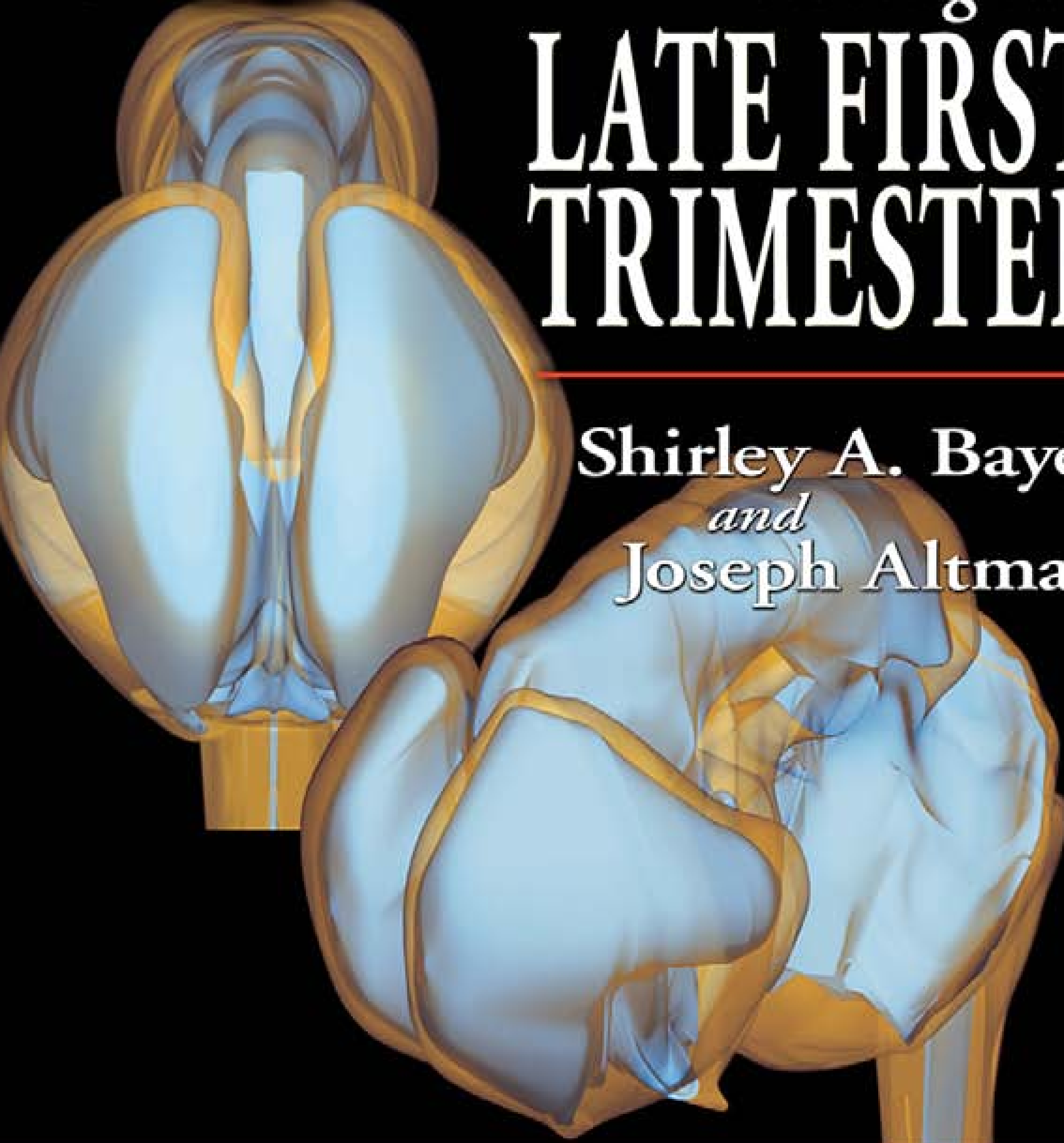
ATLAS OF
HUMAN CENTRAL NERVOUS SYSTEM DEVELOPMENT

VOLUME 4

The HUMAN BRAIN *during the* LATE FIRST TRIMESTER

Shirley A. Bayer
and
Joseph Altman



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The HUMAN BRAIN *during the* LATE FIRST TRIMESTER

ATLAS OF HUMAN CENTRAL NERVOUS SYSTEM DEVELOPMENT SERIES

Shirley A. Bayer *and* Joseph Altman

VOLUME 1
The Spinal Cord from Gestational Week 4 to the 4th Postnatal Month

VOLUME 2
The Human Brain During the Third Trimester

VOLUME 3
The Human Brain During the Second Trimester

VOLUME 4
The Human Brain During the Late First Trimester

VOLUME 5
The Human Brain During the Early First Trimester

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DEDICATION

We dedicate this volume to the memory of Prof. Dr. Ferdinand Hochstetter (1861-1954) for his pioneering description of the development of the human brain during the first trimester. To this day, his publication that appeared in Vienna and Leipzig in 1919 is the best source for systematically showing the external features of the human brain at this stage, and the current work is built on the foundation he provided.

ACKNOWLEDGMENTS

We thank Dr. William DeMyer, pediatric neurologist at Indiana University Medical Center, for access to his personal library on human central nervous system development. We also thank the staff of the National Museum of Health and Medicine at the Armed Forces Institute of Pathology, Walter Reed Hospital, Washington, D.C.: Dr. Adrianne Noe, Director; Archibald J. Fobbs, Curator of the Yakovlev Collection; Elizabeth C. Lockett; and William Discher. We are most grateful to Dr. James M. Petras at the Walter Reed Institute of Research who made his darkroom facilities available so that we could develop all the photomicrographs on location rather than in our laboratory in Indiana. Finally, we thank publisher Barbara Norwitz, project manager Jim McGovern, proofreader Samar Haddad, Randy Brehm, and Kari Budyk at CRC Press/Taylor and Francis for their personal attention to us and for expert help during production of the manuscript.

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PART I

INTRODUCTION

A. Organization of the Atlas

This Atlas focuses on the development of the human brain during the late first trimester, and is Volume 4 in the *Atlas of Human Central Nervous System Development* series. Volume 1 (Bayer and Altman, 2002) provides a record of the development of the spinal cord from the 4th gestational week (GW4) to the 4th postnatal month. Volume 2 (Bayer and Altman, 2004a) records brain development during the third trimester, with the specimens ranging in age from GW37 to GW26. Volume 3 (Bayer and Altman, 2005) presents brain development during the second trimester, from GW24 to GW13.5. The specimens dealt with in the present volume cover the period from GW11 to GW7.5. The major theme of Volume 2 is the *maturation* of the brain's *settled* and *enduring* neuron populations. The major theme of Volume 3 is the *migration, sojourning,* and *settling* of neuronal populations. Prominent migratory streams and sojourning structures are evident by GW13.5 and many of these are still present at GW24. The major theme of the present volume is *late neurogenesis* and *early neuronal differentiation*. The structures of central interest are the visually distinguishable divisions, or mosaics, of the germinal neuroepithelium that generate different populations of neurons and neuroglia. The major theme of the forthcoming Volume 5, which will deal with brain development during the early first trimester (GW3-GW7), will be *neuroepithelial expansion* along the *expanding brain ventricles*, and *early neurogenesis*. As in Volumes 2 and 3, the specimens are presented in a reverse, older-to-younger order. We do that for both heuristic and pedagogical reasons: proceeding from the familiar and better known to what is less familiar and often uncertain or hypothetical.

The present volume contains grayscale photographs of nine sets of Nissl-stained, and one set of Bodian-stained sections, of normal brains ranging in age from early fetuses, crown-rump (CR) length 57-60 mm and estimated age GW11, to late embryos, CR length 21-23 mm and estimated age GW7.5. As in the previous volumes, we sought to select for each age group, brains sectioned in the coronal, horizontal, and sagittal planes. However, this posed a problem as the terms "coronal" and "horizontal" (but not "sagittal") become more and more ambiguous when applied to younger and younger fetal brains and then embryonic brains. The conventional neuroanatomical designation of "coronal" comes from the practice of placing the dissected brain on a horizontal surface, and with the base of the cerebral cortex and the cerebellar cortex lying flat on that surface, making transverse (left-to-right) cuts perpendicular to the supporting surface. In a similar manner, "horizontal" sections are made by making the cuts parallel to the surface. With this convention, there is little ambiguity, for instance, that the frontal lobe is situated anteriorly and the occipital lobe posteriorly. However, this practice has not been consistently followed by embryologists; indeed, it could not be followed when the brains are not shelled out and the embryo is sectioned *de toto*. Moreover, since the whole embryo, and more particularly the medulla, pons and brainstem (as described in this volume) undergo a series of flexures, a coronal cut made at one point becomes an oblique or horizontal cut at another point. The same applies to horizontal cuts. Indeed, perusal of embryological textbooks reveals little consistency in the positioning of an embryonic brain or series of brains in the illustrations. In order to produce consistency in presenting the human brains of different fetal and embryonic ages, and facilitate comparisons of the changes across all the ages, we have therefore adopted the following procedure. Each brain, irrespective whether it was designated in the original protocol as "coronal" or "horizontal," has been placed into an X-Y coordinate frame as if it were a mature brain; i.e., the ventral surface of the cortex and the cerebellum lie flat on an imaginary line that we call the "cardinal horizontal plane." The line perpendicular to it, we call the "cardinal coronal plane." Given this coordinate system we then indicate the deviation of a given brain from the cardinal coronal or cardinal horizontal. This method allows a consistent positioning of the telencephalon, diencephalon, mesencephalon, and cerebellum (but not of the pons, medulla and spinal cord) into an age-independent stereotactic framework, and designations like anterior and posterior, and dorsal and ventral pointing in the same direction for easy comparisons across ages.

Each specimen is presented in a separate part of the Atlas: GW11 in the coronal plane in **Part II**; GW11 in the horizontal plane in **Part III**; GW9 in the sagittal plane in **Part IV**; GW9 in the horizontal plane in **Part V**; GW9 in the coronal plane in **Part VI**; GW8 in the sagittal plane in **Part VII**; GW8 in the coronal plane in **Part VIII**; GW8 in the horizontal plane in **Part IX**; GW7.5 in the coronal plane in **Part X**; and GW7.5 in the sagittal plane in **Part XI**. Selected "coronal" plates are presented from rostral to caudal in portrait orientation. The dorsal part of each section is toward the top of the page, the ventral part at the bottom, and the midline is in the vertical center of each section. Sagittal plates are presented from medial to lateral in portrait orientation. The anterior part of each section is facing left, posterior right, dorsal top, and ventral bottom. "Horizontal" plates are presented from rostral to caudal in landscape orientation. The anterior part of each section is facing to the left (bottom of page), posterior to the right (top of page), and the midline is in the horizontal center of each section. Each part contains *companion plates*, designated as **A** and **B** on facing pages; some of the plates are expanded into **C** and **D** parts. Parts **A** and **C** of each plate on the left page show the full contrast photograph without labels; parts **B** and **D** show low contrast copies of the same photograph on the right page with superimposed outlines of structures and unabbreviated labels. The *low magnification plates* show entire sections to identify the large structures of the brain, such as the various lobes and gyri of the cerebral cortex, and large subdivisions of the brain core, such as the basal ganglia, thalamus, hypothalamus, midbrain, pons, cerebellum, and medulla. The *high magnification plates* feature enlarged views of the brain core to identify smaller structures. For ease of interpretation in all plates, the ventricles are labeled in **CAPITALS**, the neuroepithelium and other germinal zones in **Helvetica bold**, transient structures in ***Times bold italic***, and permanent structures in Times Roman or **Times bold**. Fixation artifacts and processing damage are usually outlined with *dashed lines* in parts **B** or **D** of each plate. Finally, an alphabetized **Glossary** gives brief definitions of most labels used in the plates with expanded definitions of all transient developmental structures.

B. Specimens

A total of 10 specimens are illustrated and annotated in this Volume. All of them are from the Collections of human embryos or fetal brains currently kept at the National Museum of Health and Medicine, Armed Forces Institute of Pathology, Washington, D.C. One brain, estimated age GW11, is from the Yakovlev Collection and is designated, using the prefix Y, as Y1-59. We give a brief description of the Yakovlev Collection in Volume 2 (Bayer and Altman, 2004a) and more detail is provided in Haleem (1990). Eight specimens are from the Carnegie Collection and are designated by their respective numbers with the added prefix C. The Carnegie Collection was started by Franklin P. Mall (1862-1917) and expanded at the Carnegie Institution of Washington under the direction of George L. Streeter (1873-1948) and George W. Corner (1889-1981). One specimen, estimated age GW9, is from the Minot Collection and is designated, using the prefix M, as M841. The Minot Collection is named after Charles S. Minot (1852-1914), who collected and prepared more than 1900 embryos of different animal species, and about 100 human embryos, close to a century ago. We made use of models of the embryonic and fetal brains prepared in the Carnegie Institution, and by Hochstetter (1919).

C. Photography and Computer Processing

Selected sections of the Yakovlev specimen (Y1-59) were photographed at low magnification, using a macro lens (Vivitar, 55mm 1:2.8 auto macro) attached to a Nikkormat 35mm camera that was mounted on a stand over a fluorescent light board. The Carnegie and Minot specimens and all higher magnification views were photographed using either an Olympus photomicroscope or a Wild phototmakroskop. The magnification varied for each specimen according to the size of the dissected brain or entire fetal head: the section with the largest area that could be accommodated within the field of view set the magnification for all sections of a particular specimen. All photographs were taken with a green filter to increase the contrast of the black and white film (Kodak technical pan #TP442). The film was developed at 20°C for 6 to 7 minutes in Kodak HC110 developer (dilution F), followed by Kodak stop bath for 30 seconds, Kodak fixer for 5 minutes, Kodak hypo clearing agent for 1 minute, running water rinse for 10 minutes, and a brief rinse in Kodak photoflo before drying.

The negatives were scanned at 2700 dots-per-inch (dpi) with a Nikon Coolscan-1000 35mm film scanner which was interfaced to a PowerPC G3 Macintosh computer running Adobe Photoshop (version 5.02) with a plug-in Nikon driver. To capture the subtle shades of gray, the negatives were scanned as color positives, inverted, and converted to grayscale. Using the enhancement features built into Adobe Photoshop and the additional features of Extensis

Intellihance, adjustments were made to increase contrast and sharpness. When the image resolution was set to 300 dpi, a full-size photographic file printed at approximately 12-10 inches. Images are shown at slightly reduced full size on separate pages. Adobe Illustrator was used to superimpose labels and outline structural details on low contrast copies of the Adobe Photoshop files. The Plates were placed into a book-form layout using Adobe InDesign. Finally, camera-ready files were provided to Taylor and Francis in Adobe portable document format.

The entire brain and upper cervical spinal cord of C966 was three-dimensionally reconstructed to show the large superventricles and the surface features of the neuroepithelium in the telencephalon, diencephalon, and rhombencephalon (**Figures 10-19, Part X**). The brain reconstructions (**Figures 10-15**) involved five steps. *First*, photographs of serial sections were made throughout the entire brain; the negatives were scanned and converted to computer files as described in the preceding paragraph. *Second*, all the files of sections selected for the reconstruction were placed into one large Photoshop file that contained a separate photograph in each layer. By altering the visibility and transparency of these layers the sections were aligned to each other as they were before sectioning. Then each layer was saved as a separate file. *Third*, Adobe Illustrator was used to outline the brain surface and the edge of the ventricles, and the outlines of each section were saved in separate Adobe Illustrator eps (encapsulated postscript) files. *Fourth*, the eps files were imported into 3D space (x, y, and z coordinates) using Cinema 4DXL (C4D, Maxon Computer, Inc.), a modeling and animation software package. For each section, points on the outlines have unique x-y coordinates and the same z coordinate. By calculating the distance between sections, the entire array of outlines was stretched out in the z axis. The outlines were segregated into two groups, one for the brain surface, the other for the ventricular surface. The C4D loft tool builds a "skin" for each group of outlines by creating a spline mesh of polygons. The polygons start from the x-y points on the first outline with the most anterior z coordinate, to the x-y points on the next outline behind it, and finish with the x-y points on the last outline at the most posterior z coordinate. The spline meshes were rendered either as completely opaque or partly transparent surfaces using the C4D ray-tracing engine. Selected surfaces can be made either invisible or visible using the various options in C4D. The complex structure of the brain requires that the surface be built in several different lofts to avoid twisting the surface in the regions of the brain flexures. When these different loft segments are shown together, there are a few unavoidable artifacts, such as surface indentations and changes in the way light reflects from the surface; some of these are labeled in **Figures 10-19**. *Fifth*, the rendered images were converted to Adobe Photoshop files, and Adobe Illustrator was used to label the structures and to draw thin lines on some of the surfaces to make the images easier to understand. The reconstruction of the parts of the neuroepithelium (**Figures 16-19**) followed the same five steps except that only the selected parts of the neuroepithelium in each section were outlined, and these were always rendered as completely opaque blocks of tissue.

D. Identification of Immature Brain Structures

In contrast to the mature human brain, there are no comprehensive textbooks or atlases available on the entire course of the human brain development. The few publications that cover the late first trimester give overviews that identify the largest brain structures in chapters included in embryology textbooks (e.g., Patten, 1953; Hamilton et al., 1964) and atlases (Gasser, 1975; O'Rahilly and Müller, 1994). Some facets of human brain development during this period are part of an overview in an edited publication (Sidman and Rakic, 1982), and there are a few research papers available on the development of specific brain regions (e.g., Gilbert, 1935; Pearson, 1941; Kappers, 1958; Humphrey, 1960, 1968; Richter, 1965; Kahle, 1956; Hewitt, 1958; Shuangshoti and Netsky, 1966; Rakic and Sidman, 1970; Moore et al., 1999; Forutan et al., 2001; Koutcherov et al., 2002). There is no single publication that labels both large and small structures in the developing human brain in serially sectioned specimens at several different ages during the late first trimester. Many of the transient features of the early fetal/late embryonic human brain have never been studied. Therefore, we rely to a great extent on our experimental work in the developing rat brain to identify formative brain structures, migratory streams, and components of the germinal neuroepithelium. In those studies, we labeled proliferating cells in the germinal matrices of the brain with ^{3}H-thymidine administered at daily intervals through the entire prenatal period, and every other day up to weaning. By varying survival times after ^{3}H-thymidine exposure from 1 hour, to days, we used the autoradiographic technique to establish quantitative timetables of neurogenesis, trace the speed and route of neuronal migrations, and document the settling patterns of neurons in the maturing brain. The results of these studies were published over a period of three decades in journal articles (see below) and reviewed in chapters contributed to edited books (Altman and Bayer, 1975, 1995, 2004; Altman, 1992; Bayer and Altman, 1995a, 1995b). We have also presented evidence for many parallels in the sequential order of brain development in rat and man (Bayer et al., 1993). Readers interested in details of those experimental results and the rationale of some of the anatomic and morphogenetic identifications made in this Atlas may consult the following publications.

Amygdala: Bayer (1980c).
Basal Ganglia: Bayer (1984, 1985b, 1987).
Cerebellum: Altman and Bayer (1978a, 1982, 1985a, 1985b, 1985c, 1997).

Cerebral Cortex: Altman and Bayer (1990a, 1990b); Bayer and Altman (1990, 1991a, Bayer et al., 1991a).
Cranial Nerve Nuclei: Altman and Bayer (1980a, 1980b, 1980c, 1982b).
Hippocampus: Altman and Bayer (1975, 1990c, 1990d, 1990e); Bayer (1980a, 1980b).
Hypothalamus: Altman and Bayer (1978c, 1978d, 1978e, 1986).
Medulla: Altman and Bayer (1980a, 1980b, 1980c, 1982b).
Midbrain: Altman and Bayer (1981a, 1981b, 1981c).
Olfactory Bulb: Altman (1969); Bayer (1983).
Pontine Area: Altman and Bayer (1978b, 1980d, 1987a, 1987b, 1987c, 1987d).
Preoptic Area: Bayer and Altman (1987).
Rhinencephalon: Bayer (1985a, 1986a, 1986b); Bayer and Altman (1991b).
Septal Area: Bayer (1979a, 1979b).
Spinal Cord: Altman and Bayer (1984, 2001).
Thalamus: Altman and Bayer (1979a, 1979b, 1979c, 1988a, 1988b, 1988c, 1989a, 1989b, 1989c).

E. Major Transitional Brain Structures in the Late First Trimester

Transitional brain structures in late first trimester fetuses include the following: *(i)* The neuroepithelium (NEP), the primary germinal matrix of neural stem cells that are the ultimate source of all the neurons and neuroglia of the central nervous system. *(ii)* The rhombencephalic, mesencephalic, diencephalic, and telencephalic superventricles that provide the greatly expanded cerebrospinal fluid (CSF) interface for the shuttling nuclei of the pseudostratified NEP cells that undergo mitotic division near the lumen. *(iii)* The expanding fetal choroid plexus (CP), and its later shrinkage and transformations, which appears to play a role in neurogenesis and neuronal differentiation. *(iv)* The spreading glioepithelia (GEP) along several fiber tracts, and the glioepithelia associated with the formative ependymal layer that lines the enduring portions of the brain ventricles (G/EP). *(v)* The secondary germinal matrices abutting the neuroepithelium, such as the subventricular zone (SVZ) of the cerebral cortex, and others situated some distance from the ventricles. *(vi)* Short-distance migratory routes, and long-distance migratory streams, such as the telencephalic rostral migratory and lateral migratory streams and several precerebellar migratory streams. *(vii)* The transient sojourn zones and stratified transitional fields, such as the cortical stratified transitional field (STF) and the cerebellar transitional field (CTF).

The *Neuroepithelium and its Mosaic Organization.* The NEP is a cell-dense pseudostratified proliferative matrix that lines the extensive ventricular system of the developing brain and spinal cord. It used to be called the ependymal layer, but that term is no longer used because the ependyma is a highly specialized tissue that lines the shrunken ventricles of the maturing and adult central nervous system. The NEP is composed of stem cells that either differentiate as specialized populations of neurons and neuroglia or give rise to secondary germinal matrices some distance from the ventricular system. The latter include the SVZ of the cerebral cortex, the external germinal layer of the cerebellar cortex, and the subgranular zone of the hippocampal dentate gyrus. At the outset of its development, the NEP stem cells are the sole constituents of the brain (to be described and illustrated in Volume 5). The bulk of NEP cells either keep proliferating or generate differentiating (postmitotic) neurons that, following a precise spatio-temporal order, migrate over a short or long distance to form various brain structures. While NEP cells all look alike in Nissl-stained preparations, discontinuous NEP "stretches" and "patches," or *mosaics*, can be distinguished along the ventricles in terms of matrix thickness (pseudostratified cell depth), cell packing density, and as growing or shrinking ventricular protuberances, invaginations and evaginations. Using experimental techniques in rats (short-survival, sequential survival, and long-survival ^{3}H-thymidine autoradiography, respectively), we dated the changing proliferative dynamics of these NEP mosaics, tracked their migratory paths and settling patterns, and related that information to the time of origin of different neuronal populations in various brain regions and structures. On the assumption that the neurons that form discrete parenchymal regions and structures (different lobes, ganglia, nuclei, etc.) in the neighborhood of these NEP mosaics are progeny of those mosaics, we name the latter as putative NEPs of those structures. Examples of broader identifications of NEP "stretches" are frontal cortical NEP, hypothalamic NEP, thalamic NEP, and hippocampal NEP. An example of more specific identification of "patches" along the hippocampal NEP are subicular NEP (the mosaic that generates neurons of the subiculum), ammonic NEP (the mosaic that generates neurons the pyramidal cells of Ammon's horn), and dentate NEP (the mosaic that generates the granule cells of the dentate gyrus). In cases where a germinal matrix abuts a fiber tract, we identify that as a putative glioepithelium (GEP), e.g, the fornical GEP. In addition to the cells that migrate short distances from their germinal sites of origin, there are others that migrate over long distances. Examples are the cells of the rostral migratory stream in the anterior telencephalon that migrate to the olfactory bulb (Altman, 1969), and the intramural (parenchymal) and extramural (subpial) migratory streams of the rhombencephalon that form the precerebellar nuclei in the medulla and pons (Altman and Bayer, 1987a-d). In such instances, we identify these NEP mosaics on the basis of the available experimental evidence of their ultimate destinations. Finally, there are many sites where we have no information at all on the destination of the neurons leaving particular NEP mosaics and indicate that uncertainty either by a question mark following a tentative identification or by omitting any identification.

Neurogenesis and its relation to the Expansion and Shrinkage of the Superventricles. The NEP originates as an open proliferative sheet, the neural plate, without its own fluid environment. As we shall illustrate in Volume 5, the ventricles begin to form at about GW3, after the closure of the neural tube (the future spinal cord) and the cephalic vesicles (the future brain) is completed. Following that momentous morphogenetic event, the ventricles expand enormously during the rest of the first trimester and, with differences among the different ventricles, then begin to shrink during the second or third trimester, and gradually assume their mature size and configuration. The first lumen to expand is the rhombencephalic ventricle. Beginning as a shallow invagination beneath a thin membrane (the medullary velum) at about GW4, it expands greatly as a cavernous cistern is formed by the flexures of the medulla, pons and brainstem, underneath the cover of the medullary velum. As illustrated in this Volume, the expansion of the rhombencephalic ventricle continues until about GW9, and then it starts to shrink and gradually assumes the form of the familiar 4th ventricle. Next, the mesencephalic ventricle (the future aqueduct) and the diencephalic ventricle (the future 3rd ventricle) start to expand and, after a shorter developmental period, begin to shrink. Finally, at about GW5.5, the lateral ventricles begin to form as symmetrical balloon-like fluid compartments of the midline diencephalic ventricle and expand enormously up to GW11; thereafter the lumen of the lateral ventricles begin to shrink as the basal ganglia and the cerebral cortex develop. We name these greatly expanded embryonic cisterns *superventricles* to distinguish them from the greatly diminished and transformed mature ventricles for the following reasons.

(1) Unlike the shrunken mature ventricles, the cavernous embryonic ventricles are lined by proliferating NEP cells rather than differentiated ependymal cells. This raises the possibility that the embryonic and mature ventricles and the CSF they contain serve different functions.

(2) We know since the pioneering studies of Sauer (1936) that the NEP is a pseudostratified epithelium and that the nuclei of NEP cells shuttle to the ventricular lumen before undergoing mitosis (Sauer called the process interkinetic nuclear migration). This shuttling to the lumen as a prerequisite for cell division means that the rate of NEP cell proliferation is limited by the length of the ventricular shoreline because the elongated cells straddling the depth of the pseudostratified NEP cannot divide unless there is room for them to move to the NEP/CSF interface. An interesting point in this context is the spatial orientation of the dividing cells near the lumen. It has been noted in the past (e.g., Bayer and Altman, 1991a) that the cleavage plane of these mitotic cells may be radial, or vertical (tangential to the ventricular lining) or horizontal (parallel to the ventricular lining). Vertically cleaving cells occupy double of the NEP/CSF interface when compared with horizontally cleaving cells. It has been hypothesized recently that vertical cleavage results in symmetrical cell division, and horizontal cleavage in asymmetric cell division (e.g., Chenn and McConnell, 1995; Kornack and Rakic, 1995). Symmetric cell division is assumed to produce two proliferative NEP cells lying next to one another along the ventricle; collectively that should result in an expansion of the ventricular shoreline. Asymmetric cell division is assumed to produce a postmitotic daughter cell, presumably the one farther from the ventricle, a differentiating cell that is ready to leave the NEP. Some evidence has been presented recently of an increase in asymmetric division in the cortical NEP of mice as a function of increasing fetal age (Estivill-Torrus et al., 2002). Asymmetric division should not affect the length of NEP/CSF interface. The shrinkage of the NEP during fetal development would take place if more and more NEP cells lost their mitotic potency and their nuclei no longer returned to the ventricular lumen.

(3) Why is it obligatory for NEP cell nuclei to move to the ventricular lumen to divide when the stem cells of secondary germinal matrices, like the subpial external germinal layer of the cerebellum or the subgranular zone of the hippocampus, divide some distance from the ventricles? One possibility is that the embryonic CSF contains some factor or factors necessary for primary (pluripotent) NEP cell division. This is supported by reports that embryonic CSF promotes NEP cell survival, proliferation, and neurogenesis in experimental animals (Mashayekhi et al., 2002; Gato et al., 2005).

(4) The distinctiveness of the two ventricular systems is suggested by a different functional relationship between the *superventricles* and the *fetal CP,* and the enduring *ventricles* and the *mature CP*. To begin with, the initial expansion of the rhombencephalic and the telencephalic superventricles starts before the CP forms (this will be documented in Volume 5 of this series). Hence, unlike the CSF of the mature ventricular system, the CSF of the embryonic superventricles must originate from some other source than CP secretion.

(5) Moreover, the fetal CP that forms later and rapidly expands to fill the rhombencephalic and telencephalic superventricles (as illustrated in this Volume) has a different cellular organization than the mature CP (Kappers, 1958; Tennyson and Pappas, 1964; Shuangshoti and Netsky, 1966; Dohrmann, 1970; Dziegielewska et al., 2001; Johansson et al., 2005). The adult choroid plexus is a distinctive frond-like tissue composed of a monolayer of differentiated cuboidal cells that surround a capillary core. The exposed surface of these cuboidal cells is covered by a rich meshwork of microvilli and some cilia, and the cell interior is filled with mitochondria. These features, and added evidence, is the basis of the widely held view that the mature CP is a secretory tissue involved in CSF production. In contrast, the fetal CP is a smooth, multilayered

(pseudostratified) epithelium composed of spindle-shaped cells that have a simple exposed surface and contain few mitochondria. Unlike the mature CP cells, these fetal CP cells are filled with glycogen. Hence, it has been suggested that the principal function of the embryonic CP is the glycolytic (anaerobic) support of NEP cell proliferation and neurogenesis rather than the production of CSF.

(6) Finally, and most importantly, the chronological differences in the expansion, configurational transformations, and persistence of the different superventricles can be related to regional differences in the kinetics, date of origin, and time span of cell proliferation in stretches and patches of the NEP lining that produce neurons and neuroglia for different brain structures. For instance, the dorsal roof and lateral wall of the telencephalic superventricle is formed by an extensive, continuous dome-like stretch of NEP that generates an immense number and homogeneous set of cortical neurons in a precise sequential order (infragranular layer cells first, granular layer cells next, and supragranular layer cells last) through its entire extent and over an extended period of time. These neurogenetic features account for the smooth, spherical configuration of the NEP lining of the telencephalic superventricle over an extended period during embryonic and fetal development. In contrast, the ventral and medial shores of the telencephalic superventricles are much less regular because discrete NEP stretches or patches generate neurons here for diverse brain structures – septum, basal ganglia, nucleus accumbens, basal telencephalon, amygdala, hippocampus, etc. – each with different neurogenetic timetables, cell compositions, and population sizes. At these sites, the expanding and shrinking NEP mosaics (and the differentiating parenchymal structures associated with them) produce variably shaped ventricular pools, recesses, and narrows. Still more complex are the configurational changes over time in the diencephalic, mesencephalic, and rhombencephalic superventricles. This is so because at these locations short NEP patches give rise to a multitude of structurally and functionally different brain nuclei, many of which are composed of a relatively small number of neurons generated over a short time span. For instance, we can distinguish along the diencephalic superventricle not only NEP stretches that give rise to the thalamus, epithalamus, subthalamus and hypothalamus, but also patches – temporary evaginations and invaginations – that generate neurons, for instance, for the distinct thalamic nuclei. These expanded and short-lived shorelines create an expanded NEP/CSF interface for the optimal generation of neural stem cells of a particular type.

Glioepithelia and the Ependymal Linings of the Enduring Ventricles. Glioepithelia (GEP) are fate-restricted tissues of proliferative cells that produce neuroglia. On the basis of experimental studies in rats, in which proliferative cells are tagged with ^{3}H-thymidine, we distinguish four types of GEP. The first is difficult to distinguish from the primary NEP lining the ventricles except that these patches tend to be thin and display proliferative activity for some time after local neurogenesis has ended. These patches begin to appear caudally in the older fetuses of the age group covered in this Volume, and because at most of these sites an ependymal lining will be forming around the enduring ventricles, they are designated uncertainly as glioepithelium/ependyma (G/EP). Examples are the medullary, pontine, hypothalamic, and thalamic G/EP. The second type lines fiber tracts that are devoid of neuronal cell bodies. In the older fetuses of this age group this type is exemplified by the fornical GEP, a continuation of the hippocampal NEP. The fornical GEP probably contains precursors of oligodendrocytes. The third type is the perifascicular GEP that surrounds and penetrates large fiber tracts. In the older specimens of this age group these are seen around the olfactory tract and the optic nerve, chiasm and tract. The fourth type, the subpial GEP, is found as a covering of the telencephalon, known as the subpial granular layer (Brun, 1965). The perifascicular and subpial GEPs may be continuous and of placodal rather than neuroepithelial origin.

Secondary Germinal Matrices, Migratory Streams, and Sojourn Zones. Prominent transitional structures of the developing brain during the second trimester, as illustrated in Volume 3 of this series, are the secondary germinal matrices, the prominent sojourn zones, and the large migratory streams. The principal secondary germinal matrices are the subventricular zone (SVZ) abutting the cortical NEP, the SVZ of the basal ganglionic (anterolateral, anteromedial and posterior) eminences, the subgranular zone of the hippocampal dentate gyrus, and the external germinal layer of the cerebellar cortex. All of these secondary matrices are late-generated, fate-restricted stem cells that divide some distance from the ventricles and produce microneurons (neurons with small cell bodies and locally ramifying axons); many of which are known as "granule cells." In the specimens we use, the time of emergence of the cortical SVZ could not be determined because of the difficulty of distinguishing it from the NEP, but it is clearly present by GW11. The basal ganglionic SVZ begins to form as early as GW7.5 and is prominent between the NEP and the parenchyma by GW8. The external germinal layer that originates in the germinal trigone of the cerebellar NEP is not recognizable until GW9. The hippocampal dentate NEP, which is the source of the dentate migration (and which will later form the subgranular zone) is present by GW9; however, the dentate gyrus is only a miniscule structure at GW11. In general, there is no evidence for the onset of microneuron production during this period.

There are long and short migratory streams that carry neural stem cells and/or immature neurons from the NEP to their destination. A prominent long-distance migration during the second trimester is the rostral migratory stream of the telencephalon which, among others, contains cells that differentiate as olfactory bulb granule cells. The rostral migratory stream is not clearly distinguishable at GW9 from the olfactory NEP, which generates the output neurons (mitral cells) of the olfactory bulb; it becomes recognizable as a distinct entity by GW11, and expands greatly during the second trimester (Volume 3). Among the long-distance precerebellar migratory streams, the posterior intramural migratory stream, which contains the neurons that migrate to form the prominent inferior olive, is evident by GW7.5, and remains so throughout the late first trimester. Also present in these specimens are the posterior extramural migratory stream that contains neurons of the lateral reticular and external cuneate nuclei, and the anterior extramural migratory stream that contains pontine gray neurons. However, the pontine gray nucleus is not evident until GW11 when the earliest corticofugal fibers begin to traverse it and the earliest fibers of the middle cerebellar peduncle begin to form.

In Volume 3 during the second trimester, we have illustrated the prominence of the cortical stratified transitional field (STF) sandwiched between the NEP and the cortical plate, the future gray matter. We have identified six distinct cellular and fibrous layers within the STF, where cortical neurons sojourn for some time and mingle with afferent, efferent, and commissural fibers before they resume their migration and settle in the cortical plate. We postulated that the STF is a staging area where connections are formed between unspecified cortical neurons and the functionally and topographically specified thalamocortical fiber systems that provide input to them. As seen in the present Volume, the cortical STF is developing during the late first trimester. STF1 and STF5 are first evident at GW8 in the earlier-maturing anterolateral cortical region spreading into the later-maturing dorsomedial cortical region. The formation of STF5 appears to coincide with the growth of thalamocortical fibers through the diencephalic-telencephalic junction and their penetration into the formative cerebral cortex. Between GW9 and GW11 an additional layer, STF4, begins to emerge slowly and uncertainly in the earlier maturing regions of the cortex (i.e., the lateral aspect of the anterior hemisphere). The emergence of STF4 may be associated with the onset of the descent of corticofugal fibers. The other STF layers (STF3, STF2, and STF6) do not start to form until the beginning of the second trimester (Volume 3).

Several other transitional fields are seen in the developing brain during this period. In the GW7.5-GW8 specimens, large cell aggregates surround the thalamic NEP that we interpret to be sojourning neuronal populations of the anterior, dorsal and ventral thalamic complexes. And, based on observations in rats, we assume that the posterior thalamic complex that will produce neurons for the lateral geniculate body and the pulvinar is initially in a dorsomedial position and then migrates gradually ventrolaterally toward the growing optic tract. The morphogenetic significance of the transitional cell columns and fiber bands seen in the GW9 thalamus, before the thalamic neurons assume their “nuclear” configuration, remains to be elucidated. Another region with alternating bands of sojourning cells and growing fibers is the cerebellar transitional field (CTF). Six layers are distinguished in the formative cerebellum in GW7.5 specimens from the surface toward the NEP: the fibrous CTF1, the cellular CTF2, CTF3 with cells and fibers, the cellular CTF4, CTF5 with cells and fibers, and the cellular CTF6. On the basis of experimental evidence in rats, we interpret the upper cellular layers (CTF2-4) as the earlier generated deep neurons that sojourn for a while superficially, and the lower cellular layers (CTF5-6) as consisting mainly of the later generated Purkinje cells. This stratification becomes blurred by GW8 and GW9 as the Purkinje cells migrate toward the surface and the deep neurons move back toward the core of the cerebellum. The upward migration of Purkinje cells is associated with the spreading of the external germinal layer over the surface of the formative cerebellar cortex. By GW11 most of the Purkinje cells are in a superficial position, where they form parasagittal bands beneath the continuous canopy of the external germinal layer.

F. A Note on Genetic Analyses of NEP Mosaicism

As we noted earlier, the NEP cells that line the banks of the superventricles look alike in Nissl-stained preparations. The idea of NEP mosaicism is based on the site- and age-dependent distinctiveness of stretches and patches of the NEP in terms of their thickness, the temporary formation of larger protuberances and smaller evaginations and invaginations into the ventricle, and their differential proliferative dynamics, as ascertained with ^{3}H-thymidine autoradiography. These spatiotemporal differences in the regional appearance and proliferative dynamics of NEP mosaics, and the fact that they give rise to different brain structures and cell types, raise the possibility that the stem cells composing them are different genetically before they start to differentiate. There is, indeed, emerging experimental evidence in embryonic and fetal mammals (mostly mice) for the genetic distinctiveness of some of the stretches and patches of NEP that are homologous with those we describe here in the first trimester human brain. The experiments are based mostly on *in situ* hybridization of homeodomain-containing transcription factors that are visualized in the developing brain of normal and mutant mice with immunohistochemical markers. Several laboratories, for instance, have reported a pronounced expression of *Pax6*, in combination with other transcription factors, in the dorsal neocortical NEP (e.g., Walther and Gruss, 1991; Stoykova and Gruss, 1994; Warren et al., 1999; Estivill-Torrus et al., 2002; Kimura et al., 2005). At the embryonic age when *Pax6* expression is limited to the dorsal telencephalon, *Nkx2.1* and *Gsh2* are expressed in the ventral telencephalon and the medial telencephalon (Corbin et al.

2003). Some differences were noted in the expression of these factors in the lateral, medial and posterior components of the ganglionic ventral telencephalon. According to another study, different markers highlight different components of the medial telencephalon and the diencephalon in 12.5 day-old mouse embryos (Kimura et al., 2005). Using a different terminology from that used by the authors, *Wnt8b* appears to demarcate the entire hippocampal primordium in the medial cortex, and the epithalamus and the mammillary body in the diencephalon. Within the domain of the medial telencephalon, *Ephb1* demarcates the Ammonic NEP, *Wnt3a* the dentate NEP, and *TTR* the primordium of the telencephalic choroid plexus. Although as yet this genetic approach is limited to a single species in mammals, it is expected that it will shed considerable light on NEP cell heterogeneity and the regional differentiation of the embryonic and fetal brain in other animals and man.

G. A Note on Functional Maturation

There is currently considerable scientific interest in the physiological maturation of the prenatal human brain, and the correlated issue of the mental status of the embryo and fetus is receiving much public attention. Studies in the first half of the twentieth century with aborted fetuses have indicated that embryos of about 20-21 mm CR length (corresponding to the GW7.5 specimens in the present volume) begin to reliably respond to tactile stimulation with *holokinetic* ("total pattern") body movements (Fitzgerald and Windle, 1942; Hooker, 1942). In GW10 fetuses (CR 48.5 mm) *ideokinetic* or isolated movements are also elicited, such as partial closure of the fingers (though not effective grasping), when the palm of the hand was stimulated (Humphrey, 1964). The more recent introduction of ultrasonic recording techniques has permitted the observation of the emergence of "spontaneous" fetal behavior in normal embryos and fetuses *in utero*. A pioneering study showed that the holokinetic "startle" response emerges as early as GW6, isolated arm and leg movements by GW7, and head rotation and hand and face contact beginning at about GW8 (de Vries, 1982, 1985). According to a more recent study with improved ultrasonic recording methods, isolated arm movements are more frequent than isolated leg movements during the first trimester, and head turning and hand to head contact do not occur with high frequency until the second trimester (Kurjak et al., 2005).

Are the late-embryonic and early-fetal movements reflex reactions mediated by lower-level spinal cord and brain stem mechanisms, or are they emerging voluntary activities carried out under higher-level cortical guidance, reflecting sentience? We have raised this question earlier in the context of our study of the development of the reflex circuitry of the human spinal cord (Altman and Bayer, 2001). Because the spinal cord substrate of the sensorimotor reflex arc begins to form between GW7 and GW8 – the collateral branches of dorsal root sensory nerves sprout and then reach the ventral horn motor neurons during this period – we proposed that the isolated limb movements displayed by embryos of that age are reflex reactions. The morphogenetic evidence presented in this Volume extends that inference by showing that the first trimester embryonic movements cannot be cortically mediated voluntary activities. First, the higher-level sensory channel, the medial lemniscal system relayed in the thalamus, does not reach the cortical plate (the future cortical gray matter) during this period. The internal capsule that contains the thalamocortical fibers is not yet evident at GW7.5 either in the lateral border of the thalamus or the narrow parenchymal bridge that links the diencephalon and the telencephalon. A large collection of thalamocortical fibers "funnel" through the internal capsule by GW8, passing through the basal ganglia and approaching the base of the formative cerebral cortex. These fibers begin to penetrate STF4 of the paracentral lobule by GW9 and that process continues through GW11. It is probable, but this needs to be experimentally verified, that the neurons of layer IV of the cortex, the principal target of thalamocortical fibers, are either still being generated or are still in the STF5 sojourn zone. Thus, there is as yet no functional connection between the thalamus and cells of the cortical plate. The second consideration concerns corticofugal output to the brain stem and spinal cord, which is a prerequisite for cortically mediated motor control. The pontine gray, through which the corticospinal tract descends to the spinal cord, is not evident at GW9; it begins to form about GW11. In one such specimen illustrated (Y1-59; CR 60 mm), but not in the other (C1500; CR 57 mm), a bundle of corticofugal fibers traverses the pons. Although the earliest contact between thalamocortical fibers and differentiating cortical neurons may be established during this period, we have shown earlier that the lateral and ventral corticospinal tracts do not penetrate the spinal cord until the second trimester (Altman and Bayer, 2001: Figs. 7-23, 7-24, 7-35) and are still unmyelinated at birth (Altman and Bayer, 2001: Fig. 8-14).

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PART II: GW11 CORONAL

PART II: GW11 CORONAL

This specimen is a stillborn female fetus with a crown-rump length (CR) of 60 mm estimated to be at gestational week (GW) 11 (Yakovlev case number RPSL-WX-1-59, referred to here as Y1-59). The brain was cut in the coronal (frontal) plane in 35-µm thick sections and is classified as a Normative Control in the Yakovlev Collection (Haleem, 1990). Since there is no photograph of this brain before it was embedded and cut, a specimen from Hochstetter (1919) that is comparable in age to Y1-59 is used to show the approximate section plane and external features of a GW11 brain (**Figure 1**). Photographs of 22 Nissl-stained sections (**Levels 1-22**) are shown at low magnification in **Plates 1-21**. **Plates 22-35** show high-magnification views of various parts of the brain from the cerebral cortex (**Plates 22-23**) to the midbrain, pons, and medulla (**Plates 33-35**). Several high-magnification plates are rotated 90˚ (landscape orientation) to more efficiently use page space. Y1-59 has more mature brain structures in the diencephalon, midbrain, pons, and medulla than any other specimen in this Volume. Immature brain structures predominate in the telencephalon and the cerebellum.

Throughout the cerebral cortex, the ***neuroepithelium and subventricular zone*** are prominent. The ***stratified transitional field (STF)*** contains mainly ***STF1*** and ***STF5*** throughout; with ***STF4*** only in lateral areas and a questionable ***STF2*** in a few areas; ***STF6*** and ***STF3*** are not present. The ***STF*** is filled with migrating and sojourning neurons and, unlike any specimen in Volume 3, *has no regional heterogeneity*. The cerebral cortex is completely smooth except for a questionable calcarine sulcus in the left cerebral hemisphere (**Plate 15**); "lobes" are identified as future lobes. The most prominent developmental feature of the cerebral cortex is that both the ***STF*** layers and the cortical plate have a pronounced lateral (thicker) to medial (thinner) maturation gradient. There is no corpus callosum. The olfactory bulb is beneath the anterior septum and striatum; it contains the ***rostral migratory stream*** in its core. In anterolateral parts of the cerebral cortex, streams of neurons and glia appear to leave ***STF4*** and enter the ***lateral migratory stream***. The hippocampus is in an immature position dorsal to the thalamus and medial to the temporal lobe. Cells are entering Ammon's horn pyramidal layer in the ***ammonic migration***, and granule cells and their precursors are migrating to the hilus of the presumptive dentate gyrus in the ***dentate migration***; there is no granular layer. A massive ***neuroepithelium/subventricular zone*** overlies the amygdala, nucleus accumbens, and striatum (caudate and putamen) where neurons (and glia) are being generated. The caudate, the putamen, and basolateral parts of the amygdala are smaller than in the GW13.5 specimen in Volume 3, but are similar to that specimen because the ***striatal neuroepithelium and subventricular zone*** have indistinct subdivisions. The ***strionuclear glioepithelium*** forms definite continuities with the fornical glioepithelium in the telencephalon. Unlike the GW13.5 specimen, the septum in Y1-59 has a ***neuroepithelium*** at the ventriclar surface instead of a ***glioepithelium/ependyma***.

The cerebellum is a thick, smooth plate overlying the posterior pons and medulla. However, there is only a thin ***glioepithelium/ependyma*** at the ventricular surface, indicating that all deep neurons and Purkinje cells have been generated. The deep neurons are in place beneath the cortex, but have indefinite nuclear subdivisions. The cortical surface is covered by an ***external germinal layer (egl)*** that is actively producing neuronal stem cells, granule, stellate, and basket cells of the cerebellar cortex. Lamination in the cortex is nearly absent, except for a thin molecular layer beneath the ***egl***. Nearly all Purkinje cells are migrating, some in discrete clumps. Lobulation has barely begun in the vermis and is nearly absent in the hemispheres. The ***germinal trigone*** is prominent in the dorsal rhombic lip.

The third ventricle, aqueduct, and fourth ventricle are lined by a thin ***glioepithelium/ependyma*** indicating that neurogenesis in the primary neuroepithelium is complete. In the medulla, there are two active germinal sites in anterior and posterior parts of the ventral rhombic lip. 1) The ***auditory neuroepithelium*** generates cochlear nucleus neurons. 2) A large ***precerebellar neuroepithelium*** generates precerebellar (mainly pontine gray) neurons.

Neurons throughout the diencephalon are settling in fairly well-defined nuclear divisions; the major exceptions are the immature appearance of the lateral and medial geniculate bodies in the posterior thalamus and the hypothalamic medial mammillary body. Neurons are settled in the midbrain tegmentum, pons, and medulla. But the pontine gray is nearly absent, and neurons are still migrating into it from the large ***anterior extramural migratory stream***. ***Posterior extramural and intramural migratory streams*** contain lateral reticular neurons, external cuneate nucleus neurons, and inferior olive neurons. The corticospinal tract forms a small cerebral peduncle in the midbrain, but has not grown into the pons.

GW11 CORONAL SECTION PLANES

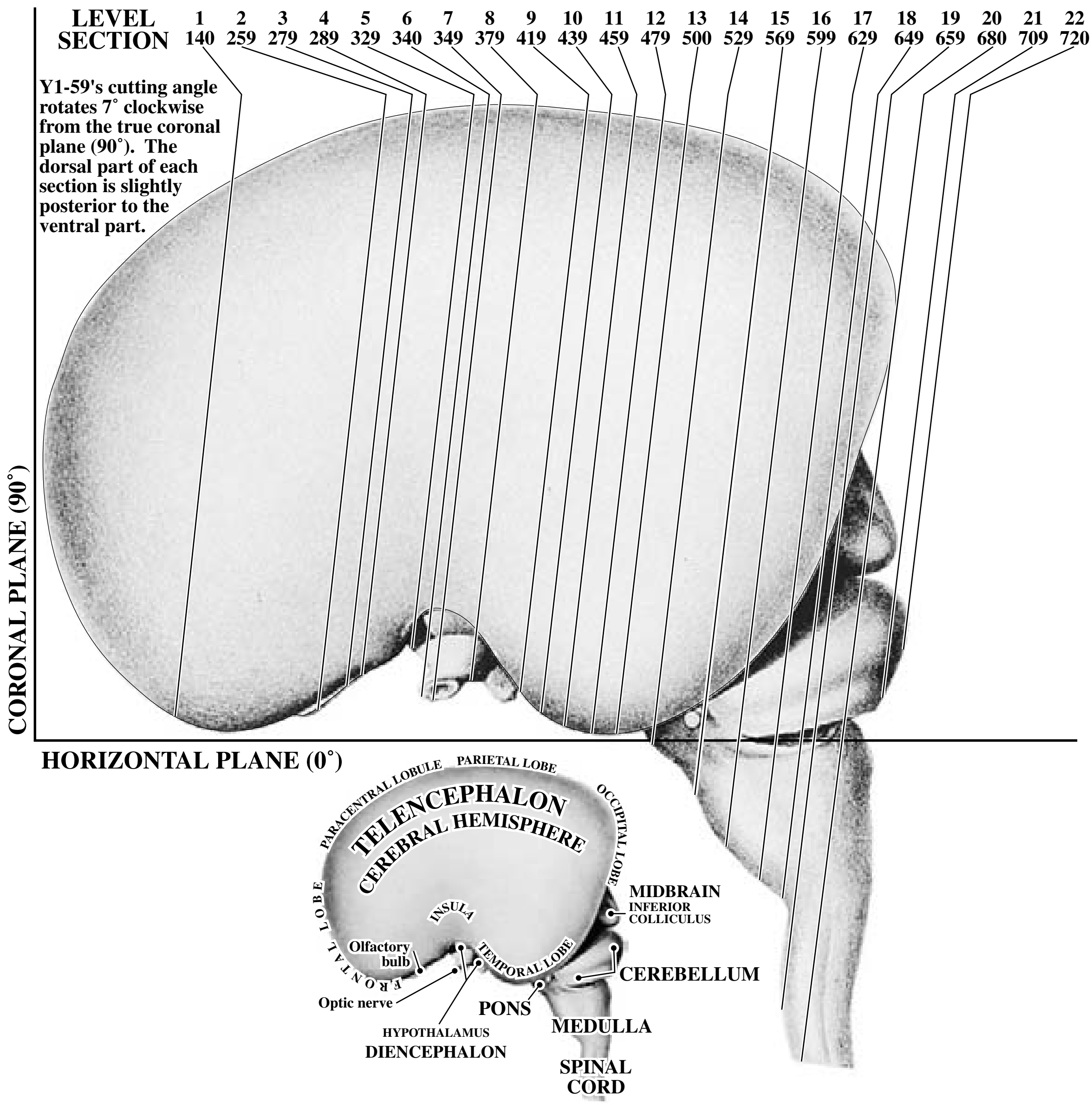


Figure 1. The lateral view of the brain and upper cervical spinal cord from a specimen with a crown-rump length of 68 mm (modified from Figure 47, Table VIII, Hochstetter, 1919) serves to show the approximate locations and cutting angles of the illustrated sections of Y1-59 in the following pages. The small inset identifies the major structural features. The cut beneath the cerebellum is the edge of the medullary velum.

