispheres and continues into the olfactory lobes, and opens posterio-laterally into the posterior cavities of the divergent cerebral hemispheres, and posterio-medially into the third ventricle(Fig.10-f). Thus the lateral ventricles are cavities which project both anteriorly and posteriorly. Both at the most anterior and most posterior portions the inner wall of the lateral ventricle, as seen in cross-section, bends inward in the middle(Fig.8-e), but in the medial portion the cavity elongates and its ventral portion becomes a narrow vertical slit(Fig.9-g; ventriculi lateralis cornu inferius, Reissner). The inner wall in the medial portion develops a longitudinal groove(Fig.8-e; Ventriculi lateralis cornu internum, Reissner), thus forming a dorsal and a ventral bulge(Fig.8,9-Dv; corpus striatum, Wiedersheim)on the inner wall. Proceeding more posteriorly the cavities occupy only the dorsal half of cerebral hemispheres(Fig.10); they become broader and diverge, making room for the lamina terminalis(Fig.8-lt)and finally widening medially to form the Foramen of Monroe. Most posteriorly behind the Foramen of

Monroe, the cerebral hemispheres become invested ventro-laterally by longitudinal fibres(Fig.7,9,10-lf; 'round bundle' Köppen), and medially by a slit, the anterior prolongation of the third ventricle(Fig.10-f), while dorsally they still possess the broadened cavities of the lateral ventricle; and a wider medial groove extends down to a position parallel with the floor of the lateral ventricle. This is the common ventricle of Stieda(Fig.9,10-c').

The olfactory lobes and the cerebral hemispheres are much the same in general cellular composition and construction. The foundation or groundwork of the olfactory lobes and cerebral hemispheres is a fine granular substance, which contains cells and nuclei which are spherical, ovoid, fusiform, and unipolar, and also very fine fibres. These cells are most abundant in the area immediately surrounding the ventricle(Fig.7-ma), and gradually become less abundant towards the periphery, being very scarce at the superficial surface(Fig.7-ps). The cells immediately adjacent to the ventricle and those near the outside, just beneath the pia mater(Fig.6,7-c), are more numerous and smaller. They are spherical or ovoid and average from 4.6 to 9.2 micra in diameter. These cells midway between the ventricle and the superficial surface, though they are sometimes spherical, are usually fusiform or tear-drop-shaped. They are larger and less abundant, averaging from 11.5 to 13.8 micra in eiameter. The fine fibres radiate around the lateral ventricle in the epithelium(Fig.6,7-a), and also extend from some of the larger nuclei.

The two bundles of longitudinal medullated nerve-fibres (Fig.7,9,10-lf)seen in transverse section and previously mentioned in the internal structure lie on or near the ventral surface of the cerebral hemispheres in their posterior region, on either side of the median line, and more posteriorly on either side of the third ventricle. A second strand of longitudinal fibres(Fig.7-x)comes from the tuber-cinereum, and can be followed to the outer wall of the posterior part of ventricles and to the anterior commissure(Fig.9-z), then it unites with the 'round bundles' and proceeds with each of these under the olfactory lobes, the entire group forming a Crus cerebri(Fig.7-cc).

In general the cells of the longitudinal medullated nerve-fibres(Fig.7,9,10-lf)are approximately the same size as the small cells of the olfactory lobes and cerebral hemispheres; they average(9.2 micra)in diameter.

In regard to the commissures Wiedersheim(1881)states, "The commissures are: (1) The corpus callosum(Fig.10-w), a large bundle of transverse fibres, seen best in a transverse section, at the point of junction between the lamina terminalis and the cerebral hemispheres, forming an arch over the roof of the anterior prolongation of the third ventricle. The fibres course to the inner and anterior parts of the hemispheres, and are situated chiefly behind the foramen Monroe. To this commissure must be added those fibres which unite the two olfactory lobes, and possibly the fibres(Commissura posterior)found in the roof of the third ventricle (Köppen). (2) The Commissura anterior (Stieda)(Fig.9-z), a smaller set, found immediately under the floor of the common ventricle, forming in their course outwards a curve, with the concavity directed downwards(Commissura inferior). This commissure connects the 'round bundles'(the bundles of longitudinal medullated nerve-fibres)of opposite sides, and those fibres coursing with the 'round bundles' to the olfactory lobes constitute the pars olfactoria of the commissura anterior. To this commissure must also be added some fibres found on the ventral surface of the commissura anterior and connecting the two strands of the Tuber-cinereum; an unusually coarse strand of these fibres can be traced to the inner wall of the ventricle, and is termed the pars olfactoria interna(Fig.9-y)by Osborne(1886). In this irregular collection of cells the following centres have been described: (1) The nucleus(Fig. 10-n)through which the corpus callosum passes(Köppen); (2) the lower internal or median cell-area(Osborne)(Fig.10-s), situated above the foregoing nucleus in the posterior and middle portions of the hemispheres; (3) the upper internal cell-area(Osborne)(Fig.8,9-t)is the area of large cells in the dorsal part of the inner wall; (4) the Corpus striatum (Osborne)(Fig.8-v)is a mass of cells between the corpus callosum and the commissura anterior; Köppen doubts the correctness of Osborne's opinion, and suggests that a group of cells found in the wall of the third ventricle in front of 'Meynert's band' may perhaps be a corpus striatum."

The epithelium of the third ventricle(Fig.10-i)like the epithelium of the other ventricles of the brain, and that of the central canal of the spinal cord, is made up of unipolar cells, whose hinder ends point away from the ventricle, and whose bases are nearest the ventricle. The nuclei of these cells are as wide as the cells themselves.

Wiedersheim(1881)states that in the choroid plexus(Fig. 5-Ad; Fig.8,9,10,11-r); where there is no nervous tissue, and the cavity is completed only by the pia mater(Fig.10-p), the epithelial cells are flattened. He also states that the epithelium is ciliated, which it seems to be, in all places but the choroid plexus, but Schmidt states that the epithelium of the central canal of the spinal cord is not ciliated.

Concerning the pigmentation of these parts Wiedersheim (1881)says, "Very little pigment exists in the cerebral hemispheres or olfactory lobes, the greater portion being found in the upper part of the inner walls of the cerebral hemispheres. The epithelium is somewhat irregularly and sparsely pigmented; the ventral parts of the central canal of the spinal cord, of the fourth ventricle, and of the Sylvian aqueduct are always more pigmented that the dorsal parts."

Thalamencephalon

The brain in transverse section at the thalamencephalon is practically circular in shape. The lateral ventricles of the cerebral hemispheres are no longer present, and the third ventricle is dorsal(Fig.11-a); the ventral portion of the section being occupied by the optic chiasma(Fig.2-cho; Fig.11-oc). The third ventricle is a vertical slit(Fig.11-a')which is somewhat enlarged dorsally. The floor of the ventricle runs dorsally posterior to the lamina terminalis and is depressed just above the optic chiasma, and also above the tuber cinereum(Fig.11-tc)which runs posteriorly and ventrally towards the infundibulum. The roof of the third ventricle(Fig.11-b) is very thin in those places where it covers the ventricle at all, and in it a band of transverse fibres arches arches across the ventricle.

Holmes(1927)says, "The roof of the thalamencephalon is thin and lined with a vascular membrane, the anterior choroid plexus(Fig.11-r); it bears two outgrowths in the mid-dorsal line, the paraphysis(remnant of the parietal body or parietal eye), a vascular outpocketing of the epithelium of the roof, and a short distance behind the paraphysis, the epiphysis(pineal body; Fig.3-Gp), a hollow, thin-walled canal which terminates blindly at its anterior end. A small parietal nerve runs along the dorsal surface of the epiphysis and extends forward over the paraphysis and then passes through the sagittal suture of the skull to end in the brow spot. The epiphysis(pineal body), which originally was continuous with the brow spot, becomes constricted off from it in early larval life. On the ventral side of the thalamencephalon is the optic chiasma(Fig.2-Cho; Fig.11-oc), or crossing of the nerves which go to the eyes. In the frog all of the fibers cross to the opposite side."

The inner part of the thalamencephalon, surrounding the third ventricle, is composed of grey matter, and contains many rows of cells and nuclei(Fig.11-d)from(9.2 to 11.5 micra)in diameter. These rows of cells lie in a fibrous foundation. Surrounding this abundantly celled grey matter is a more sparsely celled white matter. The cells of this white matter are from(6.9 to 9.2 micra)in diameter. On each side is the 'round bundle' of longitudinal medullated fibres of Köppen(Fig.11-lf). Stieda says that these fibres come from the optic lobes but appear to arise from either the pars commissuralis or the medulla oblongata; they pass forwards to the base of the cerebral hemispheres. They meet another band of fibres from the optic thalami, and yet another from the tuber cinereum to form a crus cerebri(Köppen).

In the anterior thalamencephalon the pigment is arranged in a curved line beginning dorsally and proceeding laterally from the ventricle, where it divides. One end proceeds laterally, while the other proceeds ventrally to the base of the ventricle. In the posterior thalamencephalon the pigment is arranged in the form of a square with corners at each end of the narrow, vertical ventricle.

Wiedersheim(1881)states that the commissural fibres of the thalamencephalon are: (1) a commissura transversa Halleri in the posterior portion of the organ; (2) an optic commissure(Fig.11-oc), consisting of fibres arising from the thalamencephalon(thalamencephalic root)and crossing the median line to join the optic tract of the opposite side; (3) a probable commissure(Fig.11-oc)between the optic nerves just in front of the chiasma opticorum; the existence of the latter is not yet proved beyond a doubt; (4) the large commissura of transverse fibres(Fig.11-lc; Fig.5-Po)found in the roof of the third ventricle; whether the fibres decussate or not is uncertain(Köppen).

The fibres of the large commissure of the roof are, in part, continued into the strand of the Tuber-cinereum and thus conducted to the posterior parts of the hemispheres (Köppen). A group of fibres(Meynert's band, Köppen)(Fig.11-m) is found in each lateral wall of the third ventricle; they pass from the region of the nucleus parvus downwards in a curved course almost parallel with the external border of the thalamencephalon. The(Nucleus parvus, Reissner; ganglion of the habenula, Köppen)(Fig.5-Hab.c; Fig.11-np)is an arched group of large spindle cells (average diameter o.o16mm.), placed under the upper border close to the third ventricle; the group extends alongside the whole length of the ventricle. A second group(Fig.11-vn)lying in the middle and posterior parts beneath the ventricle, Köppen names the 'ventral nucleus' of the thalamencephalon."

Pineal Body

The pineal body(Fig.3-Gp)and its development is discussed by Balfour(1880). Wiedersheim regards the part which was formerly known as the pineal body merely as a thickened portion of the pedicle.

In regard to the pineal body Wiedersheim(1881)says, "The pineal body is a small vesicle placed underneath the skin above the fronto-parietal bones; in the embryo it is connected with the third ventricle by means of the pedicle; the skin covering the body is always paler than the surrounding skin, and the usual cutaneous glands are absent in this part; the paler spot on the head may always be found, but is more distinct in Rana temporaria than in Rana esculenta. The structure on the roof of the third ventricle(Fig.13,14,15,-zx), which is usually known as the pineal body, is nothing more than a thickened portion of the choroid plexus, and consists of a group of convoluted vessels surrounded by pia mater, which is described by Wyman(1853)as being covered with ciliated epithelium(Rana pipiens). The true pineal body is a small body with an outer connective-tissue capsule, derived from the pia mater; this encloses an irregular mass of epithelial cells; according to de Graaf(1886)a twig of the ramus supramaxillaris reaches it subcutaneously, and a blood vessel accompanies the pedicle through the foramen parietale. According to Darkshewitsch(1886), the pedicle contains medullated nerve-fibres derived directly from the brain."

Concerning the thalamencephalon and the pineal body Marshall(1906)says, "The thalamencephalon is a lozenge-shaped portion lying immediately behind the hemispheres and between their diverging posterior ends: It is covered by a thick vascular membrane--the choroid plexus(Fig.1,3,5-Ad; Fig.8,9,10,11-r)--over which passes the stalk of the pineal body(Fig.3-Gp). A small body adherent to and generally removed with the roof of the skull."

Adams(1933)says, "There is a small opening in the chondrocranium of the shark for the epiphysis or pineal structure called the epiphyseal foramen, and in the lower fishes there are two epiphyseal bodies on the dorsal region of the diencephalon, a parietal body and a pineal body, which probably represent an original pair of accessory eyes. In reptiles the pineal body is structurally a direct eye, with a lens, retina, and nerve, and reaches the surface of the head through a foramen between the parietal bones." Marshall continues, "On removing the choroid plexus a slit-like hole is left in the roof of the thalamencephalon. The vessels of the plexus, covered by a thin layer of nervous matter(telea choroidea, Fig.8,9,10,11-r), hang into the third ventricle, or cavity of the thalamencephalon. The thickened sides of the thalamencephalon are the optic thalami." The third ventricle is usually narrow, and a large choroid plexus or telea choroidea extends down into it and runs anteriorly through the interventricular opening(Foramen of Monroe)into the lateral ventricles. The thickened side wall or thalamus of the thalamencephalon forms the main part of the brain stem, and most of the connecting tracts pass through it to get from the anterior to the posterior part of the brain.

The Infundibulum and Pituitary Body.

Immediately posterior to the optic chiasma a midventral swelling develops. This swelling in transverse section is divided vertically in the middle, its vertical slit being continuous with the third ventricle(Fig.5-III; Fig.4-Dv; Fig. 10-f; Fig.11,13,14,15,16-a)and enlarging slightly to form the infundibulum(Fig.5,13,14,15,16,17-Inf.). The entire swelling is called the tuber cinereum or infundibular lobe(Fig.2,3,5, 13,14,15,16,17,-Tu,C). As it runs posteriorly it separates from the brain, constricts, and enlarges again slightly to form the hypophysis cerebri or pituitary body(Fig.2,3,5,18, 19,20,21-Hy and Hyp).

Holmes(1927)says, "Just behind the optic chiasma is the infundibular lobe(Fig.2,3,5,13,14,15,16,17-Tu.C), a flattened bilobed structure, emarginate posteriorly and divided by a median longitudinal groove. It is formed of nervous tissue and contains a cavity which is continuous with the third ventricle(Fig.5-III; Fig.4-Dv; Fig.11,13,14,15,16-a).

The hypophysis cerebri(pituitary body; Fig.2,3,5,18,19, 20,21-Hy and Hyp)lies behind and partly covered by the infundibular lobe. It is composed of an anterior(Fig.18,19-Hy)and posterior(Fig.20,21-Hyp)part; the former is divided into a median and two lateral portions, the posterior part is flattened and more or less quadrate in outline. Genetically the true anterior part of the hypophysis has no connection with the brain, but arises as an outgrowth from the roof of the stomodeum."

Marshall(1906)states: "The tuber cinereum(Fig.2,3,5,13, 14,15,16,17-TuC)is a small median swelling immediately behind the optic chiasma, caused by the depression of the floor of the third ventricle(Fig.5-III; Fig.4-Dv;Fig.11,13,14,15,16-a) to form the infundibulum(Fig.4,13,14,15,16,17-Inf.). It is divided by a median groove into right and left halves;" he continues, "The pituitary body(Fig.2,3,5,18,19,20,21-Hy and HyP)is a flattened ovoid sac, lying behind, and continuous with, the tuber cinereum. The crura cerebri(Fig.13,14,15, 16,17,18,19,20,21-c)are two dense white columns of nervous matter, lying at the base of the optic lobes, and partly hidden by the pituitary body: They serve to connect the hemispheres with the medulla and spinal cord."

Concerning the infundibulum and pituitary body Adams (1933)says, "The tuber cinereum is a ventral extension of the diencephalon, terminating in a tube, the infundibulum. The hypophysis, an endocrine gland that appears in all vertebrates, fits into a small depression in the floor of the brain case, The sella turcica."

The pituitary body consists of two parts: A smaller, anterior, more dorsal, light portion(Fig.18,19-Hy), and a larger, posterior, ventral, dark portion(Fig.20,21-Hyp). The anterior portion(Fig.18,19-Hy)resembles a small, flat disc, surrounded by connective tissue. It is composed of two layers, a dorsal(Fig.18,19-o)and a ventral horizontal, longitudinal layer(Fig.18,19-p). These layers are separated by a thin sheet of blood vessels and connective tissue. The dorsal layer contains many nuclei(averaging 4.6 to 11.5 micra in diameter)in a foundation or groundwork of fine granular substance, and separated into many sided spaces by tissue-bands from the outer capsule. Wiedersheim(1881)says it is a more vascular layer. The lower layer is composed of a thick mass of clear and nucleated, rounded and many-sided cells(averaging from 16.1 to 25.3 micra in diameter; with nuclei from 6.9 to 11.5 micra in diameter, Reissner). Running between these cells are very fine vertical and longitudinal threads of connective tissue. They contain few blood vessels.

The greater, more posterior portion of the pituitary body(Fig.20,21,-Hyp)follows the curve of the wall of the brain on its ventral surface, but its dorsal surface is curved convexly in opposition with the curve of the ventral wall of the brain. However, it is compressed on both ends the concave compression forming two points which parallel the ventral wall of the brain itself. It is covered by a thin wall of the brain itself. It is covered by a thin wall of the brain. However, it is compressed on both ends the concompression forming two points which parallel the ventral wall of the brain itself. It is covered by a thin wall of connective tissue, and contains a large number of convoluted tubules, and also a few blood vessels. The tubes are lined with a layer of epithelium, which practically fills them. They are covered with an outer nucleated basement membrane. Separated from the larger, posterior portion of the pituitary body on its ventral side is an outer nucleated membrane-like structure(Fig.20,21,g). The nuclei are rounded and are almost as large as the cells which contain them. The nuclei average about(6.9 micra)in diameter.

The Optic Lobes

Adams(1933)says, "The mesencephalon(Fig.5), called the isthmus, is a short, small region of the brain, which connects much larger parts. Its ventral part is the brain stem, and its dorsal part is made up of the optic lobes(Fig.1,3,5-Lop). The ventricle of the mesencephalon(Fig.5IIIand Aq; Fig.17, 18, 19, 20, 21-Aq; Fig.12-h)resembles an inverted triangle whose basal angles open into the mesocoels(Fig.4-Aq; Fig.5,16,17,18, 19,20,21-V,op; Fig.12-h')of the optic lobes(corpora bigemina), which are large and conspicuous in the frog."

This central canal is called the Sylvian aqueduct(Fig. 12-h; Fig.5,17,18,19,20,21-Aq). It runs posteriorly from the third ventricle under the cerebellum to communicate with the fourth ventricle. At a point middle in the length of the optic lobes, where the mesocoels of the optic lobes are largest, the central canal or Sylvian aqueduct enlarges and communicates with the cavities of the optic lobes forming a general cavity(Fig.18,19-Gc). The roof of this cavity(Fig.12,16, 17,18,19,20,21-x), especially above the longitudinal, dorsal fissure between the optic lobes, is thinner than the floor, but the floor is also made thinner by the descending, narrow fissure of the central canal(Fig.17,18,19,20,21-f). The separate cavities of the optic lobes extend anteriorly and posteriorly from the point where they form a general cavity with the Sylvian aqueduct, and thus in a transverse section taken on either the anterior or posterior side of the general cavity, four cavities are seen: (1)&(2) The two separated cavities of the optic lobes, or the lateral portions of the general cavity(Fig.12-h'; Fig.16,17,18,19,20,21-Vop); (3) the anterior or dorsal diverticulum of the general cavity(Fig. 12,17,20-z); and (4) the lower portion of the general cavity (Fig.5,17,18,19,20,21-Aq; Fig.12-h)which is really the central canal or Aqueduct of Sylvius.

In a transverse section the grey matter surrounds the cavity and is heavier on the sides of the cavity, while the white matter entirely fills the superficial area around the periphery of the section. The grey matter contains a large number of small cells(Fig.12,17,18,19,20,21-m), whose nuclei alone can be seen, and near the descending and converging sides of the central canal, where the grey matter is heaviest, these cells form rows parallel with the sides of the dentral canal and separated, one row from another, by extremely fine bundles of medullated fibres. These cells are unipolar; their bases nearest the wall of the central canal, their tails pointing away from the wall at right angles to it. They average from(6.9 to 13.8 micra)in diameter. On each side of the medial, vertical axis, and beneath the floor of the cavity, are larger unipolar cells(Fig.12,17,18,19,20,21-u); they are are about 32.2 micra long, and 16.1 micra wide. They are arranged in the same manner as the smaller cells. This group of cells is called the oculo-motor nucleus because the oculomotor nerve(Fig.12-u)may be traced to it. Köppen states that a small commissure of decussating fibres connects the nuclei of opposite sides, running beneath the central canal.

The cells in the roof and lateral walls of the optic lobes are arranged in five distinct layers(Fig.16,17,18,19, 20,21): (1) adjacent to the cavity is a layer of epithelial cells, from (6.9 to 9.2 micra)in diameter, (2) a layer of nuclei in a granular matrix, from (9.2 to 13.8 micra) in diameter, (3) a layer of fine fibres, (4) a nuclear layer, nuclei averaging (9.2 micra) in diameter, and (5) an outside or superficial layer containing no cells, but very fibres, which Wiedersheim states have not been accurately traced. Haslam, the translator, says, "Reissner describes three nuclear layers in Bufo variabilis, and this is also the case in Rana temporaria; according to Köppen, the number is variable."

On either side of the anterior diverticulum of the cavity a distinct bundle of fibres(Fig.13,14,15,16-s)can be seen. They bend down externally and may be traced as far as the crura cerebri(Fig.13,14,15,16,17,18,19,20,21-c). A group of large irregular cells(Fig.12,17-W)occurs where the roof meets the crura cerebri. Their processes are indistinct, and they measure from(25.3 to 41.4 micra)in diameter.

Wiedersheim(1881)says, "Fibres corresponding with the commissural and arched fibres of the medulla oblongata are continued into the hinder portion of the crura cerebri, the change from pars commissuralis to crura cerebri being very gradual. The longitudinal white fibres are much increased in number in the crura cerebri(Fig.13,14,15,16,17,18,19,20,21 -c), and a portion of them can be traced to the nucleus magnus. The fibres of the optic tracts arise, according to Köppen, from two different origins: the one lies on the hindermost part of the optic lobe; from this point the fibres curve downwards and forwards to form longitudinal fibres; this root Köppen names the ventral ascending root, it can be traced through the entire length of the organ." It has been noted that these are the longitudinal, medullated fibres which unite with the fibres of the tuber cinereum forming a crus cerebri and proceeding along the ventro-lateral surface of the cerebral hemispheres.

Wiedersheim says, "The second root arises in the tectum opticum near the longitudinal fissure; it is smaller that the foregoing, and has been named the dorsal ascending optic root. The fibres of these two roots unite anteriorly near the posterior commissure(Fig.12,17-y; Fig.5-Po), at which point they receive additional fibres(Köppen). Bellonci(1883)traces a large portion of the fibres of the optic tract to the nucleus magnus, which pair of nuclei he regards as the posterior pair of corpora quadrigemina of higher animals."

Adams(1933)says, "In mammals the posterior lobes of the corpora quadrigemina serve as a relay for auditory impulses," and he defines them as, "two pairs of small rounded eminences on the roof of the mesencephalon of mammals, corresponding to the corpora bigemina,(optic lobes or visual centers), of other vertebrates."

Wiedersheim(1881)states: "The pars peduncularis is the continuation of the pars commissuralis underneath the optic lobes; a gelatinous mass lying in the median plane and containing numerous isolated nuclei(Ganglion interpedunculare) divides it into two lateral halves. The longitudinal fibres are ungrouped posteriorly, but arranged in rounded strands in the middle, especially dorsally; anteriorly the grouped arrangement is lost and the number of fibres diminished."

In a transverse section beginning under the central canal the pitment runs upwards along the wall of the canal, and then divides; one branch running around the superficial surface of the lateral ventricle, the other running medially between the aqueduct of Sylvius and the ventricle of the optic lobe.

The Cerebellum

The cerebellum(Fig.1,3,5,22-C)is a small arched cap which projects dorsally between the optic lobes and the medulla oblongata. It forms the roof of the anterior portion of the fourth ventricle(Fig.22-Av). Thus, in transverse section, the central cavity of the fourth ventricle(Fig.22-Av)though it is still narrow and pointed ventrally(Fig.22,23,24-f),has been pushed down and widened dorsally. On the anterior portion of the cerebellum is a thin sheet, the valvula cerebelli, which connects the posterior surface of the optic lobes with the anterior surface of the cerebellum. That portion of the brain stem setween the thalamencephalon and the fourth ventricle is called the pars commissuralis(Fig.22-PaC). Dorsally the pars commissuralis is covered by the valvula cerebelli, and anteriorly under the optic lobes it is called the pars peduncularis or posterior peduncle(Fig.5,17,18,19,20, 21-pp).