PLATE 1A

GW11 Coronal
CR 60 mm, Y1-59
Level 1: Section 140

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1 Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.

STF2 Upper cellular layer, the most superficial sojourn zone where cells translocate to the cortical plate.

STF3 Honeycomb trilaminar matrix ***(3a, 3b, 3c)*** of cells and fibers that is not present during the first trimester and is found in granular (sensory) cortices.

STF4 Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.

STF5 Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

STF6 Late-forming deep layer of callosal fibers outside the germinal matrix that is not present during the first trimester.

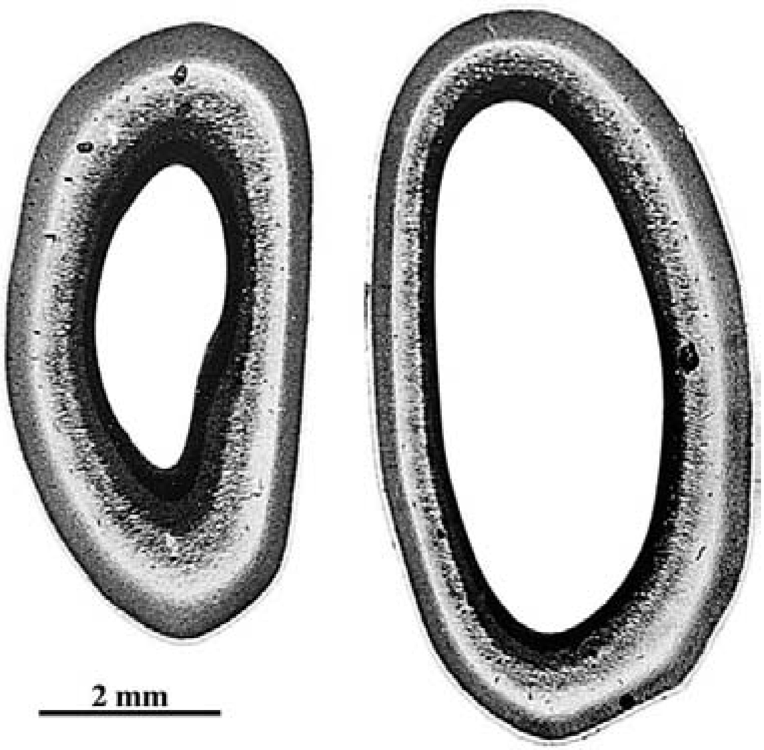
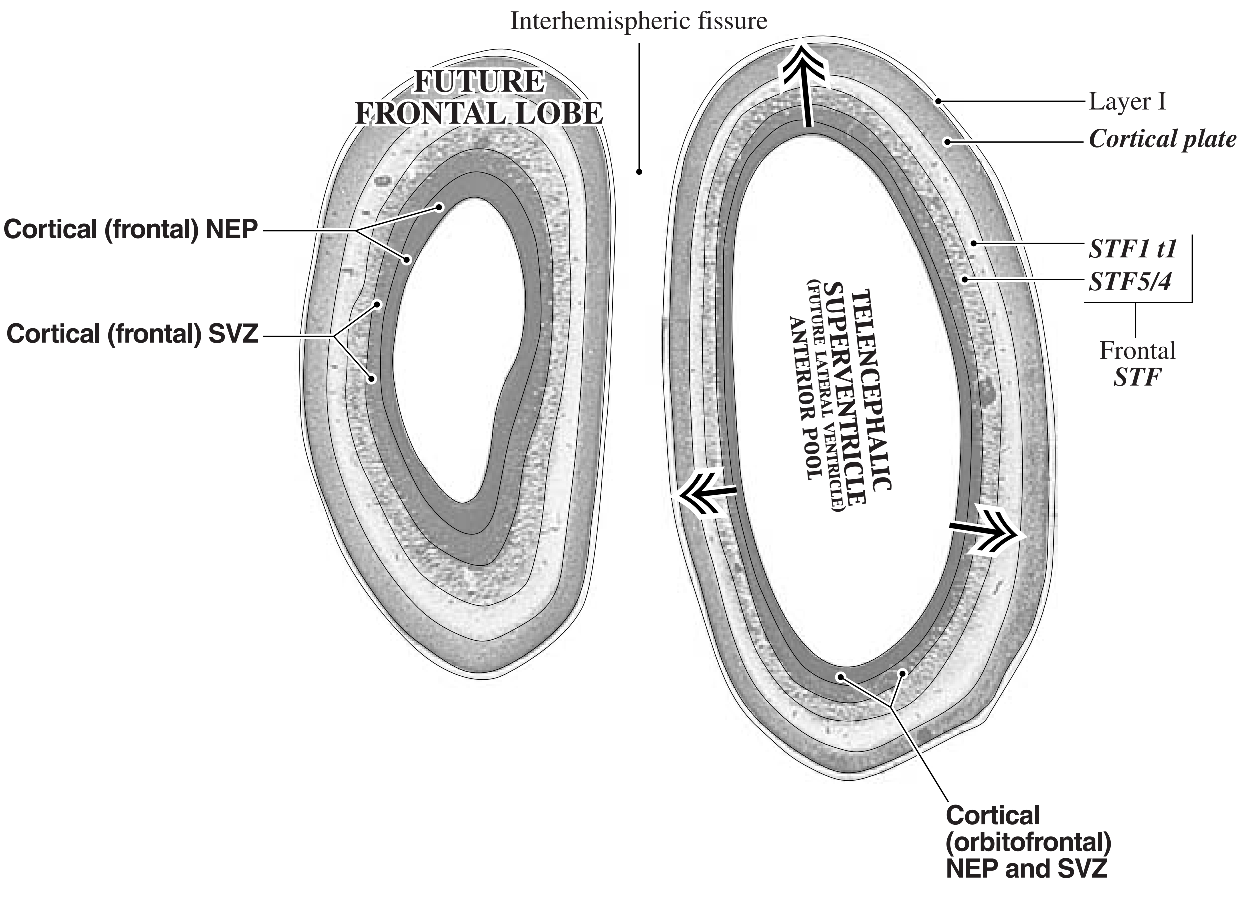


PLATE 1B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
NEP - Neuroepithelium
SVZ - Subventricular zone



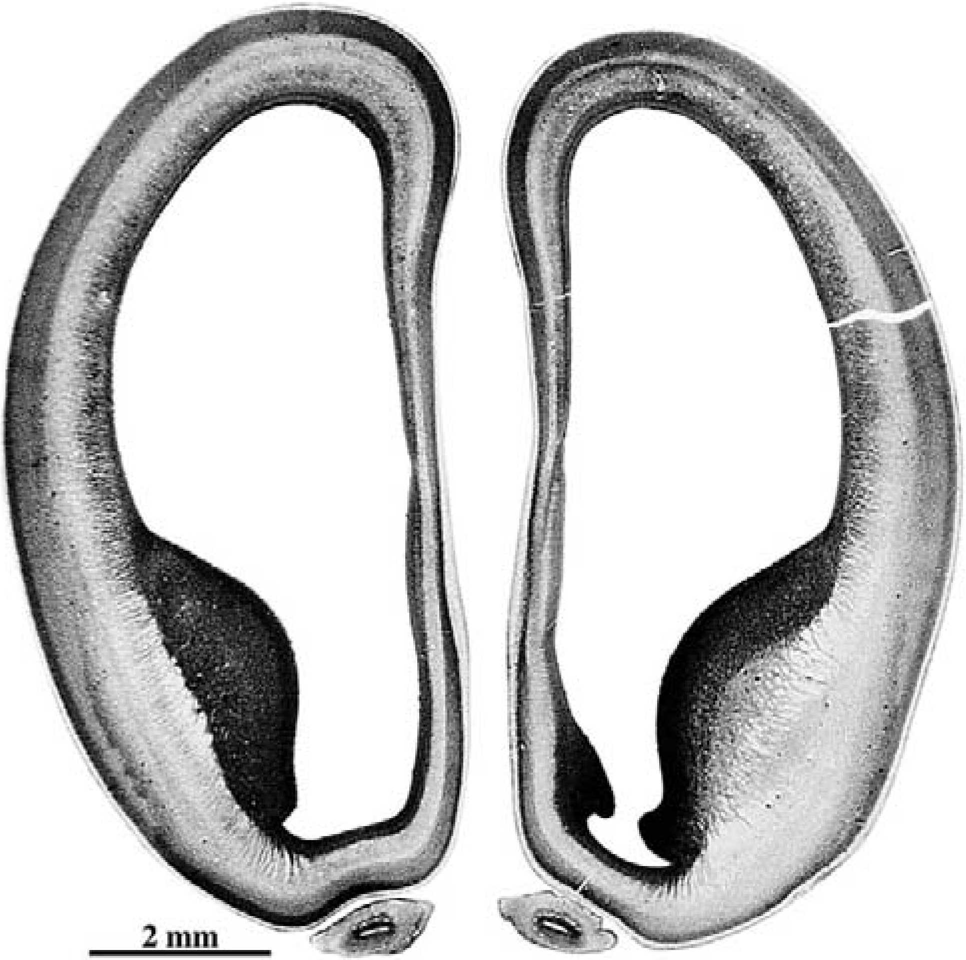
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 2A

GW11 Coronal
CR 60 mm, Y1-59
Level 2: Section 259

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.	***STF4***	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF2	Upper cellular layer, the most superficial sojourn zone where cells translocate to the cortical plate.	***STF5***	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.
STF3	Honeycomb trilaminar matrix ***(3a, 3b, 3c)*** of cells and fibers that is not present during the first trimester and is found in granular (sensory) cortices.	***STF6***	Late-forming deep layer of callosal fibers outside the germinal matrix that is not present during the first trimester.

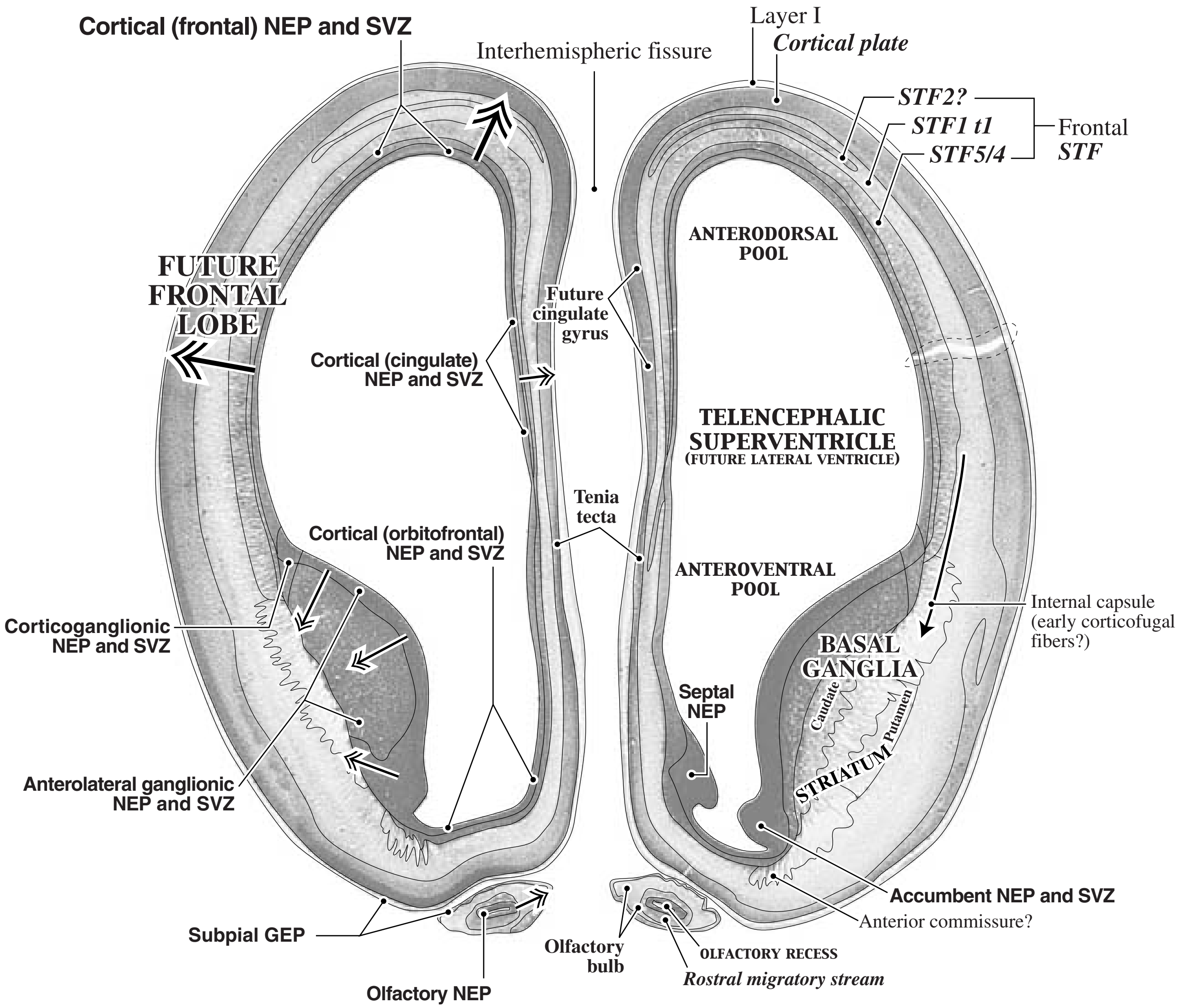


See a high-magnification view of the frontal cortex from section 269 in Plates 22A and B.

PLATE 2B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

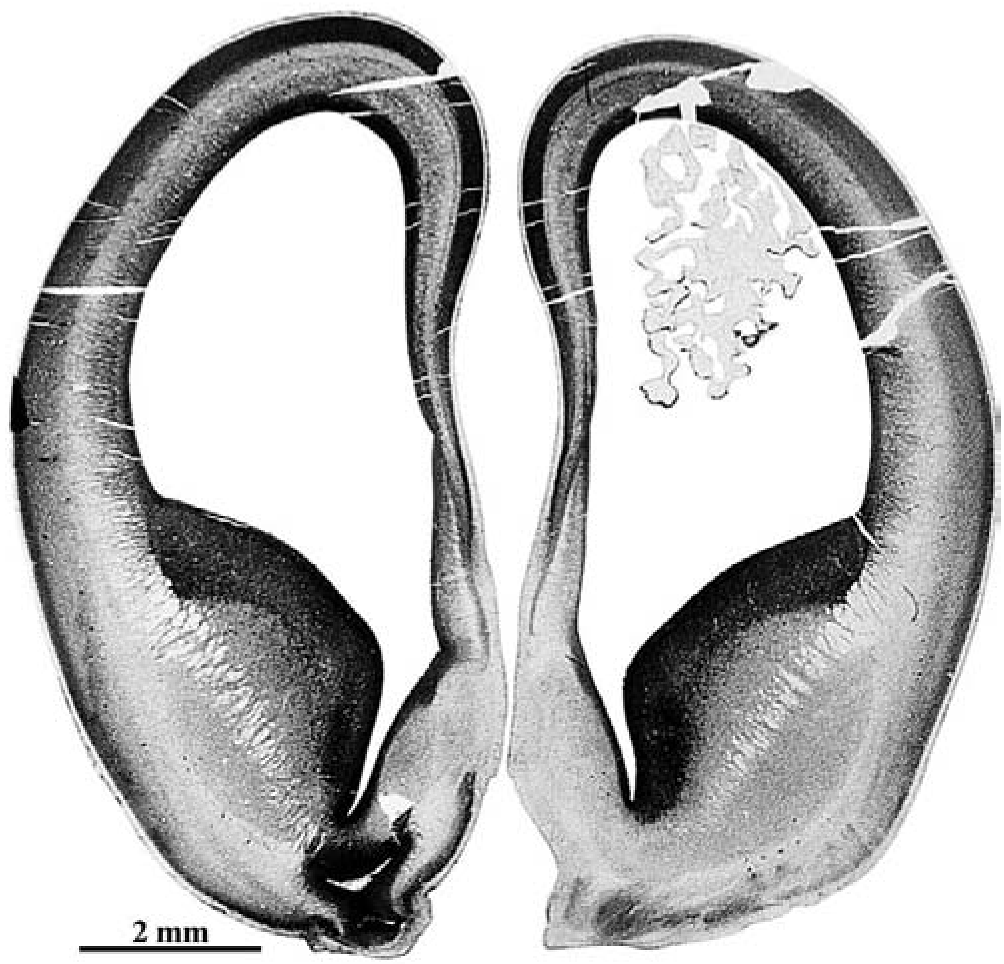
Dashed lines indicate staining and/or sectioning artifacts.

PLATE 3A

GW11 Coronal
CR 60 mm, Y1-59
Level 3: Section 279

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF2	Upper cellular layer, the most superficial sojourn zone where cells translocate to the cortical plate.
STF3	Honeycomb trilaminar matrix ***(3a, 3b, 3c)*** of cells and fibers that is not present during the first trimester and is found in granular (sensory) cortices.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.
STF6	Late-forming deep layer of callosal fibers outside the germinal matrix that is not present during the first trimester.

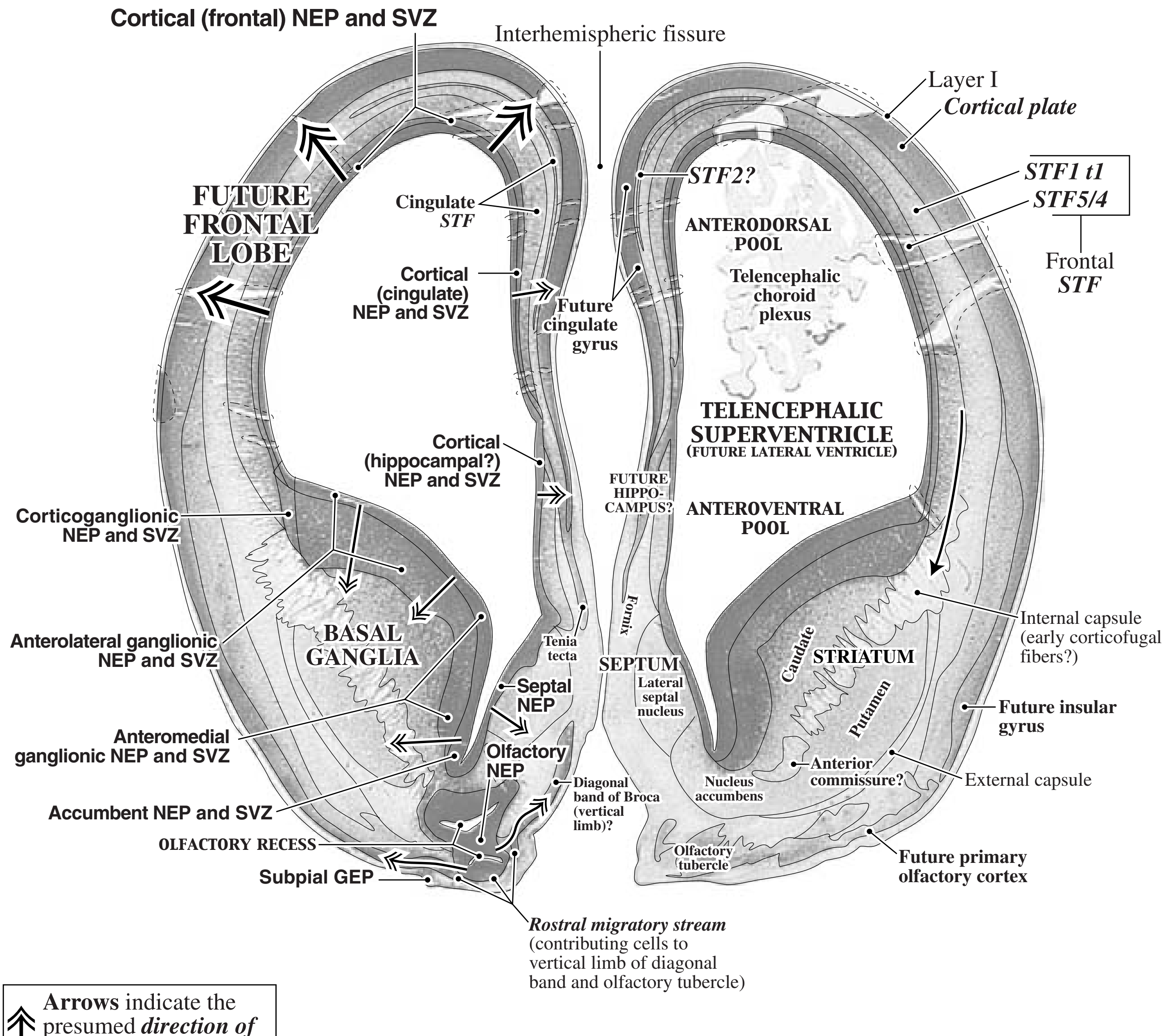


See a high-magnification view of the frontal cortex from section 269 in Plates 22A and B.

PLATE 3B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

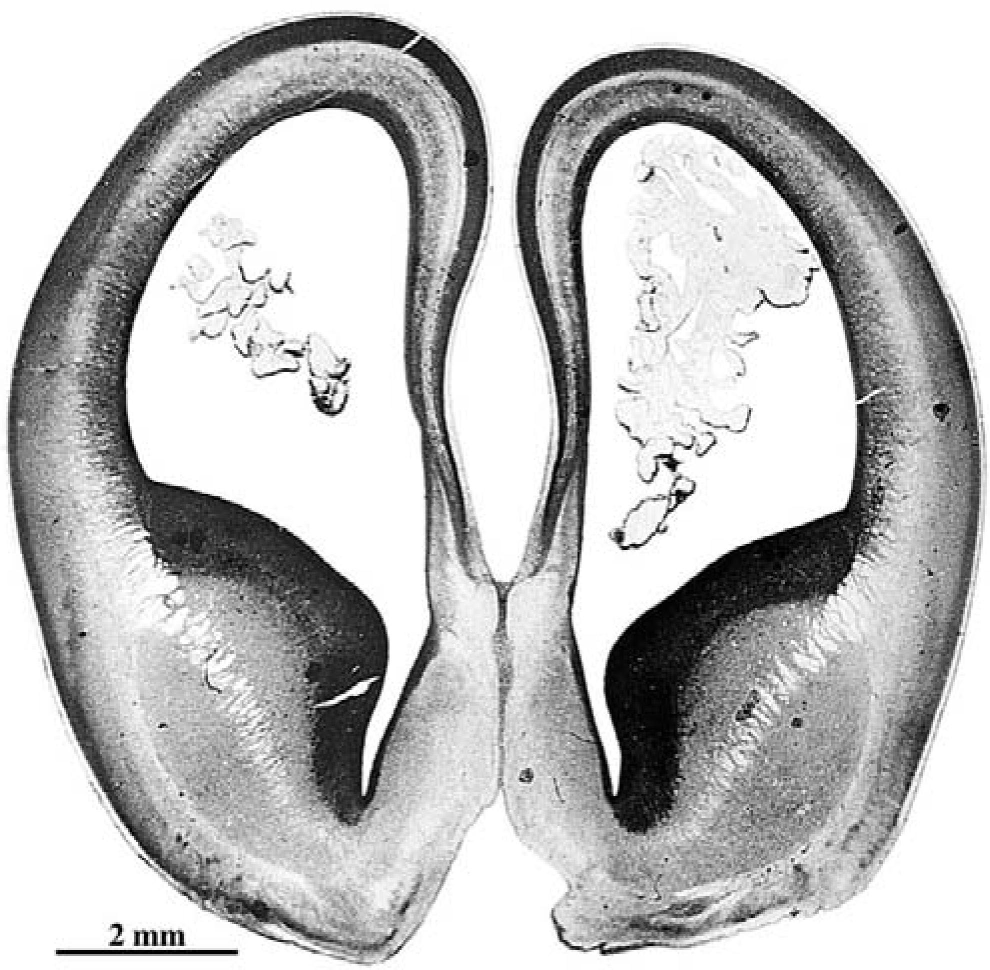
Dashed lines indicate staining and/or sectioning artifacts.

PLATE 4A

GW11 Coronal
CR 60 mm, Y1-59
Level 4: Section 289

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

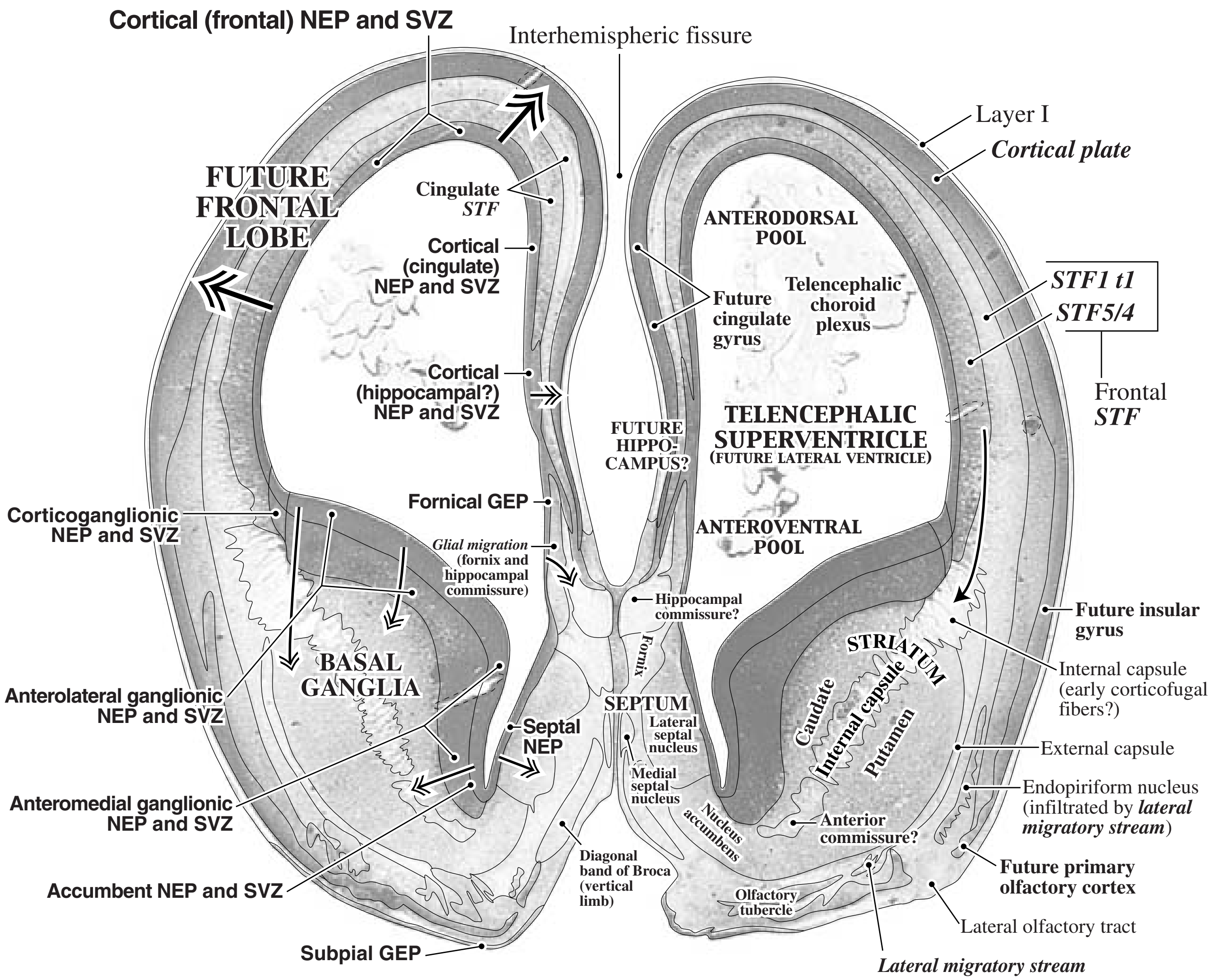
STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF2	Upper cellular layer, the most superficial sojourn zone where cells translocate to the cortical plate.
STF3	Honeycomb trilaminar matrix ***(3a, 3b, 3c)*** of cells and fibers that is not present during the first trimester and is found in granular (sensory) cortices.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.
STF6	Late-forming deep layer of callosal fibers outside the germinal matrix that is not present during the first trimester.



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

PLATE 4B



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 5A

GW11 Coronal
CR 60 mm, Y1-59
Level 5: Section 329

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF2	Upper cellular layer, the most superficial sojourn zone where cells translocate to the cortical plate.
STF3	Honeycomb trilaminar matrix ***(3a, 3b, 3c)*** of cells and fibers that is not present during the first trimester and is found in granular (sensory) cortices.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.
STF6	Late-forming deep layer of callosal fibers outside the germinal matrix that is not present during the first trimester.

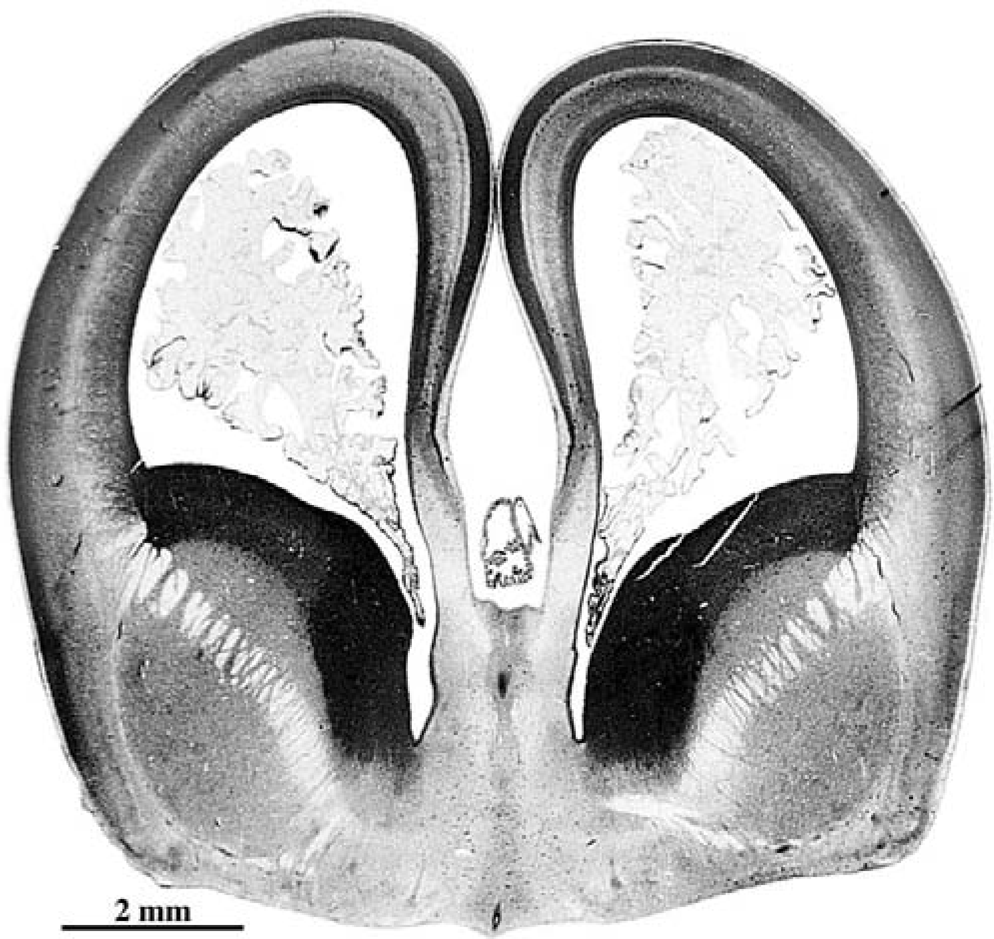
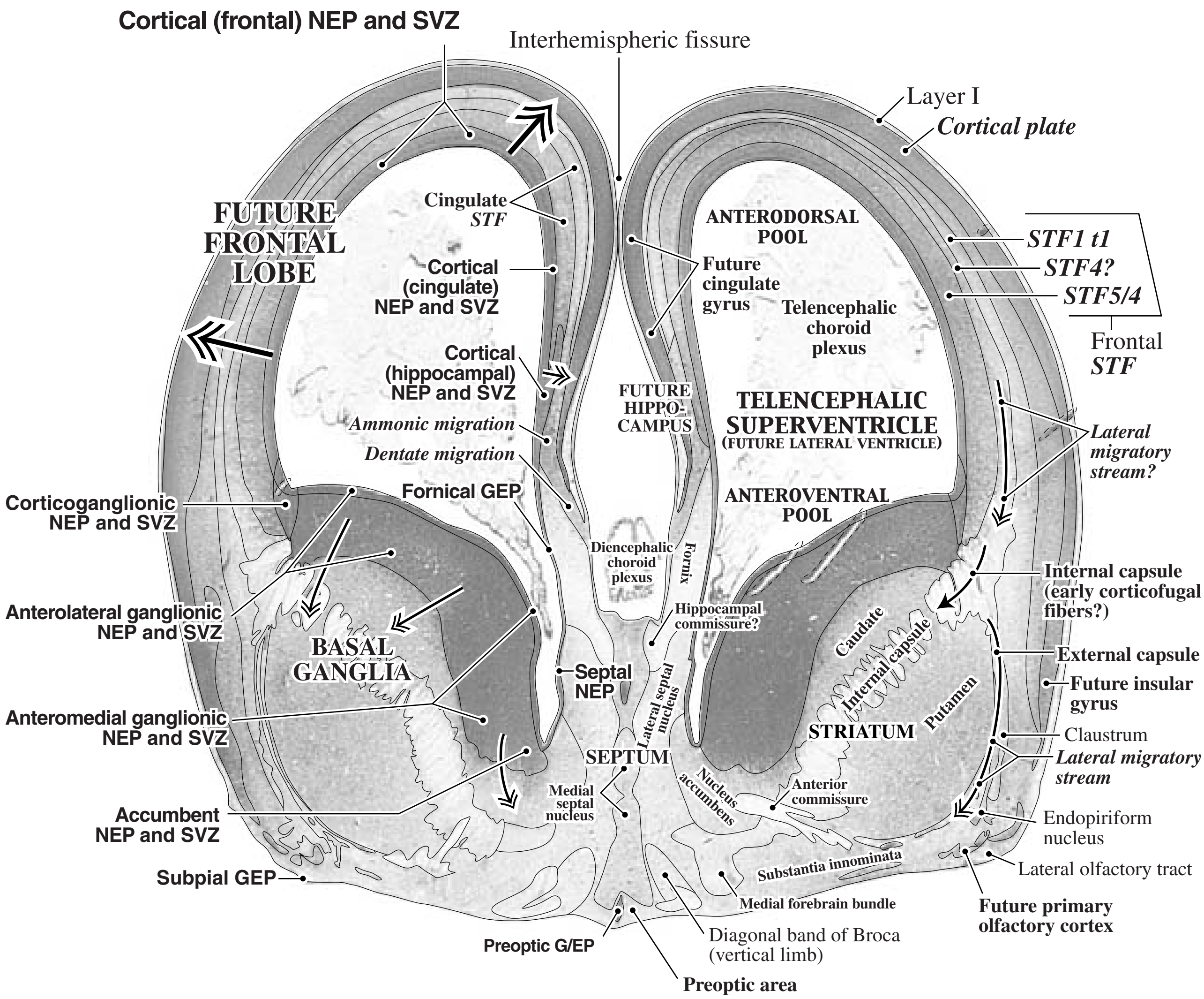


PLATE 5B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 6A

GW11 Coronal
CR 60 mm, Y1-59
Level 6: Section 340

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1 Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.

STF2 Upper cellular layer, the most superficial sojourn zone where cells translocate to the cortical plate.

STF3 Honeycomb trilaminar matrix ***(3a, 3b, 3c)*** of cells and fibers that is not present during the first trimester and is found in granular (sensory) cortices.

STF4 Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.

STF5 Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

STF6 Late-forming deep layer of callosal fibers outside the germinal matrix that is not present during the first trimester.

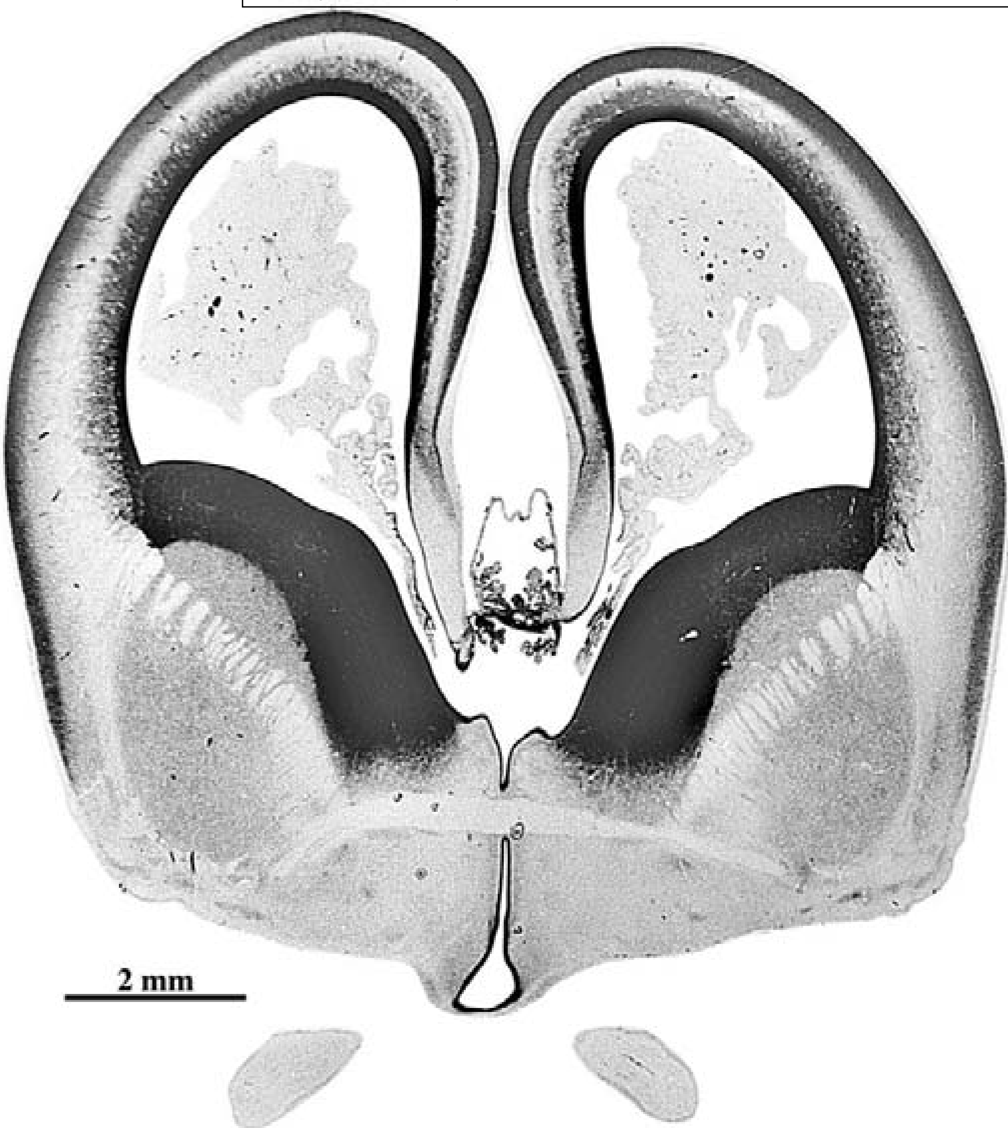
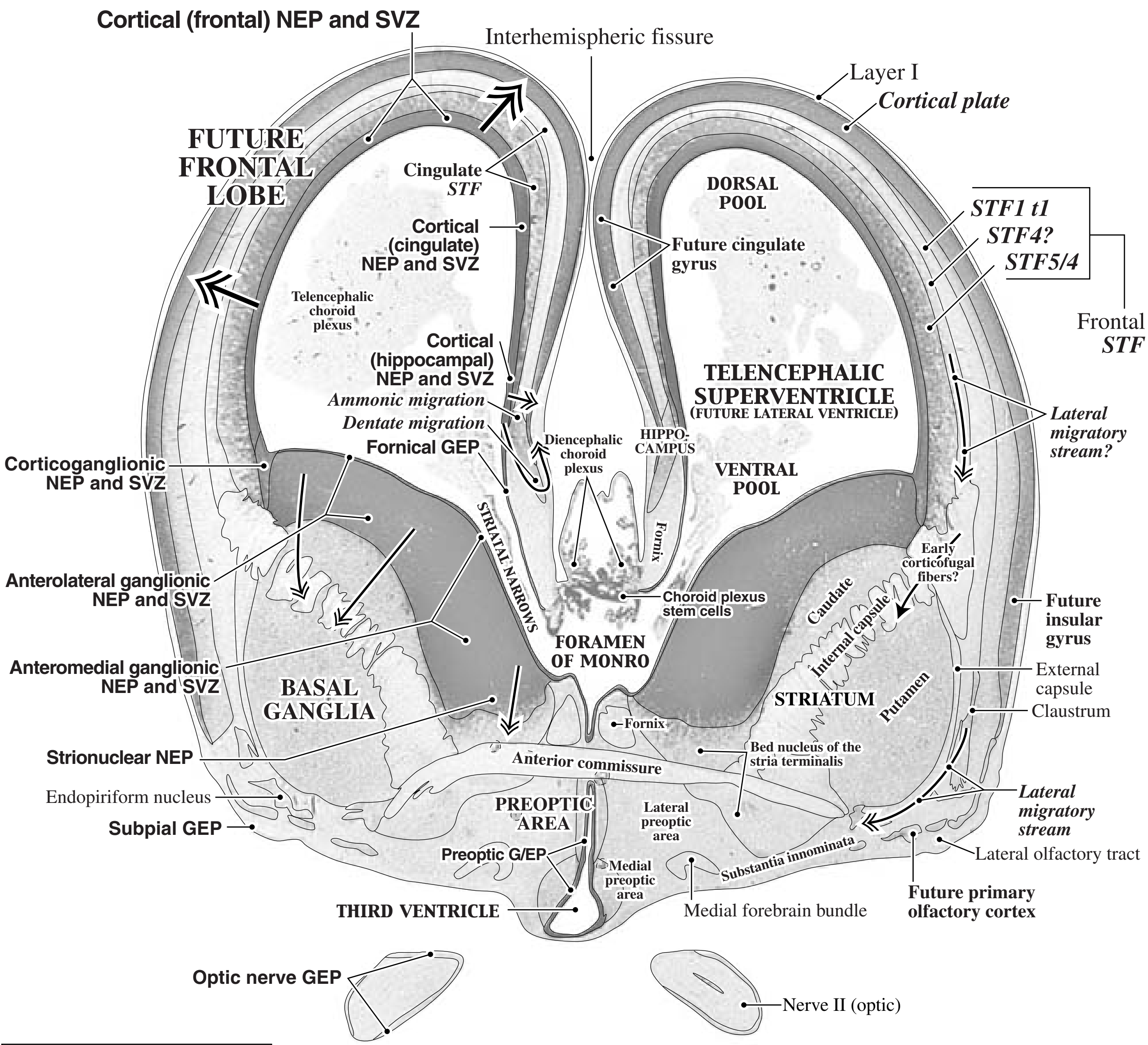


PLATE 6B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 7A

GW11 Coronal
CR 60 mm, Y1-59
Level 7: Section 349

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.	***STF4***	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF2	Upper cellular layer, the most superficial sojourn zone where cells translocate to the cortical plate.	***STF5***	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.
STF3	Honeycomb trilaminar matrix ***(3a, 3b, 3c)*** of cells and fibers that is not present during the first trimester and is found in granular (sensory) cortices.	***STF6***	Late-forming deep layer of callosal fibers outside the germinal matrix that is not present during the first trimester.

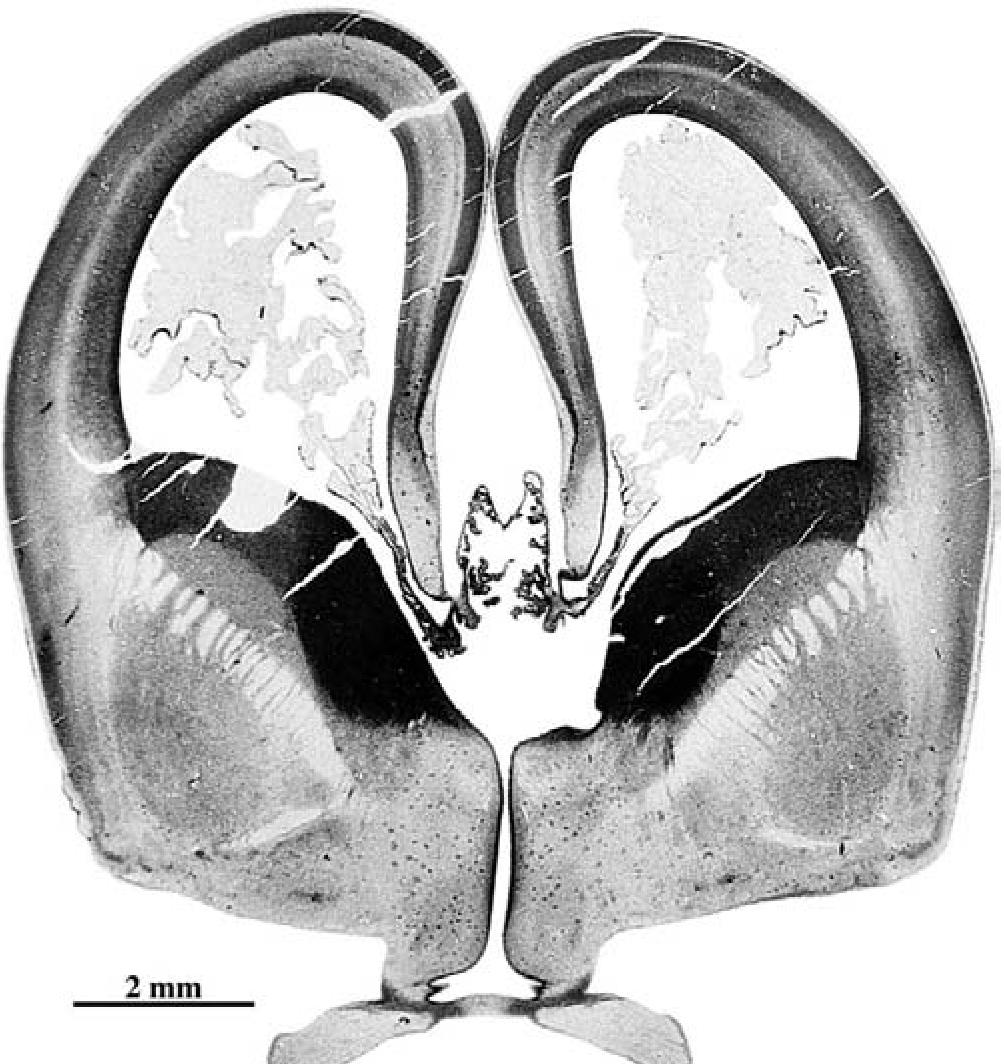
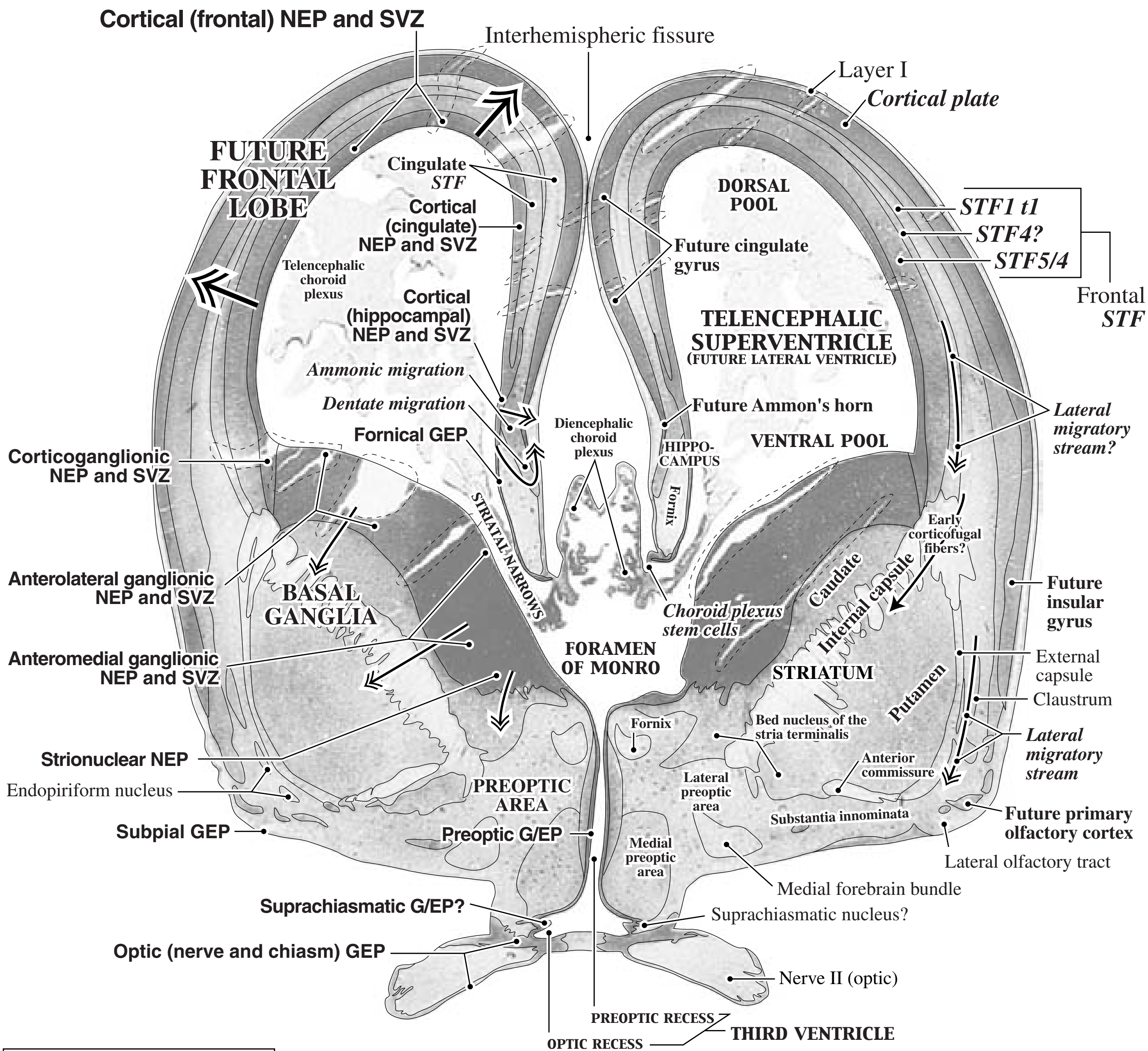


PLATE 7B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 8A

GW11 Coronal
CR 60 mm, Y1-59
Level 8: Section 379

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1 Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.