In transverse section the anterior portion of the cerebellum just above the ventricle is occupied by a circular, heavily pigmented stratum of nerve fibres(dentate nucleus; Fig.22-st)which contains many nuclei(6.9 micra in diameter). In longitudinal section these fibres form the fourth or most anterior layer of the cerebellum. They are mostly transverse, but some run in other directions. They lie just beneath the flattened epithelium which covers the anterior surface of the cerebellum. They are mostly transverse, but some run in other directions. They lie just beneath the flattened epithelium which covers the anterior surface of the cerebellum. These fibres can be followed ventrally on each side into the pars commissuralis(Fig.22-Vst), and they finally unite under the anterior portion of the fourth ventricle forming an inverted arch. This central stratum(dentate nucleus; Fig.22-st.)above the ventricle is bi-lobed, being separated vertically in the middle by a more lightly pigmented portion(Fig.22-i)which contains fewer nuclei. Dorsally a semi-circular cap covers each heavily-nucleated lobe(Fig.22-Scc), and both caps are joined medially above the more lightly-nucleated vertical area. The cells and nuclei in this cap are much larger than in the heavily-pigmented region. These cells are unipolar, and are about(18.4 micra in width and from 34.5 to 46 micra in length). Their nuclei average (13.8 to 18.4 micra in diameter). These are the cells of Purkinje which extend forward from the third longitudinal layer and are here interspersed with smaller cells, about the size of those in the heavily pigmented area, which form an outer lateral circle(Fig.22-olc)whose base(Fig.22-b)is just above the ventricle. Thus the entire nucleated regions in the transverse section may be said to assume the form of a figure eight in which the upper area is occupied by the bilobed region of small, heavily-pigmented cells, and the lower area is occupied by the open ventricle surrounded by the inverted arch of small cells in the pars commissuralis.

Concerning the cerebellum Wiedersheim(1881), who used longitudinal, vertical sections, says: "The posterior surface of the cerebellum is seen to be covered with epithelium; in the lower part of the surface this is columnar or conical, above it is flattened: immediately beneath, that is, in front of this is a finely granular layer, with very closely packed and granular nuclei. In front of these is a stratum of nerve-fibres forming the second layer of the cerebellum.

Still more anteriorly is the third layer of the cerebellum, an irregular double layer of large cells(Purkinje's cells, Denissenko); the cells have an average length and breadth of,(41.4 micra and 16.1 micra), respectively; they are pear-shaped(unipolar)or of spindle-form(bipolar, fusiform), and possess, usually, two well-marked processes, one passing into the layer behind the other forwards into the anterior layer(Fig.22-Soc-olc-b)to be immediately described, while other less distinct processes radiate irregularly in all directions. The fourth and most anterior layer, the dentate nucleus of the cerebellum(Fig.22-st-i)is a thick stratum of nerve-fibres with numerous nuclei(6.9 micra to 9.2 micra)in diameter. The fibres are for the most part arranged transversely, but some course in various directions. These fibres underlie the flattened epithelium which covers the anterior surface of the cerebellum.

The fibres of the second layer course, for the most part, in an almost vertical plane; they connect the cerebellum with the optic lobes(processus cerebelli ad corpora bigemina)and with other parts of the brain.

The fibres of the fourth layer receive numerous long processes from the large cells of Purkinje; they form a large commissural system(Fig.22-st-Vst), which can be followed ventrally on each into the pars commissuralis. A part of the fibres ends here in the grey matter, a second portion enters the auditory area and forms a descending auditory root, a third part joins the lateral columns(in the medulla oblongata), and more anteriorly some join the ventral columns. The descending fibres from the cerebellum(Fig.22-V.st), together with the fibrae arcuatae found in the ventral columns(Fig.22-Vc), indicate the presence of a pons Varolii(Fig. 22-pV). The fibres of this ventral commissure decussate only on its dorsal surface(Köppen).

The Valvula cerebelli contains a few medullated fibres and the roots of the trochlear nerves; these pass from the medulla oblongata into the valvula cerebelli, cross in the median line, and then proceed forwards as the trochlear nerves(Fig.3-IV)."

The pigment in the pars commissuralis is in the form of an inverted arch as it is in the medulla oblongata, but the bases or extremities of the arch are shortened. Thus the pigment does not extend into the cerebellum and a non-nucleated, non-pigmented dividing line(Fig.22------)is formed above the fourth ventricle separating the cerebellum from the pars commissuralis.

The Medulla Oblongata

In transverse section the medulla oblongata assumes the shape of a wide U. In the heavy floor of the cavity between the two dorsal horns is a median longitudinal fissure(sulcus centralis)(Fig.23,24-f), and on the ventral surface immediately opposite is a ventral longitudinal fissure(Fig.23,24-vlf)continuous with that of the spinal cord. The medulla oblongata, due to its proximity and similarity in structure with the spinal cord, has an increased amount of grey matter. The grey matter from the grey H or butterfly of the spinal cord forms the floor and the inner portion of the horns of the medulla oblongata, while the white matter forms the outer portion of the horns and the superficial portions of both sides of the medulla oblongata. As the medulla oblongata is formed the dorsal horns(in the medulla-fig.27-f)of the grey H of the spinal cord become smaller while the ventral horns(in the medulla-fig.27-g)increase and are forced outwards and dorsally forming the inner portion of the dorsal horns of the medulla and lying under the floor of the ventricle. The grey matter of the medulla oblongata extends anteriorly as far as the corpus restiforme(pars peduncularis or posterior peduncle-fig.22-PaC; Fig.5,17,18,19,20,21-pp), which forms the connection with the cerebellum through the pars commissuralis(Fig.22-PaC).

There are small nerve cells scattered throughout the grey matter of the medulla, and also there are larger cells which are arranged in distinct groups bearing a direct relationship to the various nerves arising from the medulla.

Wiedersheim(1881)says the chief groups are: (1) The nucleus centralis(upper inner group, Reissner(Fig.24,27-i); nucleus medullae oblongatae, Stieda), is a group of cells found towards the hinder end of the medulla oblongata, on either side of and below the central canal; the group can be traced under the floor of the fourth ventricle to about its middle. The cells are rounded or fusiform, the processes directed upwards, downwards, or outwards; their average size is(39.1 to 48.3 micra) long by (20.7 micra) broad.
(2) The auditory nucleus(nucleus acusticus, Reissner, Stieda Fig.23,25,26-n), is a large group of cells found in the wall of the fourth ventricle opposite the point of origin of the auditory nerve(Fig.25-p and p'). The cells are rounded, pear-shaped, or of spindle form, and interspersed between the nerve fibres; these cells have an average length of(40 micra), and are about half as broad. The fibres of the auditory nerve(Fig.25-p)radiate from their superficial origin in all directions through the grey matter towards these cells, and evidently communicate with them. One small group(Fig.25) passes to a lower level than the rest, and is regarded by Stieda as the true auditory centre. Köppen considers that the auditory nerve has a threefold origin: (1) from small cells on the median surface of the auditory area(Fig.25); (2) from the large cells between the above(Fig.25); (3) from a group of free nuclei on the dorsal surface of the auditory area(Fig.25).

(3) The trigeminal nucleus(nucleus trigeminus-Fig.23,25-r), lies in part beneath the auditory nucleus(Fig.23,25,26-n)but extends further forwards. It forms a rounded group of cells placed under the outer angle of grey matter. The cells are somewhat crowded together, and are chiefly of an elongated spindle-form, with their processes directed obliquely downwards and outwards. The fibres of the trigeminal nerve separate into two groups; the upper group is best traced in a horizontal section, the fibres curving round to join the longitudinal fibres continued from the dorsal columns of the cord. The fibres of the lower, smaller group pass transversely inwards to the trigeminal nucleus. According to Reissner the latter fibres are motor, the former sensory. Probably other nerves are connected with the hinder part of this group.

(4) The abducens nucleus(Fig.23,25,26-o). From its superficial origin, the fibres of the abducens nerve(Fig.26-m)may be traced vertically upwards to a small, rounded, grey mass; at this point the mass is somewhat isolated, but further forwards it may be traced as belonging to the central grey matter; it contains small spindle cells.

(5) The pneumogastric nucleus. The pneumogastric, with its numerous irregular roots arises from the side of the medulla oblongata. The hindermost fibres can be traced as a small bundle, passing almost transversely through the white matter to the outer margin of the grey matter. The larger portion of the fibres is placed in front of these; part of this seems to be directly continuous with the longitudinal fibres of the

white matter; a second part, however, can be traced from the surface transversely through the white matter to the grey matter. These latter fibres together with those of the group first described, do not arise from the grey matter in this part of the medulla oblongata, but curve round and run backwards longitudinally through the grey matter(Fig.24,27-k), thus forming a rounded bundle of fibres. Between these fibres are interspersed small nerve-cells and nuclei which disappear as the fibres approach the white matter. The vagus undoubtedly receives fibres from the grey matter throughout a long course, and again receives a large bundle just before leaving the grey matter. The more exact origin of the various fibres has not been traced.

(6) The nucleus magnus (Reissner and Stieda-Fig.22-nm)is a very peculiar group of cells placed on either side, in the most anterior porti on of the pars commissuralis, that is, immediately beneath the valvula cerebelli. The large cells are arranged in a transverse section in a single row so as to enclose a pear-shaped space on either side, which has its long axis directed from above, downwards and outwards, the narrower end being above. In longitudinal section the line of cells is seen to be open in front. The space enclosed by these cells is occupied by a granular ground-substance which contains only few nuclei. Bellonci is of opinion that these nuclei represent the corpora quadrigemina posteriora of higher animals.

The fibres of the anterior part of the medulla are thinner than those of the posterior portion(Stieda), according to Reissner they gradually thin as they pass forwards. The fibres are nearly all longitudinal, such transverse and oblique fibres as are present being chiefly in connection with the various nerve-roots and the commissures.

The commissura superior(commissure posterior-Fig.11-lc; Fig.12,17-y; Fig.5,22,Po)is naturally lost in consequence of the opening of the central canal into the fourth ventricle; the commissura inferior(anterior commissure-Fig.5-Ac; Fig.22-vc; Fig.24,27-b)is increased in the anterior half and decreased in the posterior half of the medulla oblongata; in the latter the fibres become more and more oblique, and decussate very freely; ultimately they seem to be either continued as longitudinal fibres or to join the ganglia.

Near the pars commissuralis is a transverse arched band of fibres(Fig.23-ta), passing from the under surface of one half of the cord over the ventral longitudinal fissure(Fig. 23,24-vlf)through the septum medium to the under surface of the opposite half; part of the fibres are continued upwards along the periphery to the cerebellum, part to the nucleus magnus(Fig.22-nm). Vertical, straight, or slightly arched fibres are found in the walls of the fourth ventricle.

A section from the medulla oblongata has a larger amount of pigment than a section from the spinal cord, and the anterior portion of the medulla oblongata contains more than the posterior portion. The pigment is chiefly found in a curved line, placed in the lower and outer parts of the grey matter; the amount present varies in different specimens."

The Coverings of the Brain

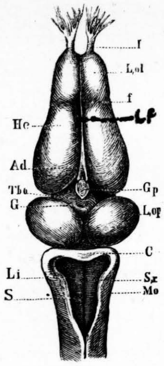
(1) The Pia mater is the superficial, flattened band of connective-tissue material, which closely envelopes and covers the brain and supports the nervous elements, and sends fine processes inward from its inner surface into the general connective tissue matrix or neuroglia. It is pigmented, except on the cerebral hemispheres where it contains very little pigment. However, the pia mater throughout is very vascular, and forms an important source of blood supply for the cerebral hemispheres and olfactory lobes. It is continued on the choroid plexuses and pituitary body, and on to the pineal body by the pedicle.

(2) The Dura mater is the lining membrane of the ventricles. It is also a connective-tissue membrane, but contains very many branched, pigmented cells. It is not as deeply pigmented as the pia mater, except on the olfactory lobes and cerebral hemispheres where it is pigmented more heavily than the pia mater.

(3) The arachnoid membrane is a layer of endothelial cells which, in turn, lines the dura mater. It is connected with the pia mater by means of blood vessels and nerves.

PLATES

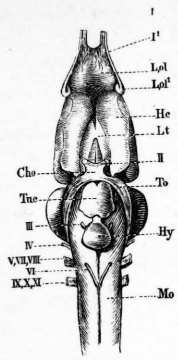
Fig. 1



Dorsal view of brain of *Rana esculenta*.

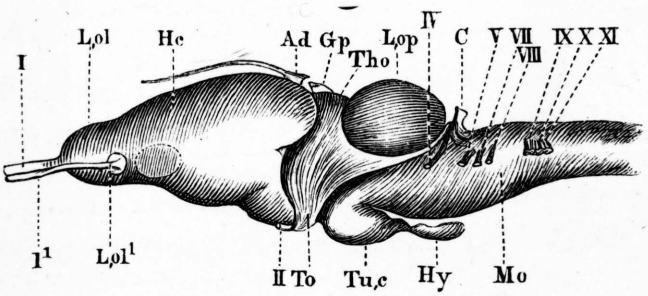
Ad Choroid plexus.
C Cerebellum.
f Groove between cerebral hemispheres and olfactory lobes.
G Opening in the roof of the third ventricle.
Gp Pineal body.
Hc Cerebral hemispheres.
I Olfactory nerve.
Li Wall of fourth ventricle.
L.ol Olfactory lobe.
L.op Optic lobe.
Mo Medulla oblongata.
S Longitudinal fissure of the fourth ventricle.
S.r Fourth ventricle.
Tho Thalamencephalon.
Lf Longitudinal Fissure.

Fig. 2



Ventral view of brain of *Rana esculenta*.

Cho Optic chiasma.
Hc Cerebral hemispheres.
Hy Pituitary body.
L.ol Olfactory lobe.
L.ol[1] Origin of olfactory nerve from the cerebral hemisphere.
Lt Lamina terminalis.
Mo Medulla oblongata.
To Optic tract.
Tu.c Tuber cinereum.
I 1st / *I*[1] 2nd } root of the olfactory nerve.
II Optic nerve.
III Oculo-motor nerve.
IV Trochlear nerve.
VI Abducens nerve.
V, VII, VIII Trigeminal, facial, and auditory nerves.
IX, X, XI Glossopharyngeal, pneumogastric, and accessory nerves.



Lateral view of brain of *Rana esculenta*.

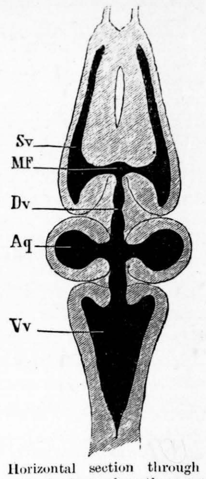
Ad Choroid plexus.
C Cerebellum.
Gp Pineal body.
Hc Cerebral hemisphere.
Hy Pituitary body.
L.ol Olfactory lobe.
L.ol[1] Disc at origin of second root.
L.op Optic lobe.
Mo Medulla oblongata.
Tho Thalamencephalon.
To Optic tract.
Tu.c Tuber cinereum.
I 1st / *I'* 2nd } root of olfactory nerve.
II Optic nerve.
IV Trochlear nerve.
V Trigeminal nerve.
VII Facial nerve.
VIII Auditory nerve.
IX, X, XI Glossopharyngeal, pneumogastric, and accessory nerves.

Fig. 3

Figure 5-Vertical, longitudinal section through the brain to show the ventricles, commissures and choroid plexi.

Ac.-Anterior or inferior commissure.
Ad.-Anterior choroid plexus.
Ad.P-Posterior choroid plexus
C-Cerebellum
Hab.C.-Nucleus parvus(Reissner),ganglion of the Habenula (Köppen)or Habenular Commissure.
Hc.-Cerebral Hemisphere.
Hy.-Hypophysis cerebri or pituitary body.
Inf.-Infundibulum
L,ol.-Olfactory lobe
L,op.-Optic lobe
Mo.-Medulla oblongata
P.-Pallium
P.C.-Pars Commissuralis
Po.-Posterior commissure or superior commissure.
Pp.-pars peduncularis, posterior peduncle or corpus restiforme(restiforme body)
Tho-Thalamencephalon
To-Optic Tract
T.u.c.-Tuber cinereum or infundibular lobe.
V.op.-Ventricle of the optic lobe or mesocoel.
I&II.-Lateral ventricle
III.-Third ventricle or aqueduct of Sylvius.
IV.-Fourth ventricle or fossa rhomboidialis.

Fig. 4



Horizontal section through the brain to show the ventricles.

Aq Ventricles of optic lobes and the aqueduct of Sylvius.
Dv Third ventricle.
MF Foramen of Monroe.
Sv Lateral ventricle.
Vv Fourth ventricle.

Fig. 5

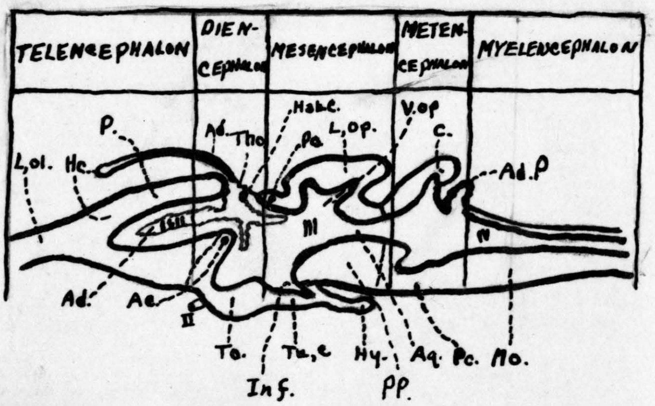
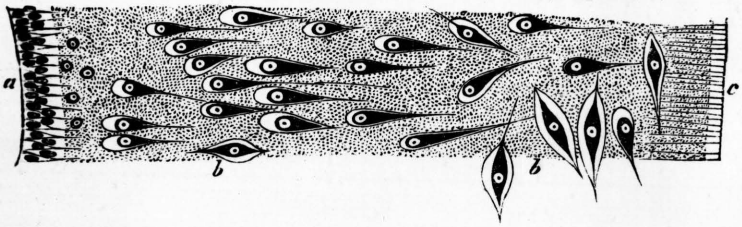


Figure 7-Transverse section through the Olfactory lobes.

a--Epithelium of lateral ventricle
c--Pia mater
cc-crus cerebri
lf-longitudinal medullated fibres; 'round bundle' of Köppen.
ma-area immediately surrounding ventricle
ps-superficial surface
x--strand of longitudinal fibres from tuber cinereum

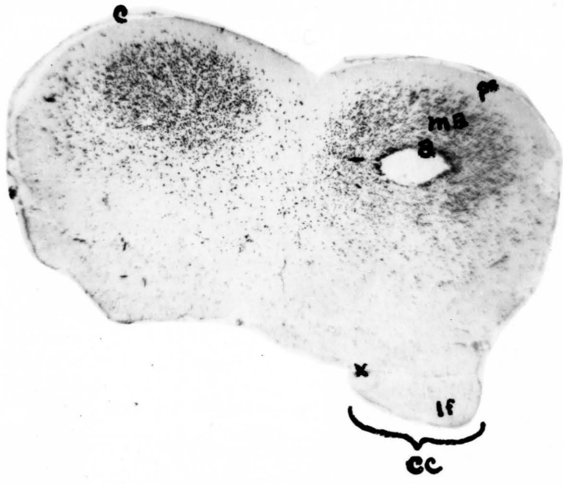
Fig. 6



From a transverse section through one of the cerebral hemispheres; from Stieda.
(Magnified 360 times.)

a Epithelium of lateral ventricle.
b Nerve cells.
c Connective-tissue processes from the Pia mater.

Fig. 7



Figures 8, 9, 10- Anterior, medial, and posterior transverse sections through the cerebral hemispheres

c'-Common ventricle of Stieda.
d-Beginning of invagination to form foramen of Monroe.
Du-Dorsal and ventral bulge on inner wall of ventricles (corpus striatum, Wiedersheim).
e--Longitudinal groove in lateral ventricle(Ventriculi lateralis cornu internum, Reissner).
f--anterior prolongation of third ventricle.
g--Ventral vertical slit in ventricle. (Ventriculi lateralis cornu inferius, Reissner).
i--epithelium of third ventricle.
lf-Longitudinal medullated fibres; 'round bundle' of Köppen.
lt-lamina terminalis (Substantia cinerea anterior).
n--nucleus through which the corpus callosum passes.
p--pea mater.
r--choroid plexus of the lateral ventricles and anterior prolongation of the third ventricle.
s--lower internal or median cell area (Osborne)
t--upper internal cell area.
v--corpus striatum(Osborne).
w-corpus callosum.
y--Pars olfactoria interna(Osborne)
z--Commissura anterior or inferior commissura.

Fig. 8

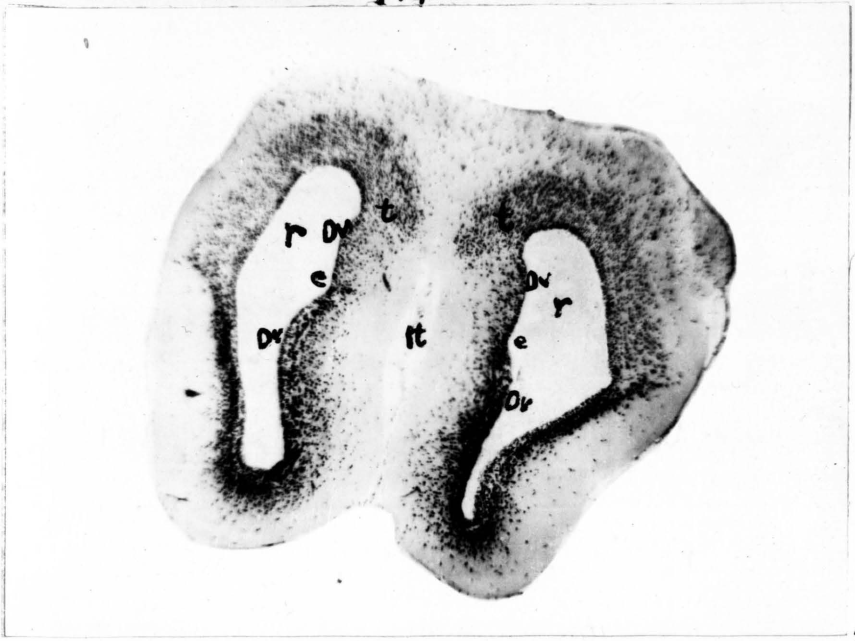


Fig. 9

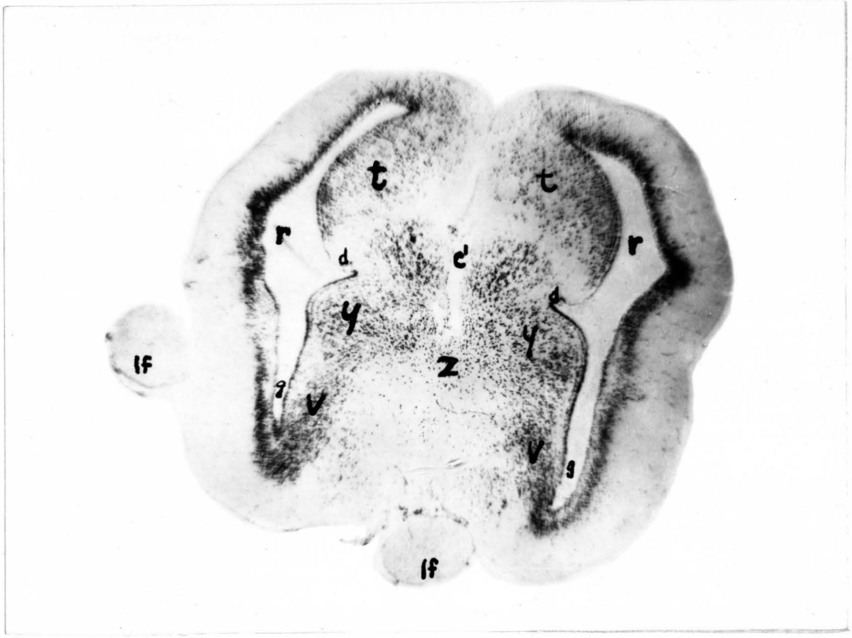


Fig. 10

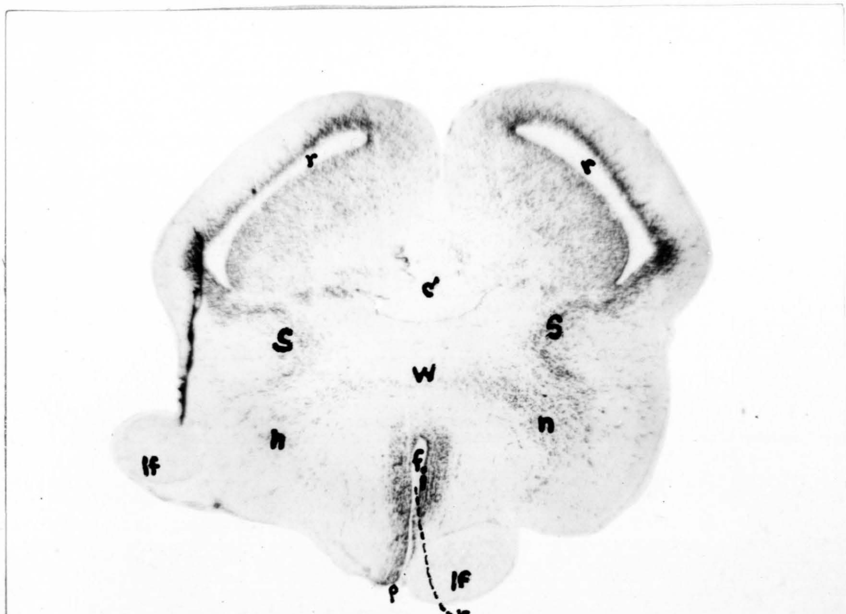


Figure 11--Transverse section through the middle thalamencephalon.