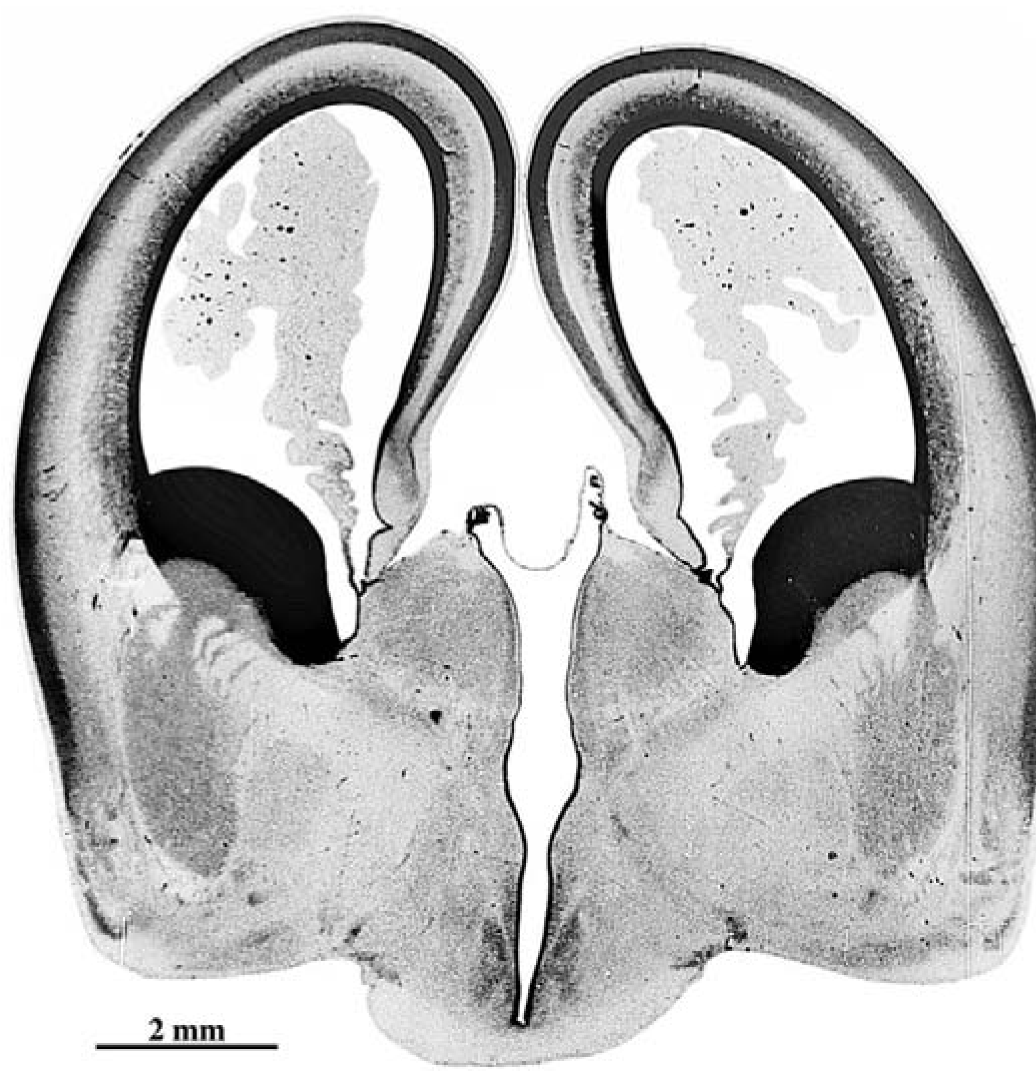
STF2 Upper cellular layer, the most superficial sojourn zone where cells translocate to the cortical plate.

STF3 Honeycomb trilaminar matrix ***(3a, 3b, 3c)*** of cells and fibers that is not present during the first trimester and is found in granular (sensory) cortices.

STF4 Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.

STF5 Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

STF6 Late-forming deep layer of callosal fibers outside the germinal matrix that is not present during the first trimester.



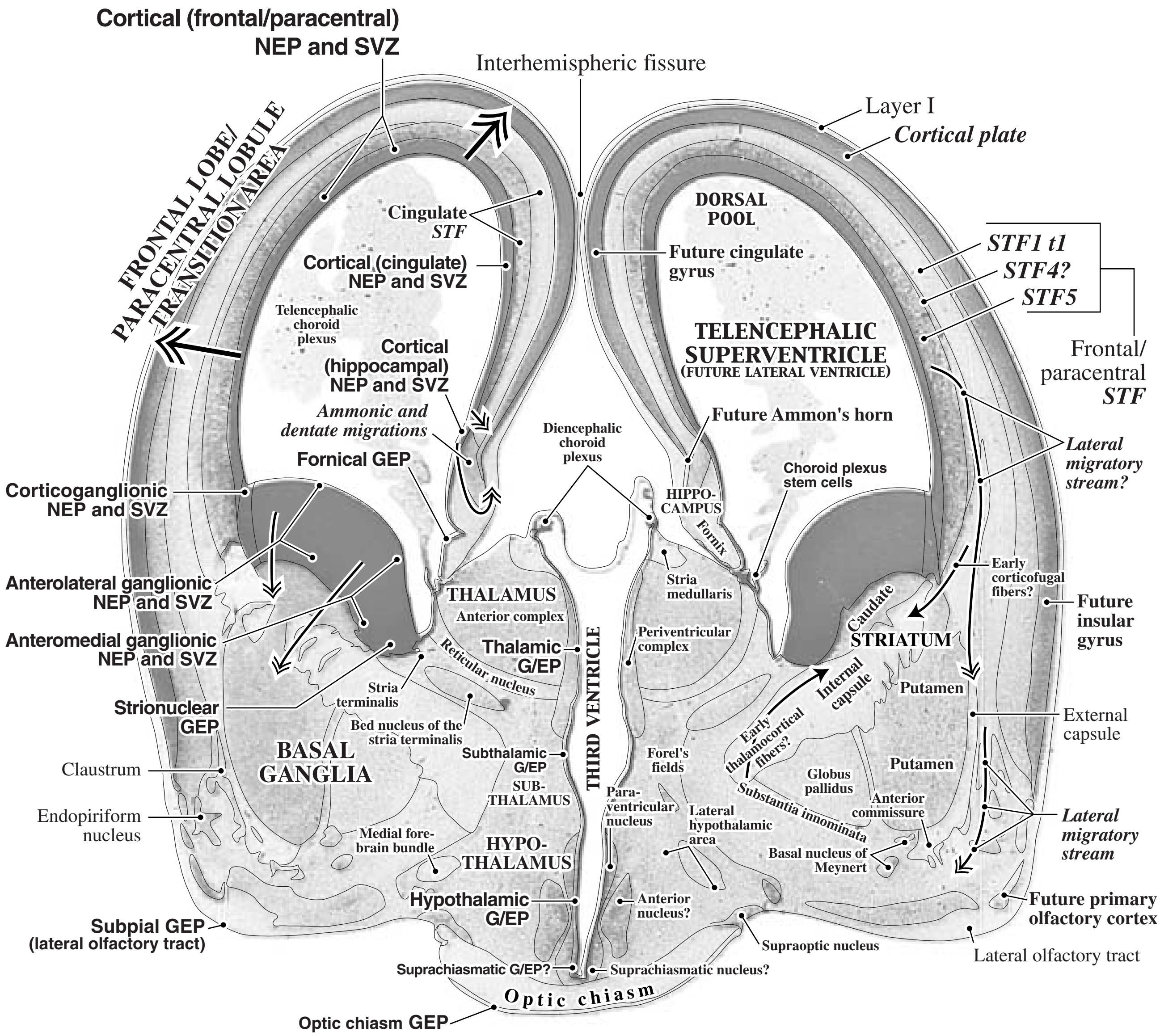
See high-magnification views of the right paracentral cortex, thalamus, and basal ganglia from section 399 in Plates 24A and B to 25A and B.

See a high-magnification view of the diencephalon and basal telencephalon from section 389 in Plates 26A and B.

PLATE 8B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

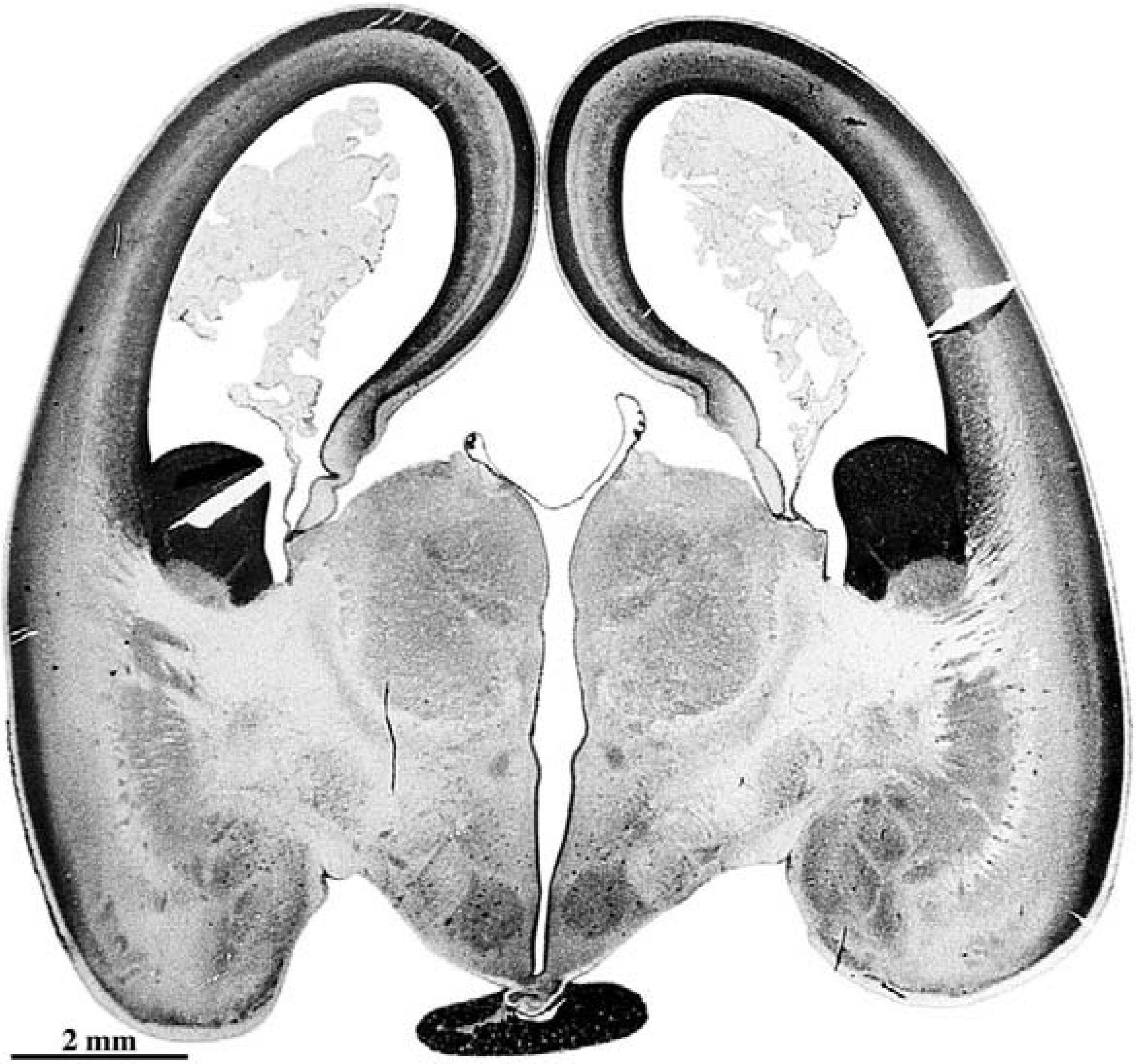
Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

PLATE 9A

GW11 Coronal
CR 60 mm, Y1-59
Level 9: Section 419

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF2	Upper cellular layer, the most superficial sojourn zone where cells translocate to the cortical plate.
STF3	Honeycomb trilaminar matrix ***(3a, 3b, 3c)*** of cells and fibers that is not present during the first trimester and is found in granular (sensory) cortices.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.
STF6	Late-forming deep layer of callosal fibers outside the germinal matrix that is not present during the first trimester.

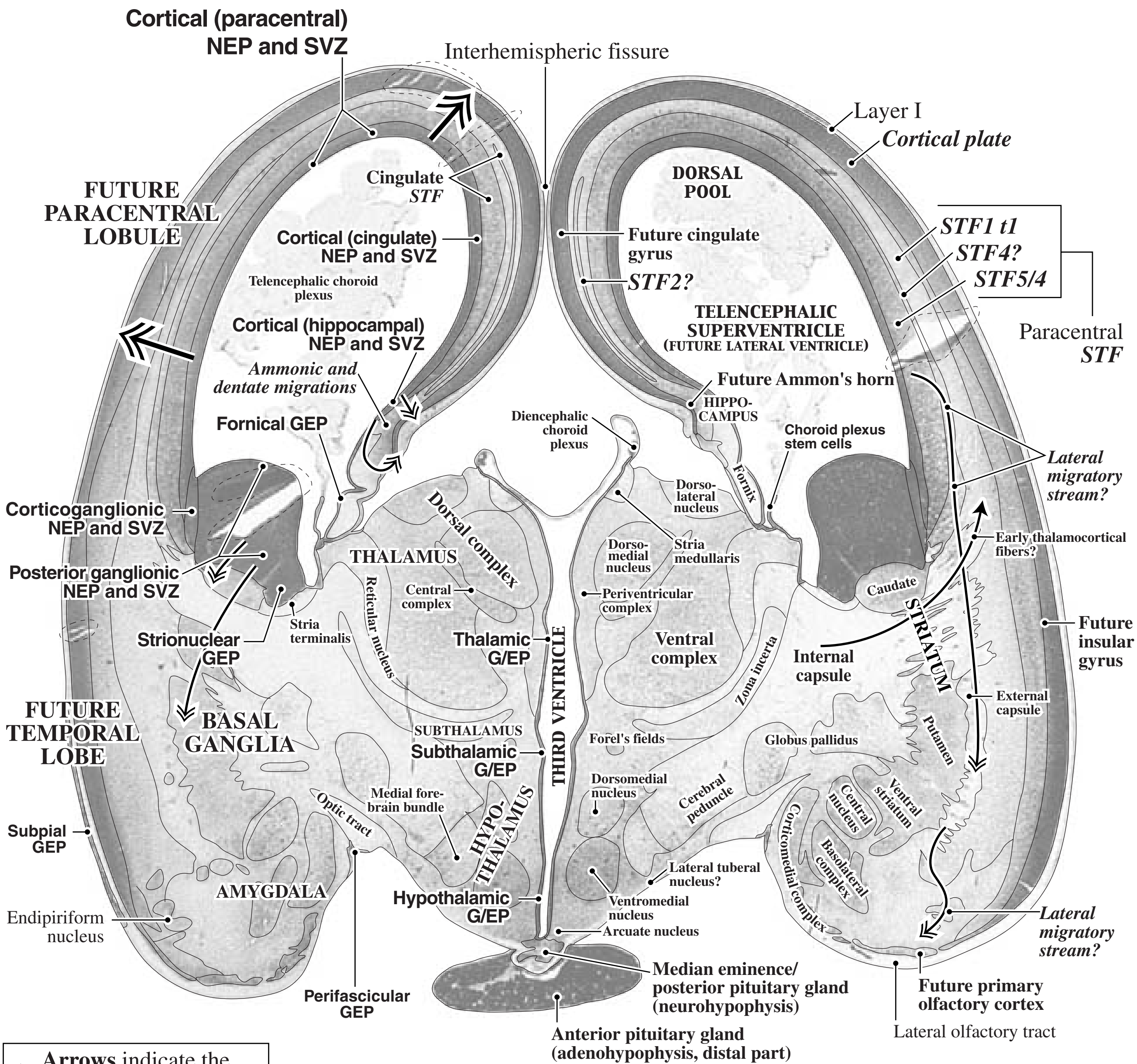


See a high-magnification view of the diencephalon and basal telencephalon from level 9 in Plates 27A and B.

PLATE 9B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

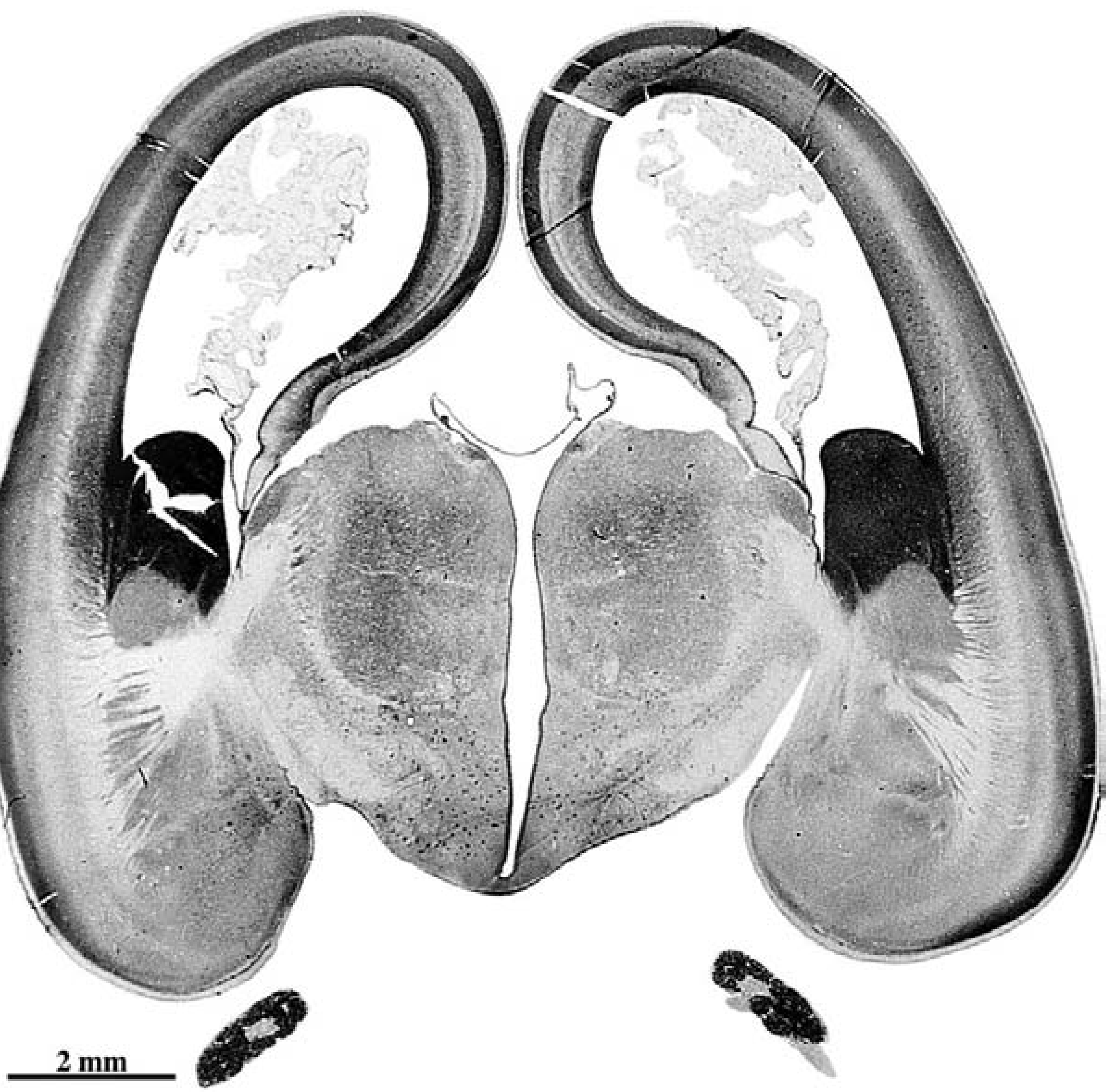
Dashed lines indicate staining and/or sectioning artifacts.

PLATE 10A

GW11 Coronal
CR 60 mm, Y1-59
Level 10: Section 439

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.	***STF4***	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF2	Upper cellular layer, the most superficial sojourn zone where cells translocate to the cortical plate.	***STF5***	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.
STF3	Honeycomb trilaminar matrix ***(3a, 3b, 3c)*** of cells and fibers that is not present during the first trimester and is found in granular (sensory) cortices.	***STF6***	Late-forming deep layer of callosal fibers outside the germinal matrix that is not present during the first trimester.

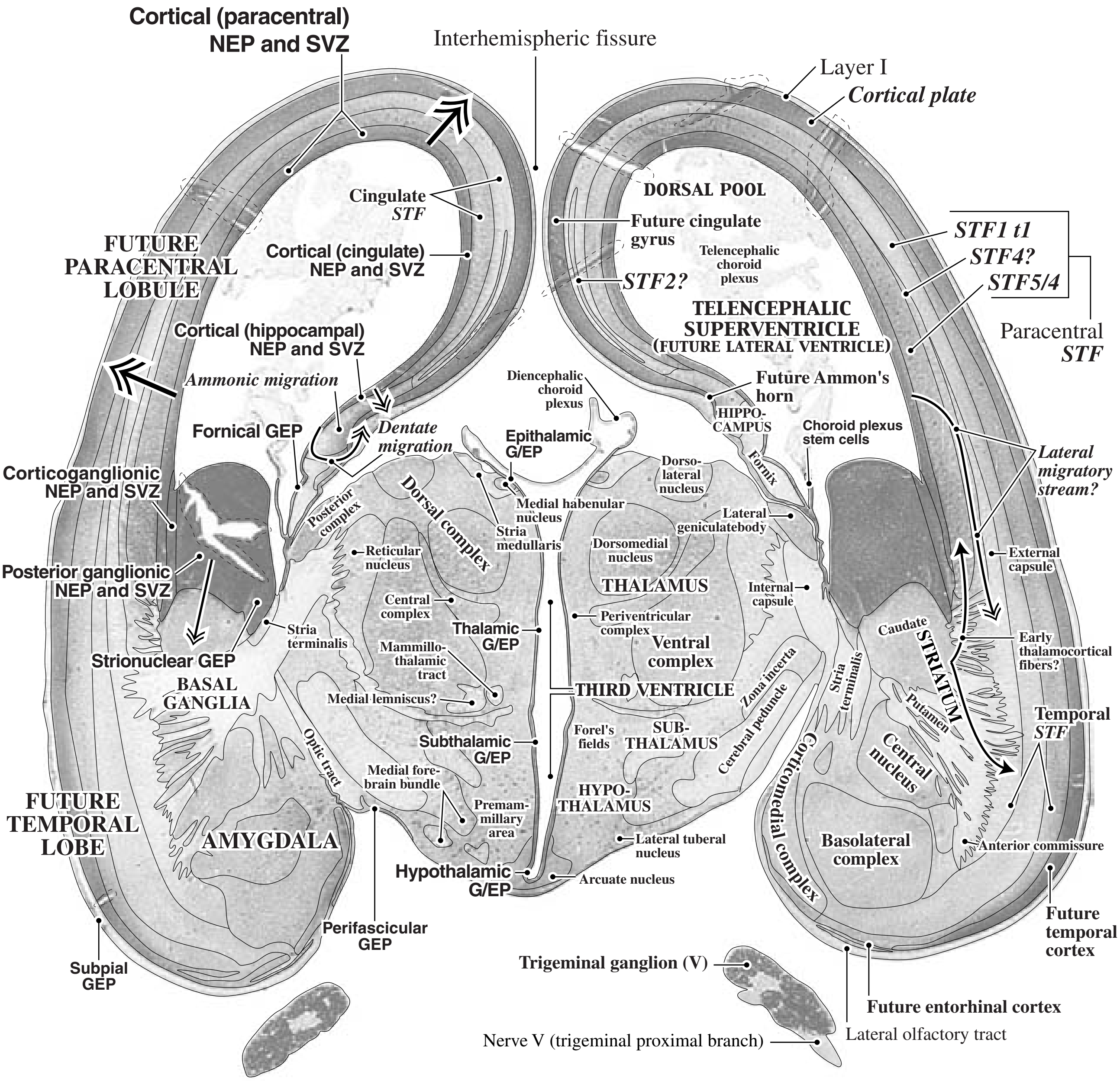


See a high-magnification view of the diencephalon from section 449 in Plates 28A and B.

PLATE 10B

FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

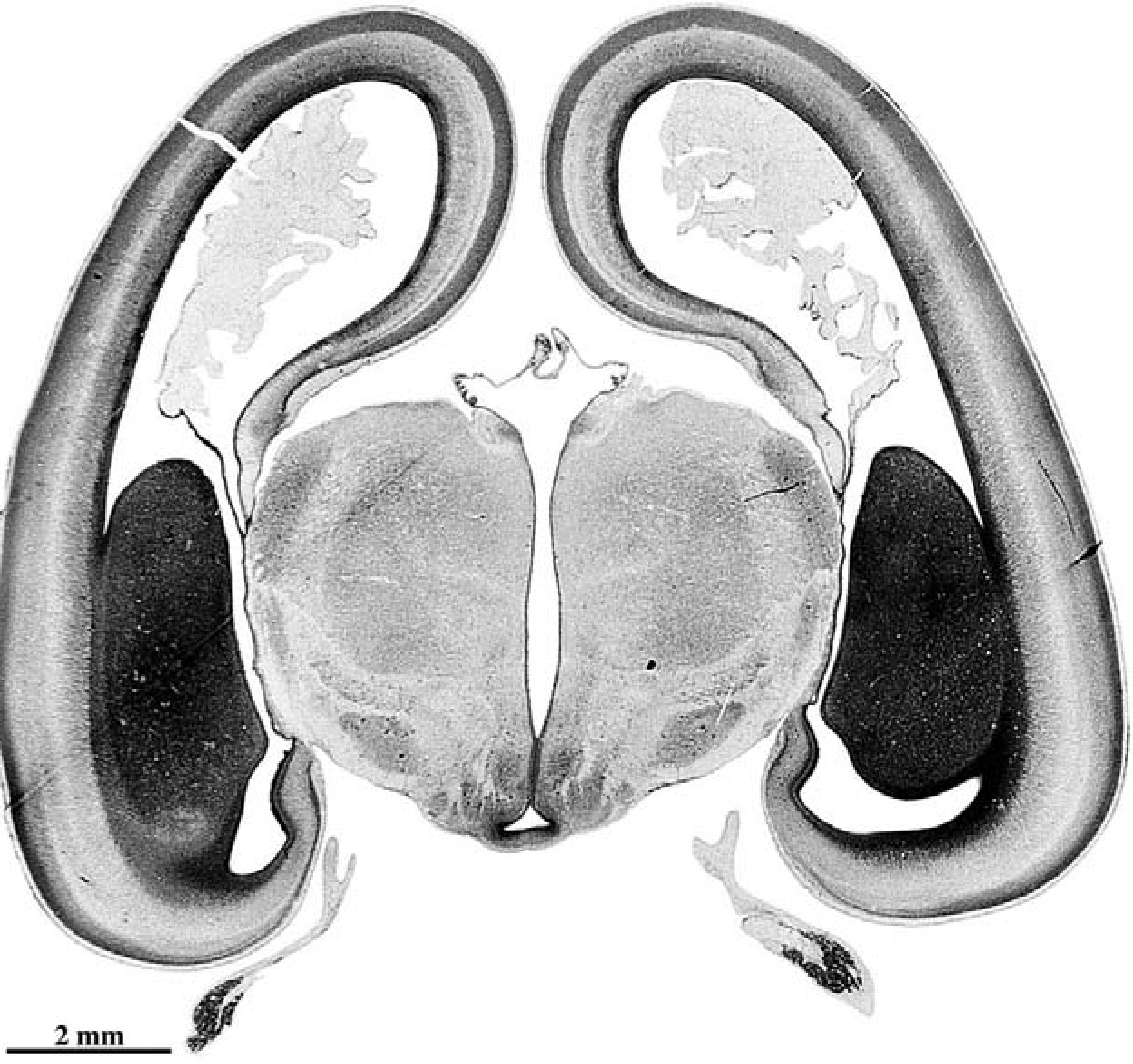
Dashed lines indicate staining and/or sectioning artifacts.

PLATE 11A

GW11 Coronal
CR 60 mm, Y1-59
Level 11: Section 459

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1 Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.	***STF4*** Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF2 Upper cellular layer, the most superficial sojourn zone where cells translocate to the cortical plate.	***STF5*** Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.
STF3 Honeycomb trilaminar matrix ***(3a, 3b, 3c)*** of cells and fibers that is not present during the first trimester and is found in granular (sensory) cortices.	***STF6*** Late-forming deep layer of callosal fibers outside the germinal matrix that is not present during the first trimester.

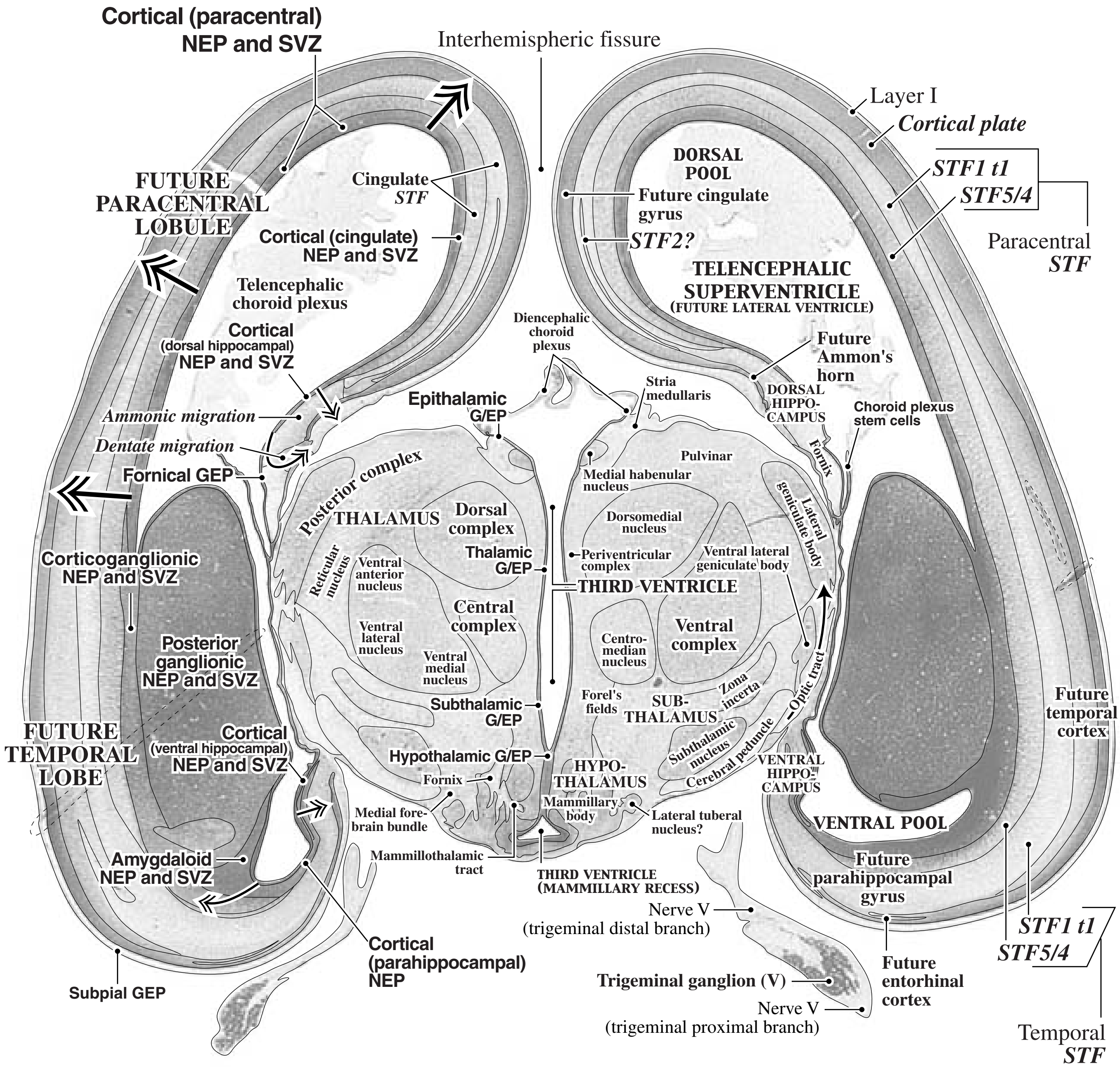


See a high-magnification view of the diencephalon from section 449 in Plates 28A and B, from section 469 in Plates 29A and B.

PLATE 11B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

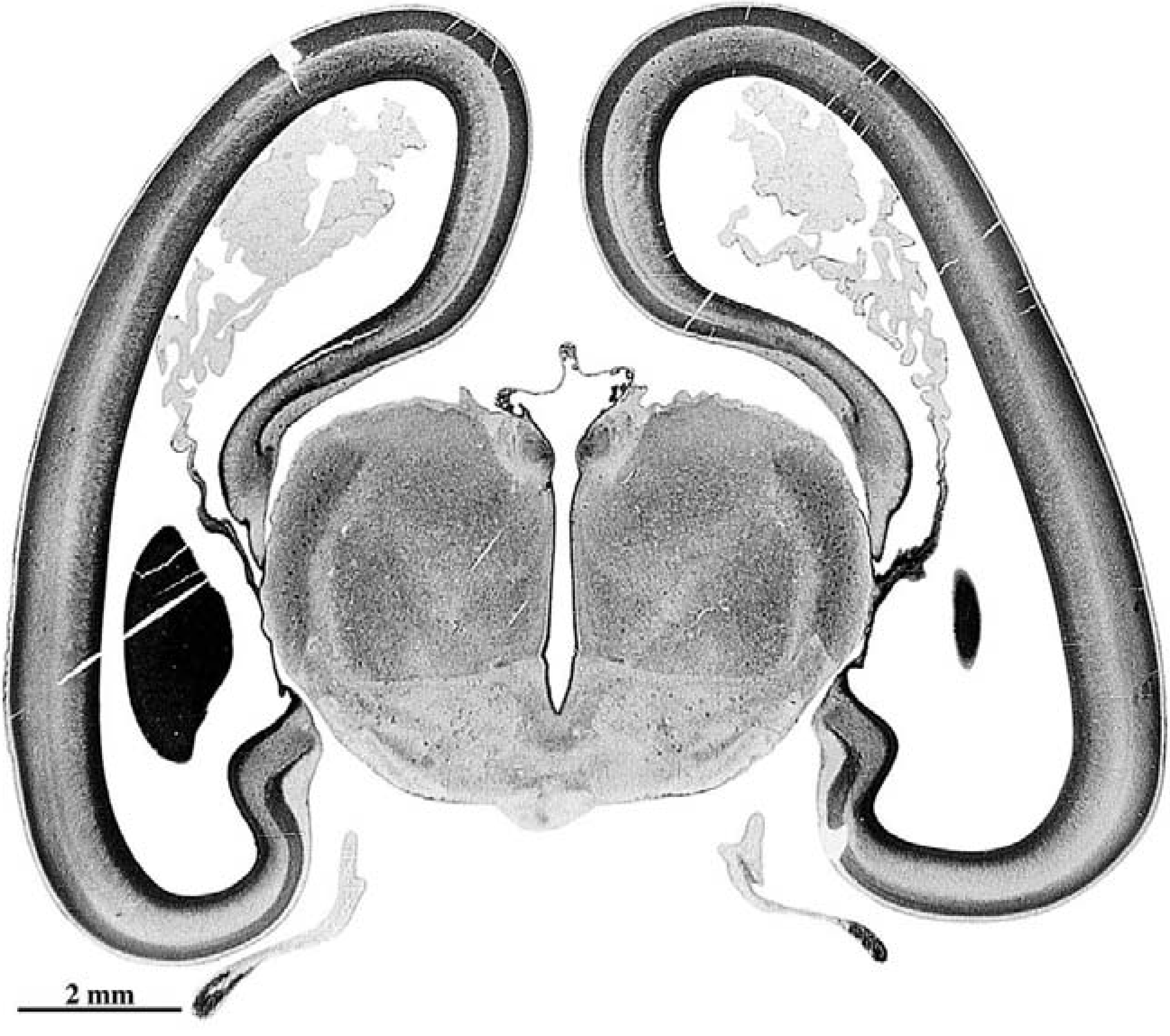
Dashed lines indicate staining and/or sectioning artifacts.

PLATE 12A

GW11 Coronal
CR 60 mm, Y1-59
Level 12: Section 479

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.	***STF4***	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF2	Upper cellular layer, the most superficial sojourn zone where cells translocate to the cortical plate.	***STF5***	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.
STF3	Honeycomb trilaminar matrix ***(3a, 3b, 3c)*** of cells and fibers that is not present during the first trimester and is found in granular (sensory) cortices.	***STF6***	Late-forming deep layer of callosal fibers outside the germinal matrix that is not present during the first trimester.

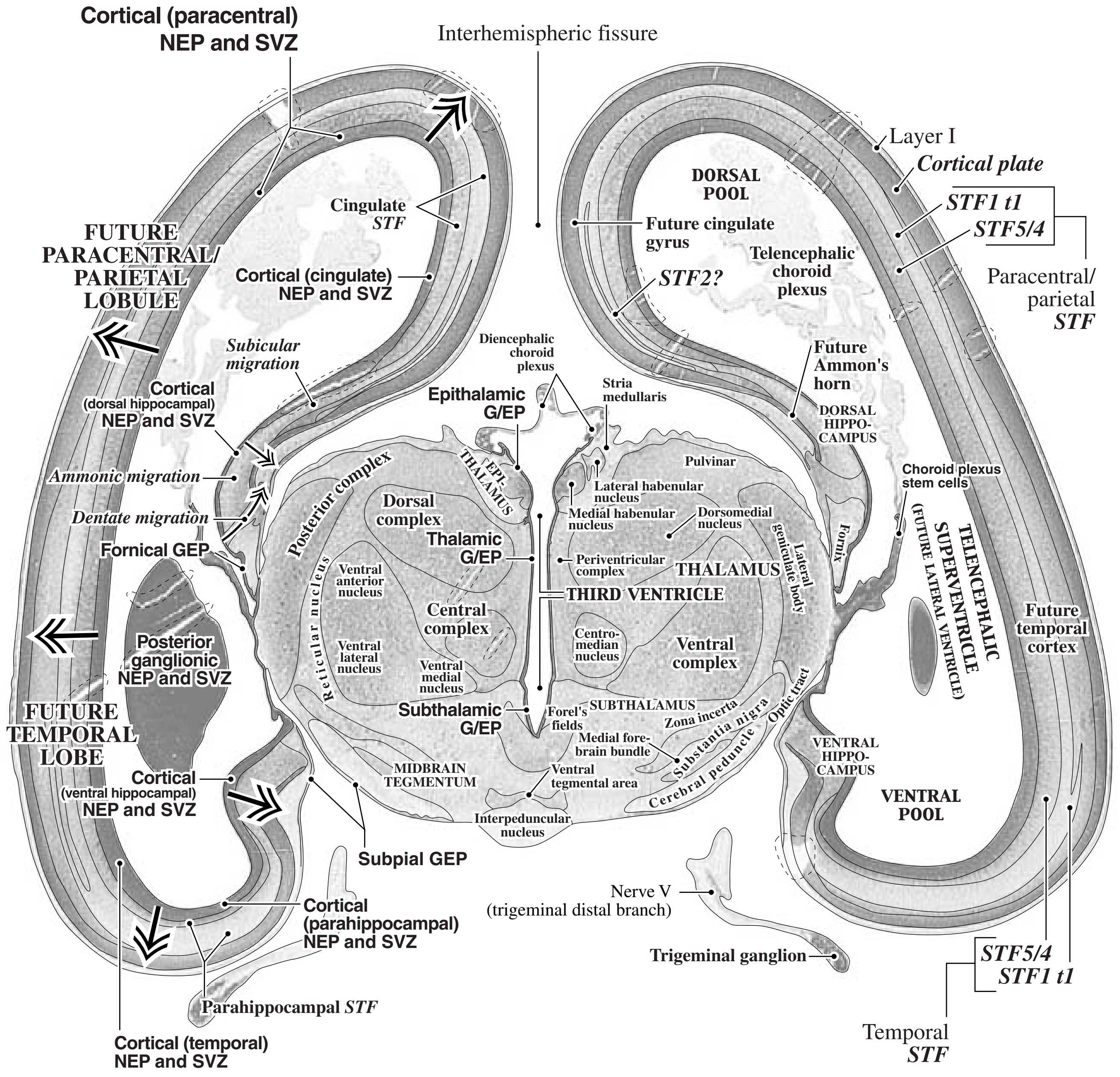


See a high-magnification view of the diencephalon from section 469 in Plates 29A and B.

PLATE 12B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

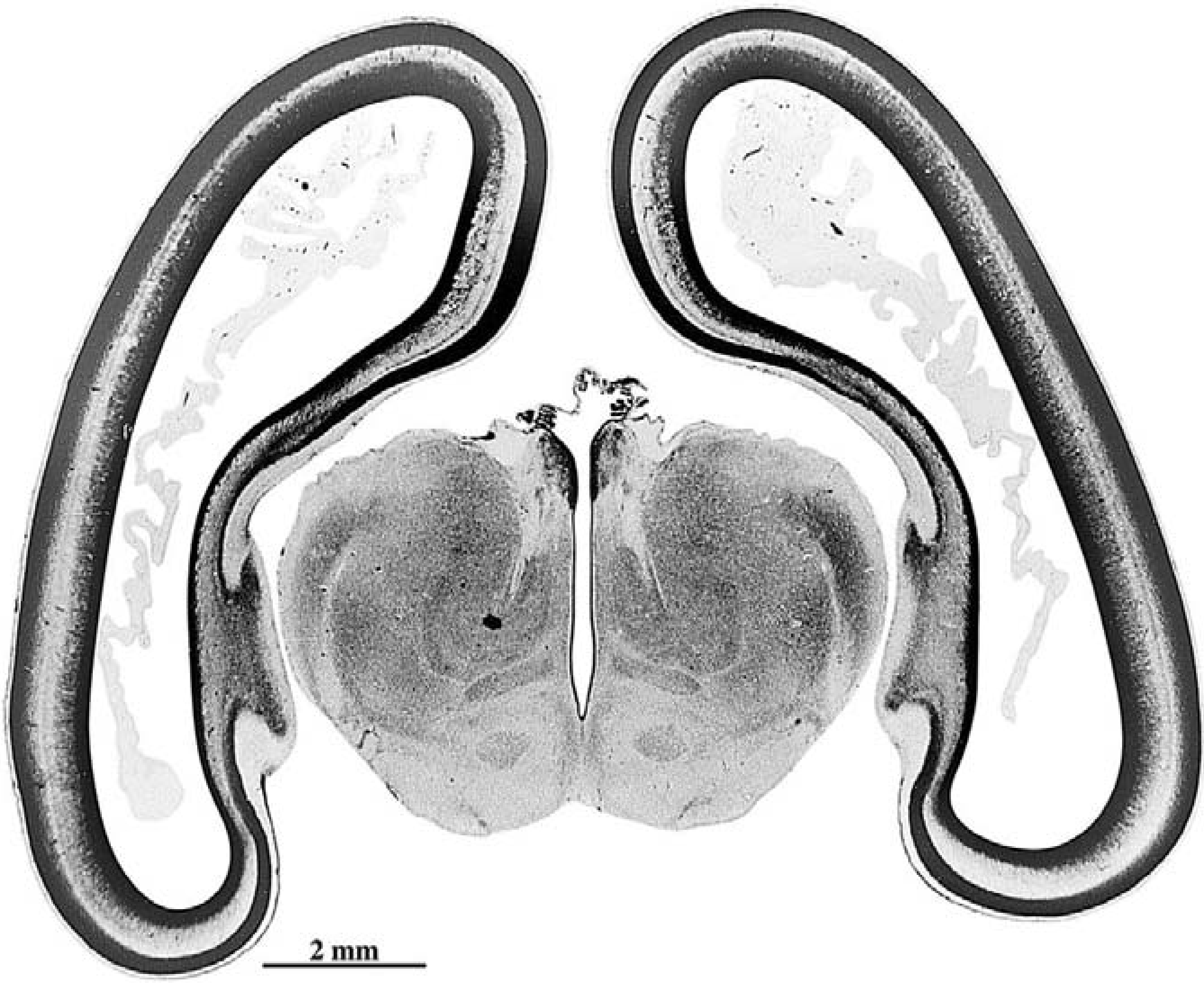
Dashed lines indicate staining and/or sectioning artifacts.

PLATE 13A

GW11 Coronal
CR 60 mm, Y1-59
Level 13: Section 500

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.	***STF4***	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF2	Upper cellular layer, the most superficial sojourn zone where cells translocate to the cortical plate.	***STF5***	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.
STF3	Honeycomb trilaminar matrix ***(3a, 3b, 3c)*** of cells and fibers that is not present during the first trimester and is found in granular (sensory) cortices.	***STF6***	Late-forming deep layer of callosal fibers outside the germinal matrix that is not present during the first trimester.

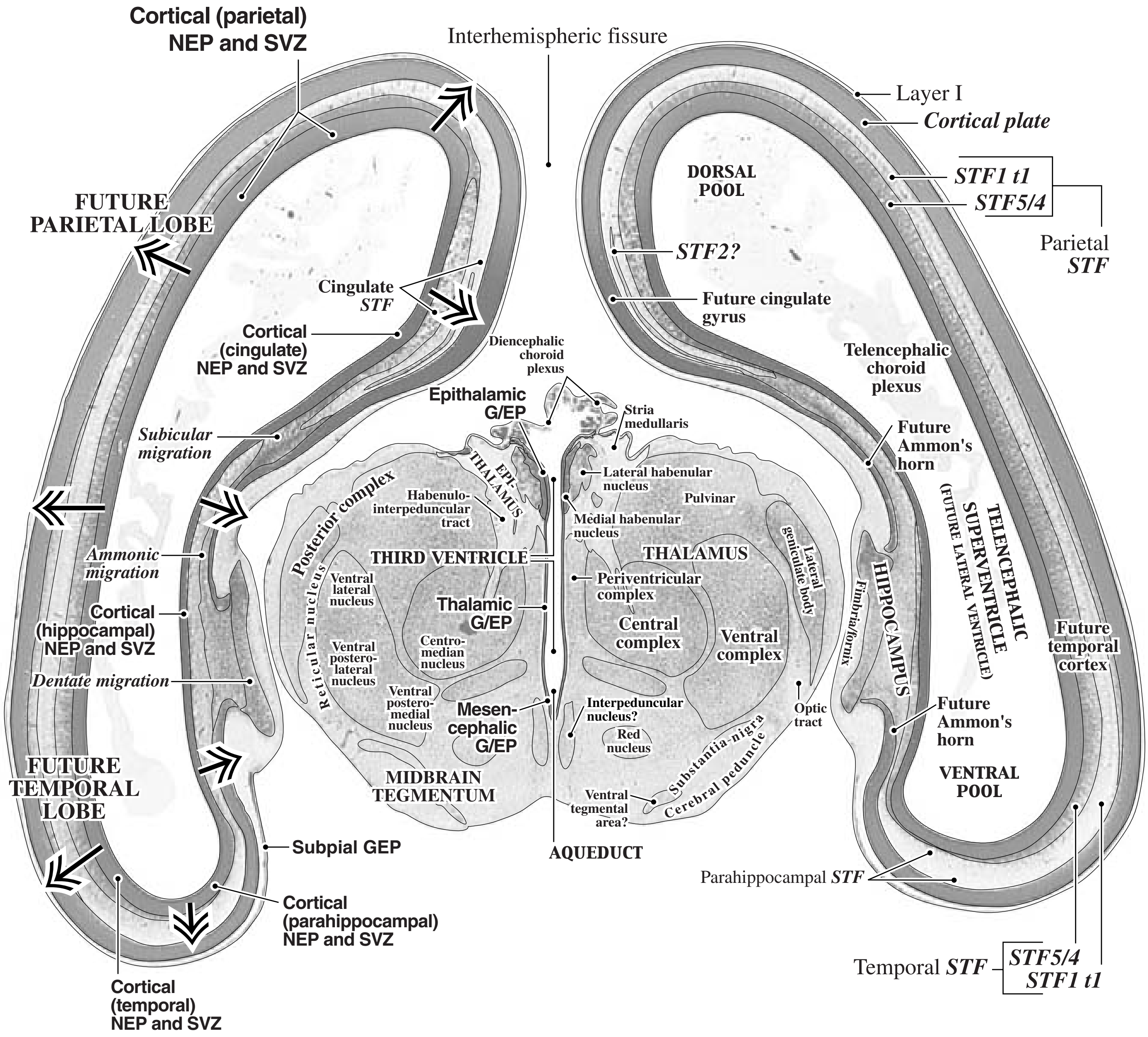


See a high-magnification view of the midbrain and thalamus from section 499 in Plates 30A and B.

PLATE 13B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

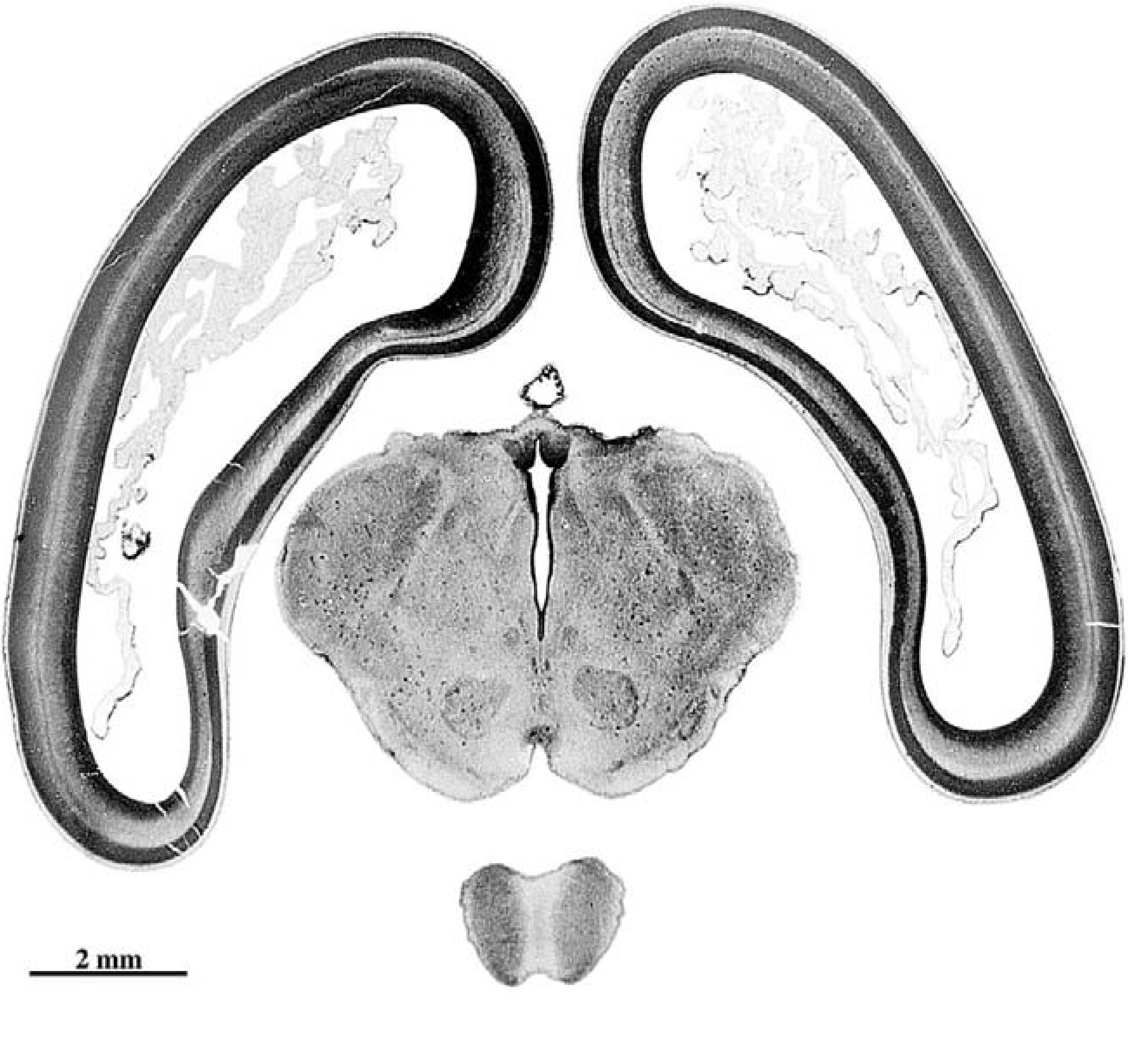
Dashed lines indicate staining and/or sectioning artifacts.

PLATE 14A

GW11 Coronal
CR 60 mm, Y1-59
Level 14: Section 529

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.	***STF4***	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF2	Upper cellular layer, the most superficial sojourn zone where cells translocate to the cortical plate.	***STF5***	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.
STF3	Honeycomb trilaminar matrix ***(3a, 3b, 3c)*** of cells and fibers that is not present during the first trimester and is found in granular (sensory) cortices.	***STF6***	Late-forming deep layer of callosal fibers outside the germinal matrix that is not present during the first trimester.

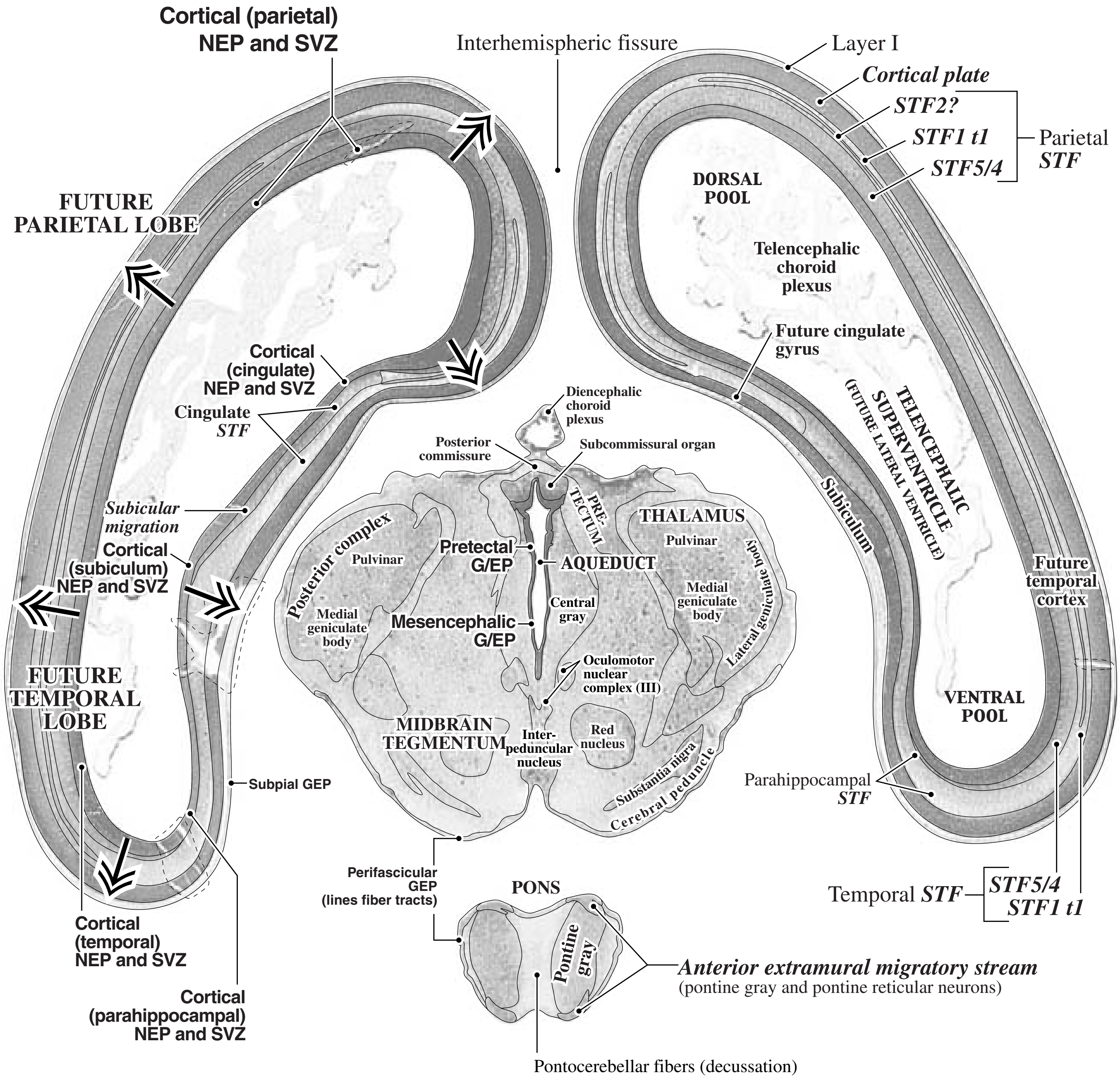


See a high-magnification view of the parietal cortex from section 519 in Plates 23A and B, and of the thalamus and midbrain from this section in Plates 31A and B.

PLATE 14B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

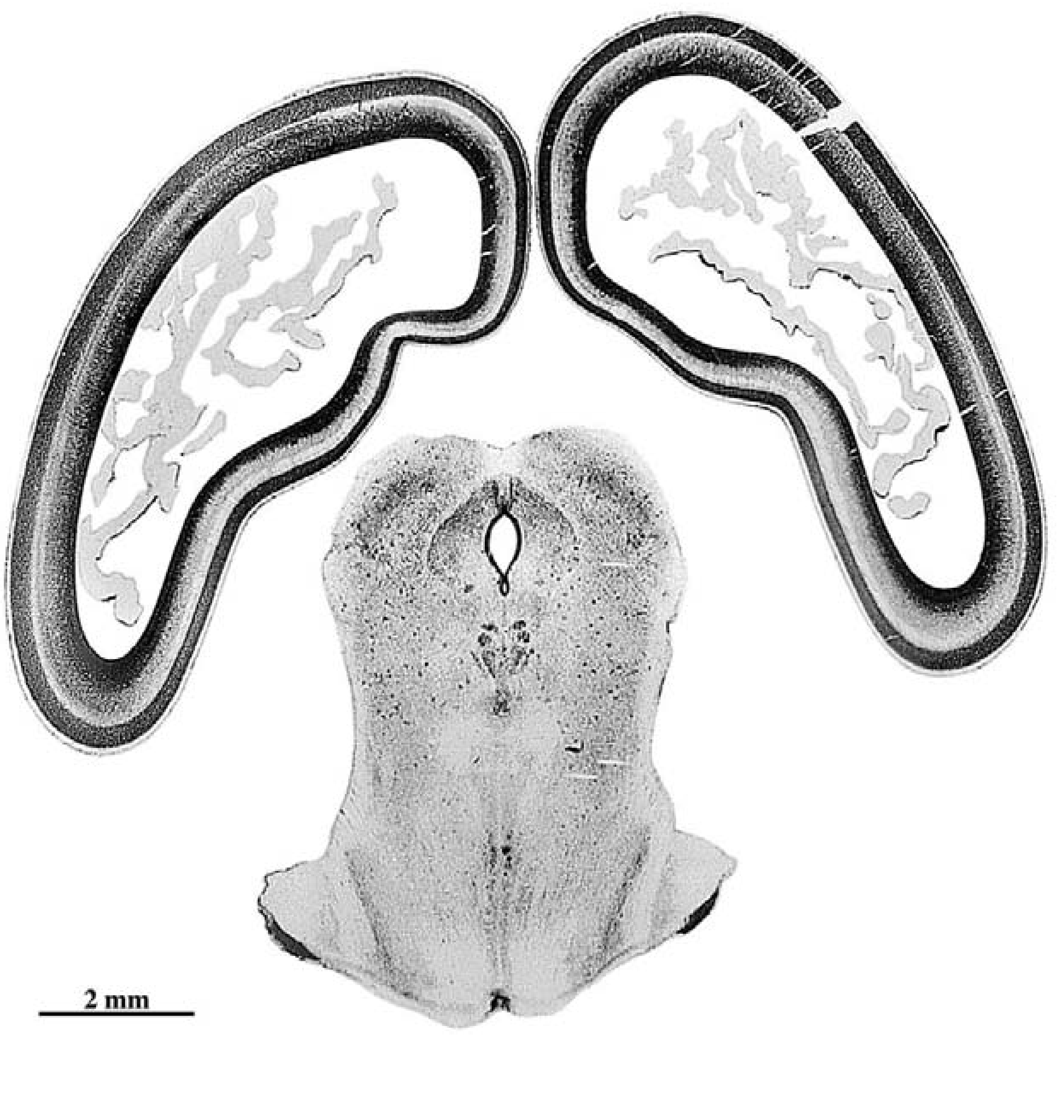
Dashed lines indicate staining and/or sectioning artifacts.

PLATE 15A

GW11 Coronal
CR 60 mm, Y1-59
Level 15: Section 569

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF2	Upper cellular layer, the most superficial sojourn zone where cells translocate to the cortical plate.
STF3	Honeycomb trilaminar matrix ***(3a, 3b, 3c)*** of cells and fibers that is not present during the first trimester and is found in granular (sensory) cortices.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.
STF6	Late-forming deep layer of callosal fibers outside the germinal matrix that is not present during the first trimester.

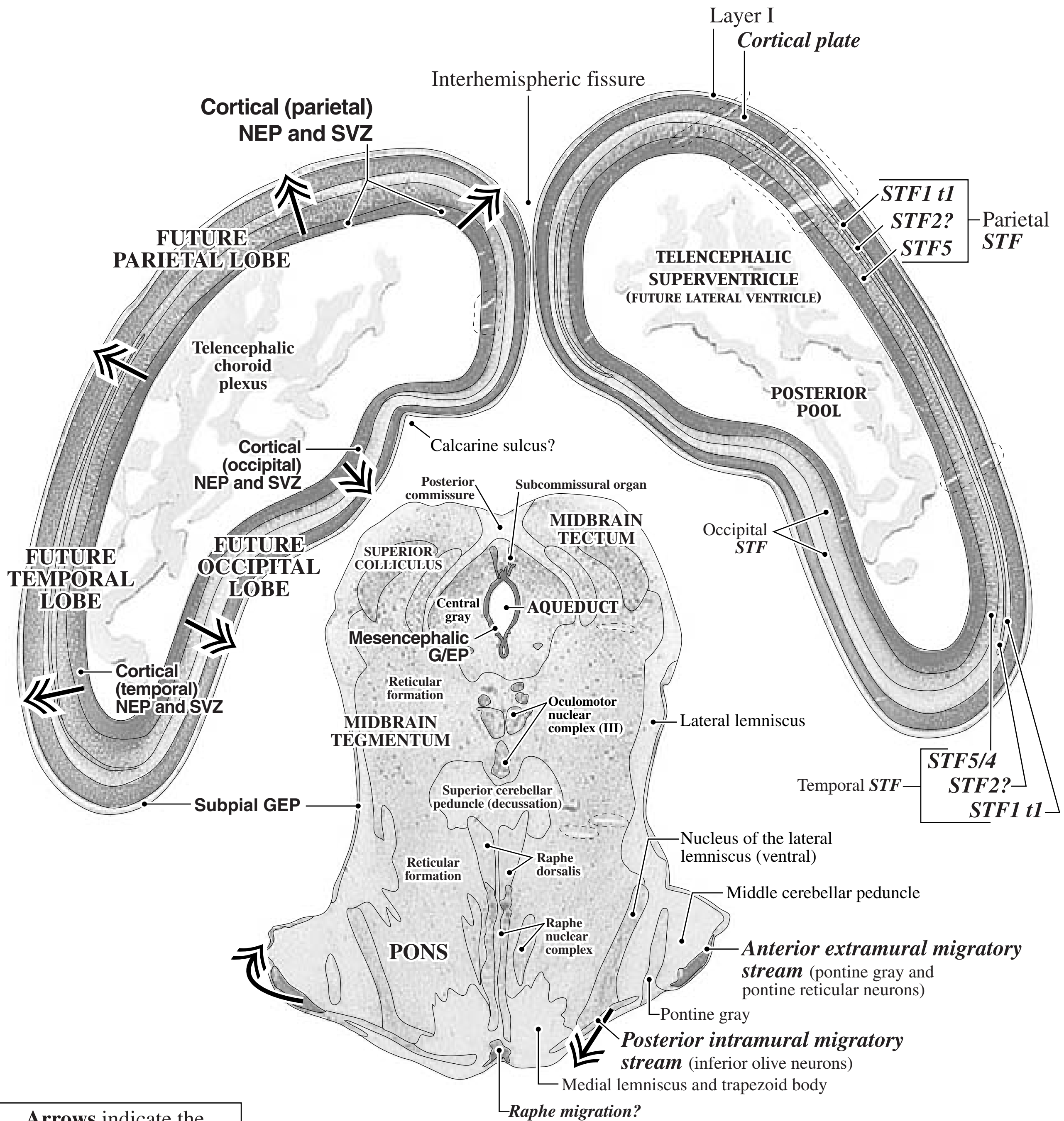


See a high-magnification view of the midbrain and pons from section 549 in Plates 32A and B, and from this section in Plates 33A and B.

PLATE 15B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

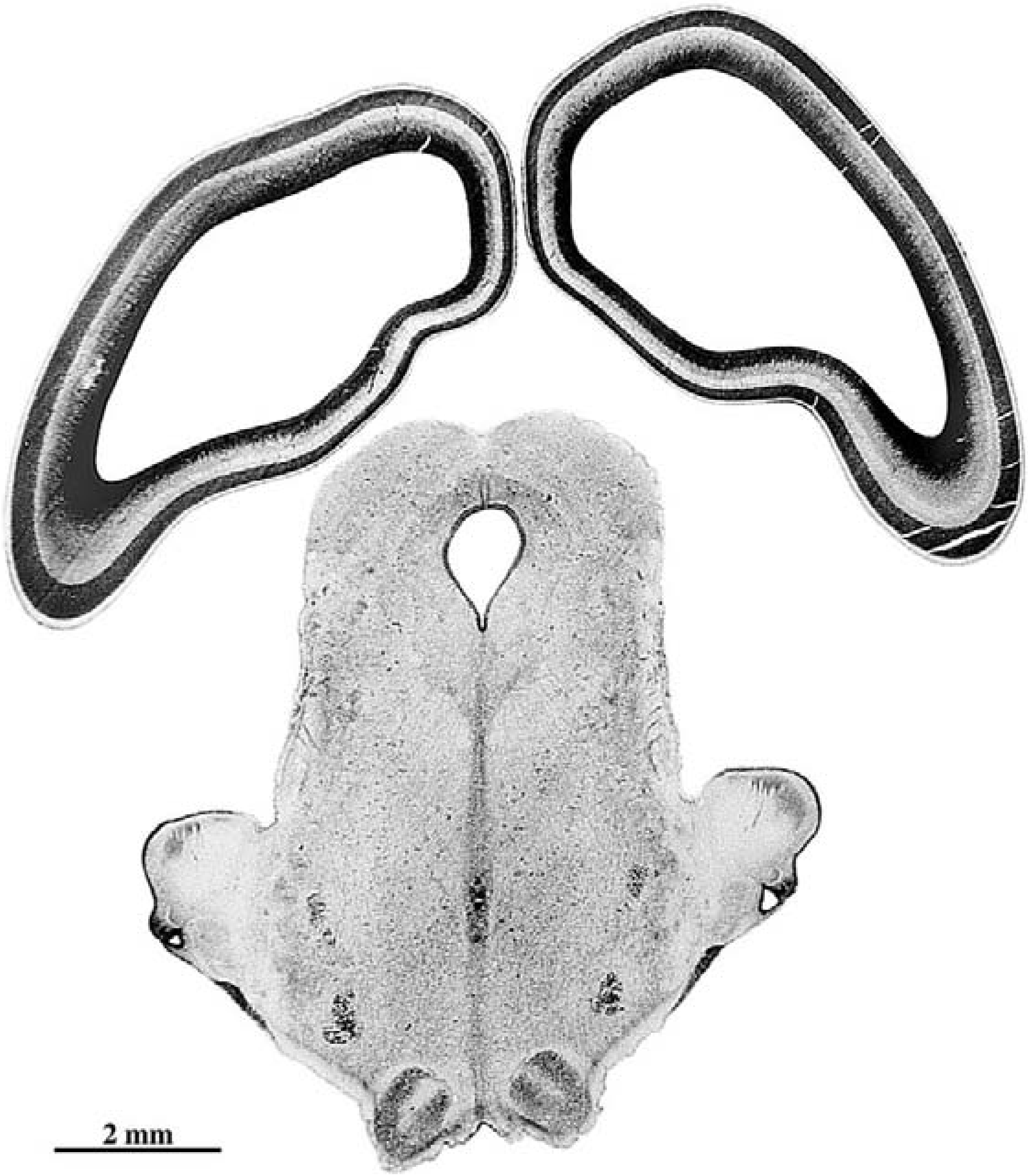
Dashed lines indicate staining and/or sectioning artifacts.

PLATE 16A

GW11 Coronal
CR 60 mm, Y1-59
Level 16: Section 599

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF2	Upper cellular layer, the most superficial sojourn zone where cells translocate to the cortical plate.
STF3	Honeycomb trilaminar matrix ***(3a, 3b, 3c)*** of cells and fibers that is not present during the first trimester and is found in granular (sensory) cortices.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.
STF6	Late-forming deep layer of callosal fibers outside the germinal matrix that is not present during the first trimester.

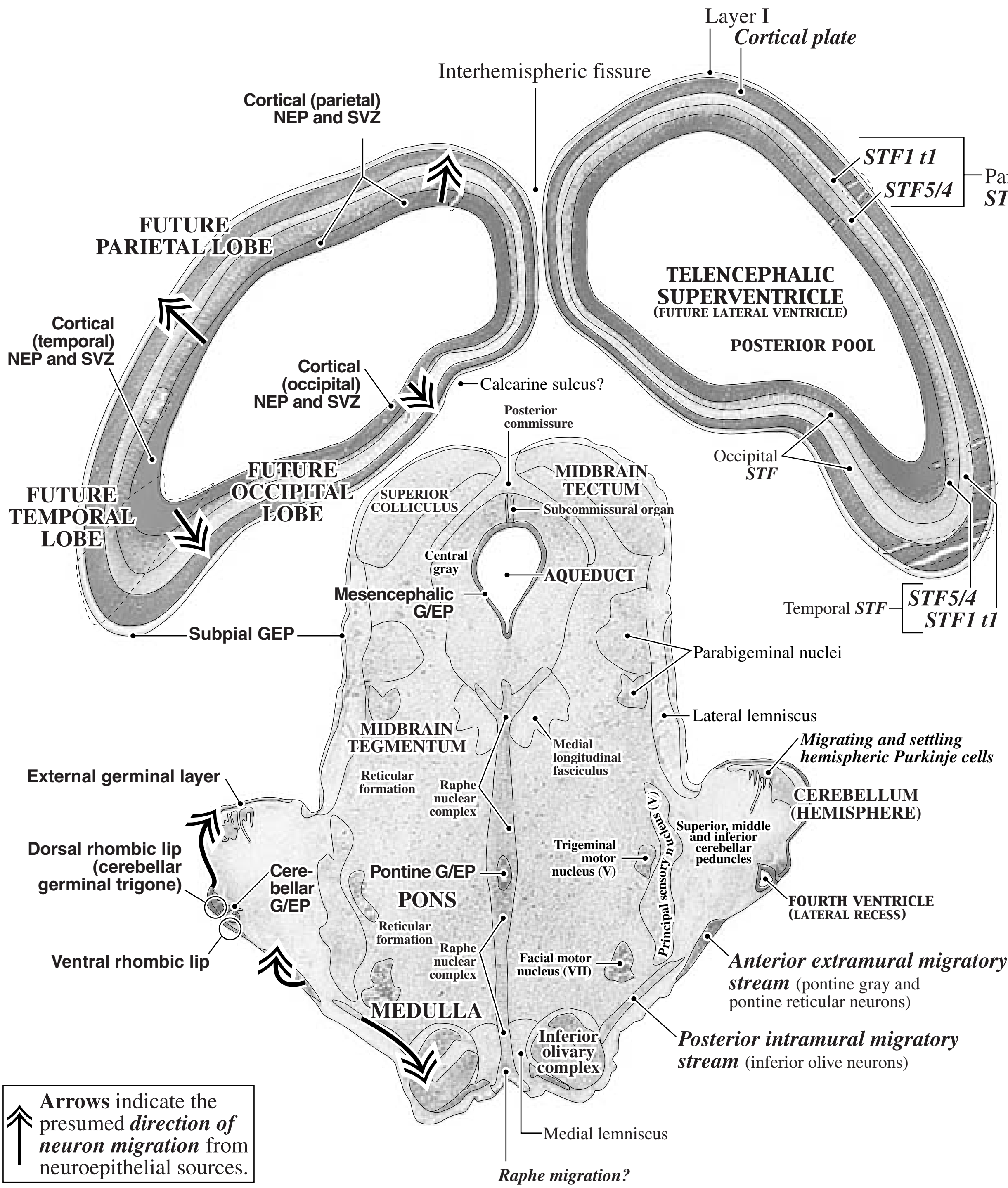


See a high-magnification view of the midbrain and pons from section 589 in Plates 34A and B and from this section in Plates 35A and B.

PLATE 16B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 17A

GW11 Coronal
CR 60 mm, Y1-59
Level 17: Section 629

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF2	Upper cellular layer, the most superficial sojourn zone where cells translocate to the cortical plate.
STF3	Honeycomb trilaminar matrix ***(3a, 3b, 3c)*** of cells and fibers that is not present during the first trimester and is found in granular (sensory) cortices.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.
STF6	Late-forming deep layer of callosal fibers outside the germinal matrix that is not present during the first trimester.

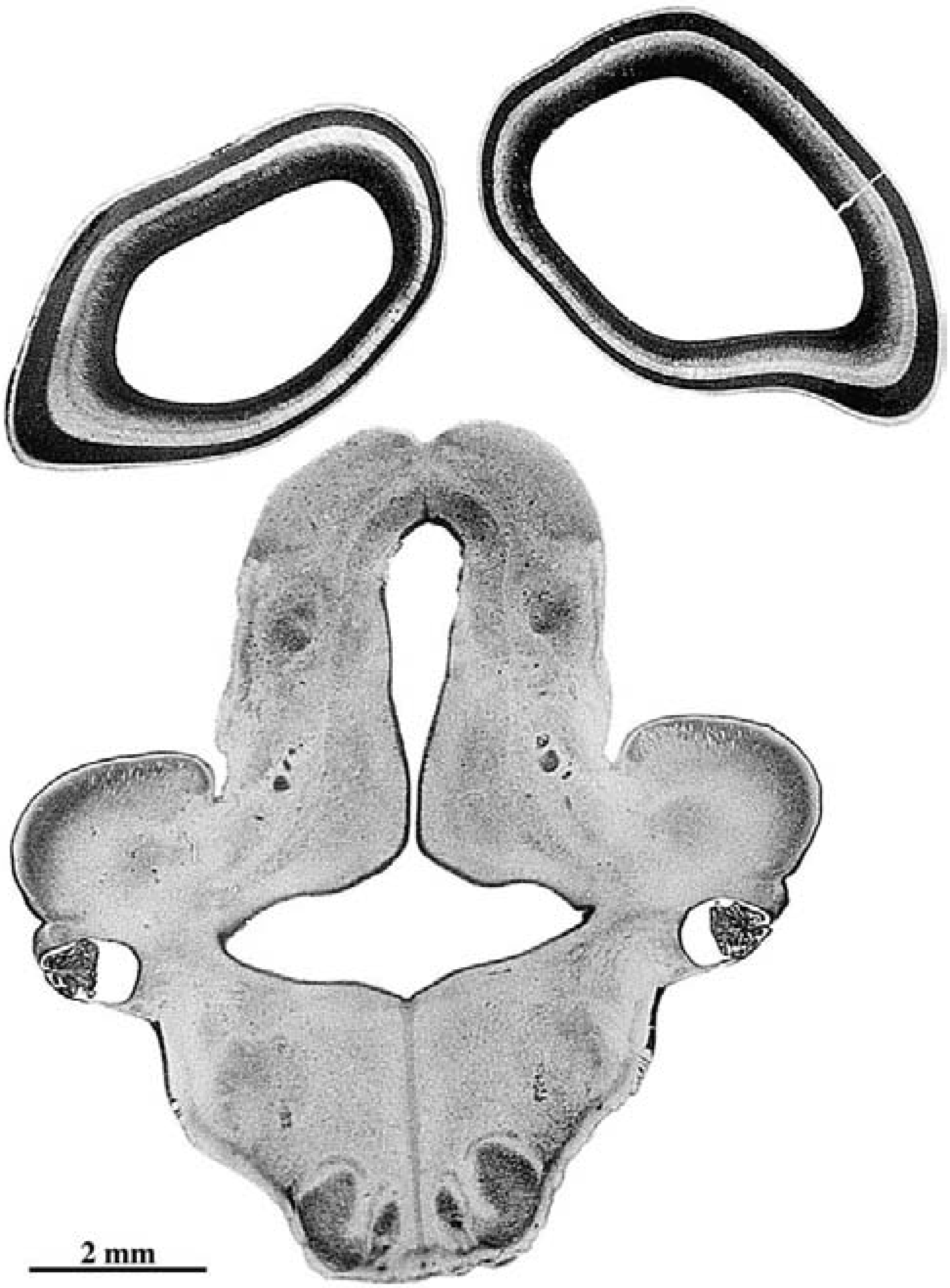
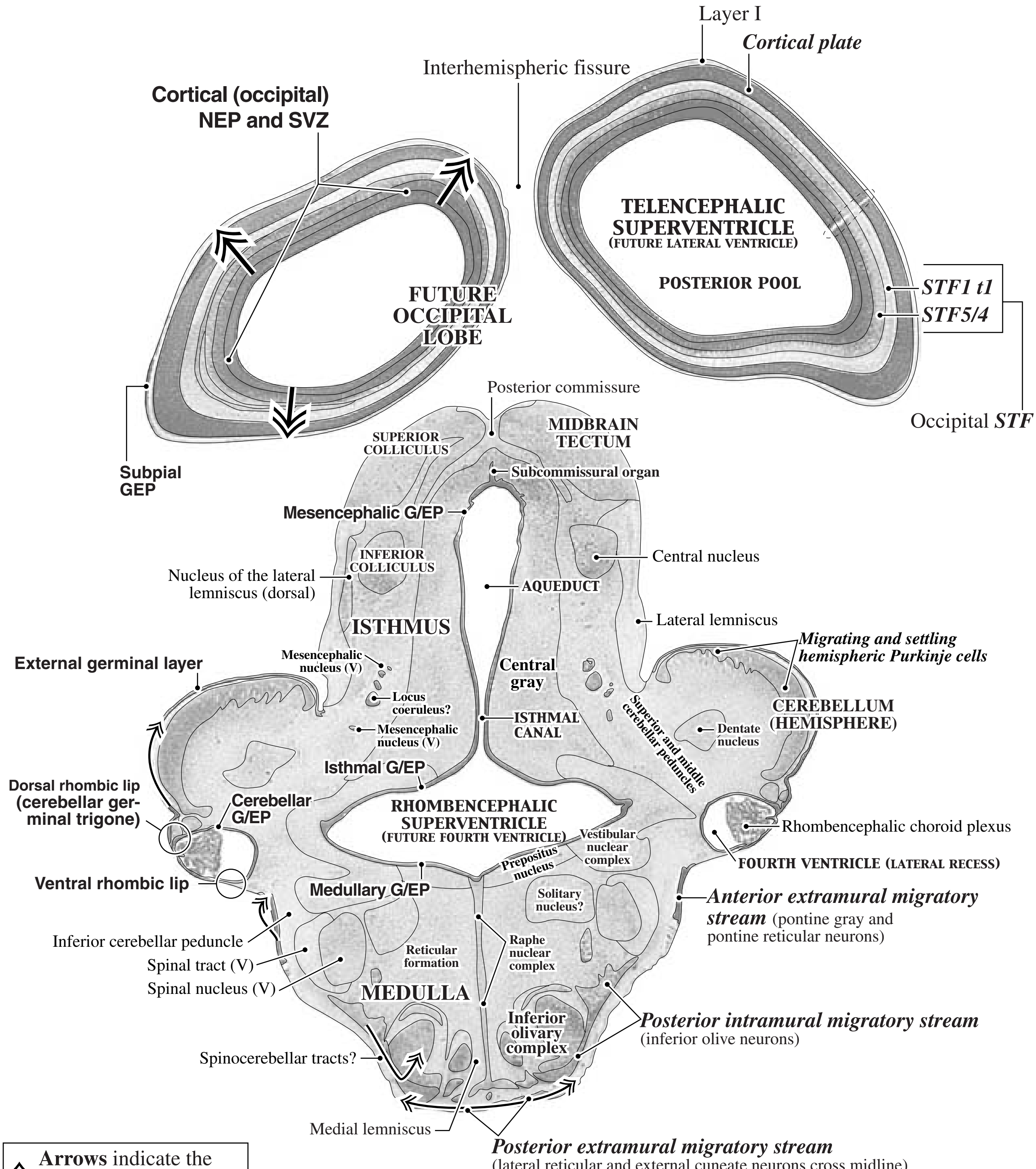


PLATE 17B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 18A

GW11 Coronal
CR 60 mm, Y1-59
Level 18: Section 649

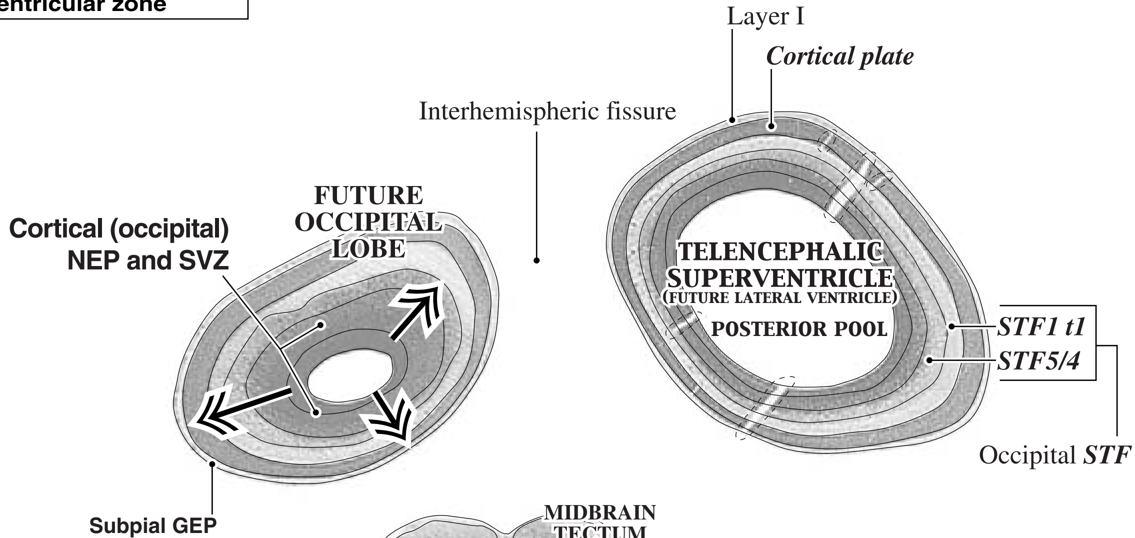
LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

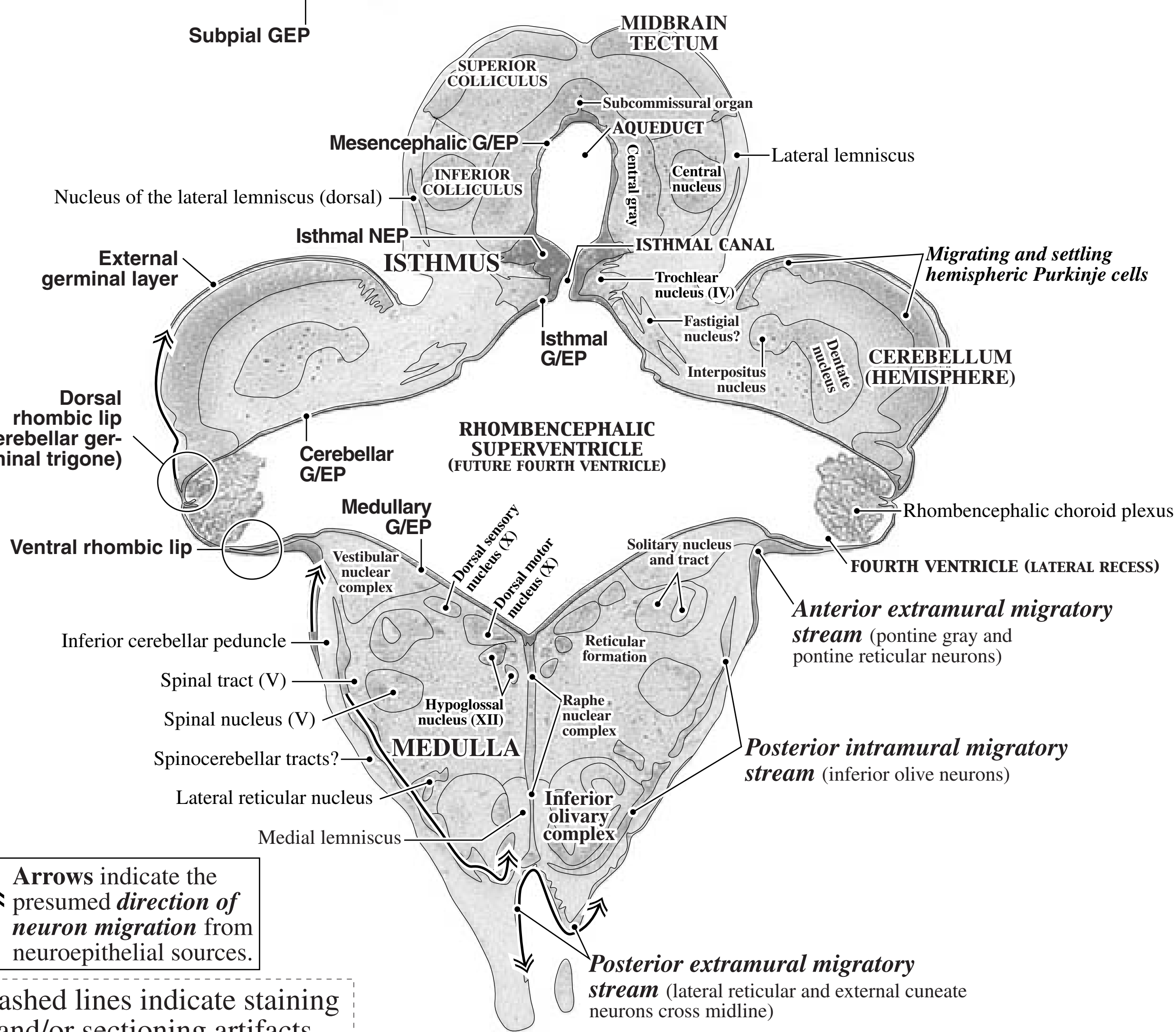
STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF2	Upper cellular layer, the most superficial sojourn zone where cells translocate to the cortical plate.
STF3	Honeycomb trilaminar matrix ***(3a, 3b, 3c)*** of cells and fibers that is not present during the first trimester and is found in granular (sensory) cortices.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.
STF6	Late-forming deep layer of callosal fibers outside the germinal matrix that is not present during the first trimester.

PLATE 18B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone





Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 19A

GW11 Coronal
CR 60 mm, Y1-59
Level 19: Section 659

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1 Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.

STF2 Upper cellular layer, the most superficial sojourn zone where cells translocate to the cortical plate.

STF3 Honeycomb trilaminar matrix ***(3a, 3b, 3c)*** of cells and fibers that is not present during the first trimester and is found in granular (sensory) cortices.

STF4 Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.

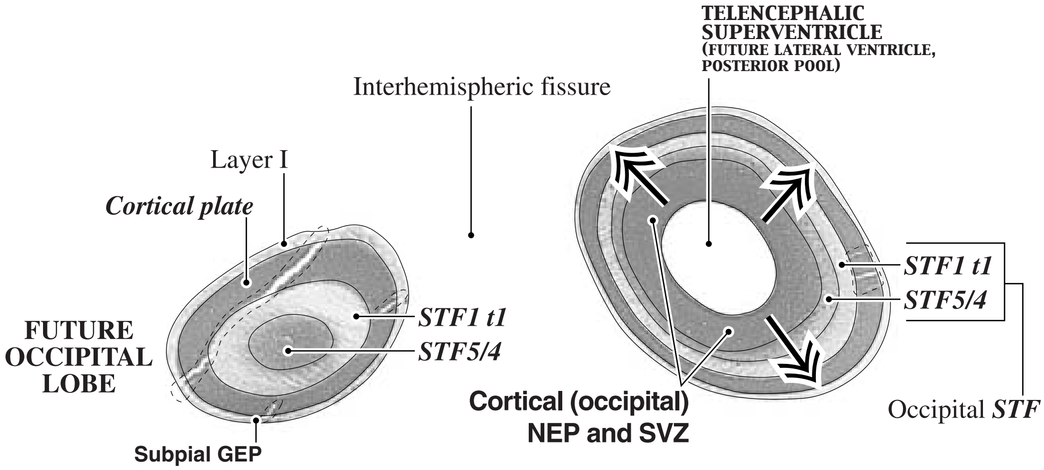
STF5 Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

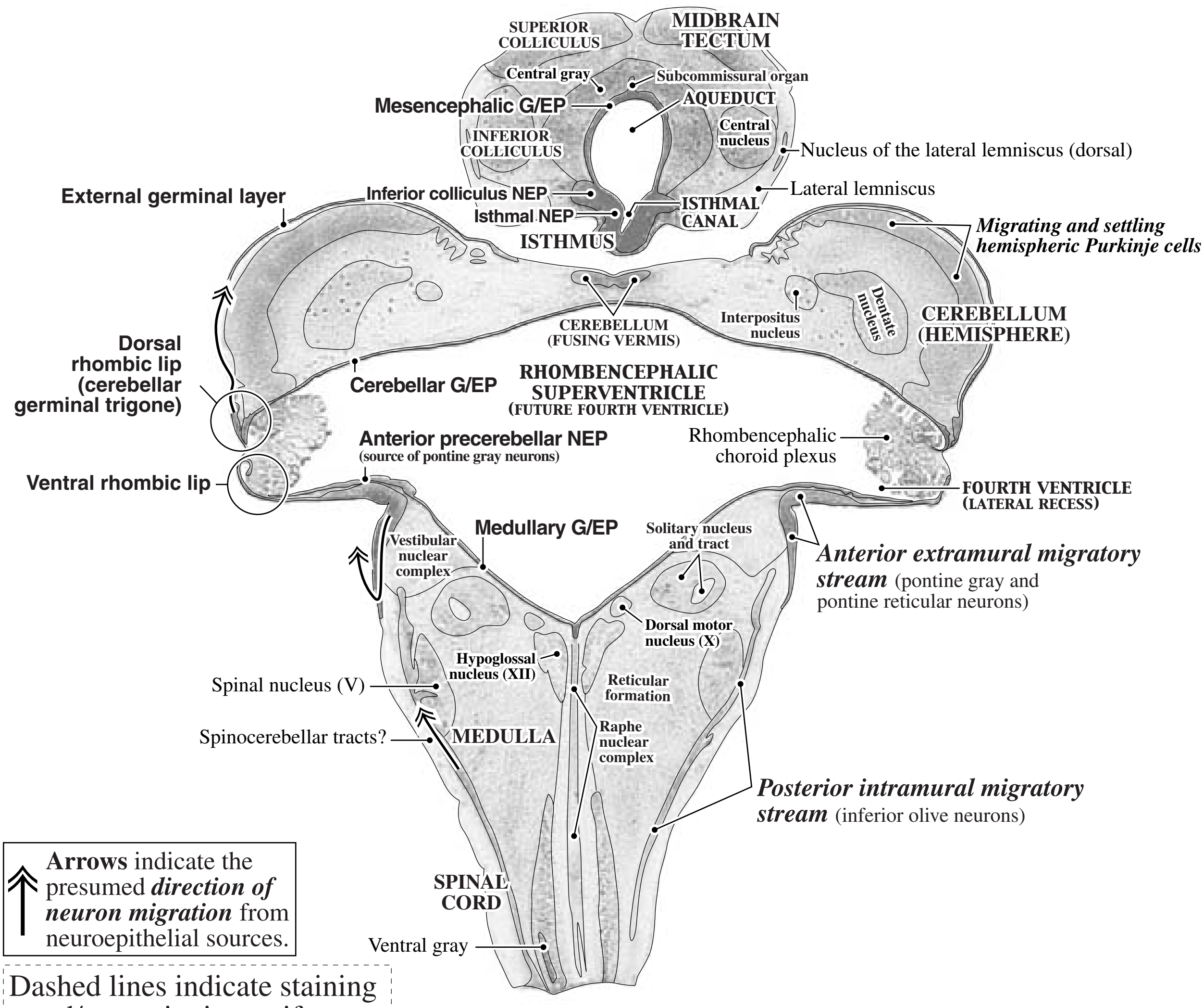
STF6 Late-forming deep layer of callosal fibers outside the germinal matrix that is not present during the first trimester.

PLATE 19B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone





Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 20A

GW11 Coronal
CR 60 mm, Y1-59
Level 20: Section 680

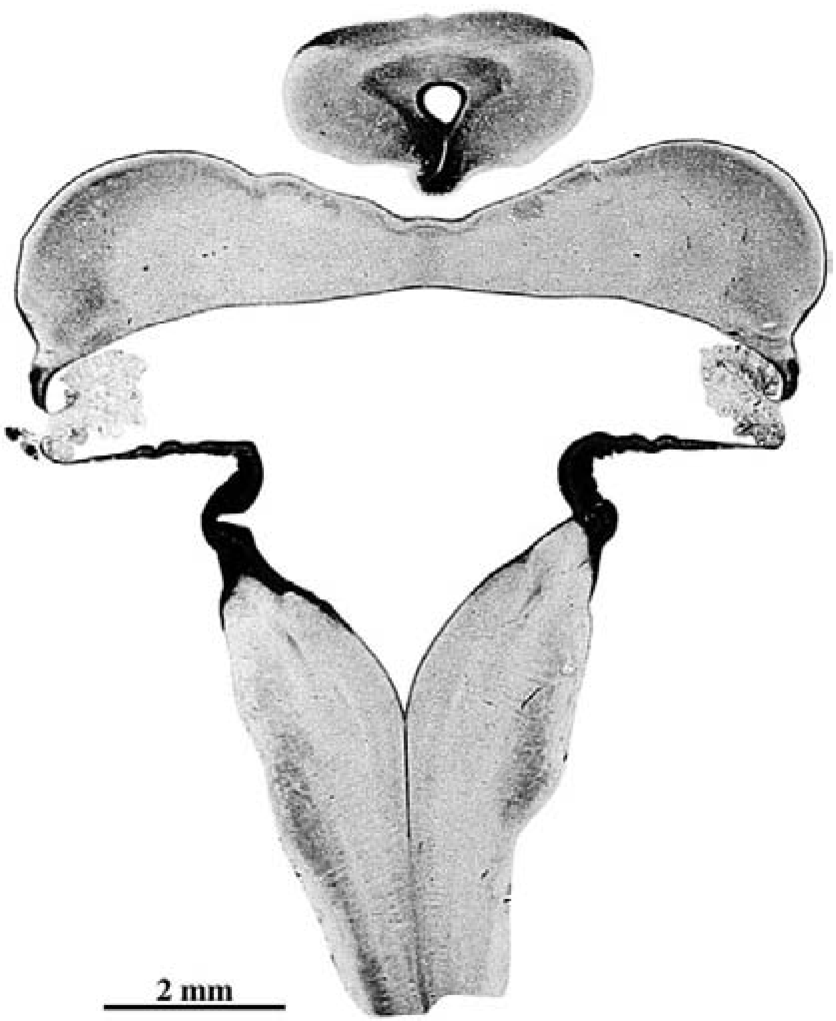


PLATE 20B

FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

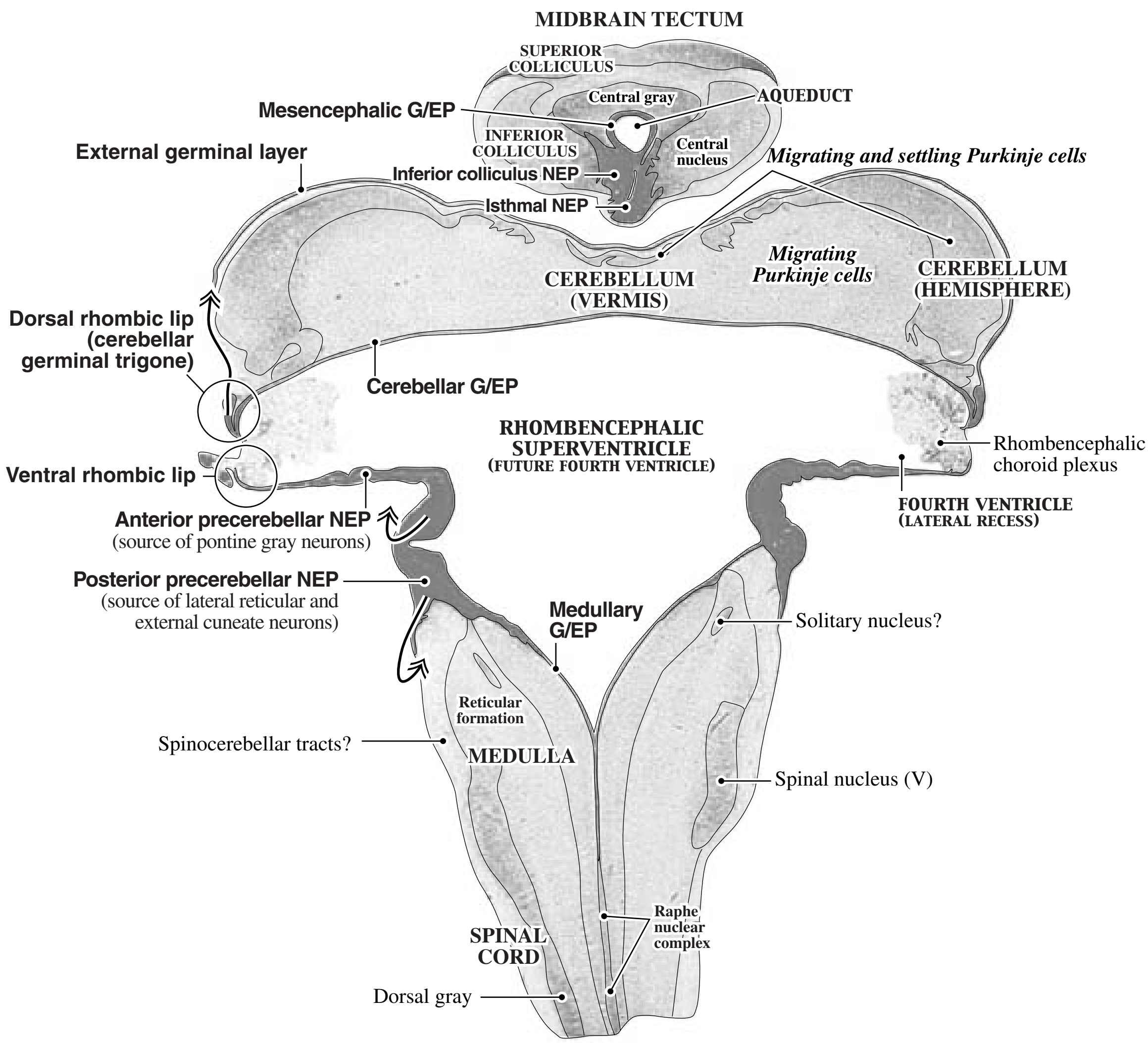
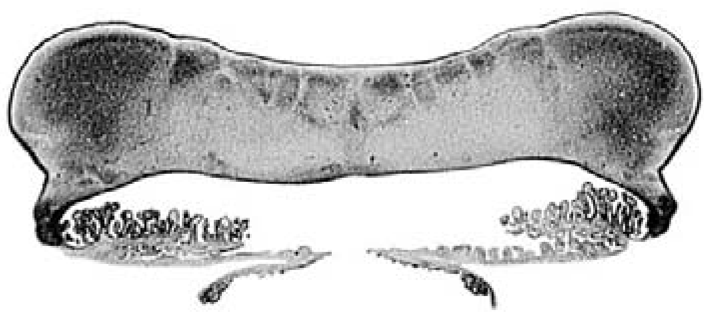


PLATE 21A

GW11 Coronal
CR 60 mm, Y1-59

Level 21: Section 709



Level 22: Section 720

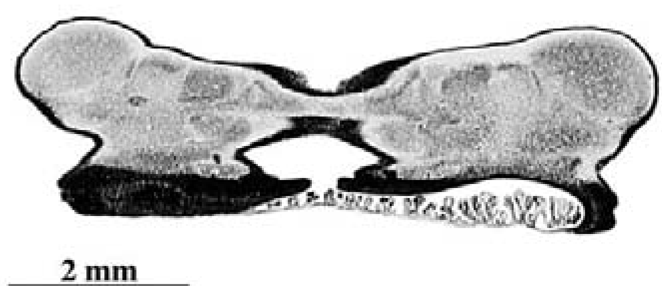
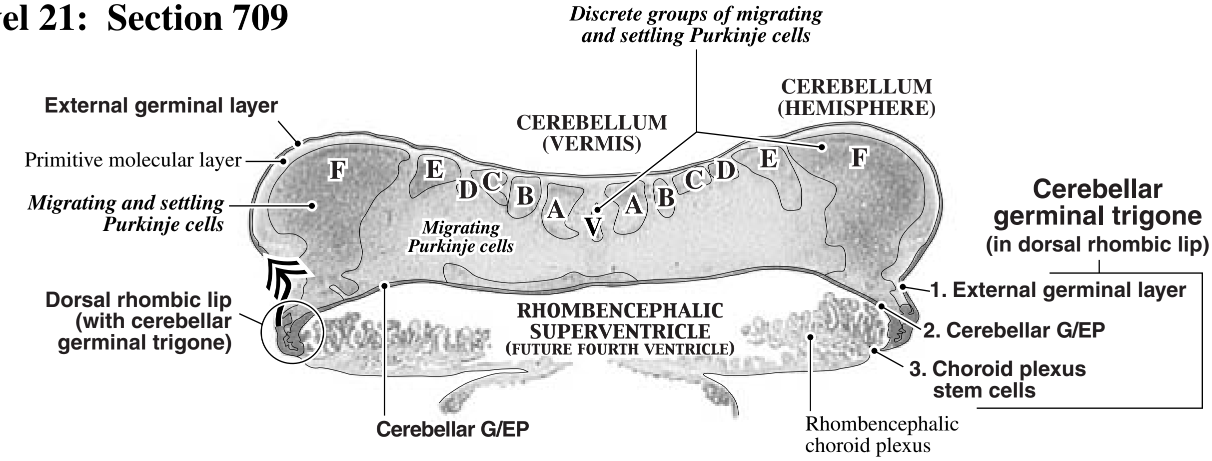


PLATE 21B

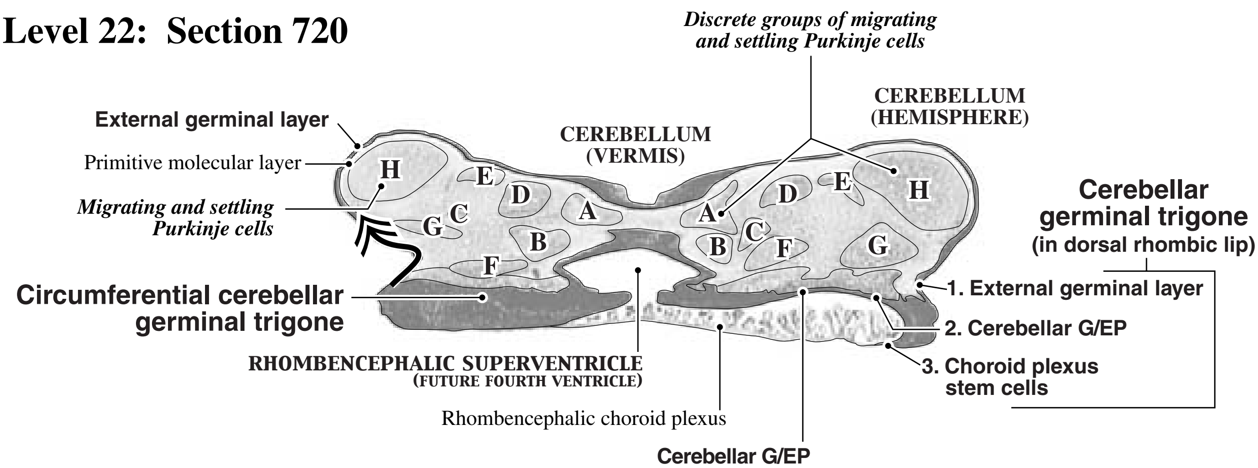
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

Gioepithelium/ependyma - G/EP

Level 21: Section 709



Level 22: Section 720



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 22A

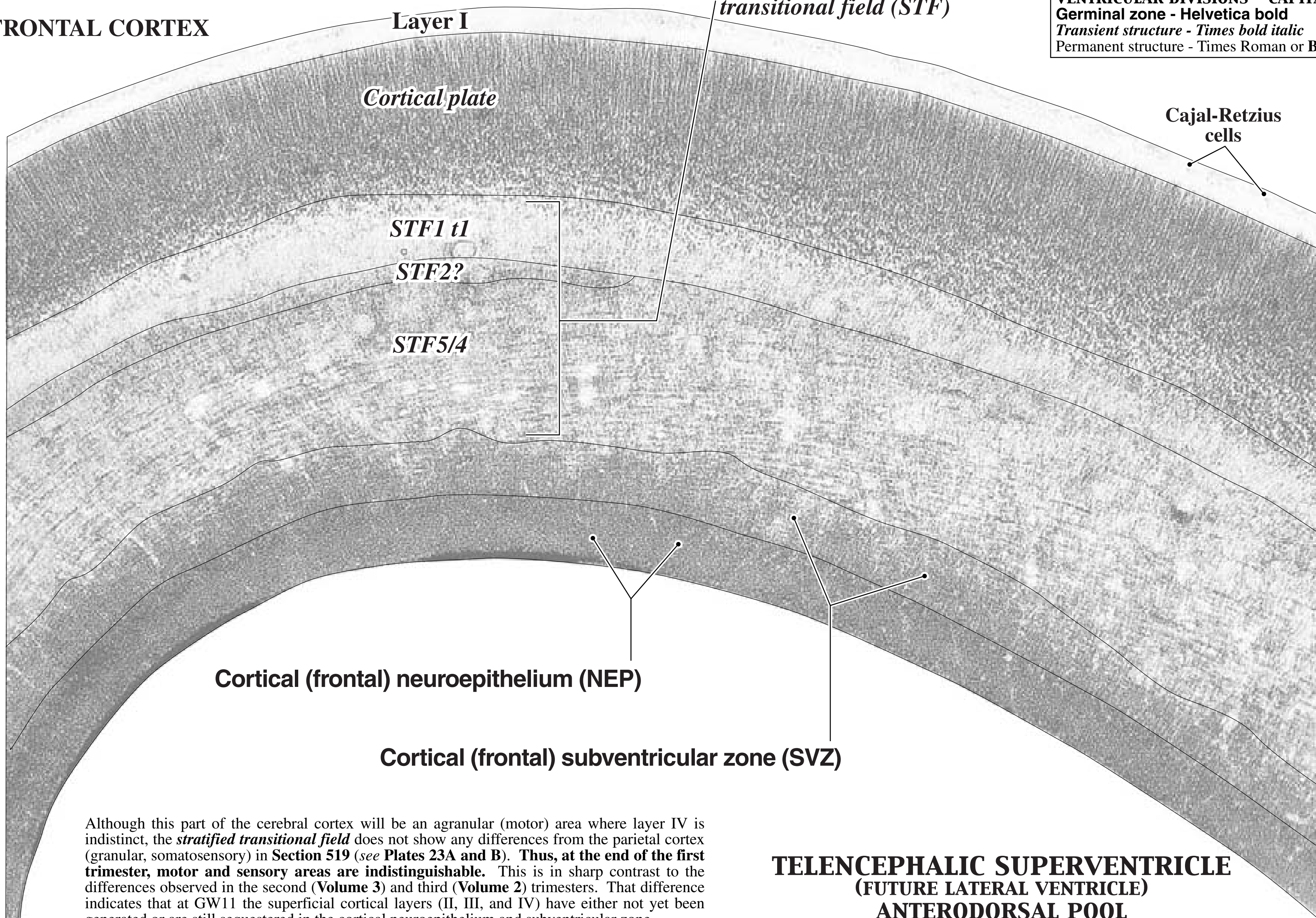
GW11 Coronal
CR 60 mm, Y1-59
Between levels 2 and 3:
Section 269
FRONTAL
CORTEX

See level 2 in Plates 2A and B, level 3 in Plates 3A and B.