a--third ventricle
a'-Vertical slit of ventral third ventricle
b--Roof of the third ventricle
d--Rows of cells & nuclei in the grey matter
lc-Large commissure of transverse fibres in the roof of the third ventricle.
lf-longitudinal medullated fibres; 'round bundle' of Köppen
m--Meynert's band(Köppen)in the lateral wall of the third ventricle
np-nucleus parvus,(Reissner)ganglion of the Habenula (Köppen)or Habenula commissure
oc-Optic chiasma and optic tract
pc-probable commissure of optic nerves.
r--anterior choroid plexus
tc-Tuber cenereum or infundibular lobe
vn-'Ventral nucleus' of the thalamencephalon (Köppen)

Fig. 11

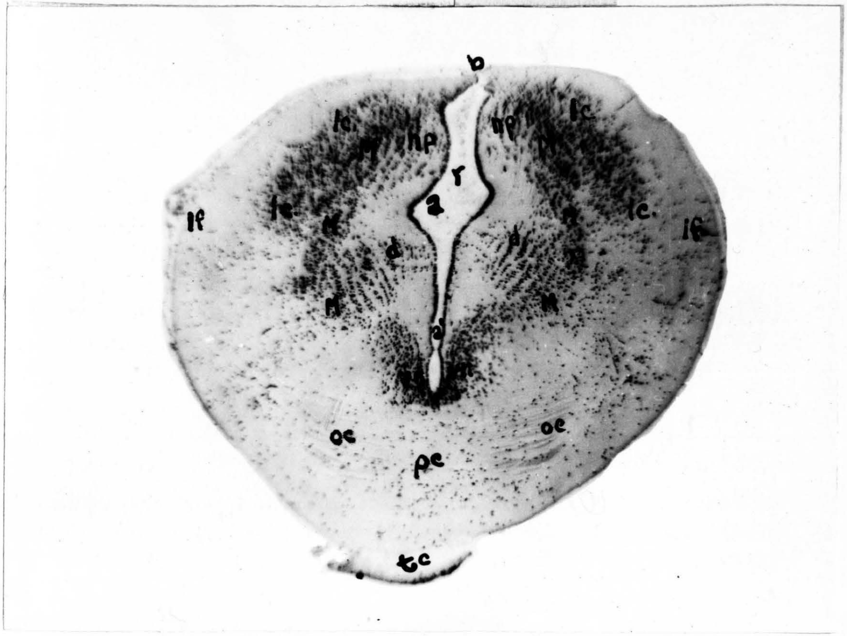
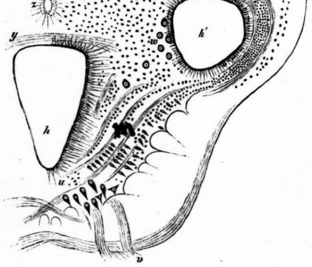


Fig. 12

Fig. 104.



Transverse section through the anterior portion of the optic lobes opposite the origin of the motor-oculi nerve; from Stieda (magnified 30–80).

- *h* Lower portion of cavity.
- *h'* Lateral portion of cavity.
- *u* Ganglia of oculi-motor nerve.
- *v* Oculo-motor nerve.
- *w* Large cells of the optic lobe.
- *x* Roof of optic lobe.
- *y* Posterior commissure.
- *z* Anterior diverticulum of the cavity.

m-Cell layer of grey matter.

Figure 13, 14, 15, 16, 18, 19, 20, 21--Transverse sections through the optic lobes, pars peduncularis, tuber cinereum, and pituitary body from anterior to posterior.

a---third ventricle
aq--aqueduct of Sylvius or ventricle of the mesencephalon aqueductus Sylvii, iter a tertio ad quartum ventriculum.
c---Crura cerebri
f---narrow descending fissure in floor of central canal
g---membrane-like structure of posterior pituitary body.
Gc-general cavity of Sylvian aqueduct and cavities of the optic lobes.
Hy--Pituitary body or hyposphysis cerebri.(Smaller, anterior, more dorsal, light portion)
Hyp-Pituitary body or hyposphysis cerebri.(larger, posterior, more ventral dark portion.
Inf-Indundibulum
m---cell layers in the grey matter
o---dorsal, horizontal, longitudinal layer of anterior pituitary body.
p---Ventral, horizontal, longitudinal layer of anterior pituitary body
pp--Pars peduncularis or brain stem under uptic lobes (continuation of the pars commissuralis under the cerebellum)
s---Bundle of fibres on each side of the third ventricle.
Tuc-tuber cinereum or unfundibular lobe
u---Oculo-motor nucleus
V.op-mesocoels or ventricles of the optic lobes(ventriculi lobi optici, Stieda
w---Large cells of the optic lobe
x---roof of optic lobes
Y---Posterior commissure or dorsal or superior commissure
z---anterior or dorsal diverticulum of the general cavity
Zx--structure on roof of third ventricle usually known as the pineal body, but is only a thickened portion of the choroid plexus.

Fig. 13

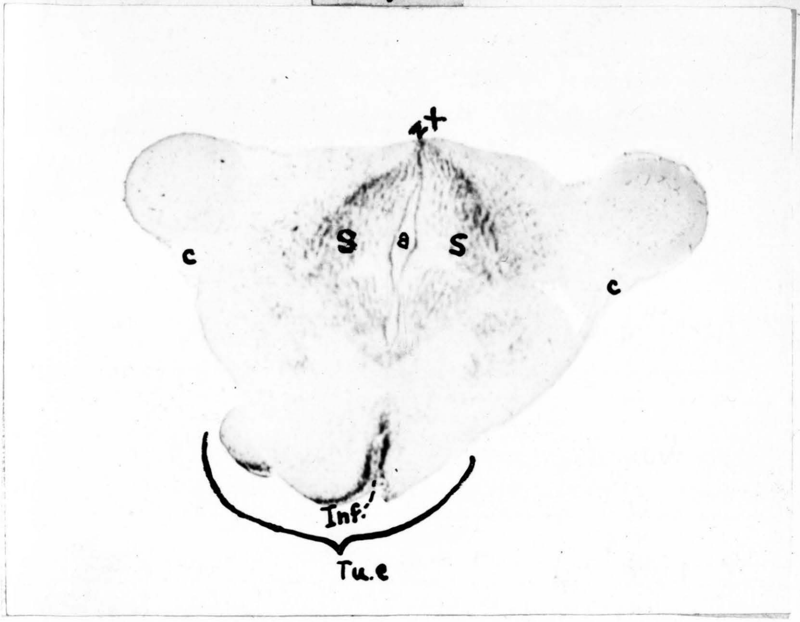


Fig. 14

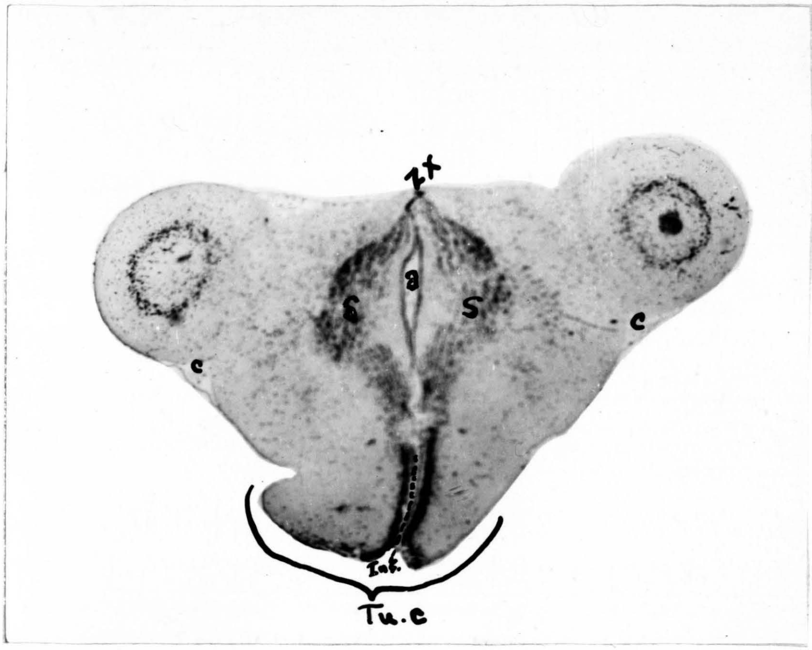


Fig. 15

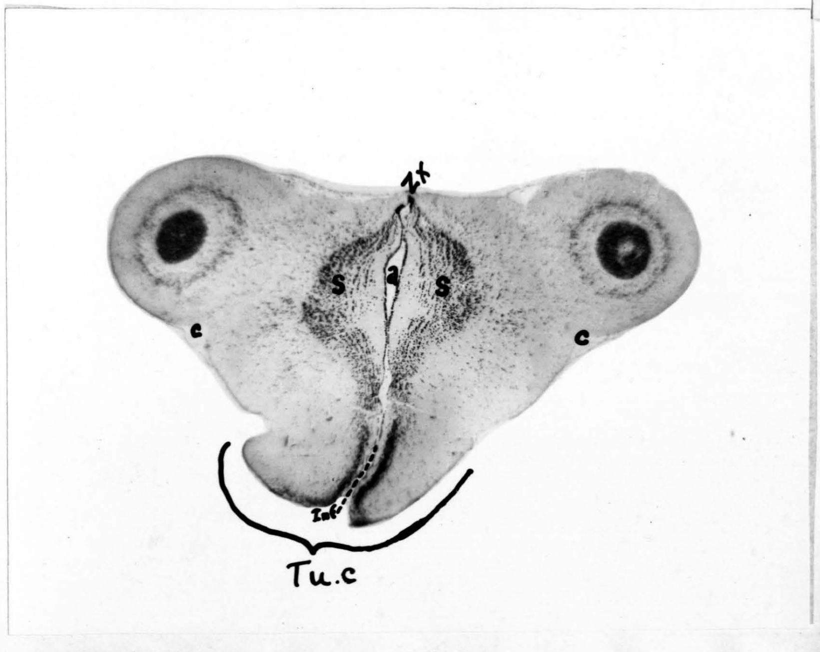


Fig. 16

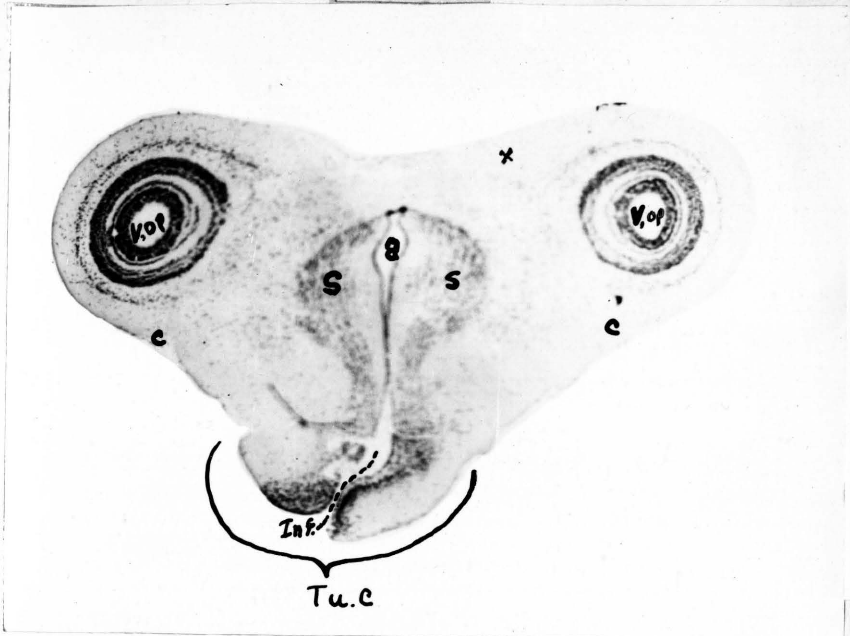


Fig. 17

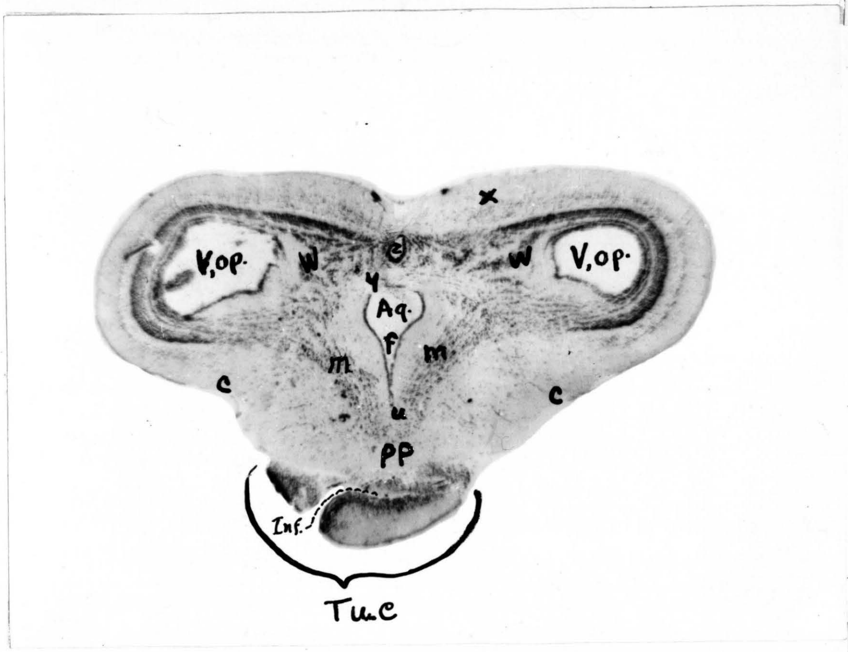


Fig. 18

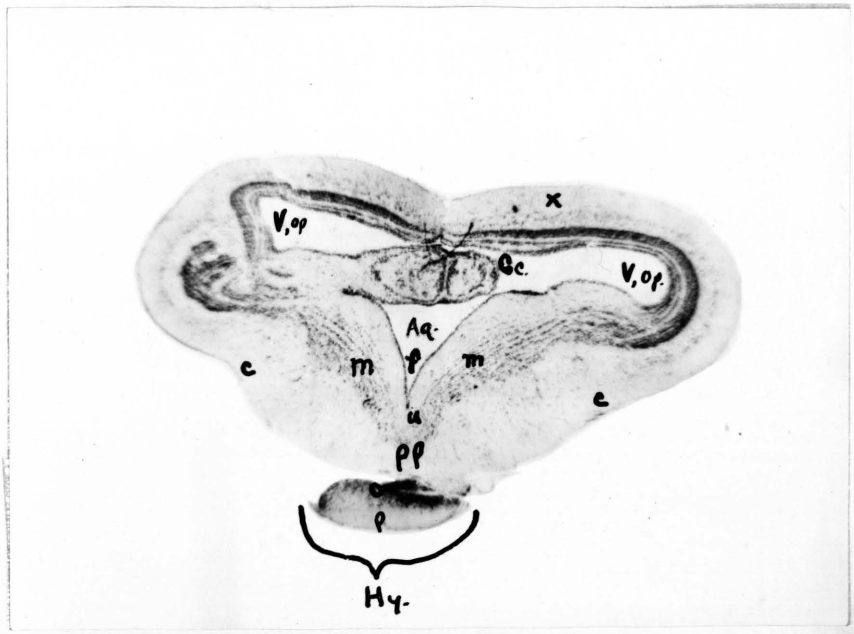


Fig. 19

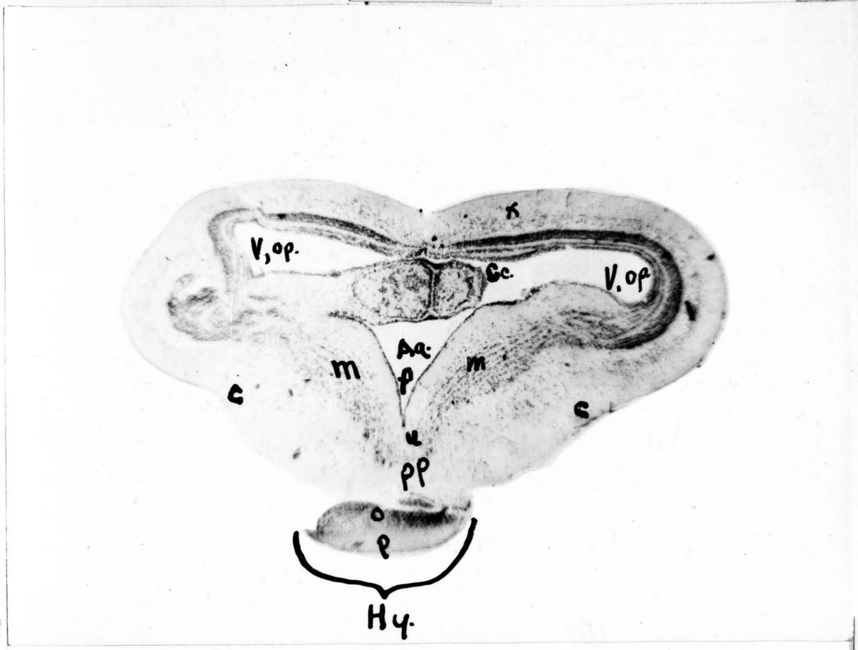


Fig. 20

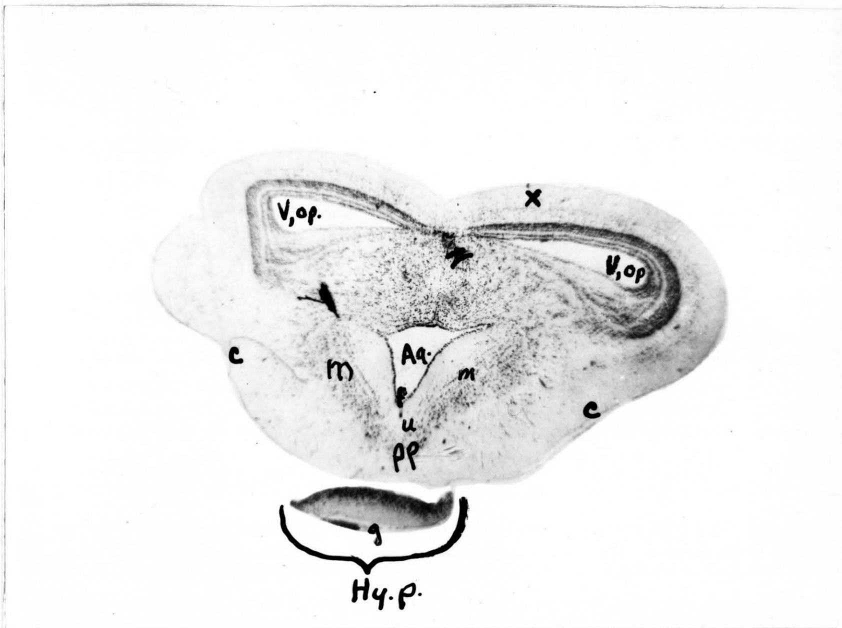


Fig. 21

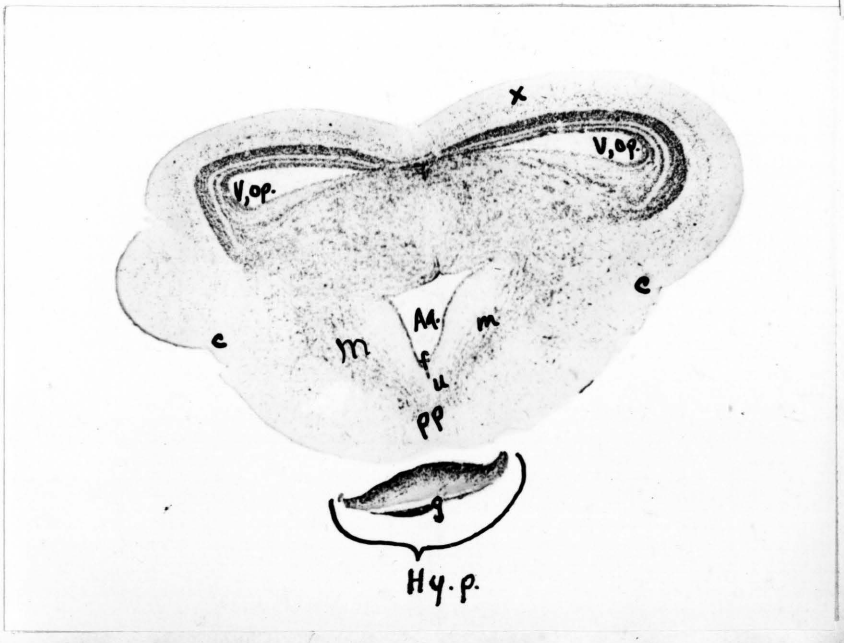


Figure 22-Transverse section through the posterior cerebellum and Pars commissuralis.

Av-anterior portion of the fourth ventricle under cerebellum

b--base of semi-circular cap.

C--cerebellum

f-sulcus centralis or median longitudinal fissure in floor of the fourth ventricle

i-slightly pigmented portion of dentate nucleus

nm-nucleus magnus(Reissner & Stieda)

Olc-outer lateral circle of semi-circular cap.

PaC-Pars commissuralis

Po-Posterior commissure; dorsal or superior commissure

Pv-Pars Varolii (commissure under ventricle)

S.cc.-Semi-circular cap over each lobe of dentate nucleus

St-large dentate nucleus or heavy stratum of nerve fibres in the anterior layer or fourth layer of the cerebellum

Vc-Ventral columns(commissura anterior or inferior commissure)

Vst-Ventral stratum of dentate nucleus

----non-pigmented septum separating the cerebellum from the pars commissuralis

Figure 23, and 24-transverse section through the anterior and posteriro medulla oblongata respectively.

b--anterior commissure-commissura inferior
f--fulcus centralis or median longitudinal fissure of fourth ventricle
i--nucleus centralis(upper inner group, Reissner; nucleus medullae oblongatae Stieda)
k--Isolated mass of grey matter in which longitudinal fibres of the pneumogastric nerve course.
n--auditory nucleus(nucleus acusticus, Reissner, Stieda)
o--abducens nucleus
r--trigeminal nucleus(nucleus trigeminus)
ta-transverse arched band of fibres in the anterior medulla
vlf-ventral congitudinal fissure of the medulla oblongata
z---anterior commissure-commissura inferior