PLATE 22B

FRONTAL CORTEX

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**



Although this part of the cerebral cortex will be an agranular (motor) area where layer IV is indistinct, the ***stratified transitional field*** does not show any differences from the parietal cortex (granular, somatosensory) in **Section 519** (*see* **Plates 23A and B**). **Thus, at the end of the first trimester, motor and sensory areas are indistinguishable.** This is in sharp contrast to the differences observed in the second (**Volume 3**) and third (**Volume 2**) trimesters. That difference indicates that at GW11 the superficial cortical layers (II, III, and IV) have either not yet been generated or are still sequestered in the cortical neuroepithelium and subventricular zone.

PLATE 23A

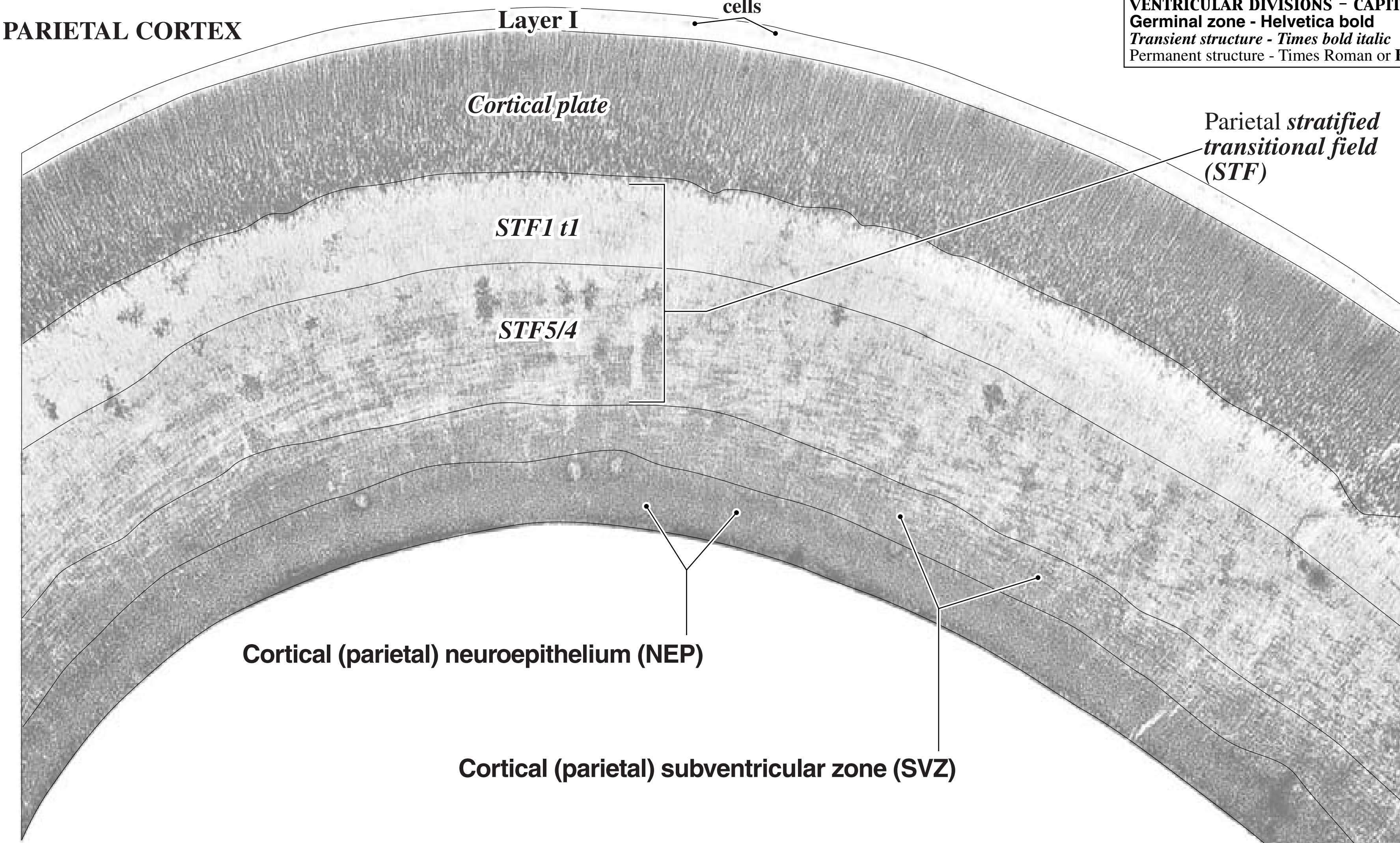
GW11 Coronal
CR 60 mm, Y1-59
Near level 14:
Section 519
PARIETAL
CORTEX

See level 14 in Plates 14A and B.

PLATE 23B

PARIETAL CORTEX

FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**



Although this part of the cerebral cortex will be a granular (somatosensory) area where layer IV is prominent, the ***stratified transitional field*** does not show any differences from the frontal cortex (agranular, motor) in **Section 269** (*see* **Plates 22A and B**). **Thus, at the end of the first trimester, motor and sensory areas are indistinguishable.** This is in sharp contrast to the differences observed in the second (**Volume 3**) and third (**Volume 2**) trimesters. That difference indicates that at GW11 the superficial cortical layers (II, III, and IV) have either not yet been generated or are still sequestered in the cortical neuroepithelium and subventricular zone.

PLATE 24A

GW11 Coronal
CR 60 mm, Y1-59
Between levels 8 and 9:
Section 399

PARACENTRAL
CORTEX

See levels 8 and 9
in Plates
8 to 9A and B.

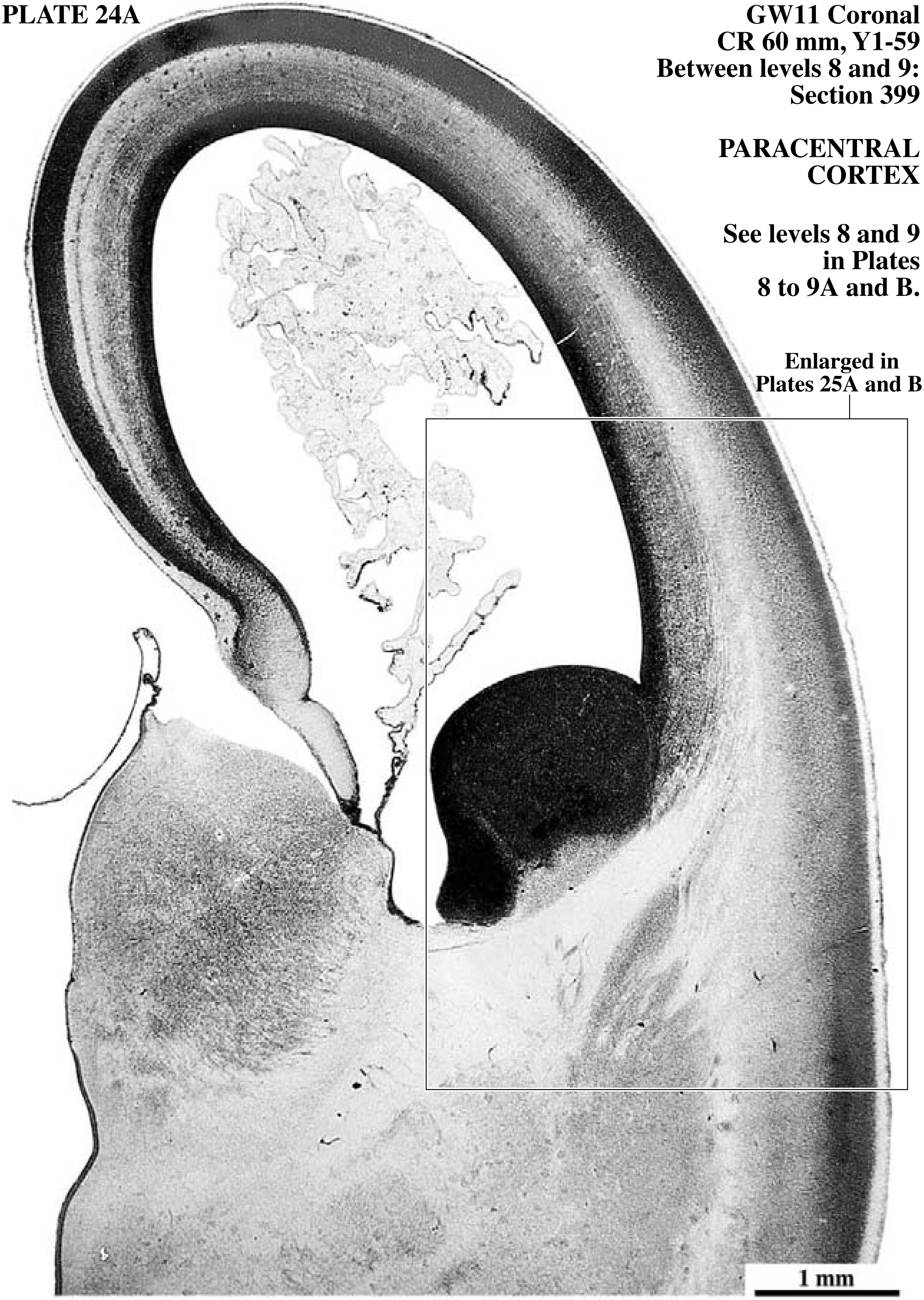
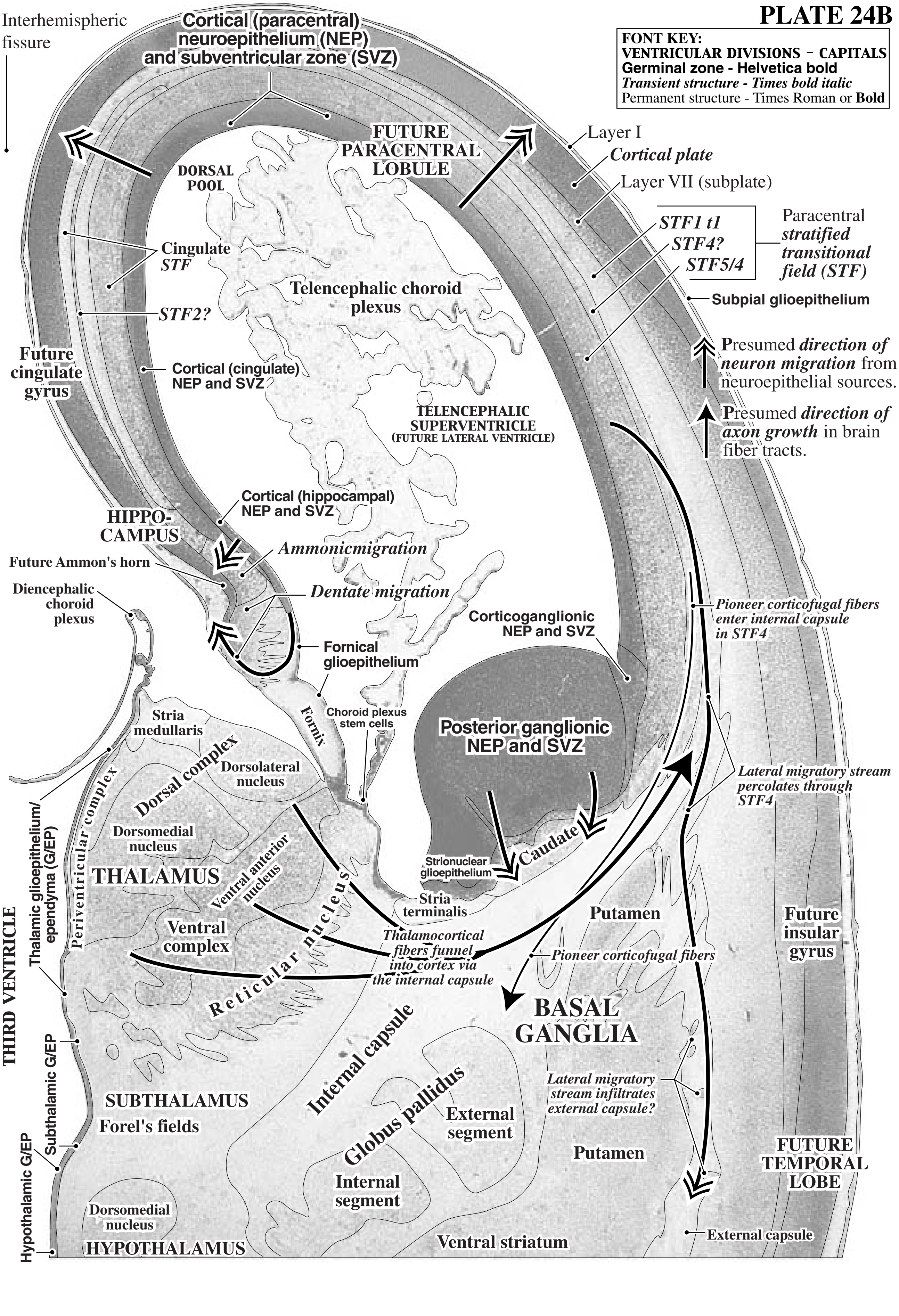


PLATE 24B



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
Interhemispheric fissure
Cortical (paracentral) neuroepithelium (NEP) and subventricular zone (SVZ)
FUTURE PARACENTRAL LOBULE
DORSAL POOL
Layer I
Cortical plate
Layer VII (subplate)
STF1 t1
STF4?
STF5/4
Paracentral stratified transitional field (STF)
Subpial glioepithelium
Cingulate STF
STF2?
Telencephalic choroid plexus
Future cingulate gyrus
Cortical (cingulate) NEP and SVZ
Presumed direction of neuron migration from neuroepithelial sources.
Presumed direction of axon growth in brain fiber tracts.
TELENCEPHALIC SUPERVENTRICLE (FUTURE LATERAL VENTRICLE)
Cortical (hippocampal) NEP and SVZ
HIPPO-CAMPUS
Ammonicmigration
Future Ammon's horn
Dentate migration
Diencephalic choroid plexus
Corticoganglionic NEP and SVZ
Pioneer corticofugal fibers enter internal capsule in STF4
Fornical glioepithelium
Stria medullaris
Fornix
Choroid plexus stem cells
Posterior ganglionic NEP and SVZ
Dorsal complex
Dorsolateral nucleus
Lateral migratory stream percolates through STF4
Thalamic glioepithelium/ ependyma (G/EP)
Periventricular complex
Dorsomedial nucleus
Ventral anterior nucleus
Strionuclear glioepithelium
Caudate
THALAMUS
Stria terminalis
Putamen
Future insular gyrus
THIRD VENTRICLE
Ventral complex
Thalamocortical fibers funnel into cortex via the internal capsule
Pioneer corticofugal fibers
Reticular nucleus
BASAL GANGLIA
Subthalamic G/EP
Internal capsule
Lateral migratory stream infiltrates external capsule?
SUBTHALAMUS
Globus pallidus
External segment
Forel's fields
Putamen
FUTURE TEMPORAL LOBE
Hypothalamic G/EP
Internal segment
Dorsomedial nucleus
External capsule
HYPOTHALAMUS
Ventral striatum

PLATE 25A

GW11 Coronal
CR 60 mm, Y1-59
Between levels 8 and 9:
Section 399

ENTRY/EXIT ZONE IN LATERAL PARACENTRAL CORTEX

See levels 8 and 9 in Plates 8 to 9A and B.

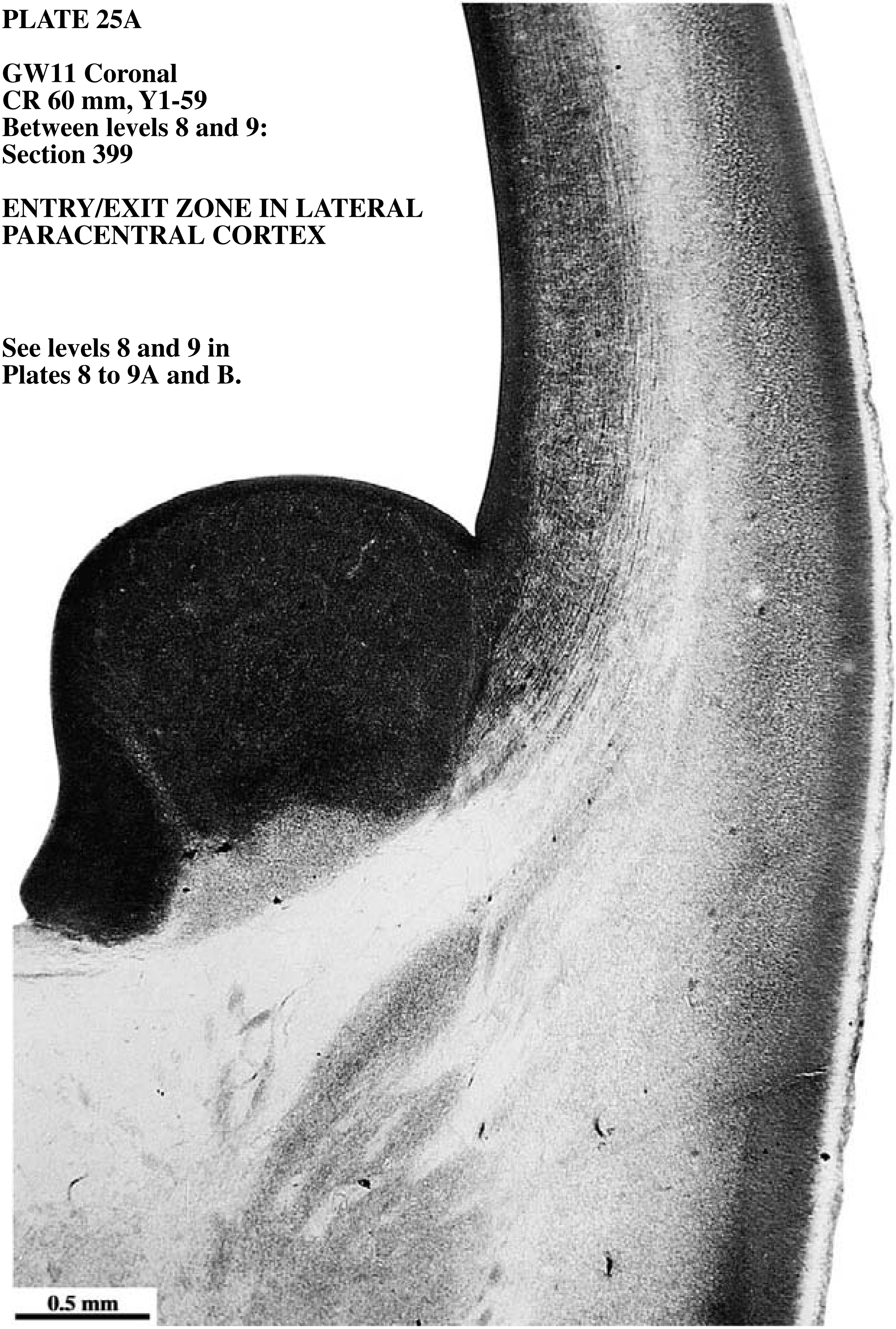


PLATE 25B

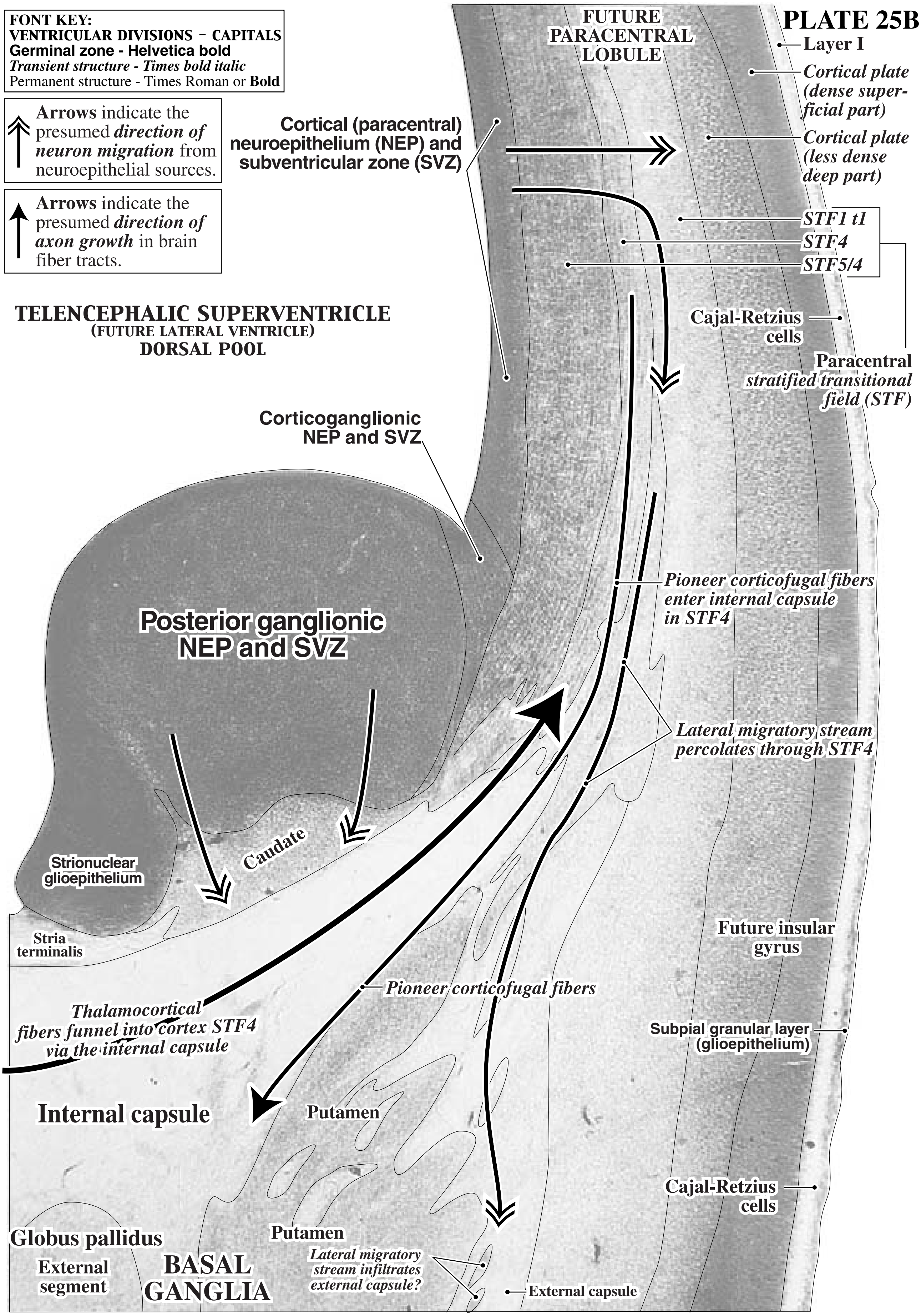
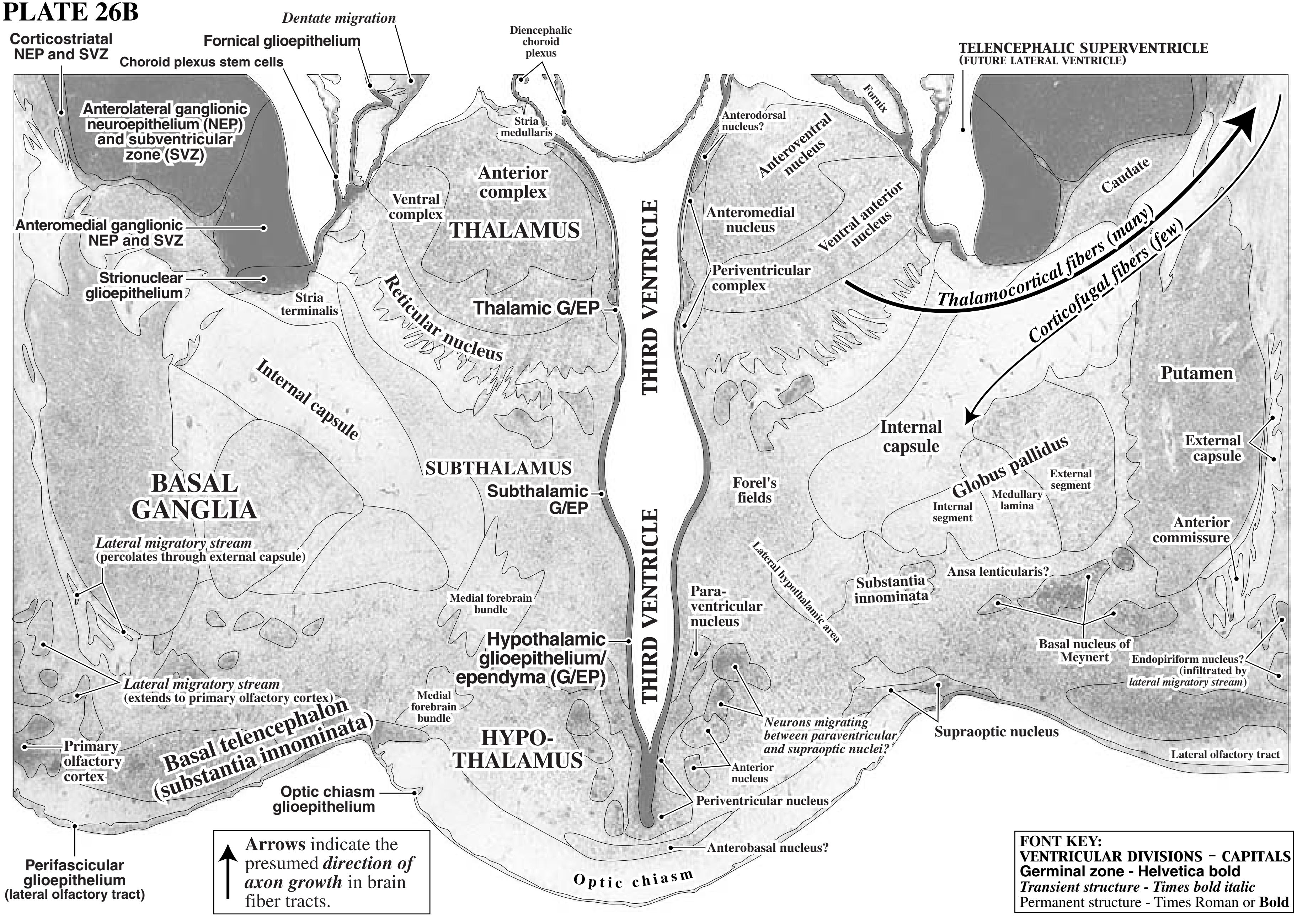

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Arrows indicate the presumed direction of axon growth in brain fiber tracts.
FUTURE PARACENTRAL LOBULE
Layer I
Cortical plate (dense superficial part)
Cortical plate (less dense deep part)
Cortical (paracentral) neuroepithelium (NEP) and subventricular zone (SVZ)
STF1 t1
STF4
STF5/4
TELENCEPHALIC SUPERVENTRICLE
(FUTURE LATERAL VENTRICLE)
DORSAL POOL
Cajal-Retzius cells
Paracentral stratified transitional field (STF)
Corticoganglionic NEP and SVZ
Pioneer corticofugal fibers enter internal capsule in STF4
Posterior ganglionic NEP and SVZ
Lateral migratory stream percolates through STF4
Caudate
Strionuclear glioepithelium
Stria terminalis
Future insular gyrus
Pioneer corticofugal fibers
Thalamocortical fibers funnel into cortex STF4 via the internal capsule
Subpial granular layer (glioepithelium)
Internal capsule
Putamen
Cajal-Retzius cells
Globus pallidus
External segment
BASAL GANGLIA
Putamen
Lateral migratory stream infiltrates external capsule?
External capsule

PLATE 26A
GW11 Coronal, CR 60 mm, Y1-59, Near level 8: Section 389

DIENCEPHALON, BASAL GANGLIA, and BASAL TELENCEPHALON

See level 8 in Plates 8A and B.

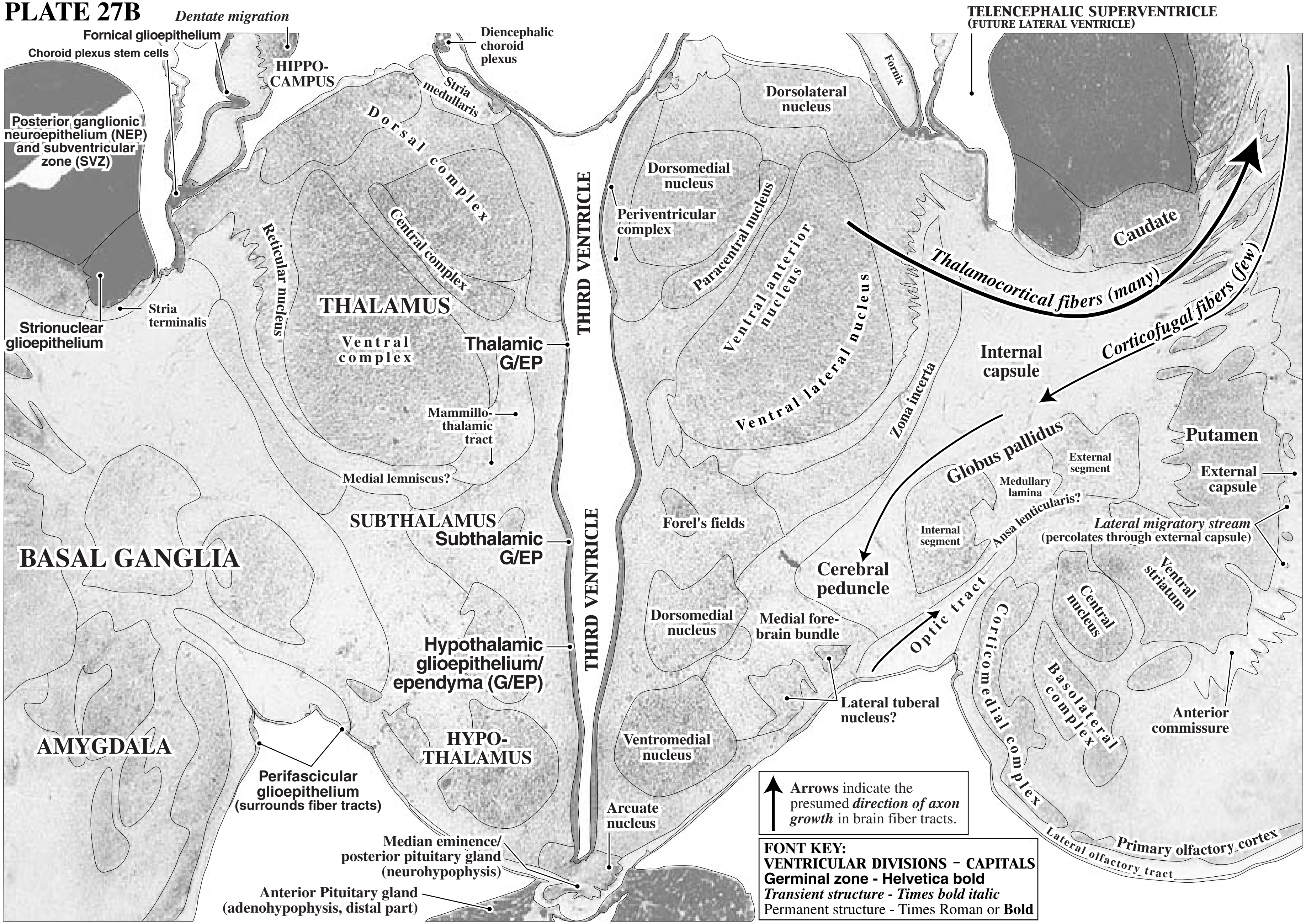
PLATE 26B



Corticostriatal NEP and SVZ
Dentate migration
Fornical glioepithelium
Choroid plexus stem cells
Diencephalic choroid plexus
TELENCEPHALIC SUPERVENTRICLE (FUTURE LATERAL VENTRICLE)
Anterolateral ganglionic neuroepithelium (NEP) and subventricular zone (SVZ)
Stria medullaris
Anterior complex
Ventral complex
THALAMUS
Anterodorsal nucleus?
Anteroventral nucleus
Fornix
Caudate
Anteromedial ganglionic NEP and SVZ
Anteromedial nucleus
Ventral anterior nucleus
Strionuclear glioepithelium
Stria terminalis
Reticular nucleus
Periventricular complex
Thalamocortical fibers (many)
Corticofugal fibers (few)
Thalamic G/EP
THIRD VENTRICLE
Internal capsule
Putamen
Internal capsule
External capsule
Globus pallidus
External segment
Medullary lamina
Internal segment
SUBTHALAMUS
Subthalamic G/EP
BASAL GANGLIA
Forel's fields
Anterior commissure
Lateral migratory stream (percolates through external capsule)
Lateral hypothalamic area
Ansa lenticularis?
Substantia innominata
Medial forebrain bundle
Para-ventricular nucleus
Hypothalamic glioepithelium/ ependyma (G/EP)
Basal nucleus of Meynert
Endopiriform nucleus? (infiltrated by lateral migratory stream)
Lateral migratory stream (extends to primary olfactory cortex)
THIRD VENTRICLE
Medial forebrain bundle
Neurons migrating between paraventricular and supraoptic nuclei?
Supraoptic nucleus
Basal telencephalon (substantia innominata)
HYPO-THALAMUS
Primary olfactory cortex
Anterior nucleus
Lateral olfactory tract
Optic chiasm glioepithelium
Periventricular nucleus
Anterobasal nucleus?
Perifascicular glioepithelium (lateral olfactory tract)
Optic chiasm
Arrows indicate the presumed direction of axon growth in brain fiber tracts.
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold

PLATE 27A, GW11 Coronal, CR 60 mm, Y1-59, Level 9: Section 419

PLATE 27B

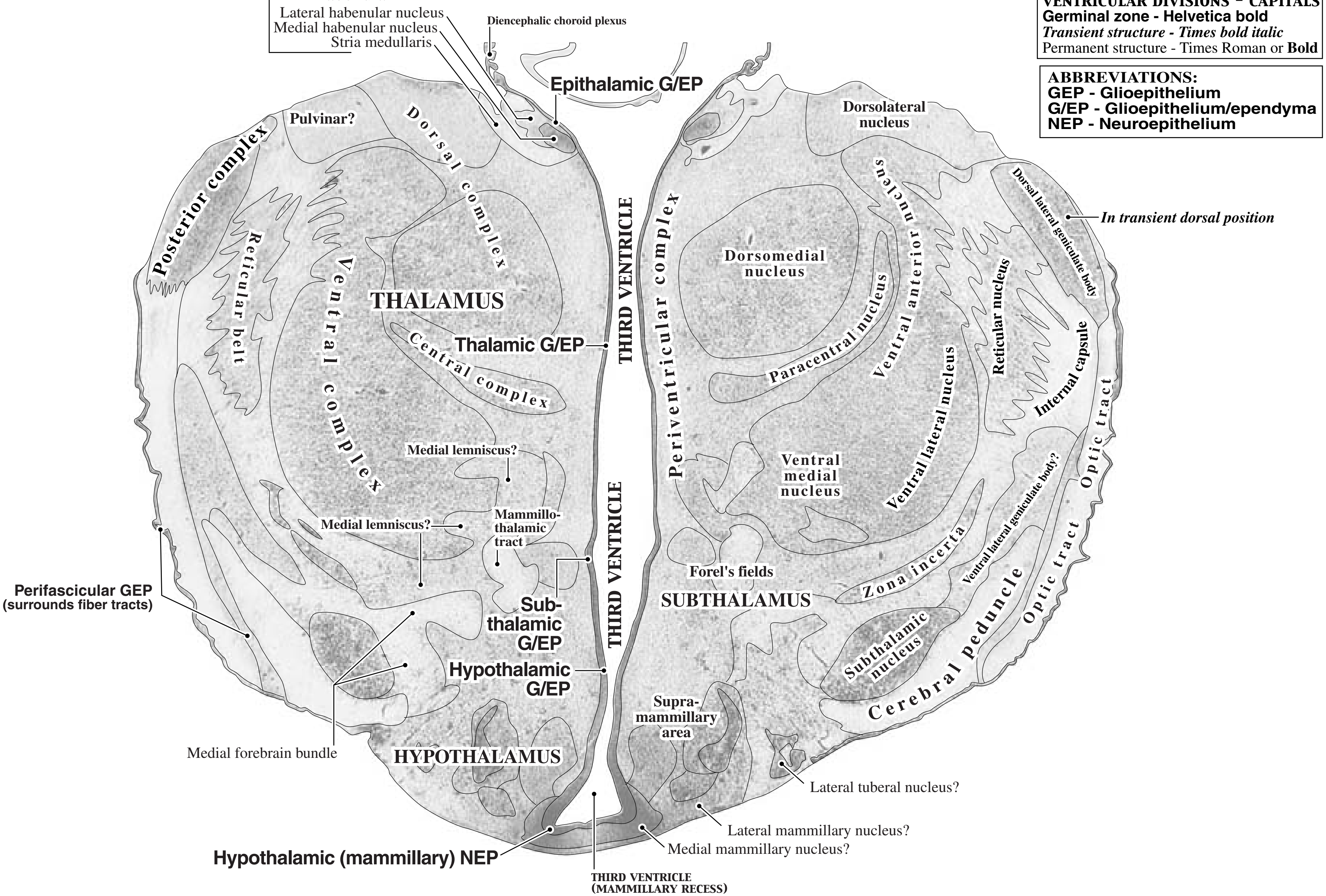


Dentate migration
Fornical glioepithelium
Choroid plexus stem cells
HIPPO-CAMPUS
Diencephalic choroid plexus
Stria medullaris
TELENCEPHALIC SUPERVENTRICLE (FUTURE LATERAL VENTRICLE)
Fornix
Posterior ganglionic neuroepithelium (NEP) and subventricular zone (SVZ)
Dorsal complex
Central complex
Reticular nucleus
THALAMUS
Ventral complex
Strionuclear glioepithelium
Stria terminalis
THIRD VENTRICLE
Thalamic G/EP
Mammillo-thalamic tract
Medial lemniscus?
SUBTHALAMUS
Subthalamic G/EP
BASAL GANGLIA
Hypothalamic glioepithelium/ ependyma (G/EP)
HYPO-THALAMUS
AMYGDALA
Perifascicular glioepithelium (surrounds fiber tracts)
Median eminence/ posterior pituitary gland (neurohypophysis)
Anterior Pituitary gland (adenohypophysis, distal part)
Dorsolateral nucleus
Dorsomedial nucleus
Periventricular complex
Paracentral nucleus
Ventral anterior nucleus
Ventral lateral nucleus
Zona incerta
Caudate
Thalamocortical fibers (many)
Corticofugal fibers (few)
Internal capsule
Putamen
Globus pallidus
External segment
Medullary lamina
Internal segment
Ansa lenticularis?
External capsule
Lateral migratory stream (percolates through external capsule)
Forel's fields
Cerebral peduncle
Dorsomedial nucleus
Medial fore-brain bundle
Optic tract
Ventral striatum
Central nucleus
Corticomedial complex
Basolateral complex
Lateral tuberal nucleus?
Ventromedial nucleus
Anterior commissure
Arcuate nucleus
Primary olfactory cortex
Lateral olfactory tract
Arrows indicate the presumed direction of axon growth in brain fiber tracts.
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold

PLATE 28A
GW11 Coronal, CR 60 mm, Y1-59,
Between levels 10 and 11: Section 449

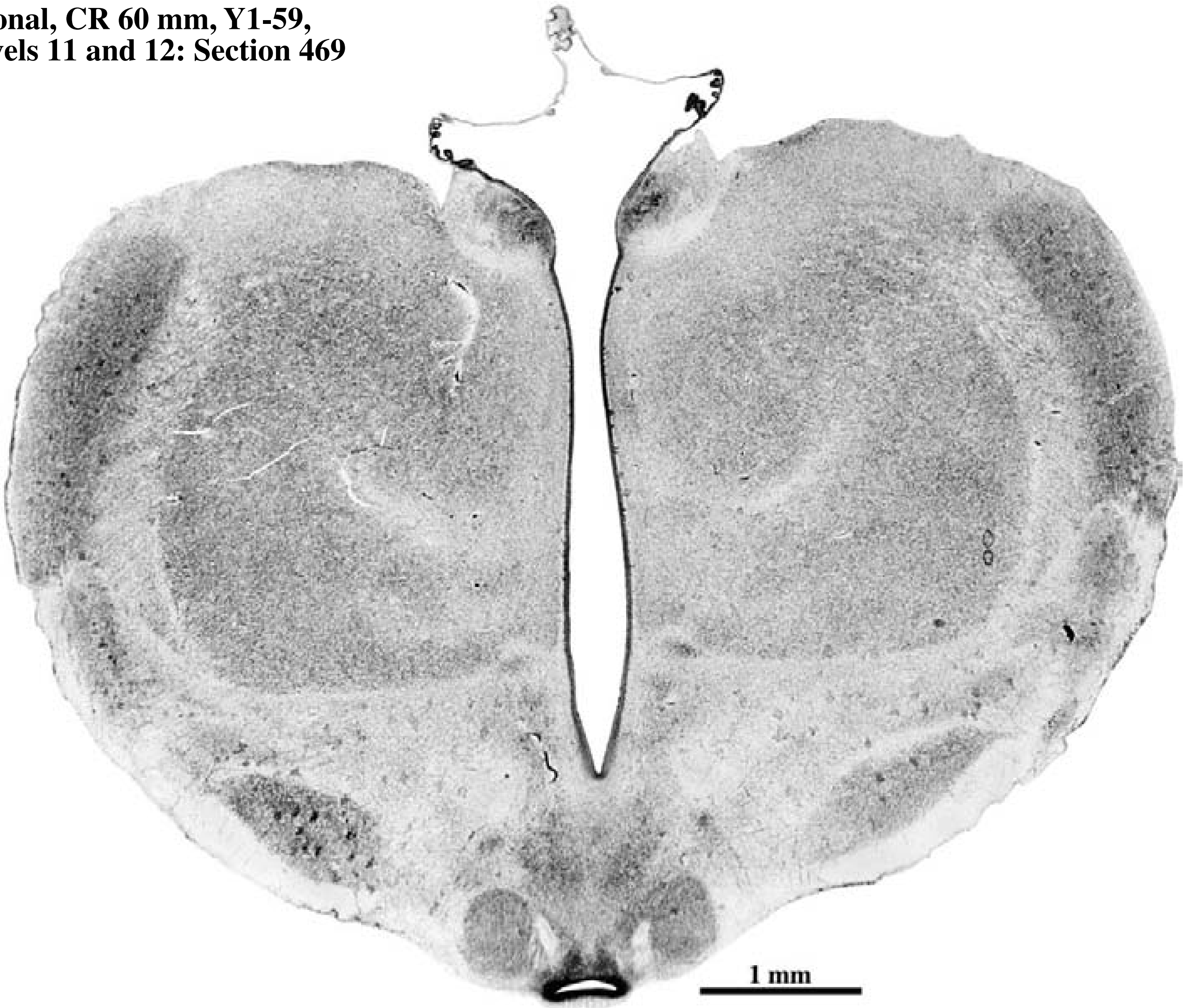
See levels 10 and 11 in Plates 10A and B to 11A and B.

PLATE 28B



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
Habenula
Lateral habenular nucleus
Medial habenular nucleus
Stria medullaris
Diencephalic choroid plexus
Epithalamic G/EP
Pulvinar?
Dorsal complex
Posterior complex
Reticular belt
Ventral complex
THALAMUS
Central complex
Thalamic G/EP
THIRD VENTRICLE
Medial lemniscus?
Medial lemniscus?
Mammillo-thalamic tract
Perifascicular GEP
(surrounds fiber tracts)
Sub-thalamic G/EP
Hypothalamic G/EP
THIRD VENTRICLE
Medial forebrain bundle
HYPOTHALAMUS
Hypothalamic (mammillary) NEP
THIRD VENTRICLE
(MAMMILLARY RECESS)
Dorsolateral nucleus
Dorsal lateral geniculate body
In transient dorsal position
Periventricular complex
Dorsomedial nucleus
Paracentral nucleus
Ventral anterior nucleus
Ventral lateral nucleus
Reticular nucleus
Internal capsule
Ventral medial nucleus
Optic tract
Ventral lateral geniculate body?
Forel's fields
Zona incerta
SUBTHALAMUS
Optic tract
Cerebral peduncle
Subthalamic nucleus
Supra-mammillary area
Lateral tuberal nucleus?
Lateral mammillary nucleus?
Medial mammillary nucleus?

PLATE 29A
GW11 Coronal, CR 60 mm, Y1-59,
Between levels 11 and 12: Section 469



See levels 11 and 12 in Plates 11A and B to 12A and B.

PLATE 29B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium

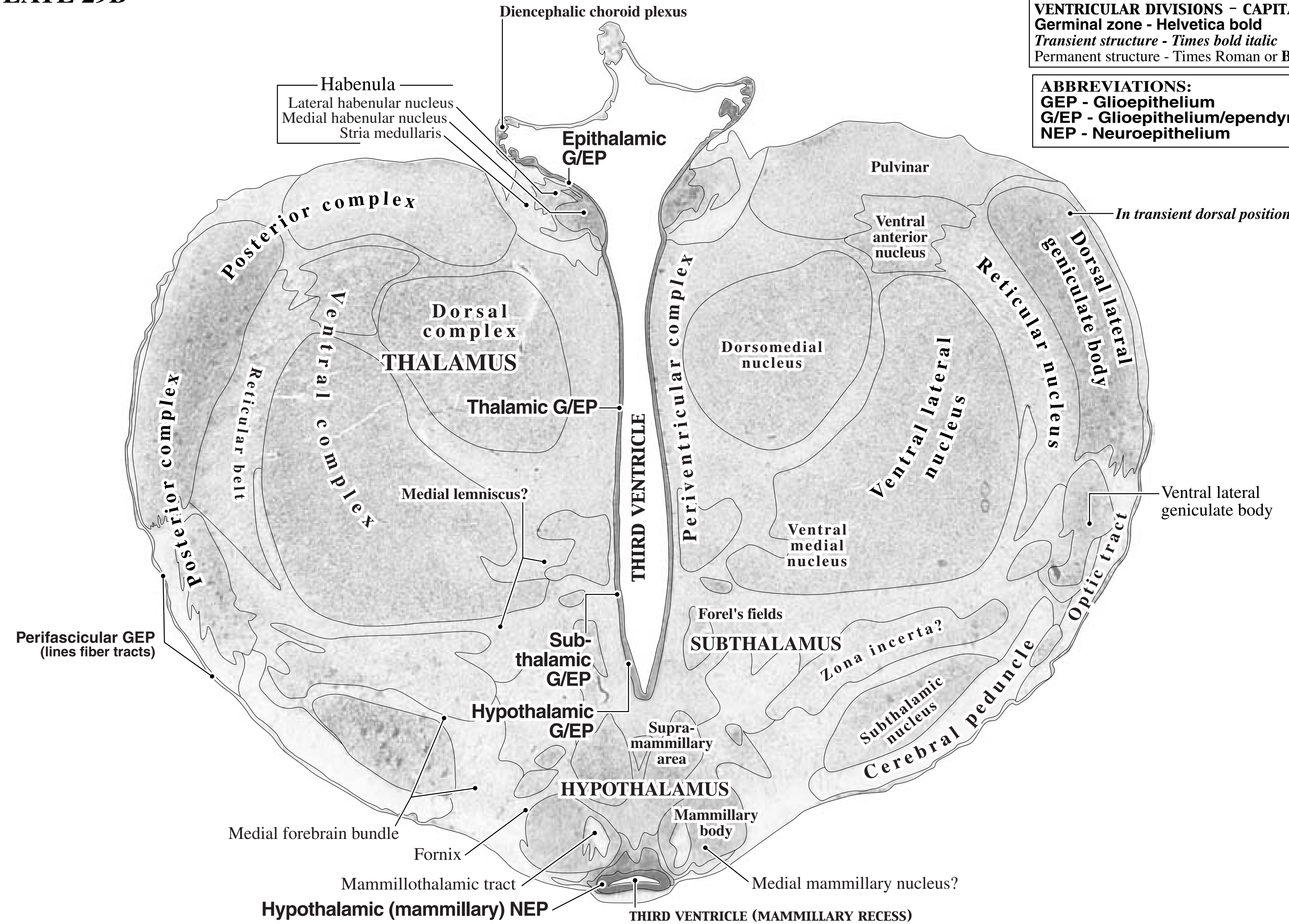
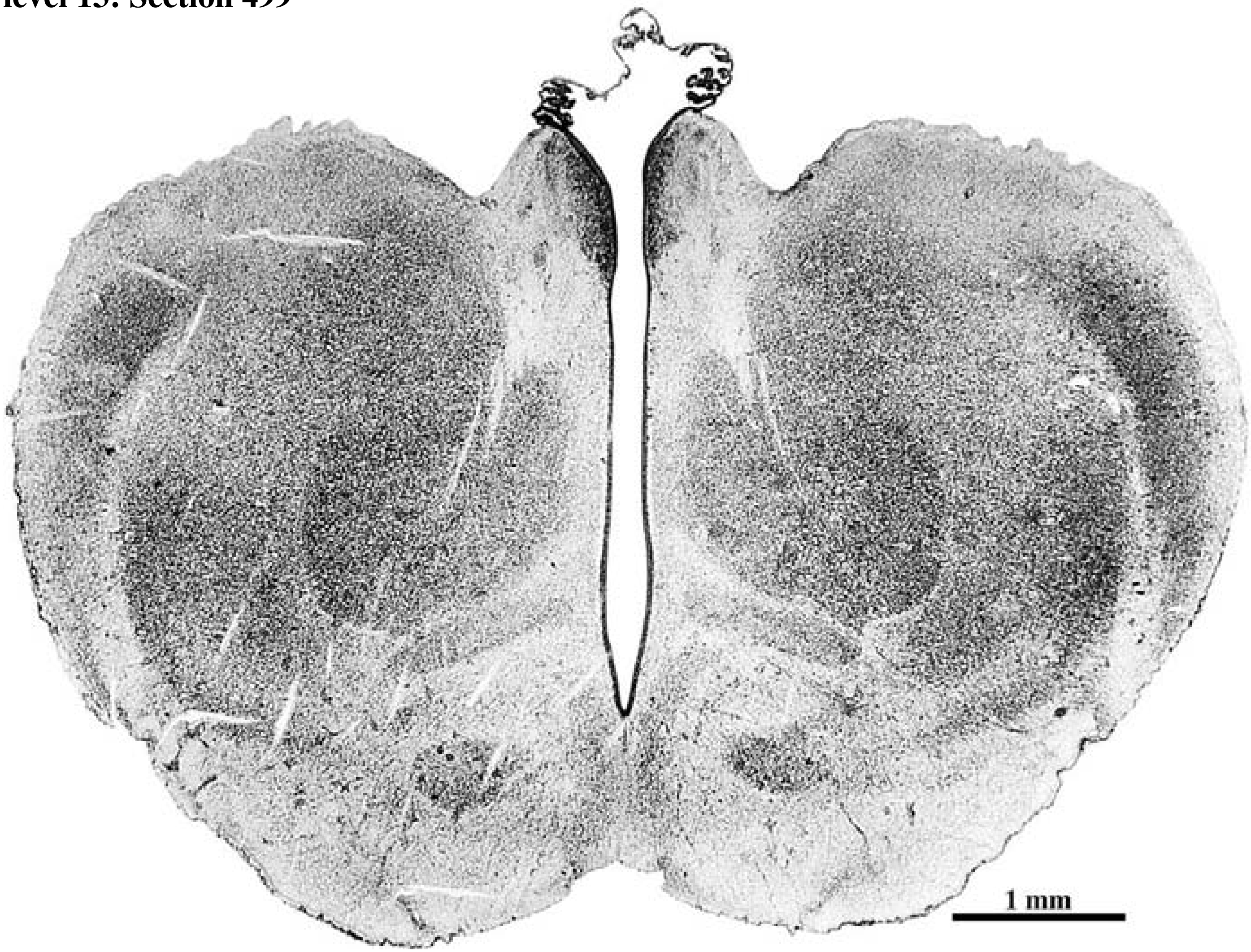


PLATE 30A
GW11 Coronal, CR 60 mm, Y1-59,
Adjacent to level 13: Section 499



See level 13 in Plates 13A and B.