Fig. 22

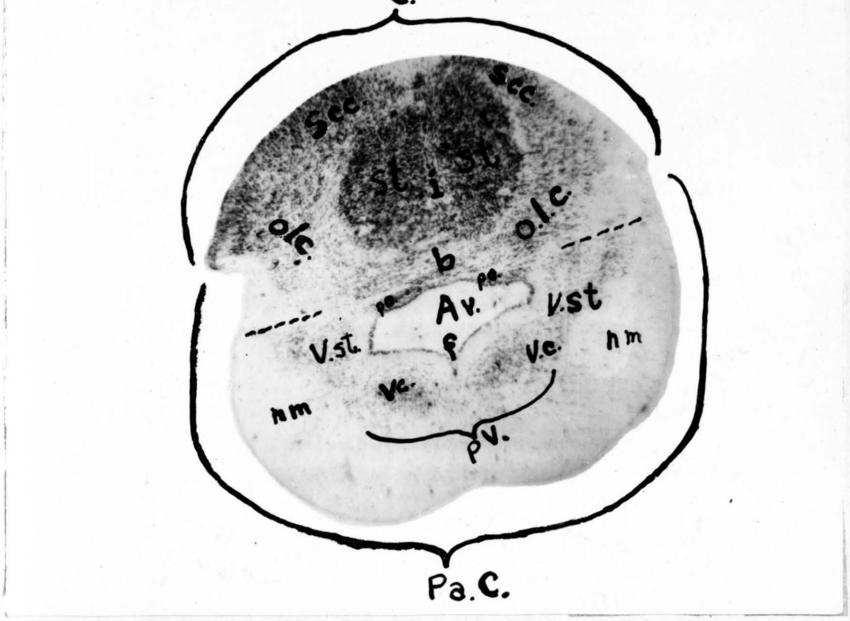


Fig. 23

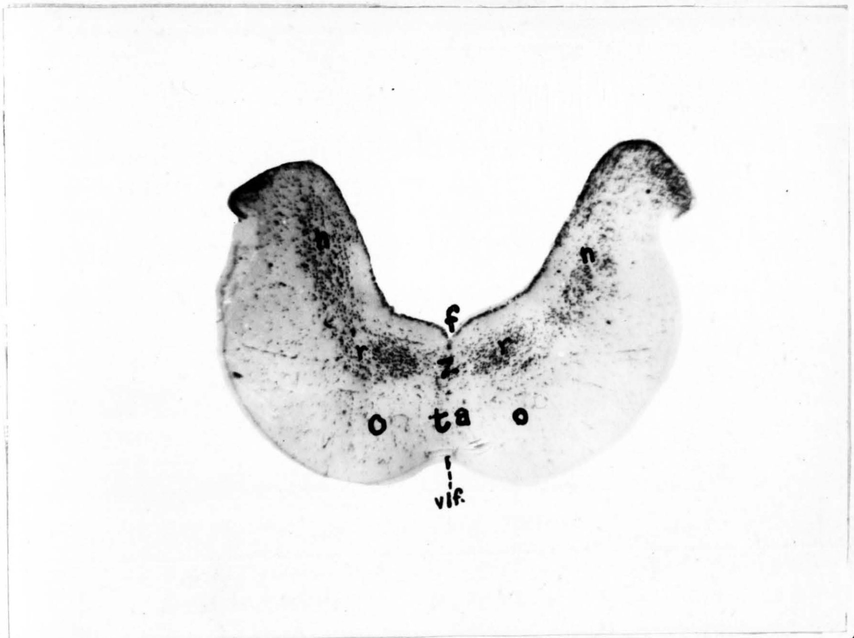


Fig. 24

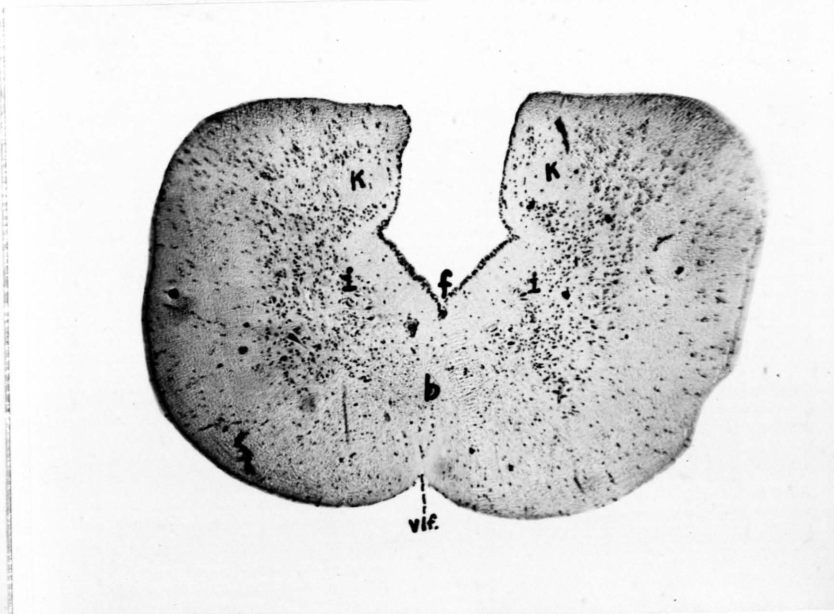
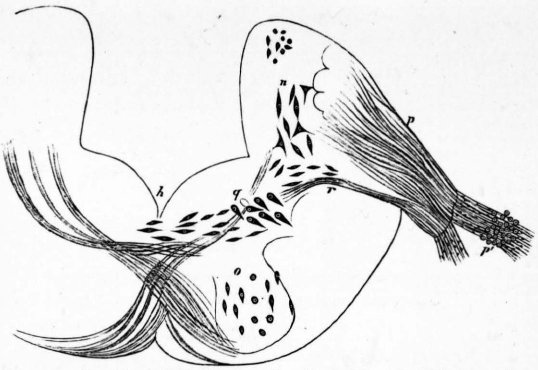


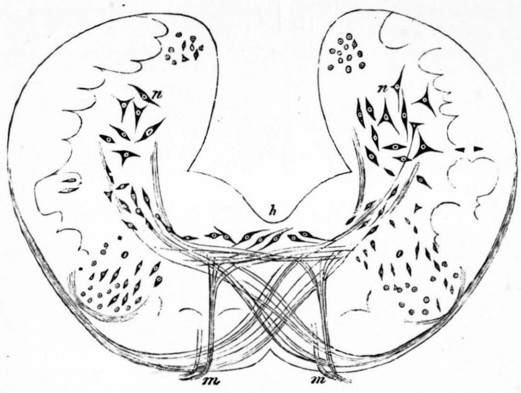
Fig. 25



Transverse section of the *Medulla oblongata*, at the point of origin of the auditory nerve, from Stieda. (Magnified 30×80.)

- *h* Fourth ventricle.
- *n* Auditory nucleus.
- *o* Abducens nucleus.
- *p* Auditory nerve.
- *p'* Ganglion of auditory nerve.
- *q* Hinder portion of trigeminal nerve.
- *r* Bundle of fibres arising from trigeminal nucleus and joining the auditory nerve.

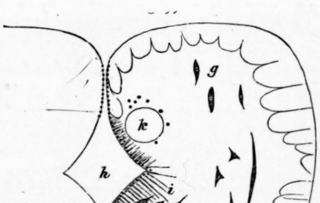
Fig. 26



Transverse section through the *Medulla oblongata* at the point of origin of the abducens nerve, from Stieda. Magnified 30×80.)

- *h* Fourth ventricle.
- *m* Abducens nerve.
- *n* Auditory nucleus.
- *o* Abducens nucleus.

Fig. 27



Transverse section through hinder end of *Medulla oblongata* (magnified 30-80)[1], from Stieda.

- *b* Inferior commissure.
- *f* Dorsal horns.
- *g* Ventral horns.
- *h* Fourth ventricle.
- *i* Nucleus centralis.
- *k* Isolated mass of grey matter in which longitudinal fibres of the pneumogastric nerve course.

GLOSSARY

abducens. The sixth cranial nerve.

abducens nucleus. The origin of the abducens nerve.

accessory. The eleventh cranial nerve.

aqueduct of Sylvius. The canal running from the anteria part of the fourth ventricle forward under the cerebellum and forming a common cavity with the ventricles of the optic lobes. (Aqueductus Sylvii, iter a tertio ad quartum ventriculum).

arachnoid layer. The thin membrane interposed between the outer dura mater and the inner pia mater, of the brain.

arbor vitae. A term applied to the nerve tracts of the cerebellum because of the pattern that they form. Also called the "Tree of Life."

archencephalon. The primitive forebrain.

auditory nerve. The eighth cranial nerve.

auditory nucleus. The origin of the auditory nerve. (nucleus acusticus, Reissner, Stieda).

bipolar cell. A cell having two poles or points.

brachium conjunctivum. A tract of nerve fibres extending from the cerebellum to the mesencephalon. (anterior peduncle).

brachium pontis. A transverse band of nerve fibres, passing under the brain stem and connecting the two cerebellar lobes. (middle peduncle).

cerebellum. A supra-segmental structure on the dorsal side of the metencephalon.

cerebral commissure, inferior. A tract of nerve fibres connecting the median geniculates. (commissura anterior, Stieda).

cerebral commissure, superior. A group of nerve fibres found in the roof of the third ventricle. (commissura posterior, Köppen).

cerebral hemispheres. Two large ovoid bodies, connected anteriorly with the olfactory lobes and posteriorly with the thalamencephalon. (lobi hemisphaerici, Stieda;

Lobi cerebrales, Reissner; Centralmasse des Geruchssinns, Carus; Hemisphaeren des grossen Hirns, Tiedemann; Grosse Hemisphaeren, Schiess; Prosencephalon, Huxley).

chiasma (optic). A crossing of the optic nerves.

choroid plexus. The thin, richly vascular roof of the diencephalon, which extends as folds into the ventricles of the brain. Of the fourth ventricle (plexus choroideus ventriculi quarti, Reissner; velum medullare posterius).

cilia. Hair-like processes, often present on cells.

commissure. A tract of fibres connecting similar parts on opposite sides of the brain.

corona radiata. A fan-shaped band of fibres which radiate from the internal capsule out to the cortex of the cerebral hemispheres.

corpora bigemina. Two small eminences on the roof of the mesencephalon.

corpora quadrigemina. Two pairs of small rounded eminences on the roof of the mesencephalon of mammals, corresponding to the corpora begemina of other vertebrates. Bellonci is of opinion that the nuclei of the nucleus magnus (Reissner and Stieda) represent the corpora quadrigemina posteriora of higher animals.

corpus callosum. A large band of commissural fibres connecting the two cerebral himispheres. (pallial commissure).

corpus restiforme. A nerve tract extending from the medulla to the cerebellum. (posterior peduncle; pars peduncularis)

corpus striatum. A ventral mass of gray and white matter, in the telencephalon. Two rounded masses, an upper and a lower, in the inner wall of the lateral ventricles of the cerebral hemispheres; divided by a longitudinal groove (Ventriculi lateralis cornu internum, Reissner), and as the cavity of the lateral ventricle proceeds posteriorly it exhibits only a vertical slit (Ventriculi lateralis cornu inferius, Reissner). These two rounded masses are the (Corpus striatum, Wiedersheim). A mass of cells between the corpus callosum and the commissura anterior (Corpus striatum, Osborne). A group of cells found in the wall of the third ventricle in front of 'Meynert's band' (Corpus striatum, Köppen).

crura cerebri. Two columns of white matter, placed beneath the optic lobes, and partly hidden by the pituitary gland.

crus cerebri. The band of fibres from the tuber cinereum together with the 'round bundle' of Köppen.

deuterencephalon. The posterior portion of the early embryonic brain, including the mesencephalon and the rhombencephalon.

diencephalon. A region of the forebrain between the telencephalon and the mesencephalon.

dura mater. The tough, fibrous outer protective covering of the central nervous system.

epiphyseal foramen. A small opening in the chondriocranium of the shark for the epiphysis or pineal structure. In the frog (foramen parietale, Wiedersheim).

epiphysis. The pineal body, pineal gland or pineal structure. (Glandula pinealis, Wiedersheim).

epithalamus. The dorsal region of the thalamus.

facialis nerve. The seventh cranial nerve.

falx cerebri. A longitudinal fold of the dura mater which extends between the lobes of the cerebral hemispheres.

fastigii nucleus. A nerve nucleus in the cerebellum.

fibrae arcuatae. Fibrillae found in the descending ventral columns from the cerebellum.

fibrillae. Fine threads in nerve cells.

flexure of brain. Bends in the neural tube of vertebrates.

flocculus. A small lateral lobe of the cerebellum.

foramen of Monroe. The canal connecting the lateral ventricles of the cerebral hemispheres with the third ventricle, and forming a common cavity between the lateral ventricles. (inter ventricular foramen).

fornix. A band of nerve fibres in the cerebral hemispheres.

fossa rhomboidalis. A deep, triangular groove on the dorsal side of the myelencephalon or medulla oblongata. It is the fourth ventricle, (ventriculus quartus, Stieda; sinus rhomboideus s. sinus triangularis, Reissner).

fusiform. Spindle-shaped

ganglion. A group of nerve cells outside the central nervous system.

ganglion interpedunculare. A gelatinous mass containing numerous isolated nuclei which lies in the median plane beneath the optic lobes, and which divides into two lateral halves the pars peduncularis, a continuation of the pars commissuralis, (Commissura anterior; Anterior; inferior commissure), underneath the optic lobes.

geniculates, lateral and medial. Two small eminences on the roof of the diencephalon.

glossopharyngeal nerve. The ninth cranial nerve.

gyrus. A ridge. A convolution of the brain.

habenula. An olfactory correlation center in the roof of the diencephalon. An arched group of cells placed under the upper border close to the third ventricle (Nucleus parvus; Reissner; ganglion of the Habenula, Köppen).

habenular commissure, superior. A band of nerve fibres connecting the habenulae.

hippocampal commissure. A tract of nerve fibres connecting the hippocampi of the two cerebral hemispheres.

hippocampus. A fold in the lateral ventricles of the cerebral hemispheres. (Corpus striatum, Wiedersheim; Ventriculi lateralis cornu internum, Reissner)

hypoglossal. The twelfth cranial nerve.

hypophysis. A ductless gland on the ventral region of diencephalon (pituitary body or gland; Hypophysis cerebri, Wiedersheim).

hypothalamus. The ventral region of the diencephalon, the floor of the third ventricle.

infundibulum. A small funnel-like structure on the ventral side of the diencephalon, closely associated with the hypophysis. (Diverticulum infundibuli, Reissner)

internal capsule. A band of nerve fibres passing through the corpus striatum of the telencephalon.

interventricular foramen. Paired foramina connecting the third with the lateral ventricles of the brain; foramina of Monroe.

lamina terminalis. The anterior wall of the third ventricle of the brain. (Substantia cinerea anterior, Wiedersheim).

massa intermedia. A band of fibres connecting the walls of third ventricle of the brain; soft commissure, commissura mollis.

maxillary nerve. A branch of the fifth cranial nerve, which reaches the pineal body subcutaneously. (Ramus supramaxillaris, DeGraaf).

medulla oblongata. The posterior region of the brain or sometimes called the myelencephalon.

mesencephalon. The midbrain consisting of the optic lobes, the crura cerebri, and the pars peduncularis.

mesocoel. An extension of the primitive ventricle of the mesencephalon into the optic lobes.

metacoel. An extension of the fourth ventricle anteriorly into the cerebellum.

metencephalon. The anterior part of the rhombencephalon of the brain, including the cerebellum.

myelencephalon. The posterior division of the brain, which becomes the spinal cord at the point of origin of the first spinal nerve; the medulla oblongata.

nerve. A bundle of conducting fibres, outside of the central nervous system.

nerve nucleus. A specialized nerve center in the central nervous system.

nerve tract. A number of nerve fibres of like origin, termination, and function.

nucleus abducens. See abducens nucleus.

nucleus acusticus. See auditory nucleus.

nucleus centralis. A group of cells found towards the hinder end of the medulla oblongata, on either side of and below the central canal or fossa rhomboidalis. (Upper, inner group, Reissner; Nucleus medullae oblongatae, Stieda).

nucleus magnus. A group of cells on either side immediately underneath the valvula cerebelli.

nucleus medullae oblongatae. See nucleus centralis.

nucleus parvus. See habenula and habenular commissure, superior.

nucleus pneumogastricus. The specialized nerve center or group of nerve cells in the central nervous system, which is the origin of the pneumogastric or vagus nerve. (Pneumogastric nucleus)

nucleus trigeminus. The specialized nerve center or group of nerve cells in the central nervous system, which is the origin of the trigeminal nerve. This nucleus lies partly beneath the auditory nucleus, but extends further forwards. It forms a rounded group of cells under the outer angle of the grey matter. (Trigeminal nucleus)

oculomotor. The third cranial nerve.

oculomotor nucleus. The specialized nerve center or group of nerve cells in the central nervous system which is the origin of the oculomotor nerve. The nucleus is a group of large cells found on either side of the middle line and under the floor of the cavity of the Sylvian aqueduct.

olfactory lobe. The anterior prolongation of the telencephalon of the brain, containing the olfactory center. The olfactory bulb. (Tubercula olfactoria, Stieda; Lobi olfactorii, Reissner; Reichkolben, Schiess; Rhinencephalon, Huxley).

olfactory nerve. The first cranial nerve.

olive. A prominent lateral nerve nucleus of the myelencephalon. The olivary nucleus.

optic lobes and crura cerebri. Two large ovoid bodies which form the widest part of the brain and lie between the thalamencephalon and the cerebellum. See Crura cerebri. (Corpora geminata and Pars peduncularis, Reissner; Lobus opticus, Stieda; Vierhügel, Tiedemann; Vierhügel(Zweihügel) and Pedunculе cerebri, Schiess; Mesencephalon, Huxley.)

optic nerve. The second cranial nerve.

pallial commissure. A connecting nerve tract of the pallial region of the cerebral hemispheres. (Corpus callosum)

pallium. The roof of the cerebral hemispheres.

parafloculus. A secondary lateral lobe of the metencephalon, on the side of the cerebellum.

paraphysis. The parietal body or parietal eye. See parietal eye.

parietal eye. An anterior eye-like structure on the roof of the diencephalon, prominent in some reptiles.

pars commissuralis. The pars commissuralis is that part of the brain stem lying under the cerebellum.

pars peduncularis. The pars peduncularis is the continuation of the pars commissuralis underneath the optic lobes. See corpus restiforme.

pars olfactoria. The coursing of the fibres of the Commissura anterior(Stieda) with the 'round bundles' of Köppen.

pars olfactoria interna. A coarse strand of fibres near the inner wall of the ventricles of the olfactory lobes. These fibres connect with the 'round bundles', the fibres of the Commissura anterior, and the fibres from the Tuber-cinereum forming a Crus cerebri.

pathetic nerve. The fourth cranial nerve, also called the trochlear nerve.

peduncle, anterior. A tract of nerve fibres connecting the cerebellum with the mesencephalon; brachium conjunctivum.

peduncle, middle. A tract of nerve fibres forming a band across the ventral surface of the metencephalon, and connecting the cerebellar lobes; brachium pontis.

peduncle, posterior. A tract of nerve fibres connecting the myelencephalon with the cerebellum; corpus restiforme. (posterior peduncle; pars peduncularis).

pia mater. The innermost covering of the brain and spinal cord.

pineal body. The posterior evagination of the roof of the diencephalon, sometimes eye-like in structure; glandular in birds and mammals. (Glandula pinealis, Wiedersheim; epiphysis).

pituitary body or gland. An endocrine gland on the ventral side of the diencephalon. (Hypophysis cerebri, Wiedersheim; hypophysis).

pituitrin. A hormone from the pituitary gland.

plexus. A network of interlacing blood vessels or nerves.

pneumogastric. The tenth cranial nerve; vagus.

pneumogastric nucleus. See nucleus pneumogastricus.

pons. A band of nerve fibres extending around the ventral side of the metencephalon, and connecting the cerebellar hemispheres. These fibres decussate only on the dorsal surface of the commissure, (pons Varolli, Köppen).

processus cerebelli ad corpora bigemina. The fibres of the second layer of the cerebellum which connect the cerebellum ventrally with the optic lobes.

prosencephalon. The first primitive brain vesicle.

pulvinar nucleus. A visual center of the diencephalon which connects the lateral geniculates.

Purkinje's cells. Named by Denissenko. The third layer of the cerebellum.

pyramids. A pair of large nerve tracts on the ventral side of the myelencephalon.

red nucleus. A center of coordination in the mesencephalon, which receiving fibres from the cerebellum through the anterior peduncle, sends them on to the cortex of the telencephalon.

rhombencephalon. The third primitive brain vesicle.

'round bundle'. Named by Köppen. A group of longitudinal medullated nerve-fibres gathered in a bundle on either side of the median fissure of the third ventricle in the region of the cerebral hemispheres. They can be traced from the posterior portion of the thalamencephalon. They finally meet with the longitudinal fibres from the Tuber-cinereum to form a Crus cerebri.

sagittal. A division of a structure in a median, vertical, longitudinal plane.

spinal accessory. The eleventh cranial nerve; accessory.

sulcus. A groove.

sulcus centralis. The median longitudinal fissure in the floor of the fourth ventricle.

telencephalon. The anterior lobe of the forebrain.

terminalis. A small cranial nerve, paralleling the olfactory; Pinkus' nerve.

thalamencephalon. A lozenge-shaped mass lying in front of the optic lobes, and behind and between the diverging posterior ends of the cerebral hemispheres. It is covered by the choroid plexus. Named thalamencephalon by Huxley. (Lobus ventriculi tertii, Stieda; Thalami optici, Reissner; Thalamus opticus s. Lobus ventriculi tertii, Stannius; Ganglien der Haemisphaeren, Carus).

trigeminus. The fifth cranial nerve. (trigeminal).

trigeminal nucleus. See nucleus trigeminus.

trochlear. The fourth cranial nerve. (pathetic).

tuber cinereum. A structure on the ventral region of the diencephalon.

unipolar cell. A teardrop-shaped cell having one pole or point.

vagus. The tenth cranial nerve. (pneumogastric).

valvula cerebelli. A thin lamella or sheet which connects the anterior surface of the cerebellum with the optic lobes. It contains a few medullated fibres and the roots of the trochlear nerves. (Velum medullare anterius, Reissner).

ventricle. A chamber; i.e. ventricle of the brain.

ventricle, fourth. A deep, triangular fossa in the dorsal side of the medulla oblongata. It is covered by the choroid plexus of the fourth ventricle (plexus choroideus ventriculi quarti, Reissner; velum medullare posterius), and runs under the cerebellum being continuous with the spinal cord posteriorly. (Ventriculus quartus, Stieda; sinus rhomboideus s. sinus triangularis, Reissner; fossa rhomboidalis).

ventricle, third. The third ventricle passes posteriorly from the foramen of Monroe to the Sylvian aqueduct. It runs through the thalamencephalon.

ventriculi lateralis cornu inferius. Named by Reissner. The lateral ventricle of the cerebral hemispheres presents in a transverse section through the middle a vertical ventral slit which is the ventriculi lateralis cornu inferius.

ventriculi lateralis cornu internum. Named by Reissner. The longitudinal groove on the inner wall of the cavity of the lateral ventricle forming an upper and a lower corpus striatum, as seen by a transverse section through the hinder portion of the cerebral hemispheres.

ventriculi lobi optici. Named by Stieda. The ventricles of the optic lobes are continuous ventrally and medially with the Sylvian aqueduct, (Aqueductus Sylvii, iter a tertio ad quartum ventriculum.

ventriculus lateralis. The common cavity of the cerebral hemispheres and the olfactory lobes, joined medially in the cerebral hemispheres by the foramen of Monroe. (Lateral ventricle) The ventricle of the common cavity is called (Ventriculus communis loborum hemisphaericorum, Stieda).

BIBLIOGRAPHY

Books and Articles Consulted.

Books:

Adams, Leverett Allen--An Introduction to the Vertebrates; First Edition-Third Printing,corrected-John Wiley & Sons, Inc. New York--(1934).

*Ecker, Dr. Alexander--The Anatomy of the Frog. Translated, with numerous annotations and additions, by George Haslam, M. D. Oxford-at the Clarendon Press--(1889).

Holmes, Samuel J.,Ph. D.-The Biology of the Frog. Fourth Revised Edition-The Macmillan Company, New York-(1930).

Little, Malcolm E.--The Structure of Vertebrates. Farrar & Rinehart, Inc., New York--(1936).

Locy, William A.,Ph.D.,Sc.D.--Biology and its Makers. Third Edition, Revised--Henry Holt and Company. New York-(1915).

Marshall, A. Milnes, M.D.,D.Sc.,M.A.,F.R.S., Edited by-F.W.Gamble,D.Sc.,F.R.S. Eleventh Edition--Macmillan & Company, Limited; St. Martin's Street, London-(1918).

Nordenskiöld, Erik--The History of Biology-A Survey. Translated from the Swedish by Leonard Bucknall Eyre. Alfred A. Knopf, New York, London-(1928).

*All references to Balfour(1880), Bellonci(1883), Carus(1814), Darkshewitsch(1886), De Graaf(1886), Denissenko(1877), Huxley, Köppen(1888), Osborne(1884), Reissner(1864), Schiess(1857), Schmidt, Stannius(1854), Stieda(1865), Tiedemann(1816), and Wyman(1853), are taken from Ecker and a list of their works may be found in that volume. Also, all references to Wiedersheim are from Ecker, since Wiedersheim wrote that portion of Ecker dealing with the anatomy of the nervous system, and of course, any reference to Haslam is taken from the same book as he translated Ecker from the original German.
Figures 1,2,3,4,6,12,25,26,27, are from Ecker.

Articles:

The Journal of Comparative Neurology.
Volume 36, page 309-322. (1924)
Larsell, Olaf, 1886. The Nucleus Isthmic of the Frog.
(University of Oregon Medical School, Portland). T2518

Ibid.
Volume 39, page 433-489. (1925)
Herrick, Charles Judson, 1868. The Optic Tracts and
Centers of Amblystoma, and the Frog.

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Date May 15, 1937