PLATE 30B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma

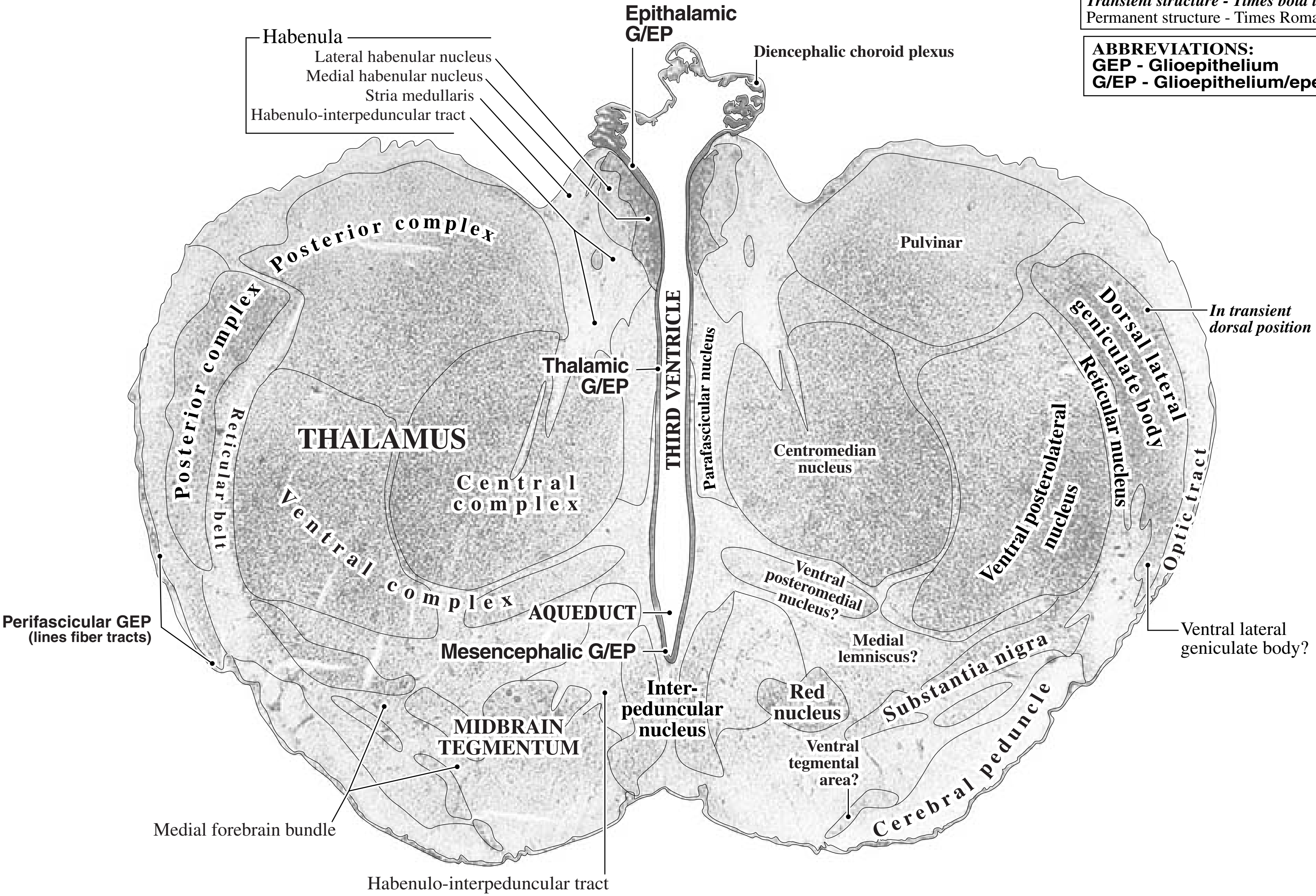
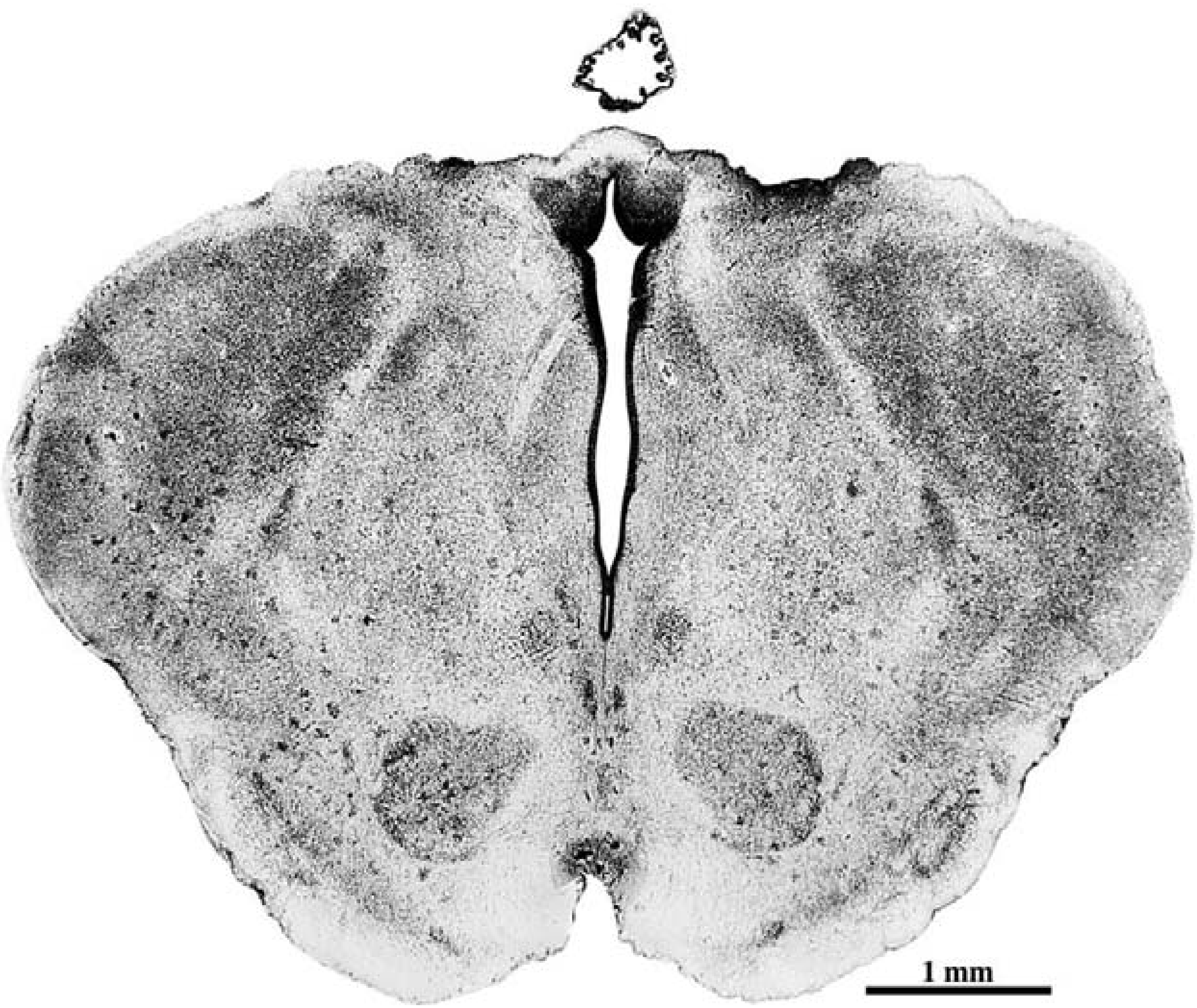


PLATE 31A
GW11 Coronal, CR 60 mm, Y1-59,
Level 14: Section 529

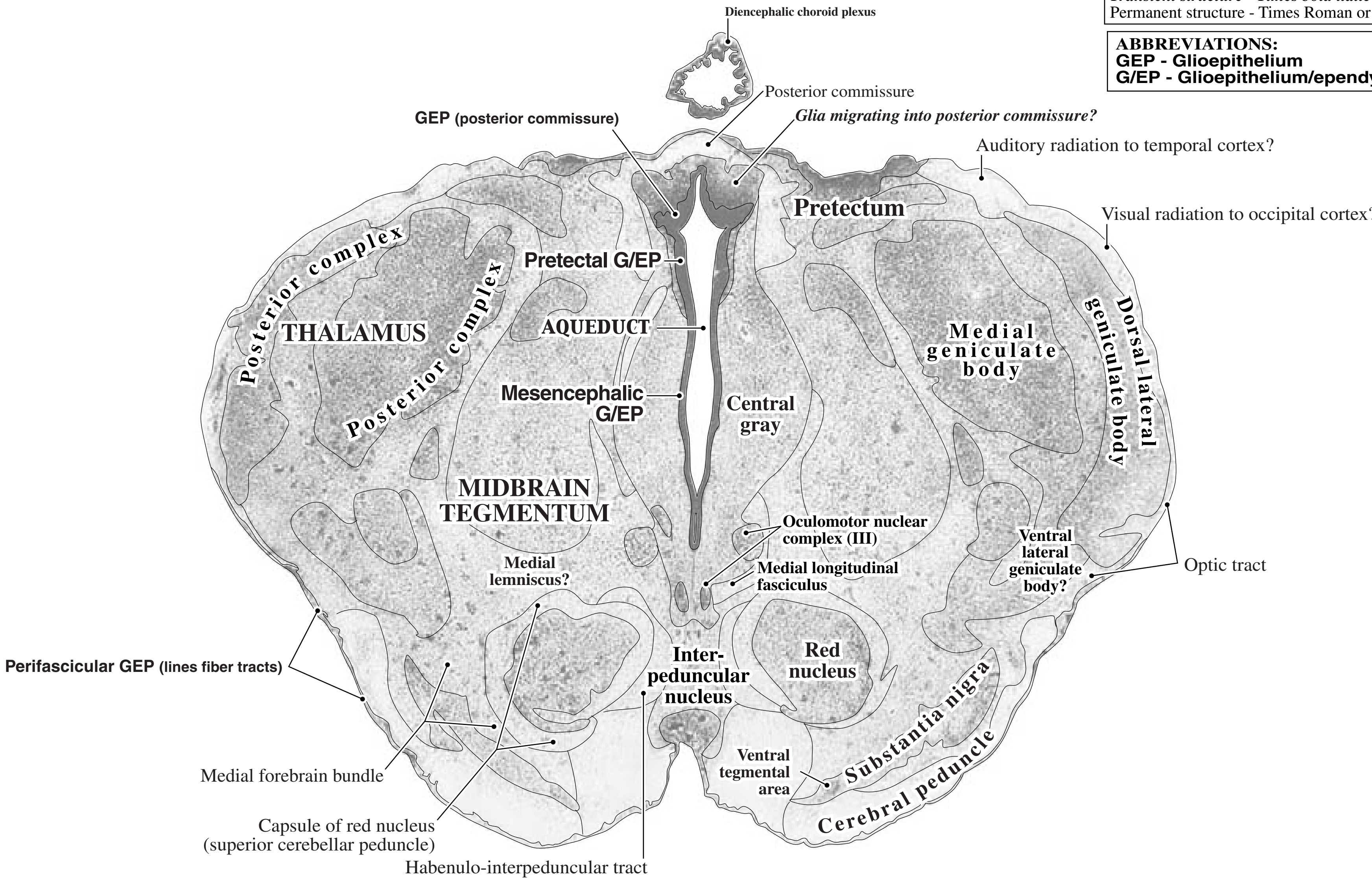


See level 14 in Plates 14A and B.

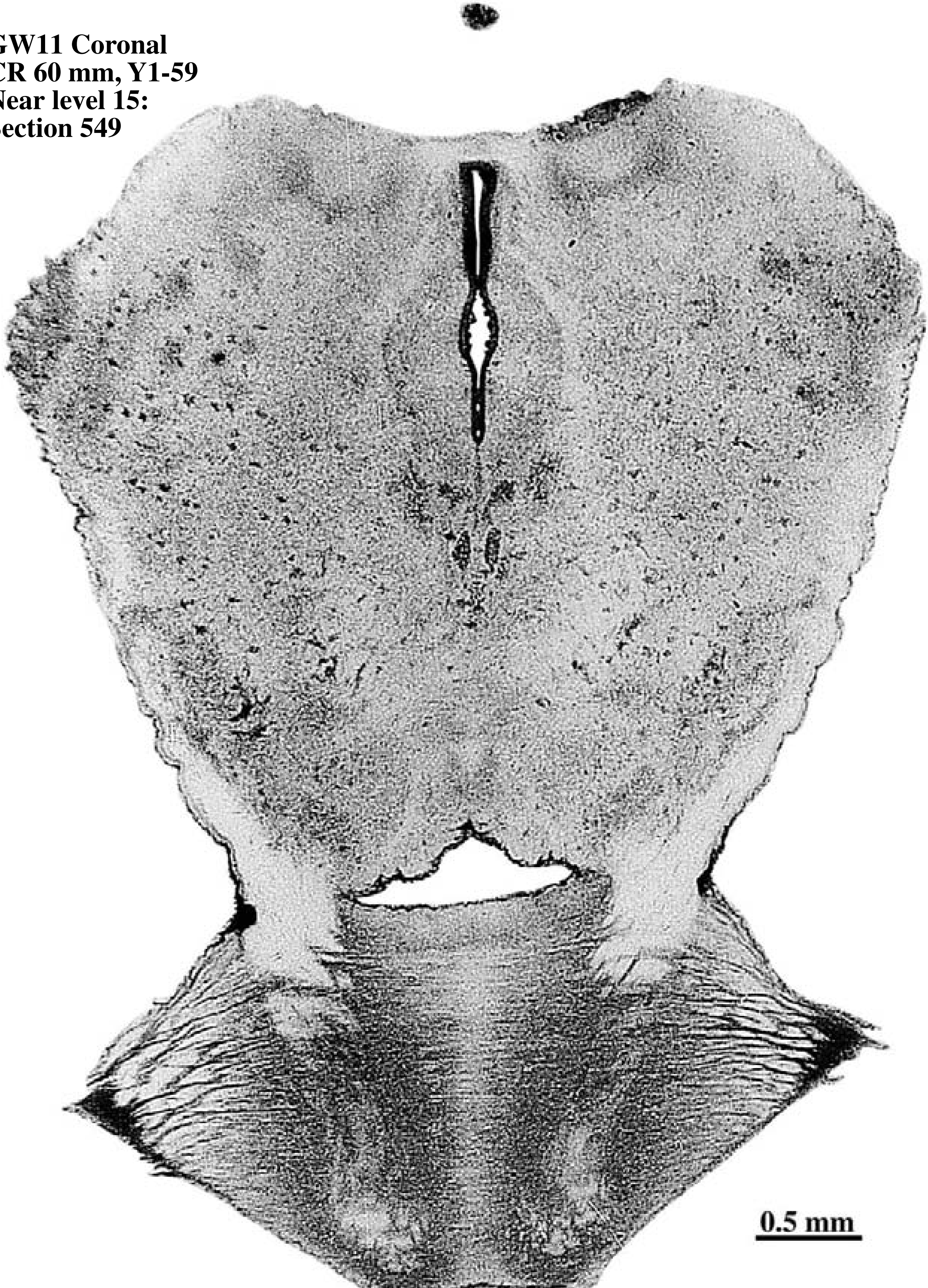
PLATE 31B

FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma



GW11 Coronal
CR 60 mm, Y1-59
Near level 15:
Section 549

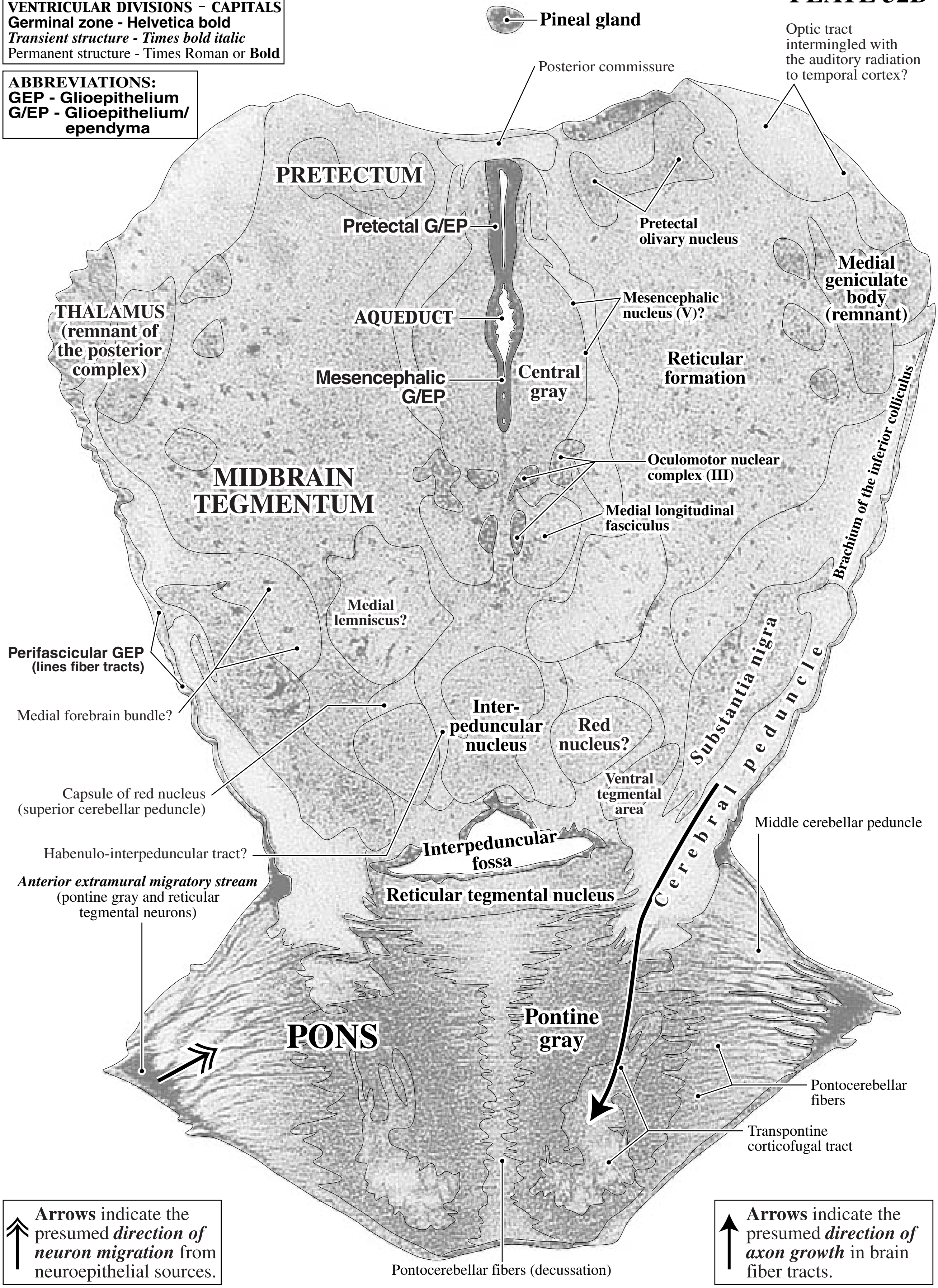


See Level 15 in Plates 15A and B.

PLATE 32B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ ependyma



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

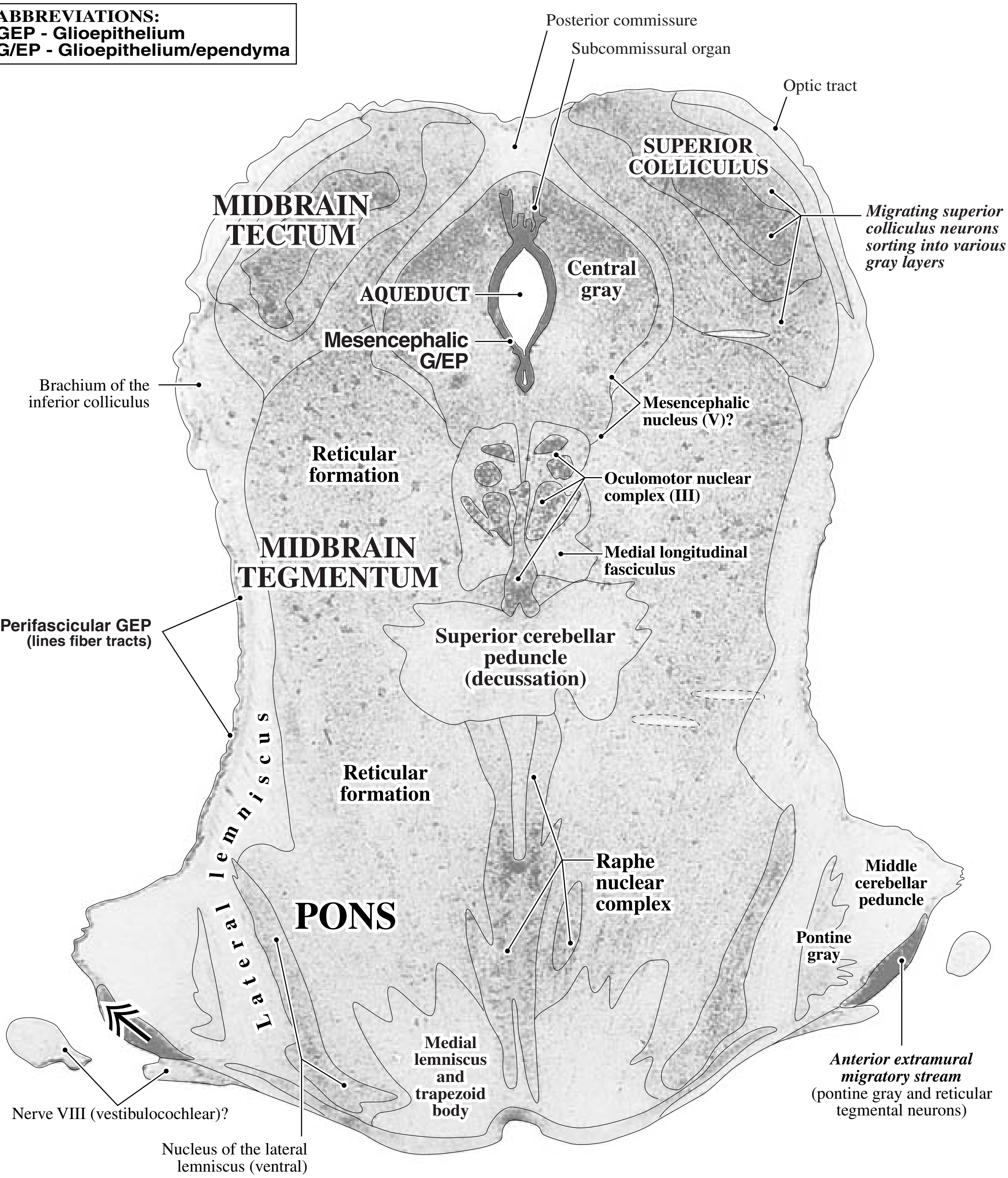
GW11 Coronal
CR 60 mm, Y1-59
Level 15:
Section 569

See Level 15 in Plates 15A and B.

PLATE 33B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma



Dashed lines indicate staining and/or sectioning artifacts.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

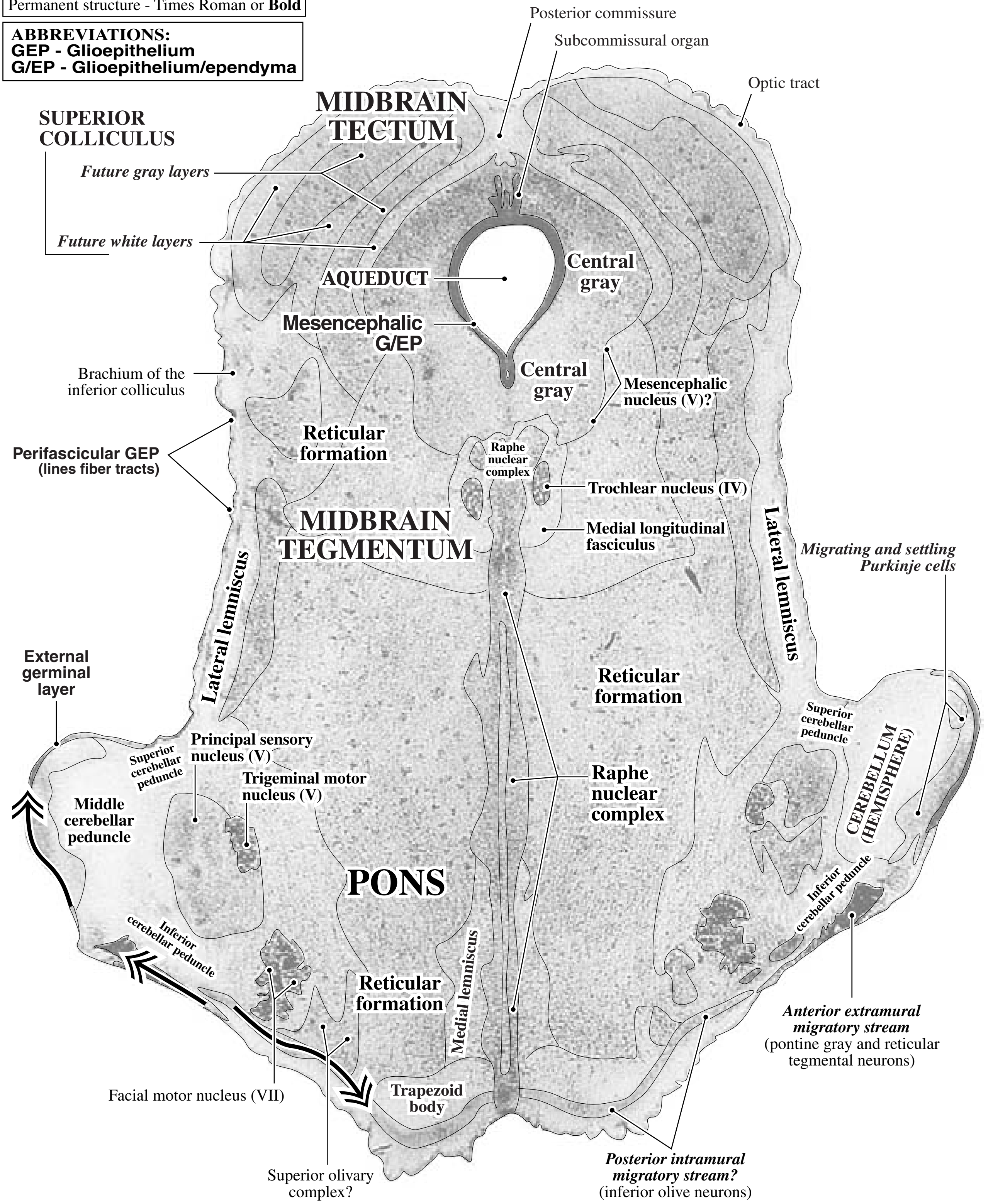
GW11 Coronal
CR 60 mm, Y1-59
Near level 16:
Section 589

See Level 16 in Plates 16A and B.

PLATE 34B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

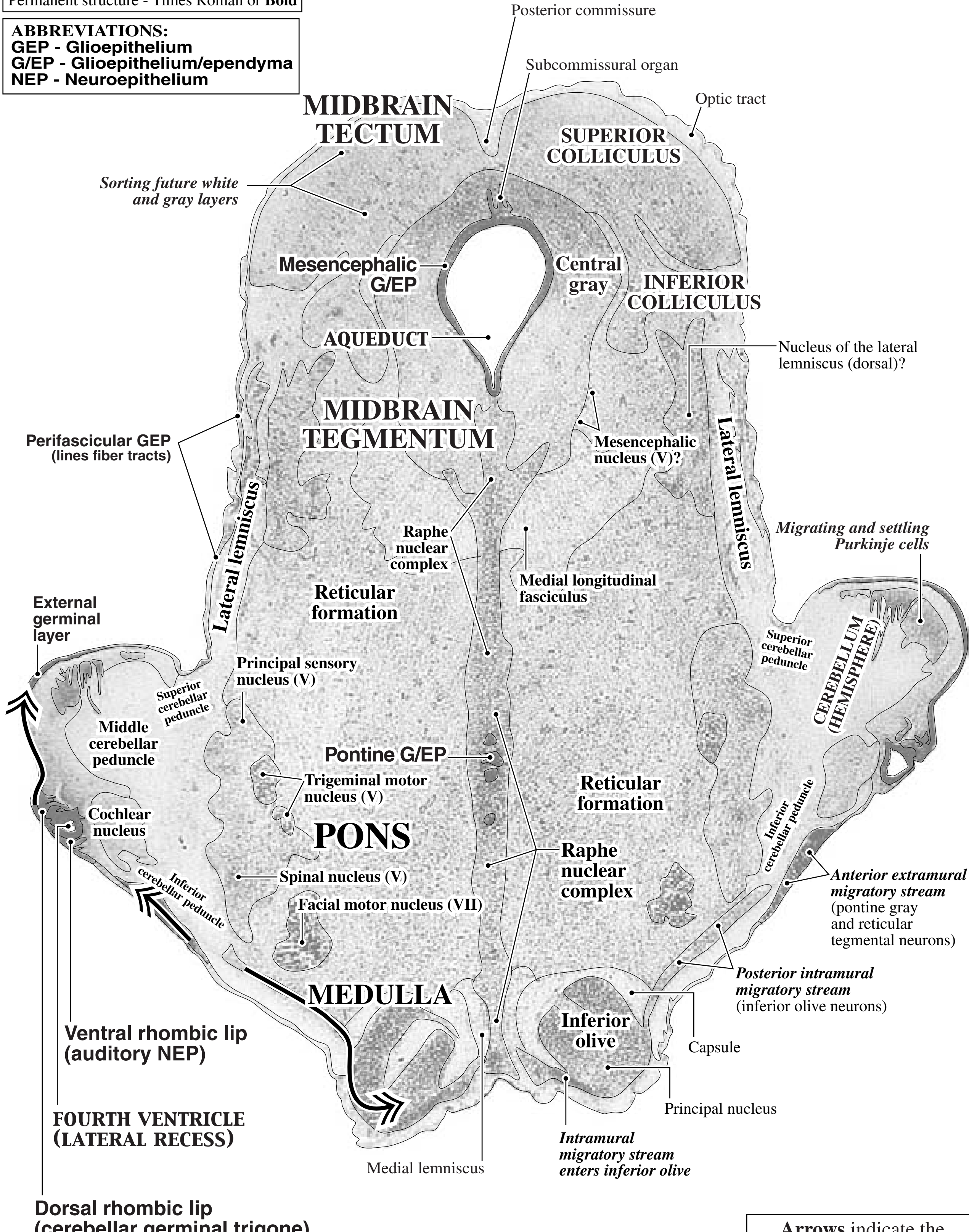
GW11 Coronal
CR 60 mm, Y1-59
Level 16:
Section 599

See Level 16 in Plates 16A and B.

PLATE 35B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PART III: GW11 HORIZONTAL

This is specimen number 1500 in the Carnegie Collection, designated here as C1500. A normal fetus with a crown-rump length (CR) of 56 mm was collected in 1916. The fetus is estimated to be early in gestational week (GW) 11. The entire fetus was fixed in formalin and was cut in the horizontal plane. The records are not clear regarding section thickness, but the brain is present in 2,400 sections, more than three times the number of 35 µm sections in the GW17 horizontally sectioned brain in the Yakovlev Collection (Bayer and Altman, 2005, Volume 3, Part IX). We estimate that the sections are between 8-10 µm thick. All sections were stained with Bodian's method to show developing fiber tracts. Since there is no photograph of C1500's brain before it was embedded and cut, a specimen from Hochstetter (1919) that is comparable in age is used to show the approximate section plane and external features in early GW11 (**Figure 2**). **Levels 1-10**, large sections containg the cerebral hemispheres, are shown at low magnification in **Plates 36-45**. **Levels 11-21**, small sections containing only the brainstem, are shown at a higher magnification in **Plates 46-56**. To maximize image size within page space, C1500's sections are rotated 90˚ (landscape orientation). The anterior part of each section is on the left (page bottom), and the posterior part of each section is on the right (page top).

C1500 has many of the same features as Y1-59, except that it is slightly less mature. Throughout the cerebral cortex, the ***neuroepithelium and subventricular zone*** are prominent. The ***stratified transitional field (STF)*** contains ***STF1*** and ***STF5*** throughout; with ***STF4*** only in lateral areas. The most prominent developmental feature of the cerebral cortex is that both the ***STF*** layers and the cortical plate have a pronounced lateral (thicker) to medial (thinner) maturation gradient. The olfactory bulb beneath the anterior septum and striatum contains a small ***rostral migratory stream*** in its core. In anterolateral parts of the cerebral cortex, streams of neurons and glia appear to leave ***STF4*** and enter the ***lateral migratory stream***. The hippocampus is in an immature position dorsal to the thalamus and medial to the temporal lobe. Cells are entering Ammon's horn pyramidal layer in the ***ammonic migration***, and granule cells and their precursors are migrating to the hilus of the presumptive dentate gyrus in the ***dentate migration***; there is no granular layer. A massive ***neuroepithelium/subventricular zone*** overlies the amygdala, nucleus accumbens, and striatum (caudate and putamen) where neurons (and glia) are being generated.

The cerebellum is a thick, smooth plate overlying the posterior pons and medulla. However, there is only a thin ***glioepithelium/ependyma*** at the ventricular surface, indicating that all deep neurons and Purkinje cells have been generated. The deep neurons are in place beneath the cortex, but have indefinite nuclear subdivisions. The cortical surface is covered by an ***external germinal layer (egl)*** that is actively producing neuronal stem cells, granule, stellate, and basket cells of the cerebellar cortex. Lamination in the cortex is nearly absent, except for a thin molecular layer beneath the ***egl***. Nearly all Purkinje cells are migrating, and settling. In contrast to Y1-59, there is no evidence of lobulation in the cerebellar cortex.

The third ventricle, aqueduct, and fourth ventricle are lined by a thin ***glioepithelium/ependyma*** indicating that neurogenesis in the primary neuroepithelium is complete. In the medulla there are two active germinal sites in anterior and posterior parts of the ventral rhombic lip. 1) The ***auditory neuroepithelium*** generates cochlear nucleus neurons. 2) A large ***precerebellar neuroepithelium*** generates precerebellar (mainly pontine gray) neurons.

Neurons throughout the diencephalon, midbrain tegmentum, pons, and medulla are settling. Because C1500 is not Nissl-stained, nuclear divisions are very indistinct. The large ***anterior extramural***, ***posterior extramural, and intramural migratory streams*** are prominent in the medulla and pons. The Bodian stain clearly shows several fiber tracts and nerves throughout the brainstem. The optic nerve and tract are well defined, along with the medial forebrain bundle. Unlike Y1-59, there is no sure evidence of a cerebral peduncle in the midbrain tegmentum or pontine gray. However, pontine gray fibers cross the midline and a distinct middle cerebellar peduncle is present. There is also a distinct superior and inferior cerebellar peduncle. There is definite staining in the trigeminal nerve and tract, the facial nerve, the abducens nerve, and the glossopharyngeal nerve.

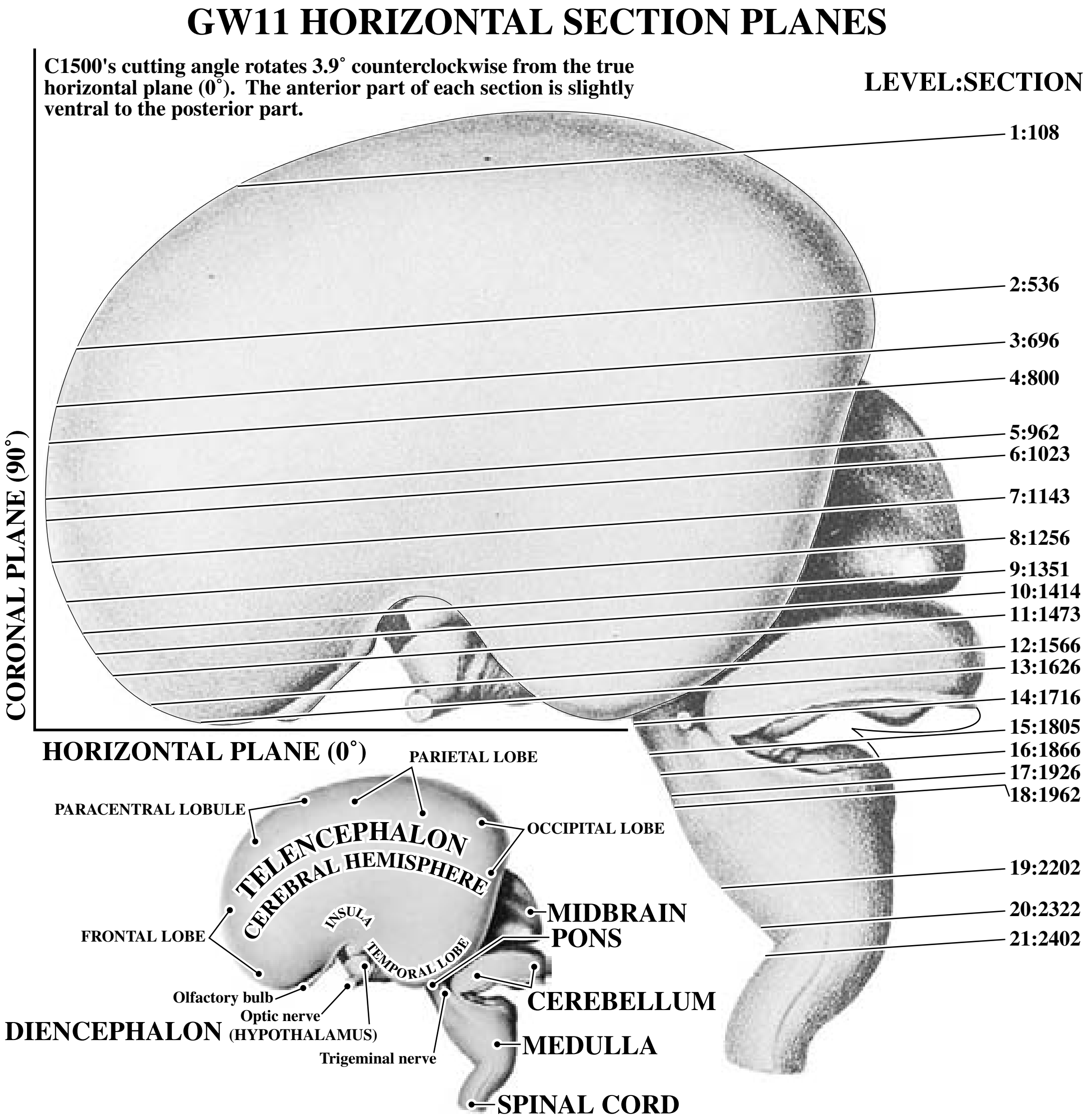


Figure 2. The lateral view of the brain and upper cervical spinal cord from a specimen with a crown-rump length of 53 mm (modified from Figure 46, Table VIII, Hochstetter, 1919) serves to show the approximate locations and cutting angles of the illustrated sections of C1500 in the following pages. The small inset identifies the major structural features. The cut beneath the cerebellum is the edge of the medullary velum.

PLATE 36A

GW11 Horizontal
CR 57 mm
C1500
Level 1: Section 108

LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

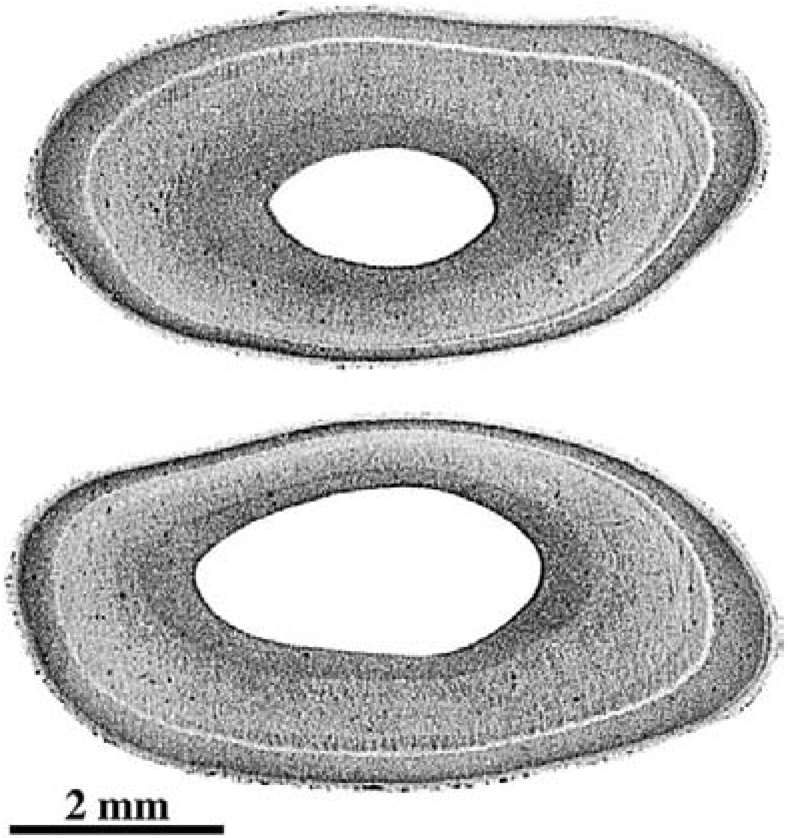


PLATE 36B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

NEP - Neuroepithelium

FUTURE PARACENTRAL LOBULE

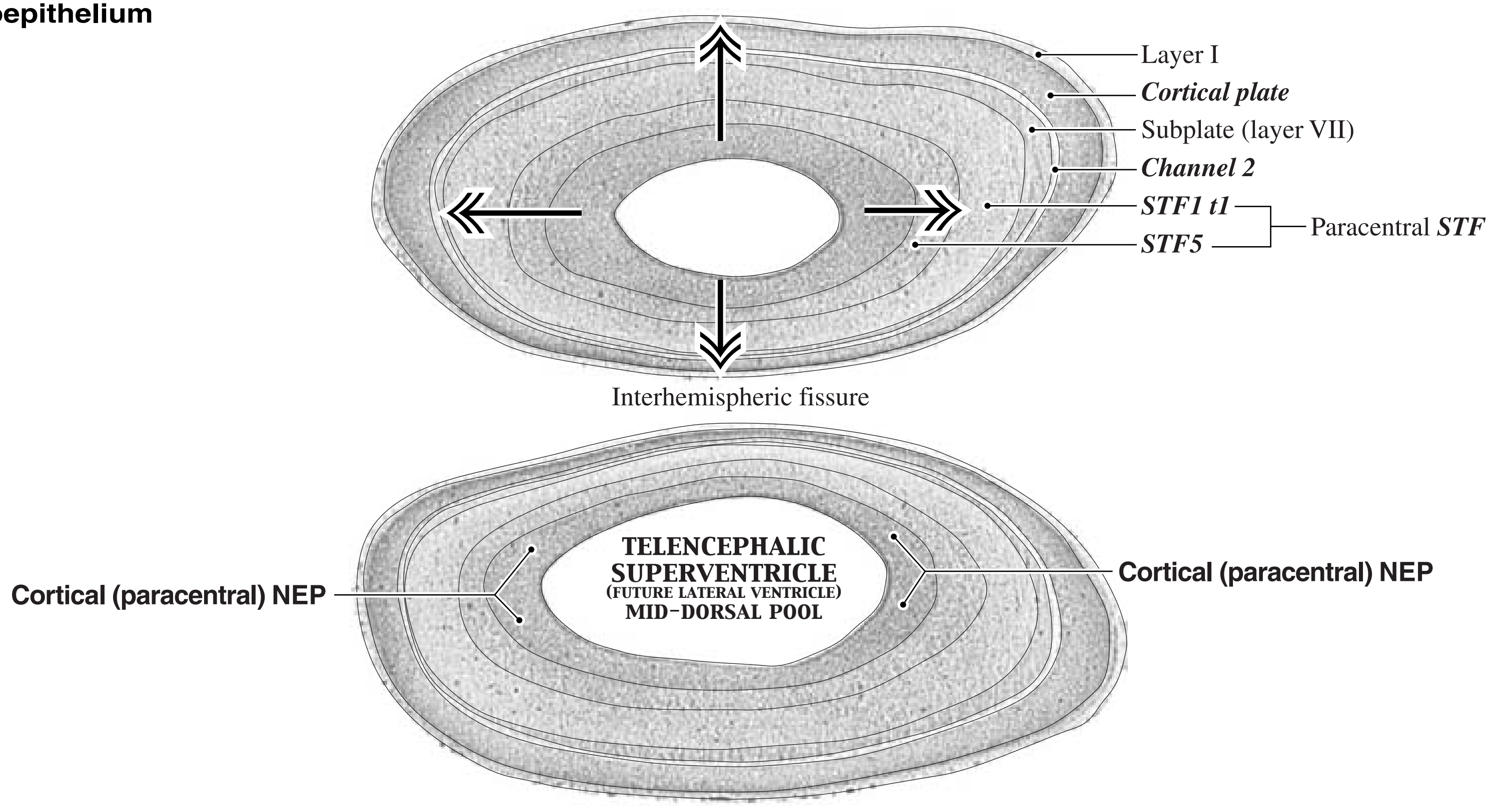
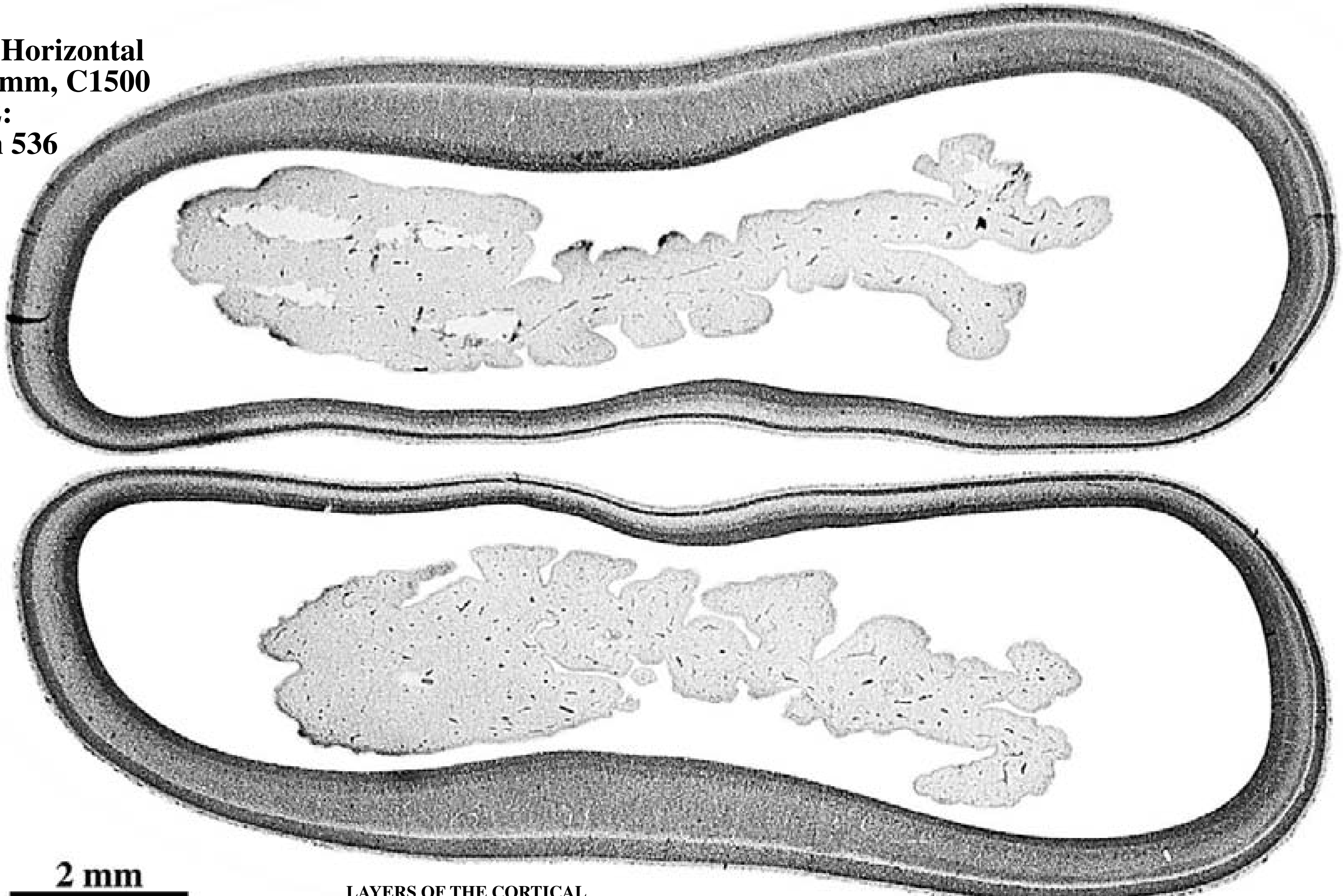


PLATE 37A

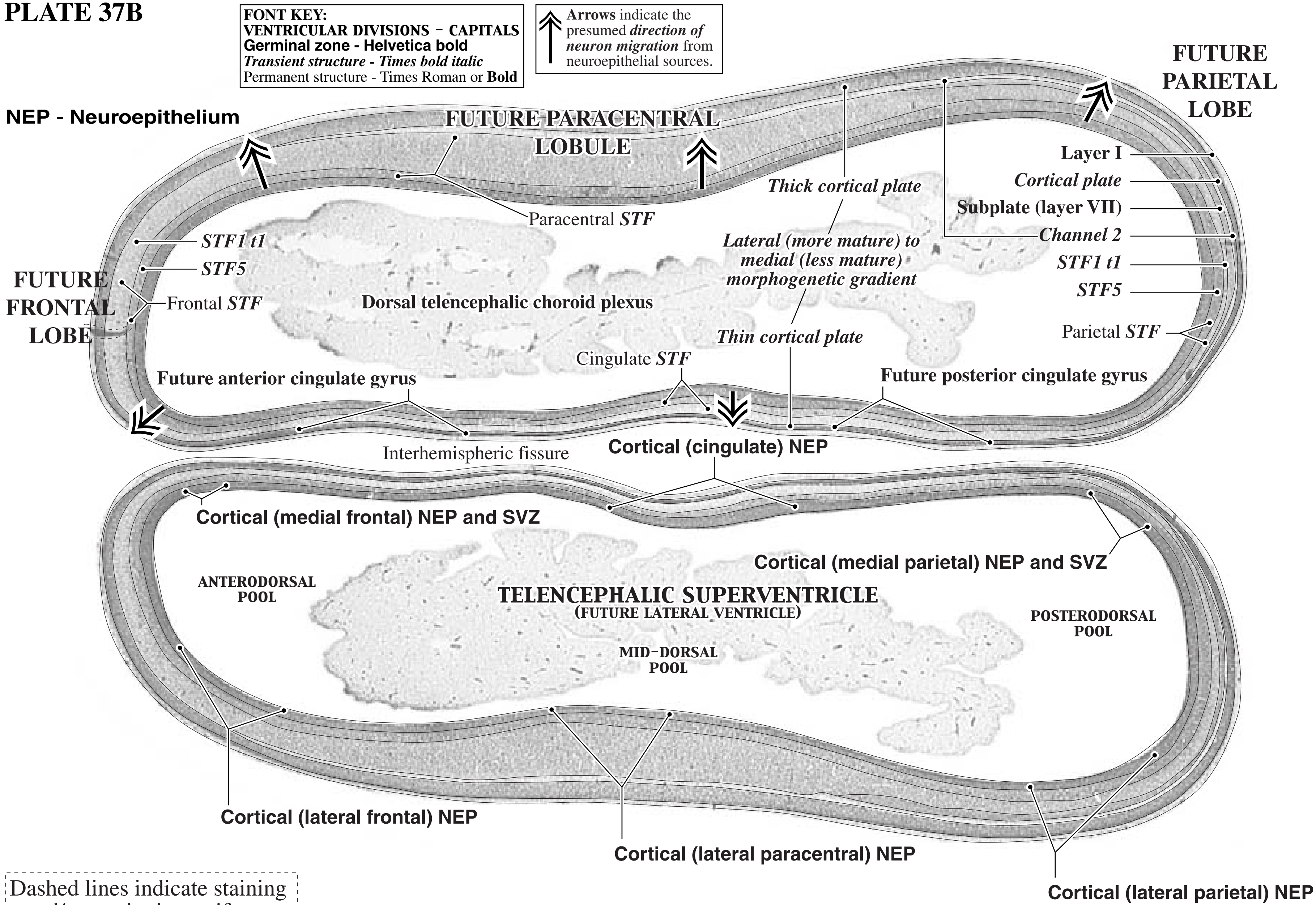
GW11 Horizontal
CR 57 mm, C1500
Level 2:
Section 536



LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

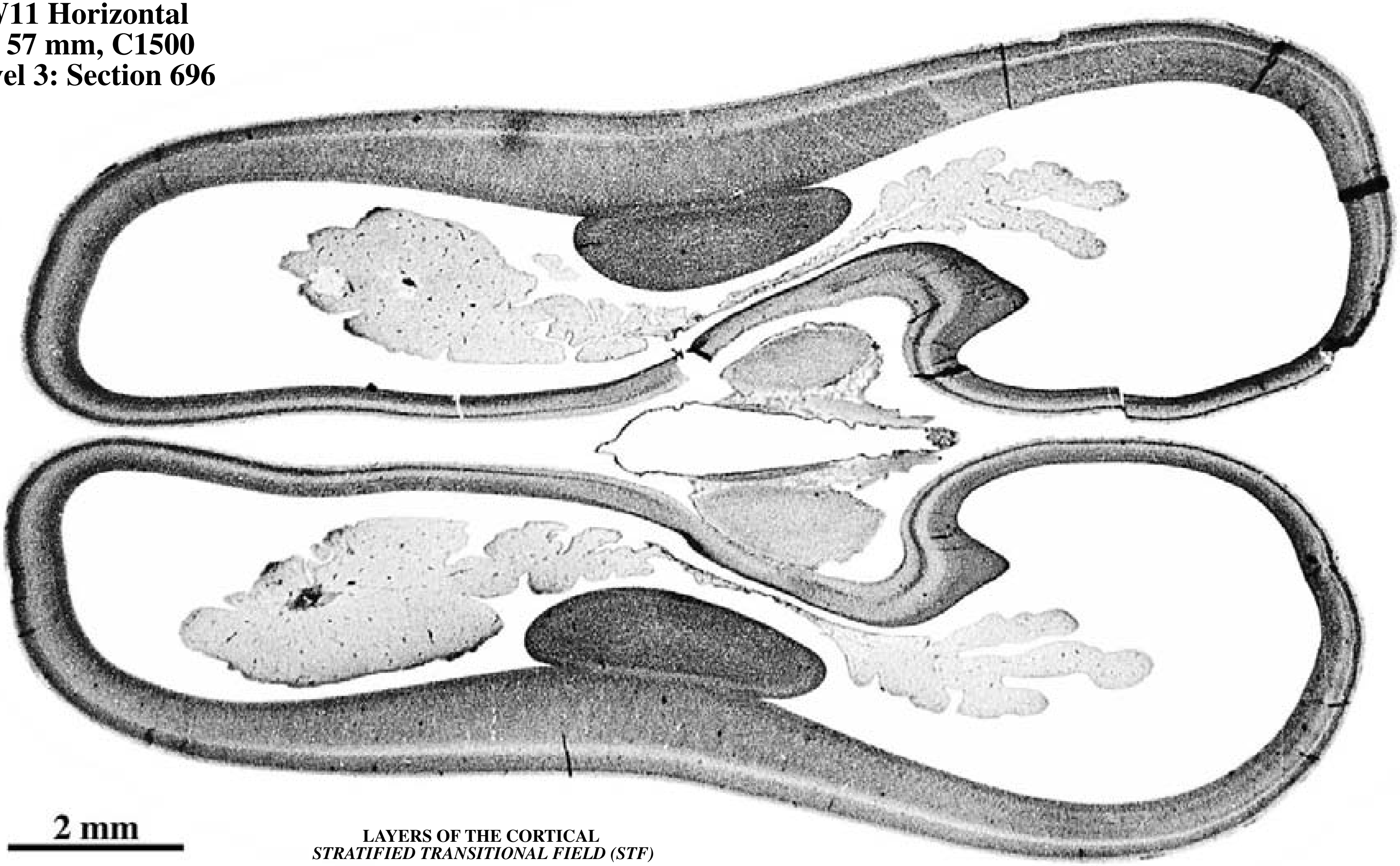
PLATE 37B



Dashed lines indicate staining and/or sectioning artifacts.

PLATE 38A

GW11 Horizontal
CR 57 mm, C1500
Level 3: Section 696



LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

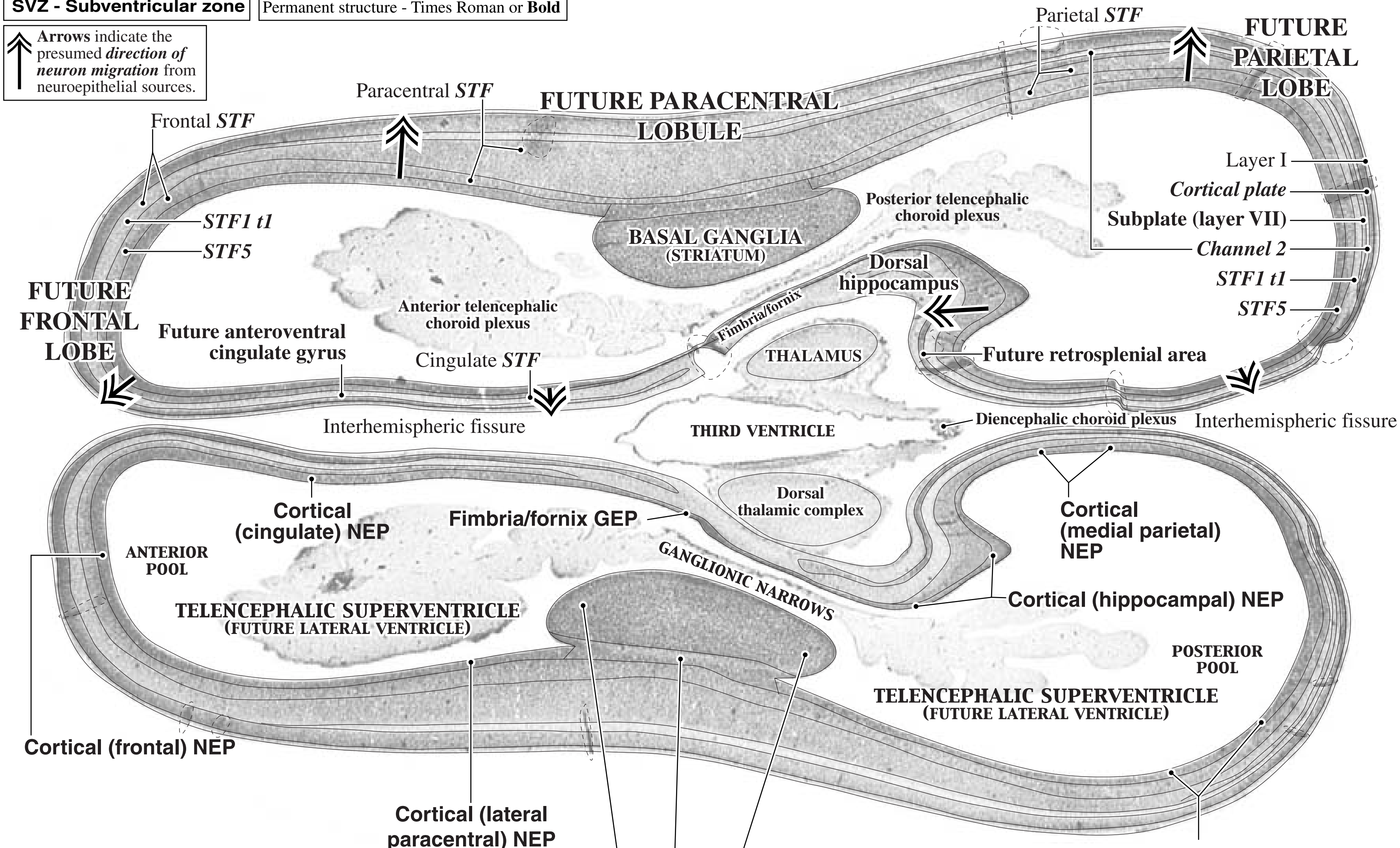
PLATE 38B

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

Note the lateral (more mature) to medial (less mature) morphogenetic gradient in the cerebral cortex.

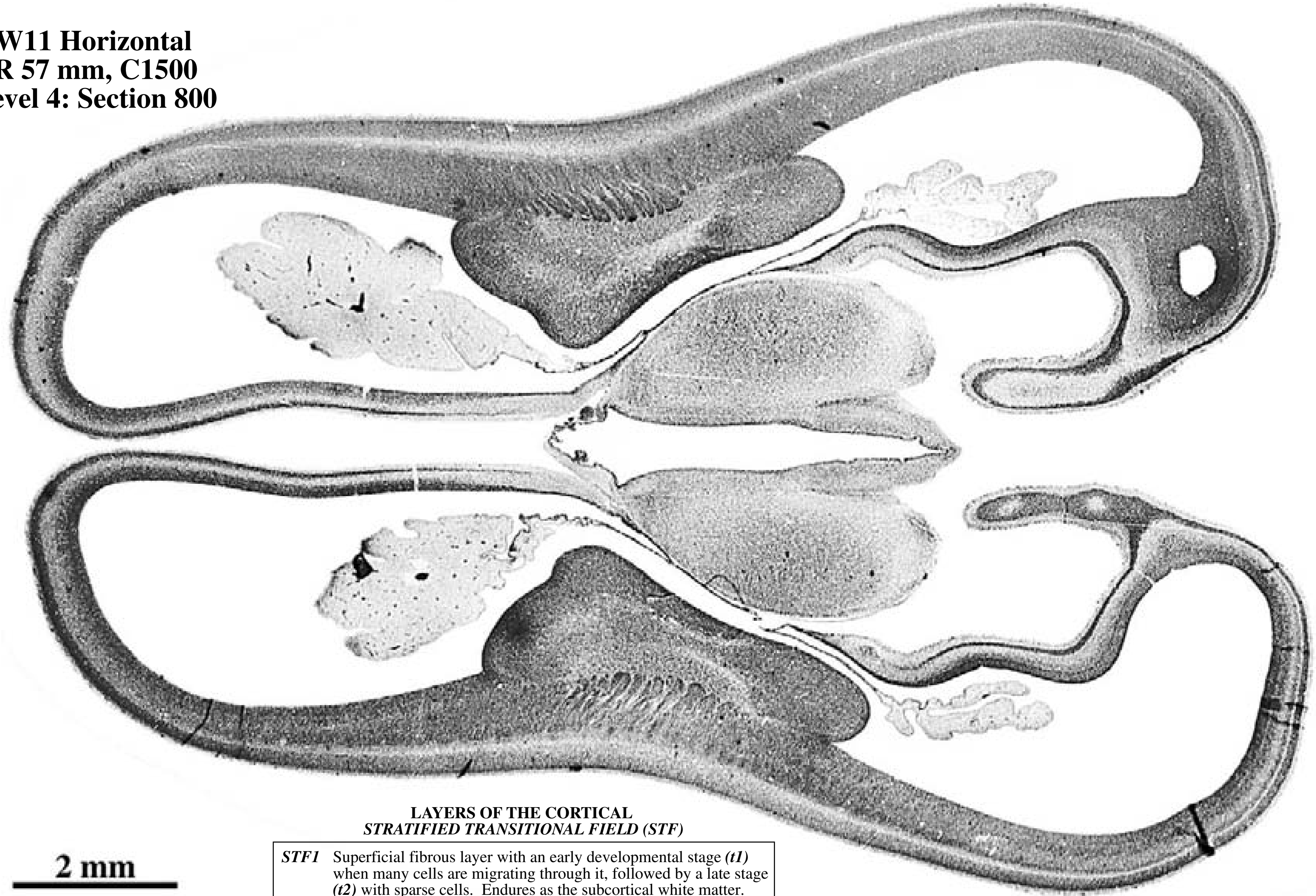
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.



Dashed lines indicate staining and/or sectioning artifacts.

PLATE 39A

GW11 Horizontal
CR 57 mm, C1500
Level 4: Section 800



2 mm

LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

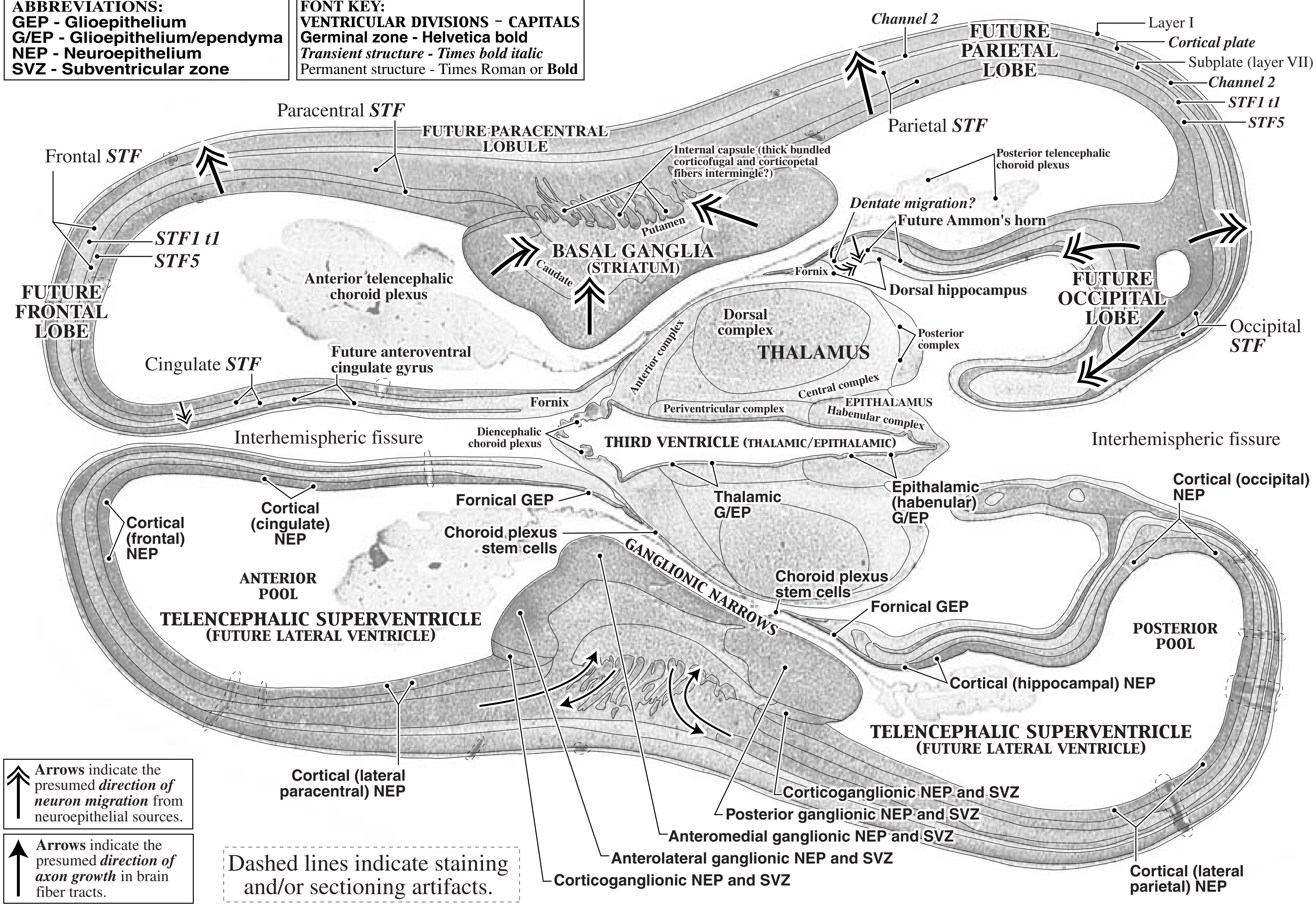
STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 39B

Note the lateral (more mature) to medial (less mature) morphogenetic gradient in the cerebral cortex.

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**



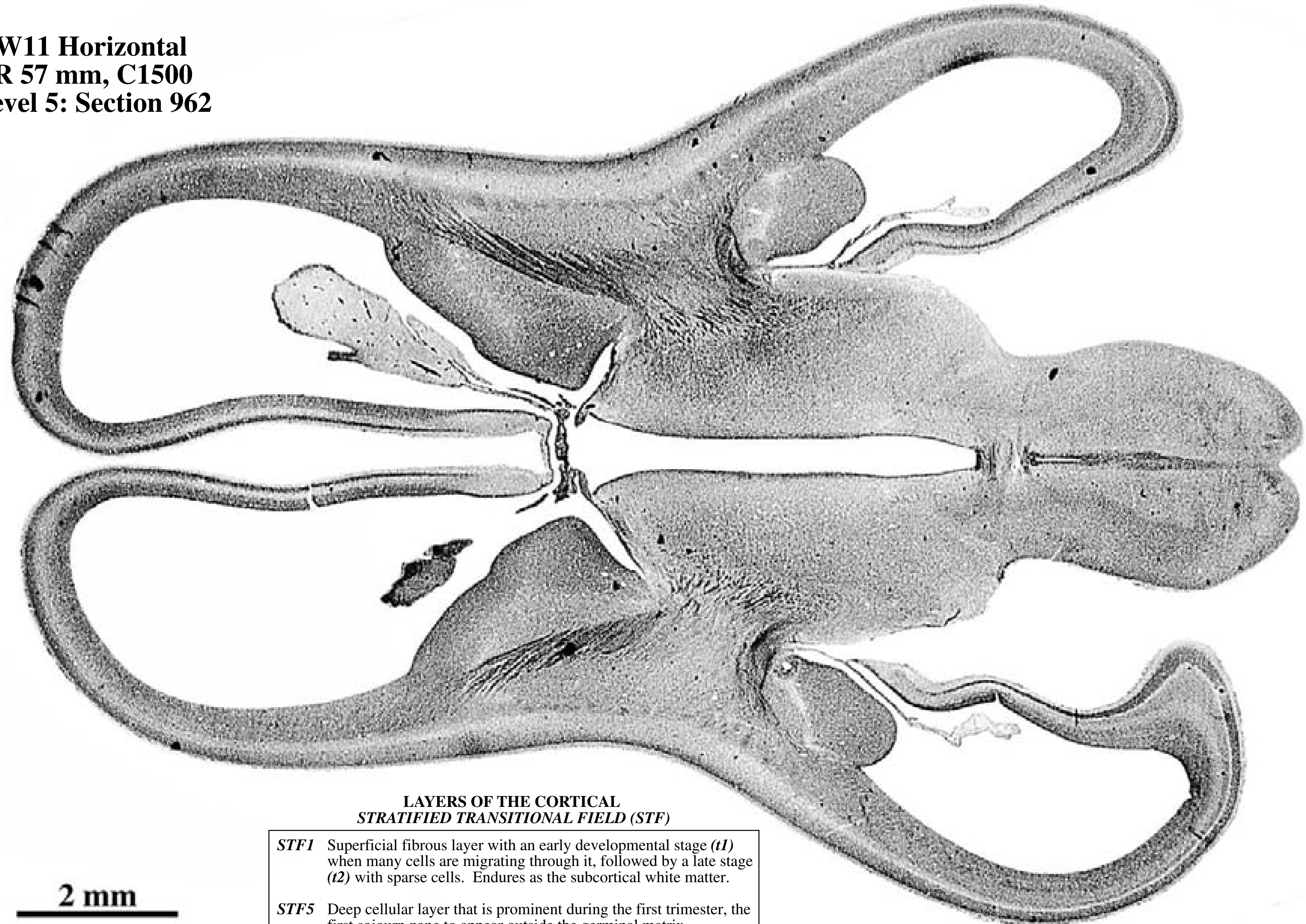
Arrows indicate the presumed *direction of neuron migration* from neuroepithelial sources.

Arrows indicate the presumed *direction of axon growth* in brain fiber tracts.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 40A

GW11 Horizontal
CR 57 mm, C1500
Level 5: Section 962



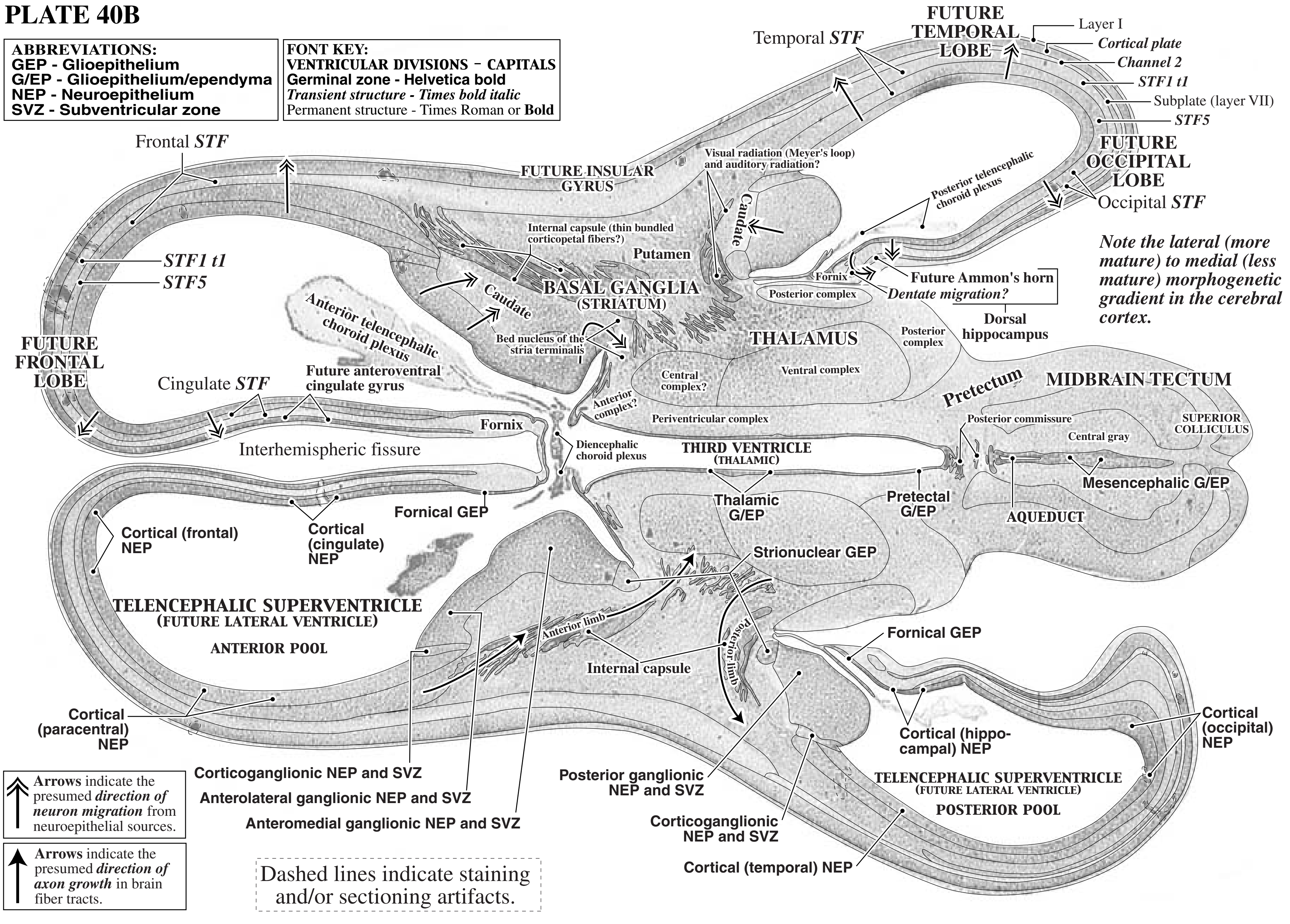
LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 40B

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**



Note the lateral (more mature) to medial (less mature) morphogenetic gradient in the cerebral cortex.

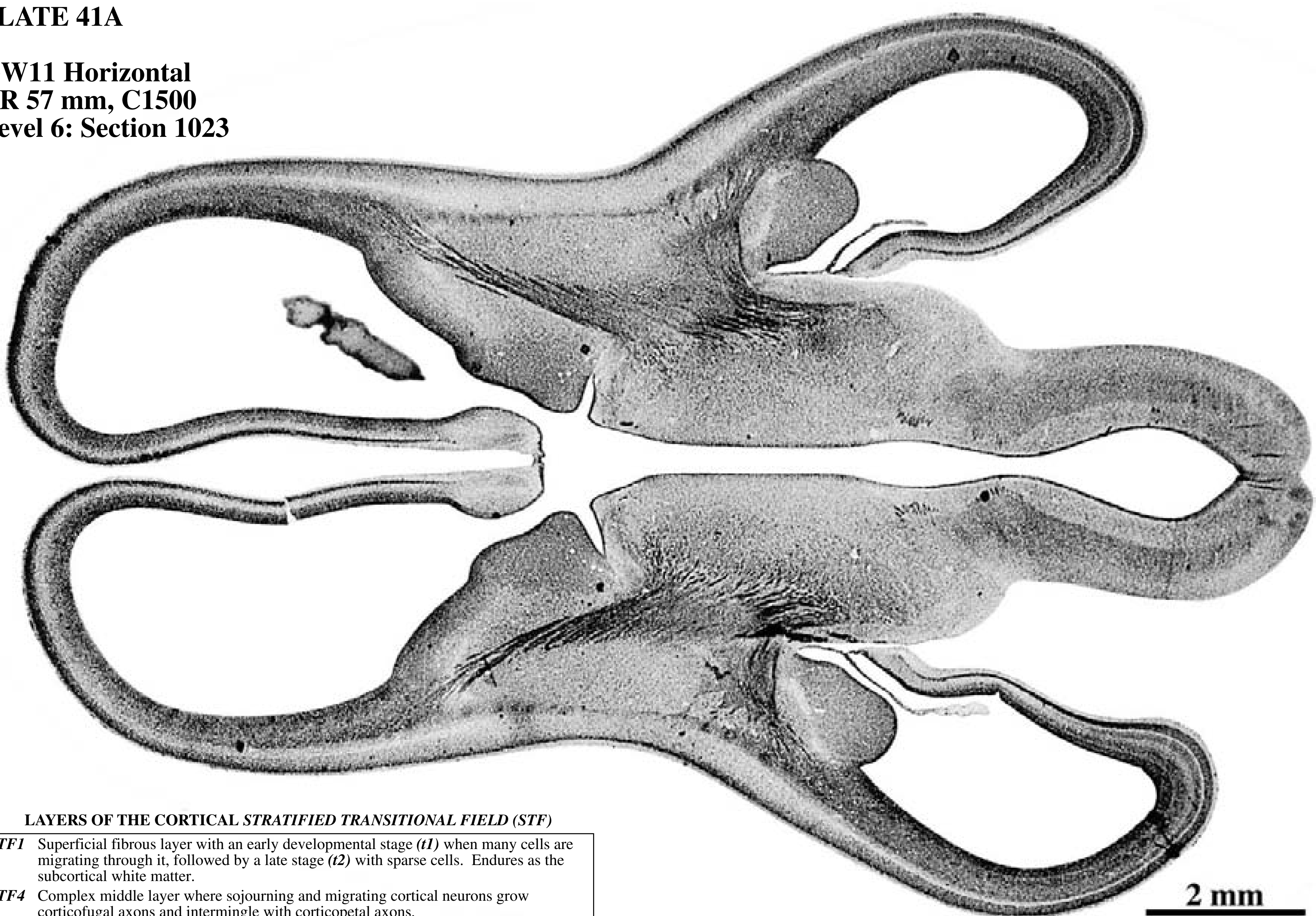
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 41A

GW11 Horizontal
CR 57 mm, C1500
Level 6: Section 1023



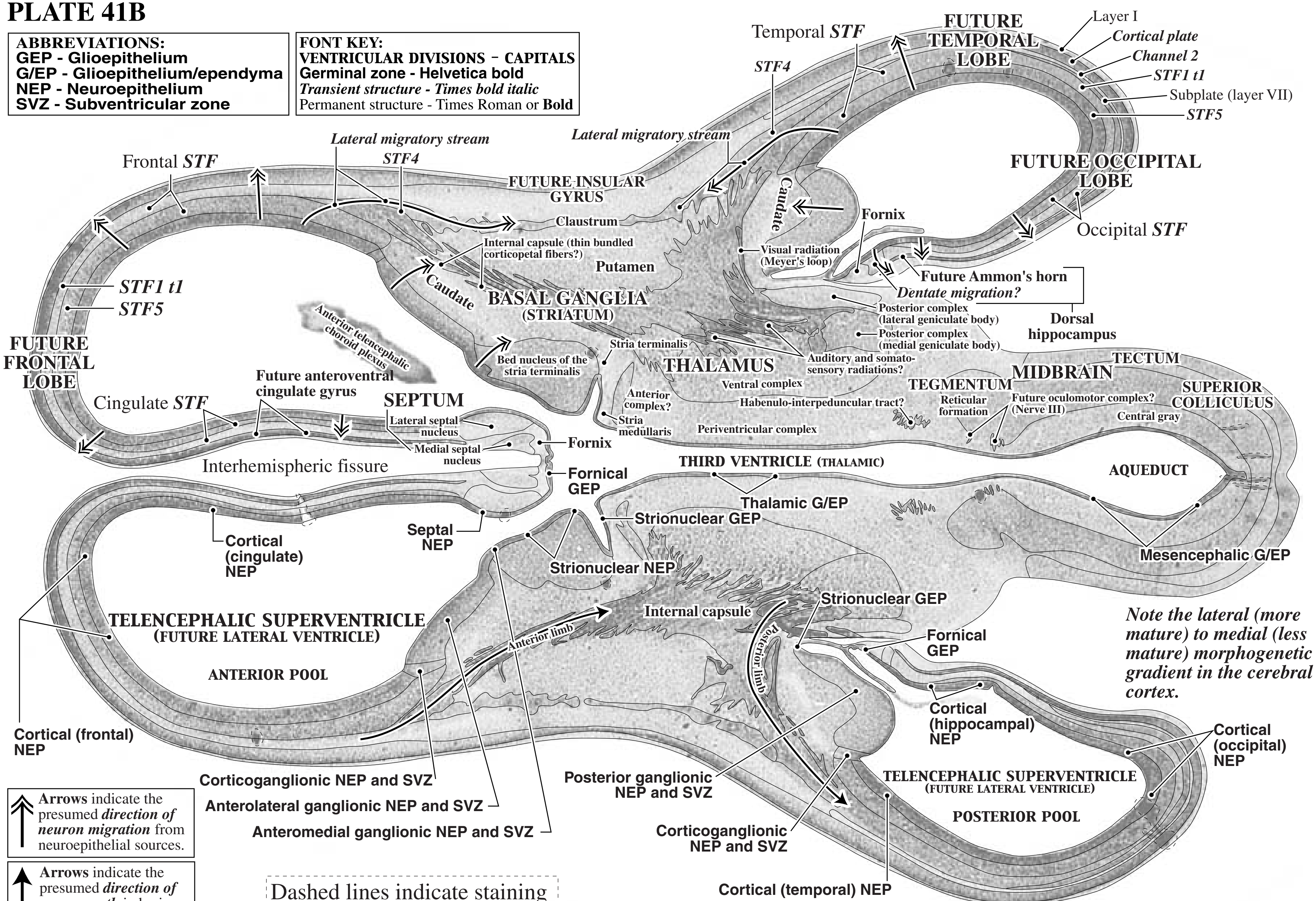
LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 41B

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**



Note the lateral (more mature) to medial (less mature) morphogenetic gradient in the cerebral cortex.

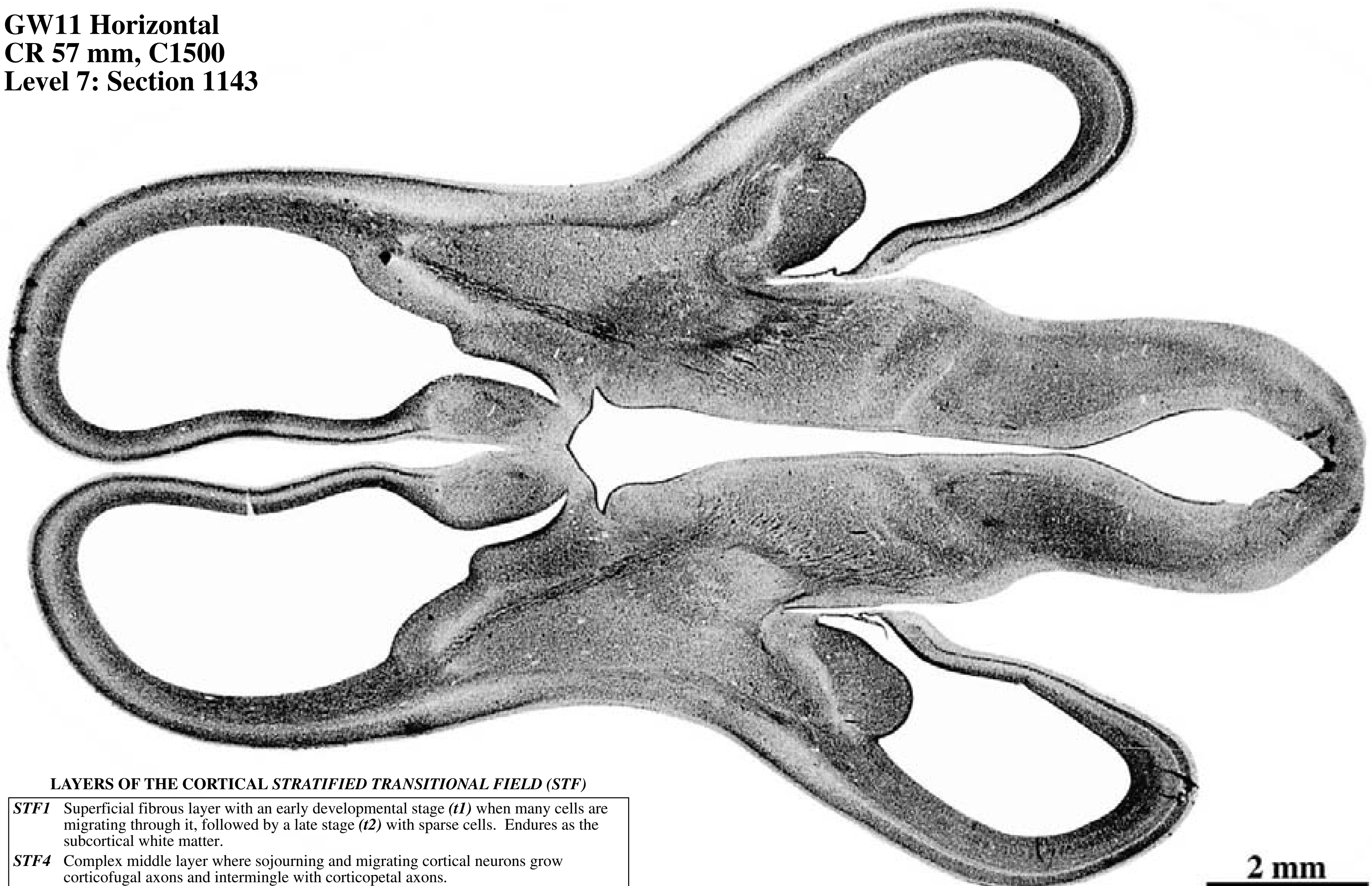
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 42A

GW11 Horizontal
CR 57 mm, C1500
Level 7: Section 1143



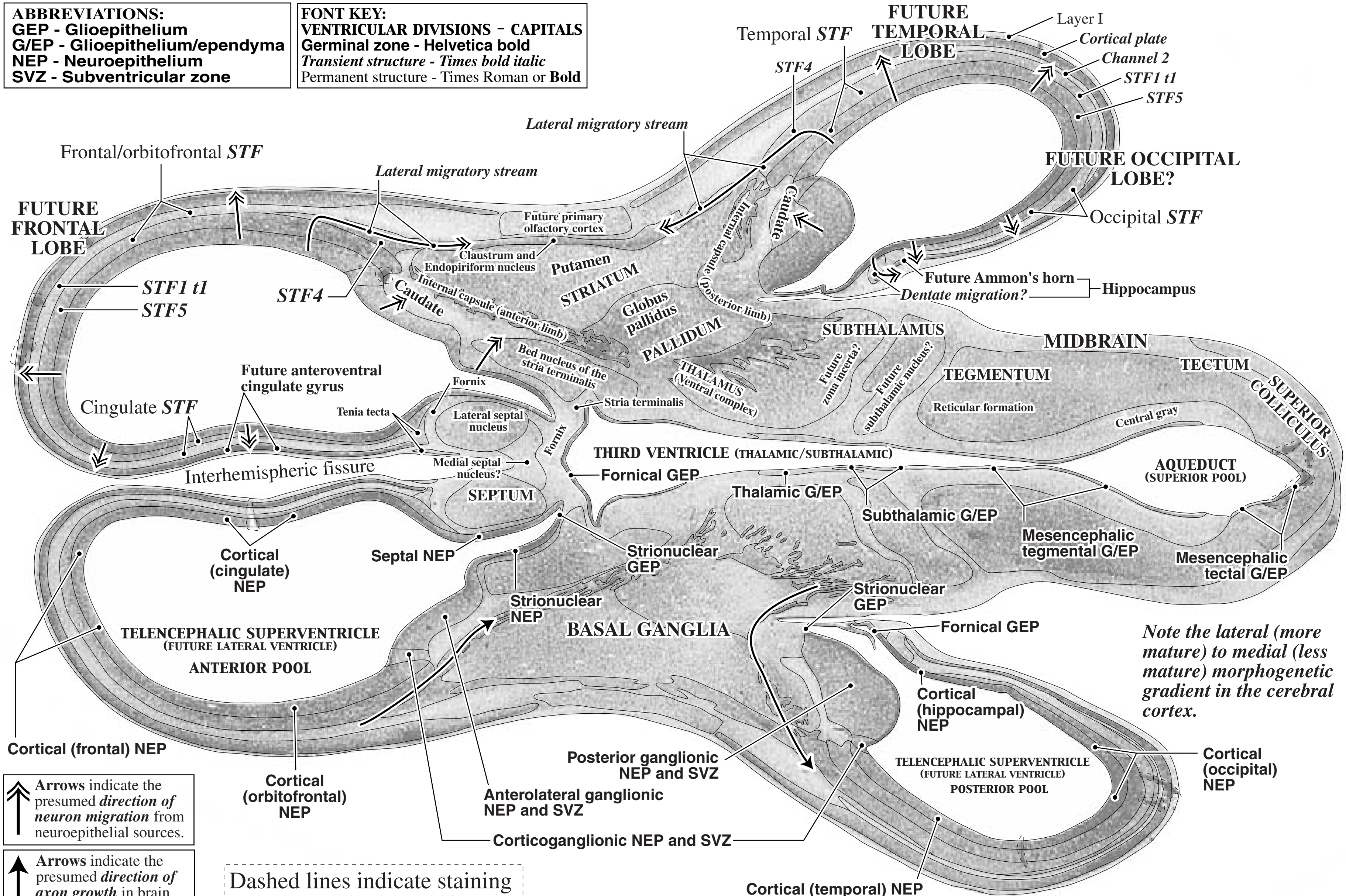
LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 42B

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone

FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**



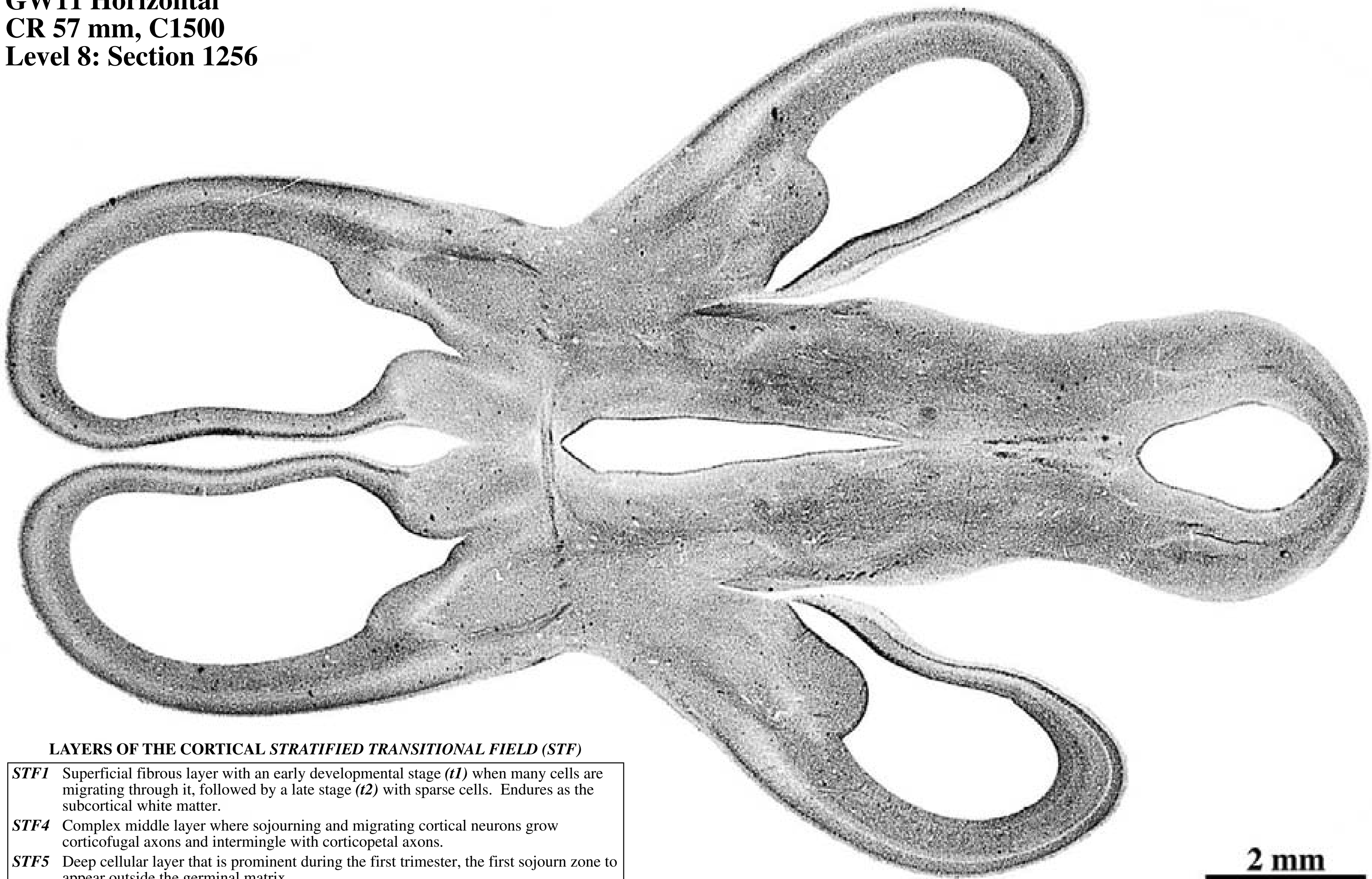
Arrows indicate the presumed *direction of neuron migration* from neuroepithelial sources.

Arrows indicate the presumed *direction of axon growth* in brain fiber tracts.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 43A

GW11 Horizontal
CR 57 mm, C1500
Level 8: Section 1256



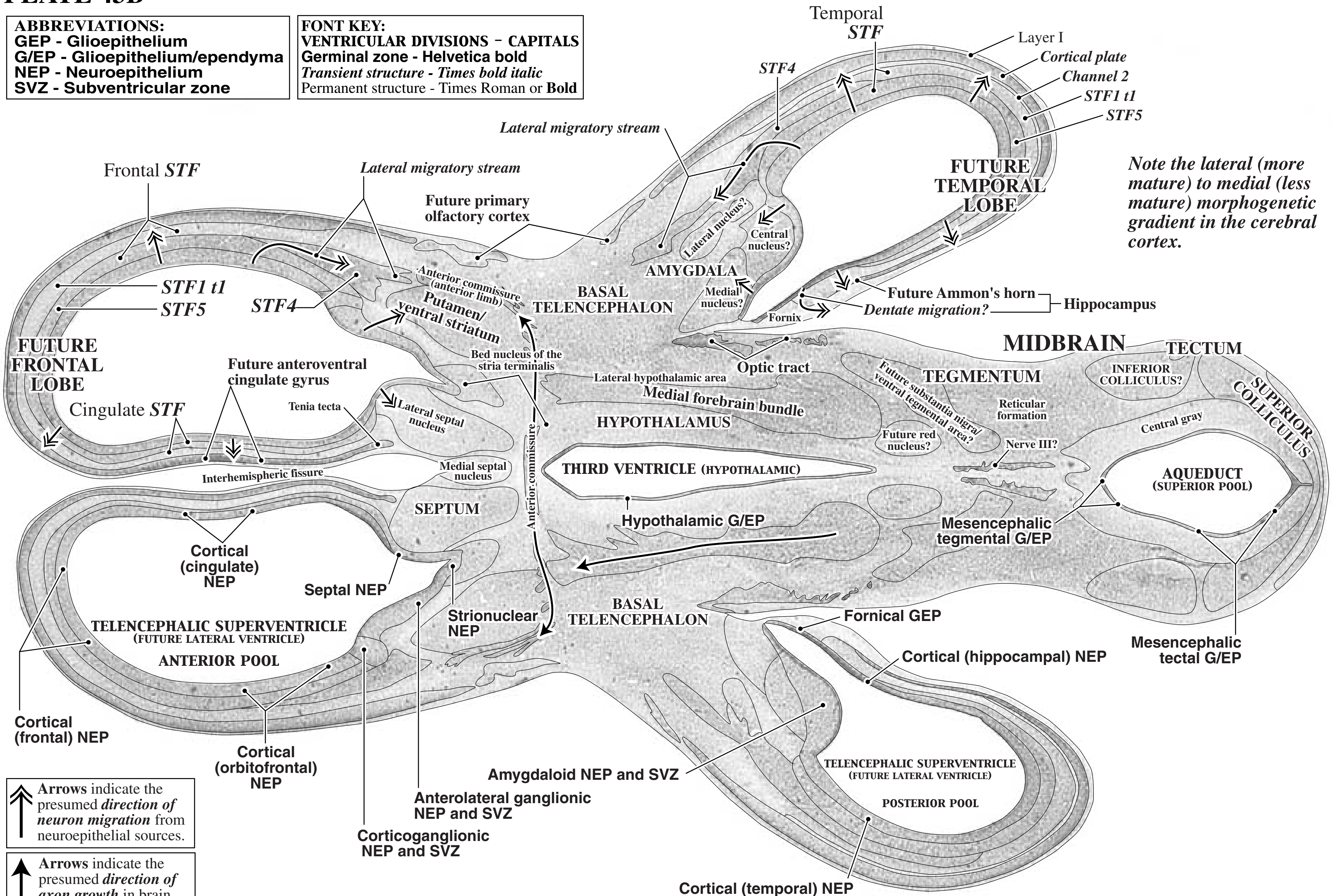
LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 43B

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**



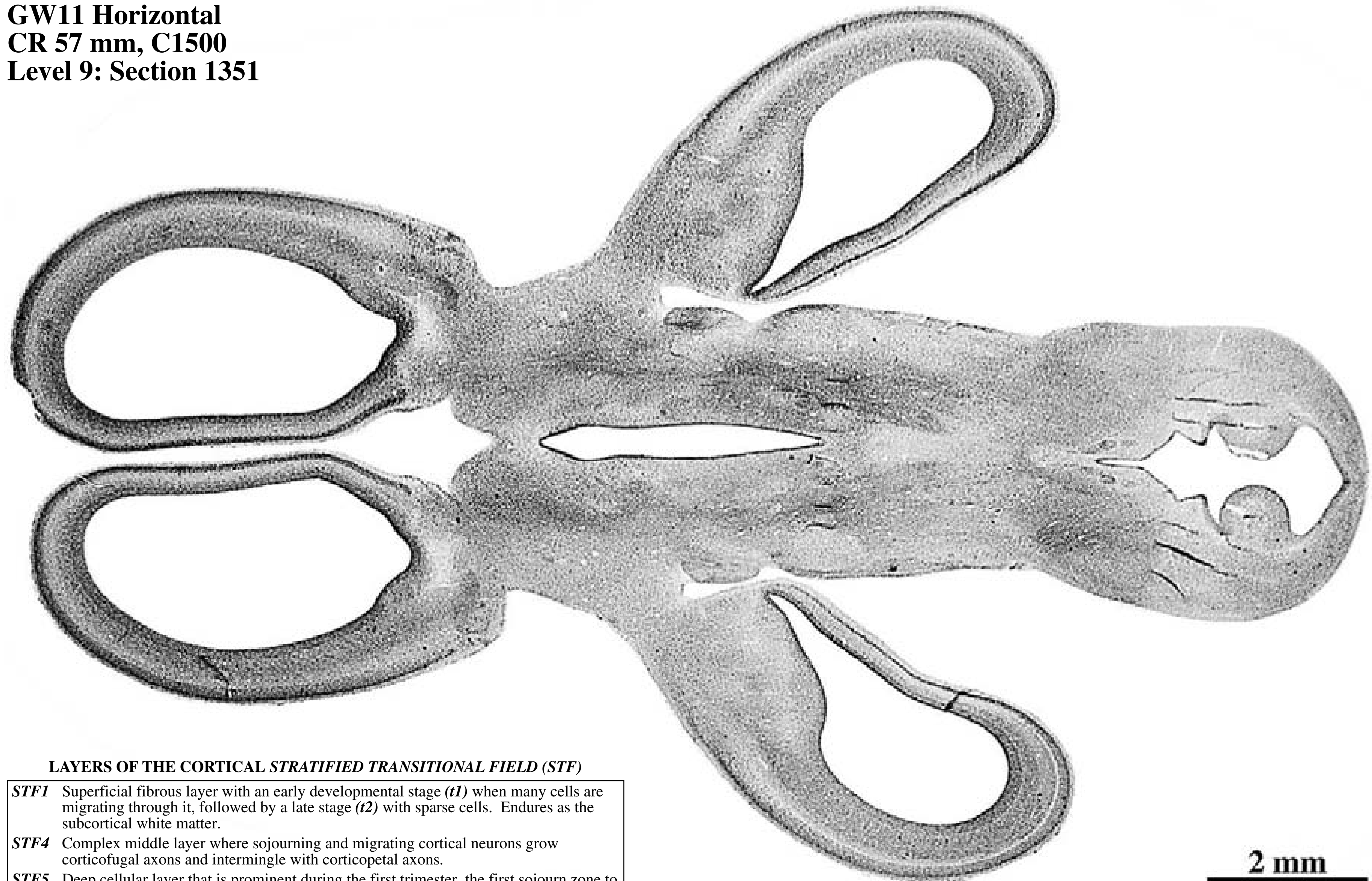
Note the lateral (more mature) to medial (less mature) morphogenetic gradient in the cerebral cortex.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

PLATE 44A

GW11 Horizontal
CR 57 mm, C1500
Level 9: Section 1351



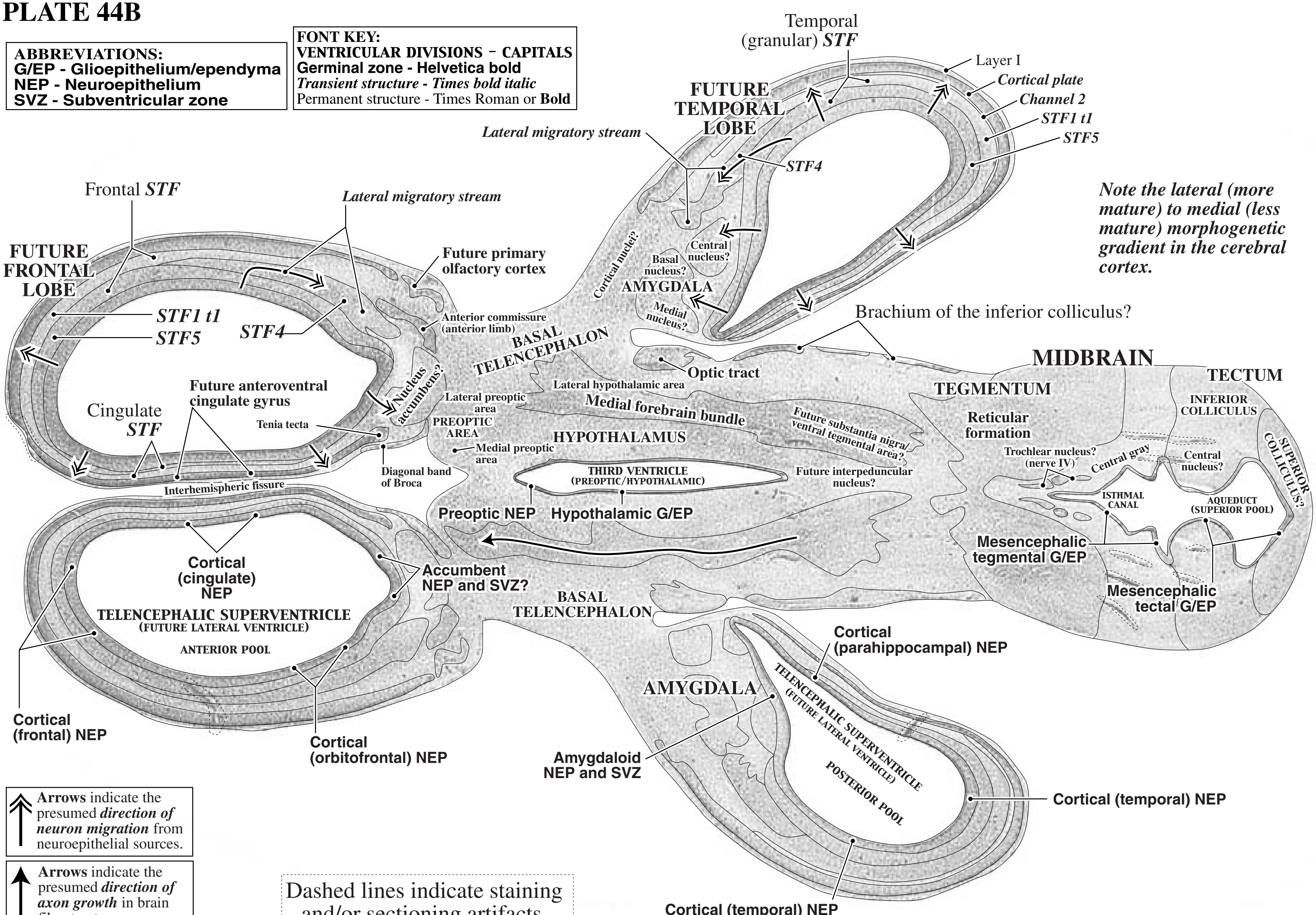
LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 44B

ABBREVIATIONS:
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**



Note the lateral (more mature) to medial (less mature) morphogenetic gradient in the cerebral cortex.

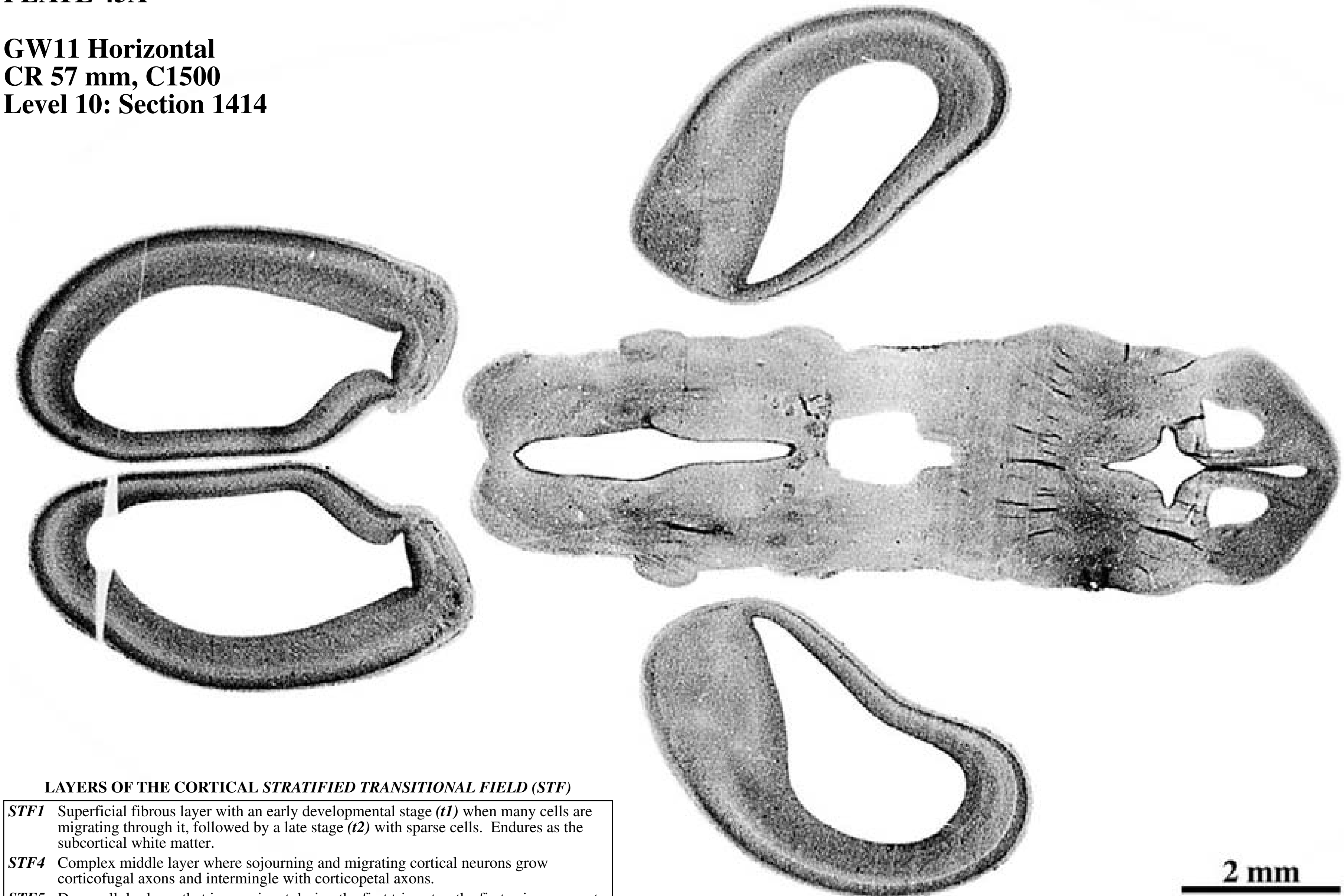
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 45A

GW11 Horizontal
CR 57 mm, C1500
Level 10: Section 1414



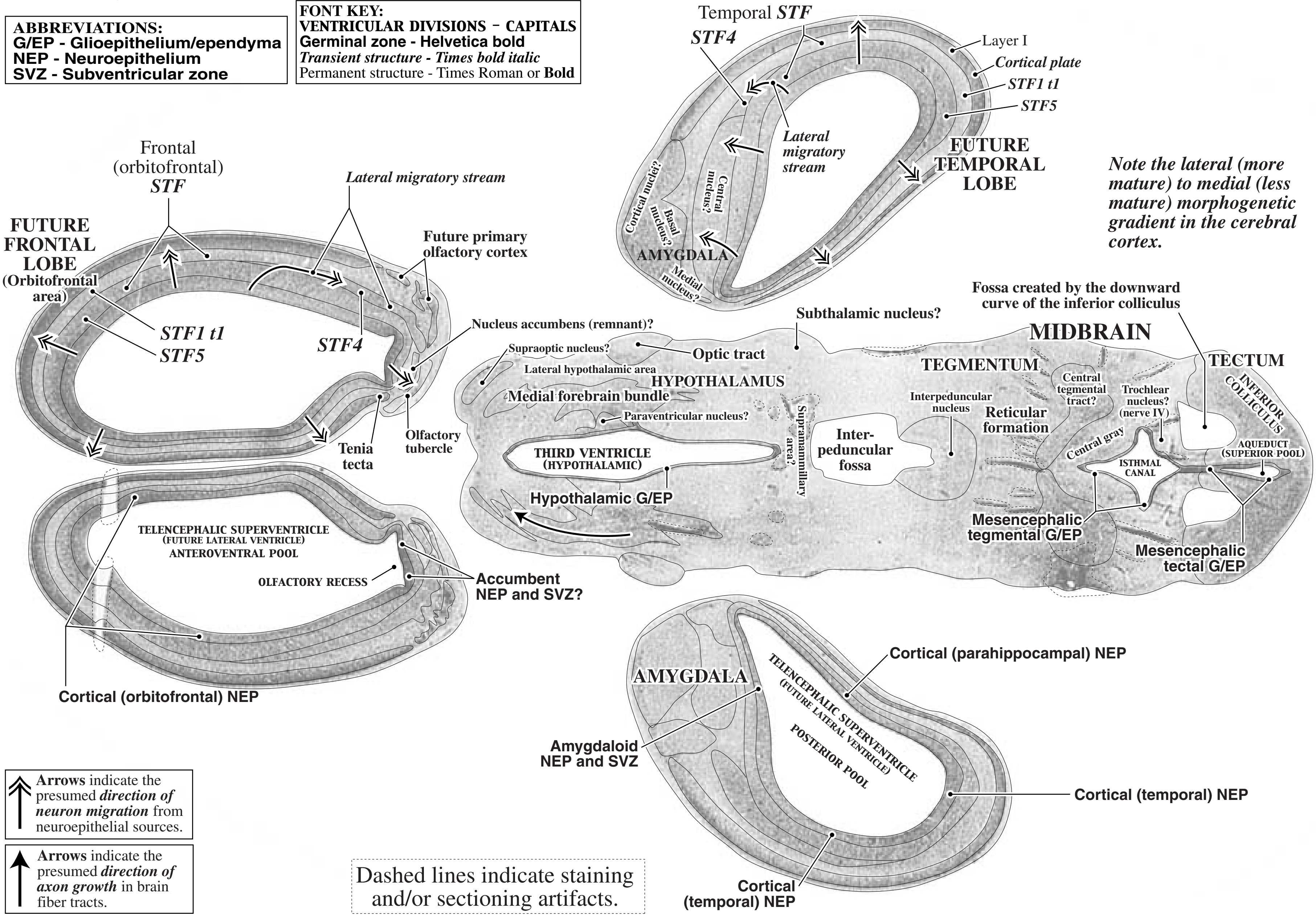
LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 45B

ABBREVIATIONS:
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**



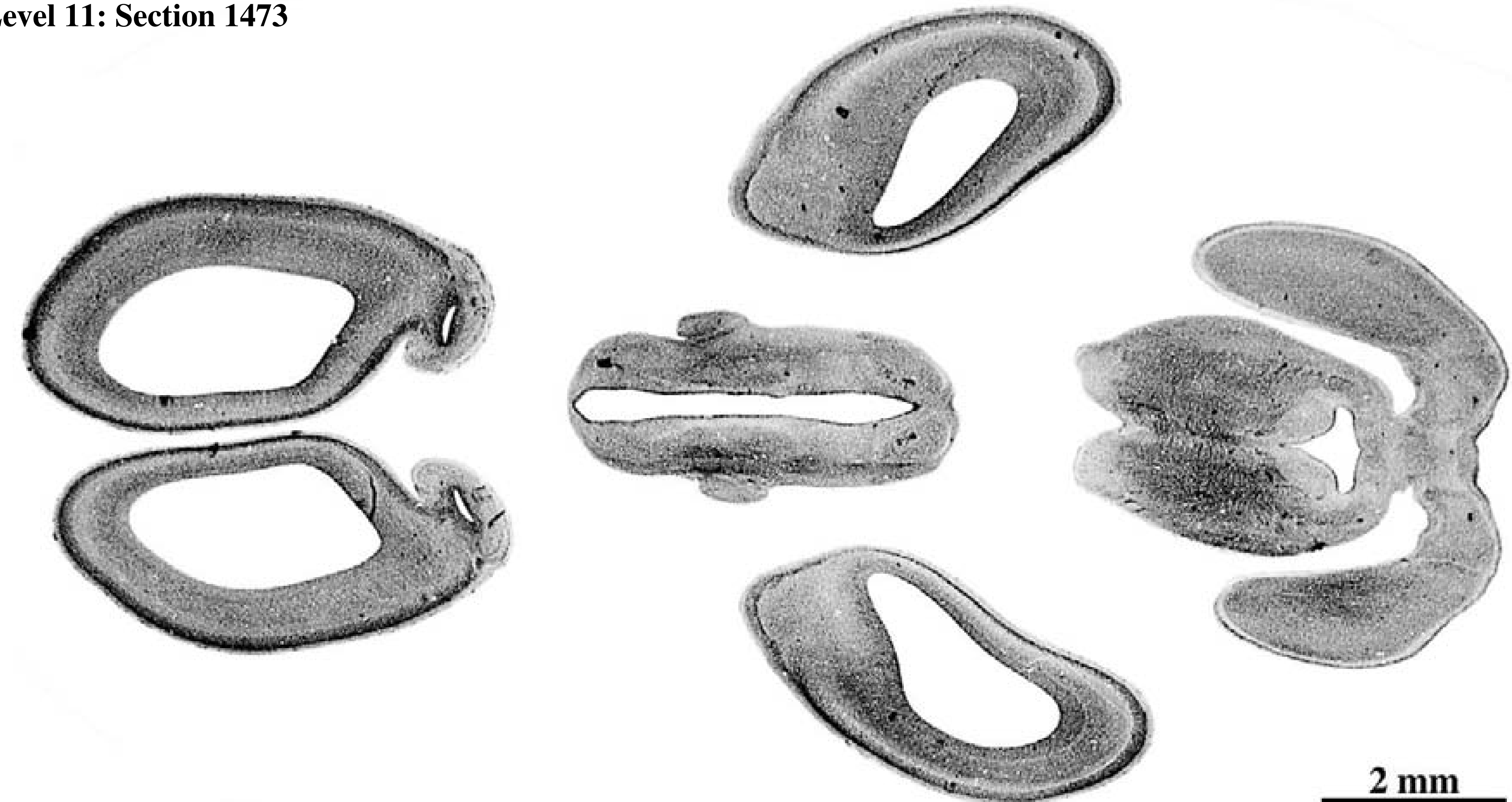
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 46A

GW11 Horizontal
CR 57 mm, C1500
Level 11: Section 1473



LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

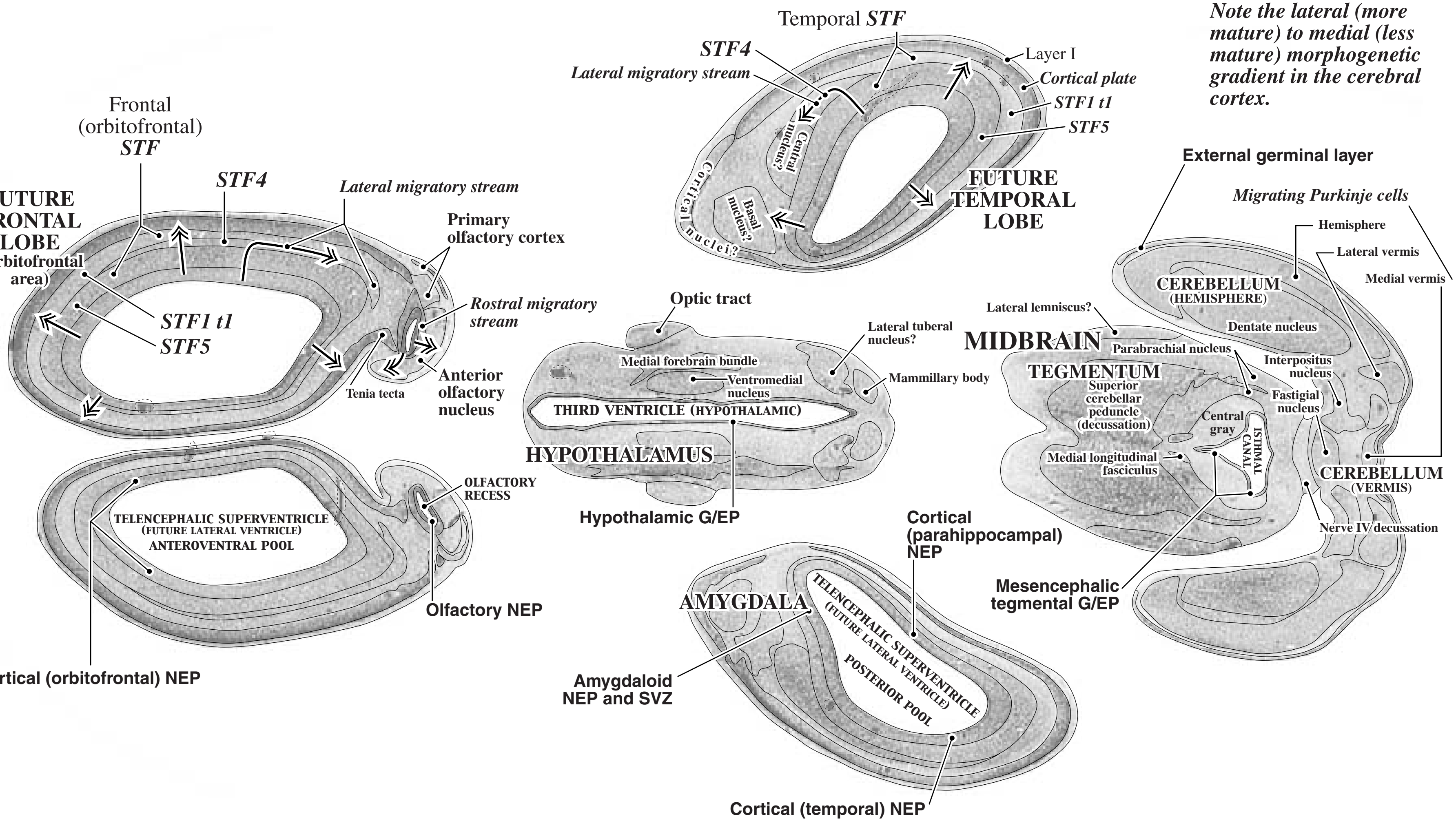
STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 46B

ABBREVIATIONS:
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone

FONT KEY:
VERTICAL DIVISIONS – CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

Note the lateral (more mature) to medial (less mature) morphogenetic gradient in the cerebral cortex.

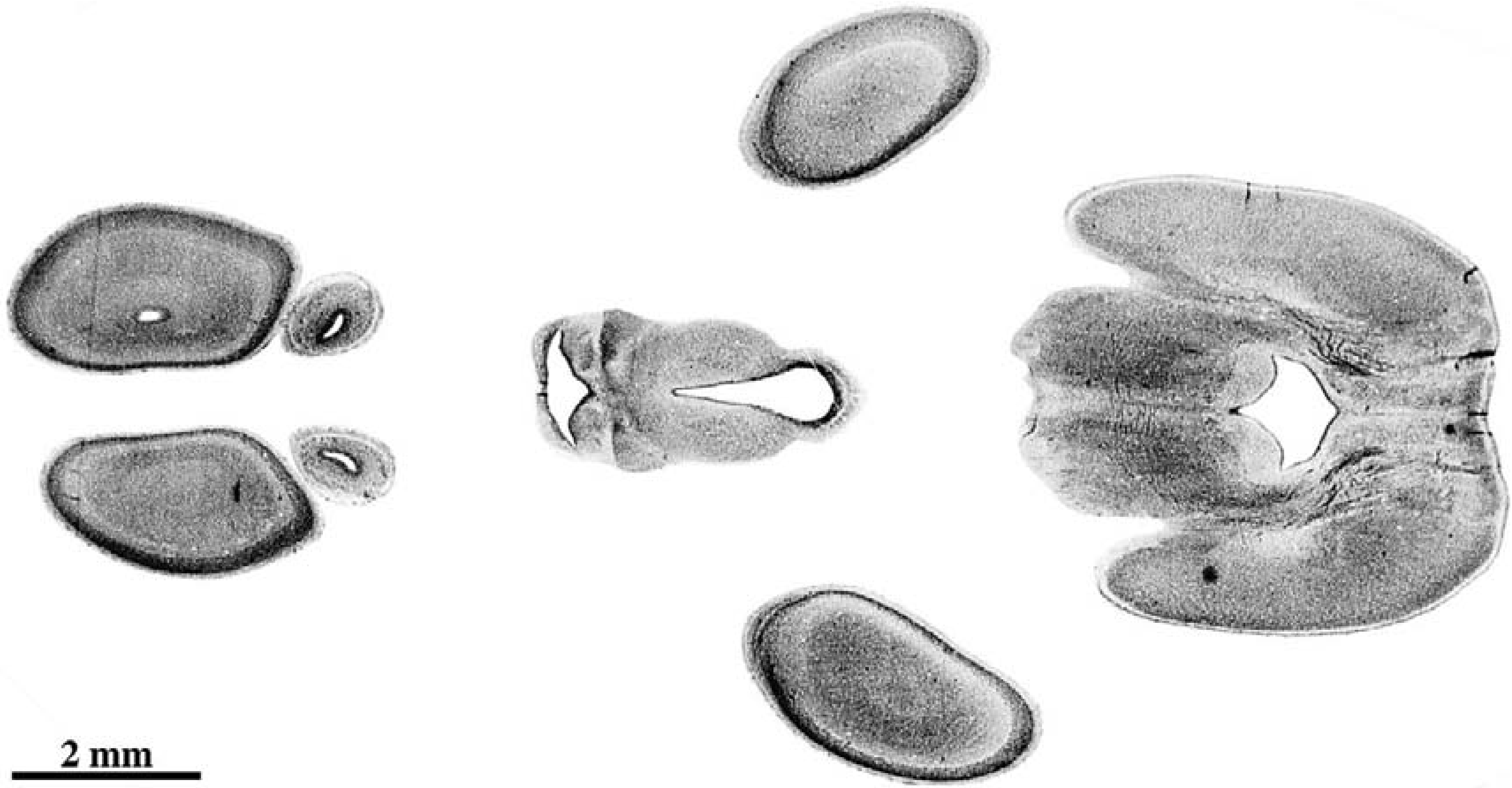


Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 47A

GW11 Horizontal
CR 57 mm, C1500
Level 12: Section 1566



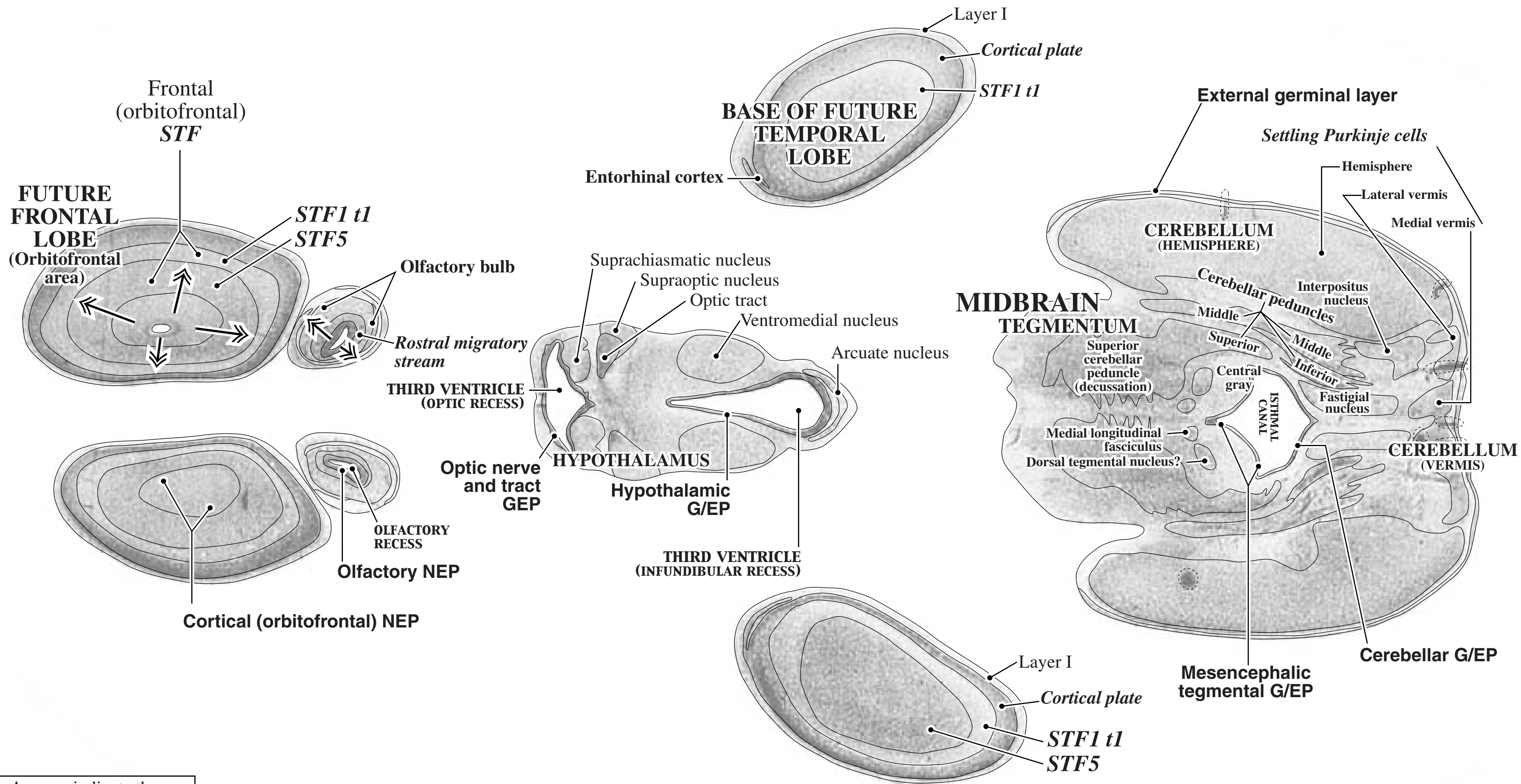
LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 47B

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone

FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 48A

GW11 Horizontal
CR 57 mm, C1500
Level 13: Section 1626

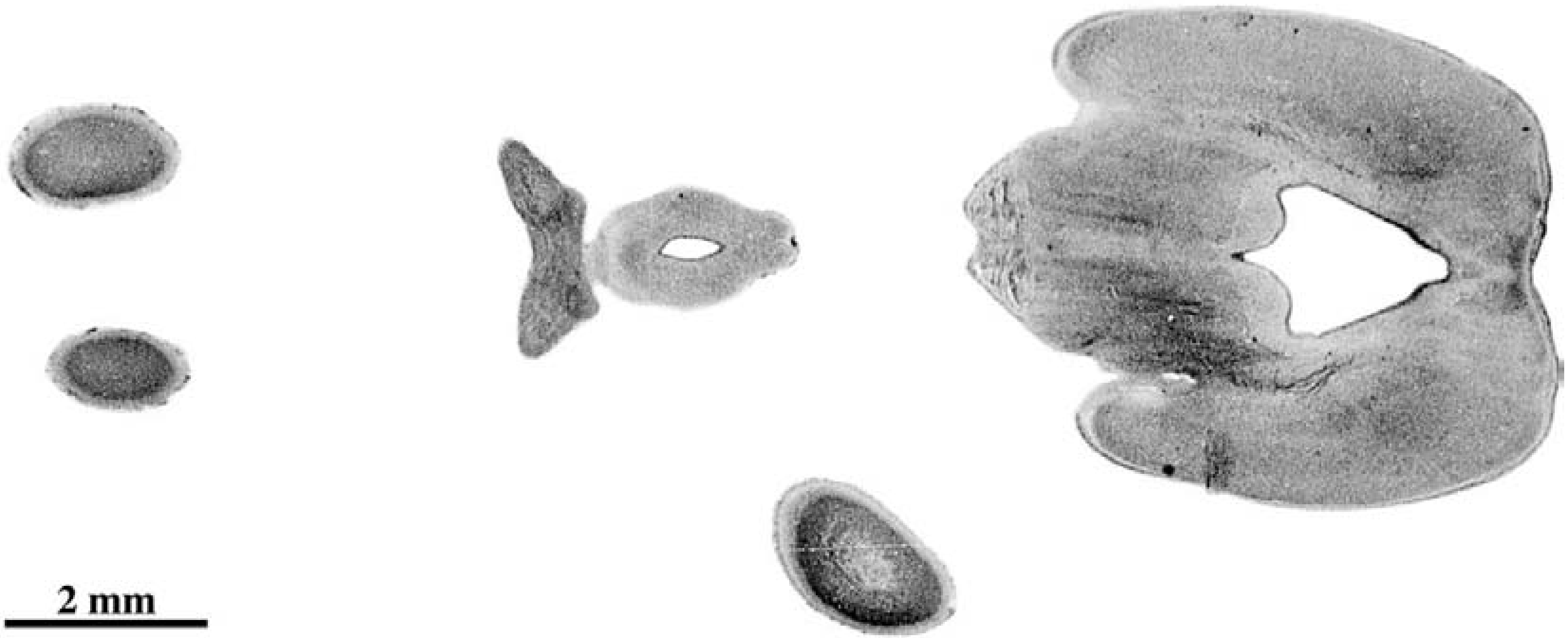
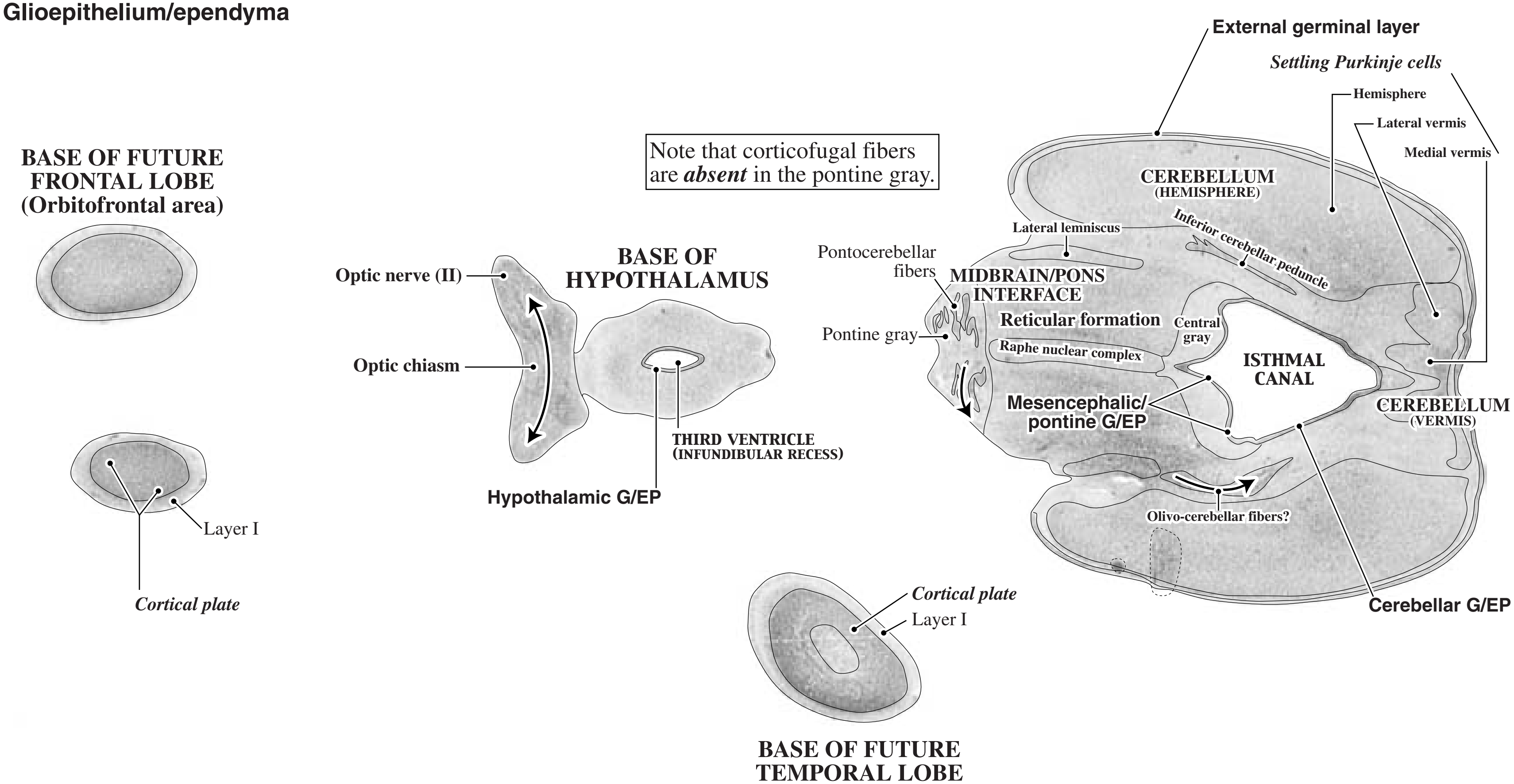


PLATE 48B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

G/EP - Glioepithelium/ependyma

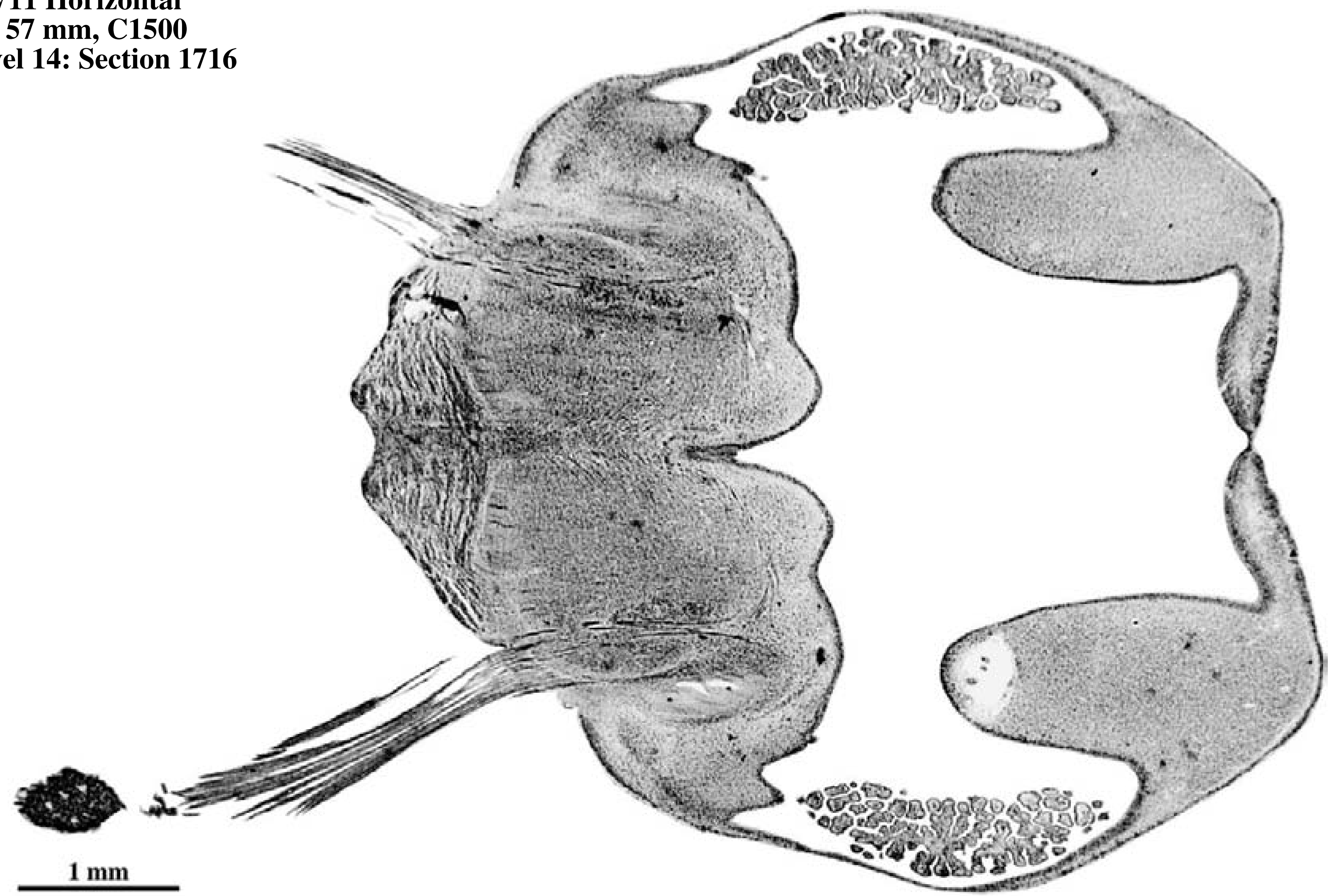


Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 49A

GW11 Horizontal
CR 57 mm, C1500
Level 14: Section 1716

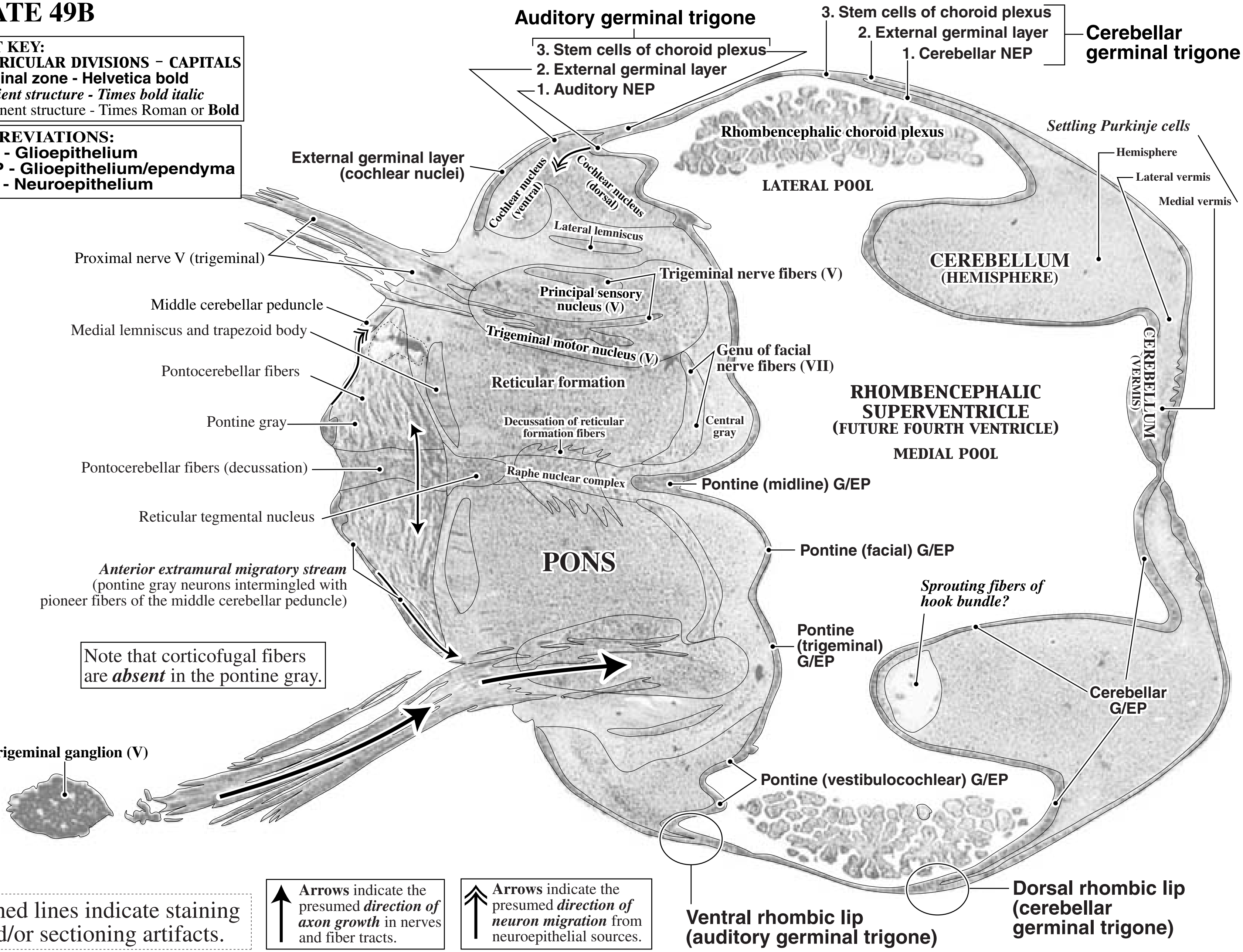


Levels 14 to 21 are only shown at high magnification.

PLATE 49B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium

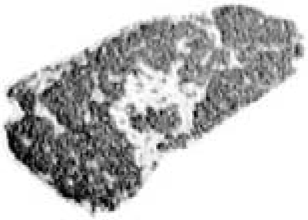


Dashed lines indicate staining and/or sectioning artifacts.

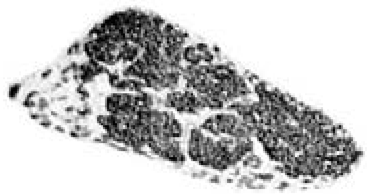
Arrows indicate the presumed ***direction of axon growth*** in nerves and fiber tracts.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 50A



GW11 Horizontal
CR 57 mm, C1500
Level 15: Section 1805

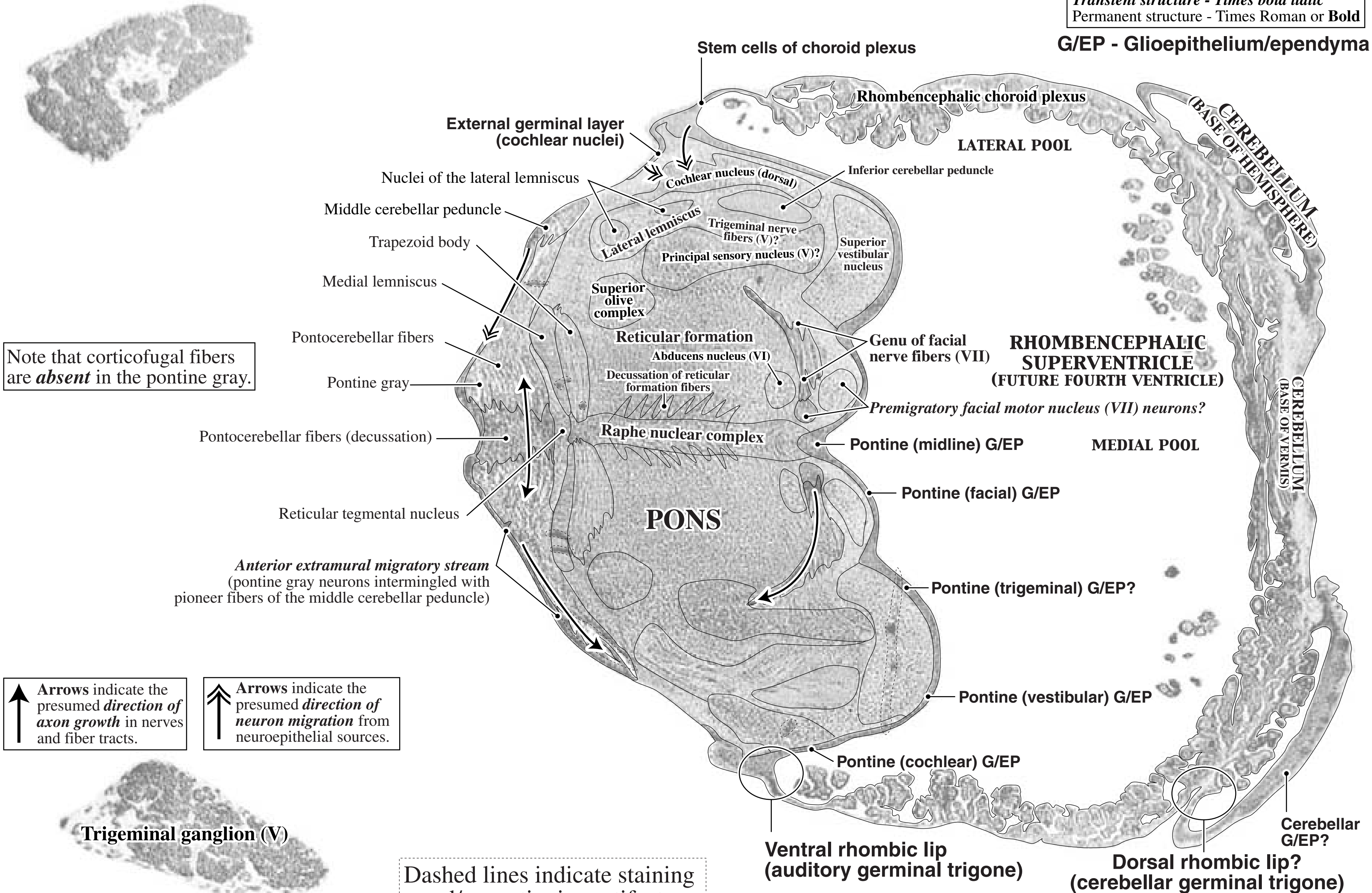


Levels 14 to 21 are only shown at high magnification.

PLATE 50B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

G/EP - Glioepithelium/ependyma



Note that corticofugal fibers are ***absent*** in the pontine gray.

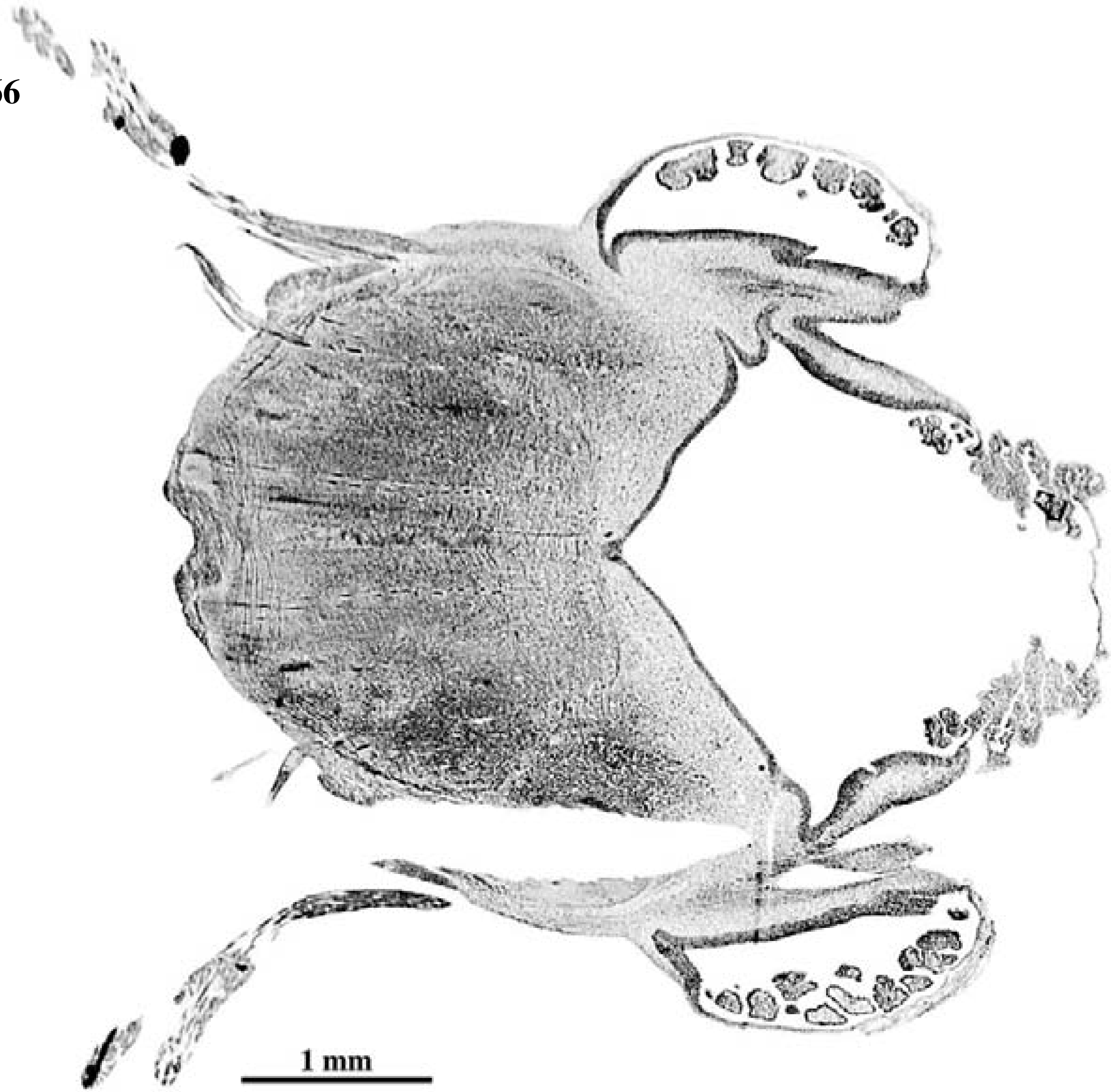
Arrows indicate the presumed ***direction of axon growth*** in nerves and fiber tracts.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 51A

GW11 Horizontal
CR 57 mm, C1500
Level 16: Section 1866

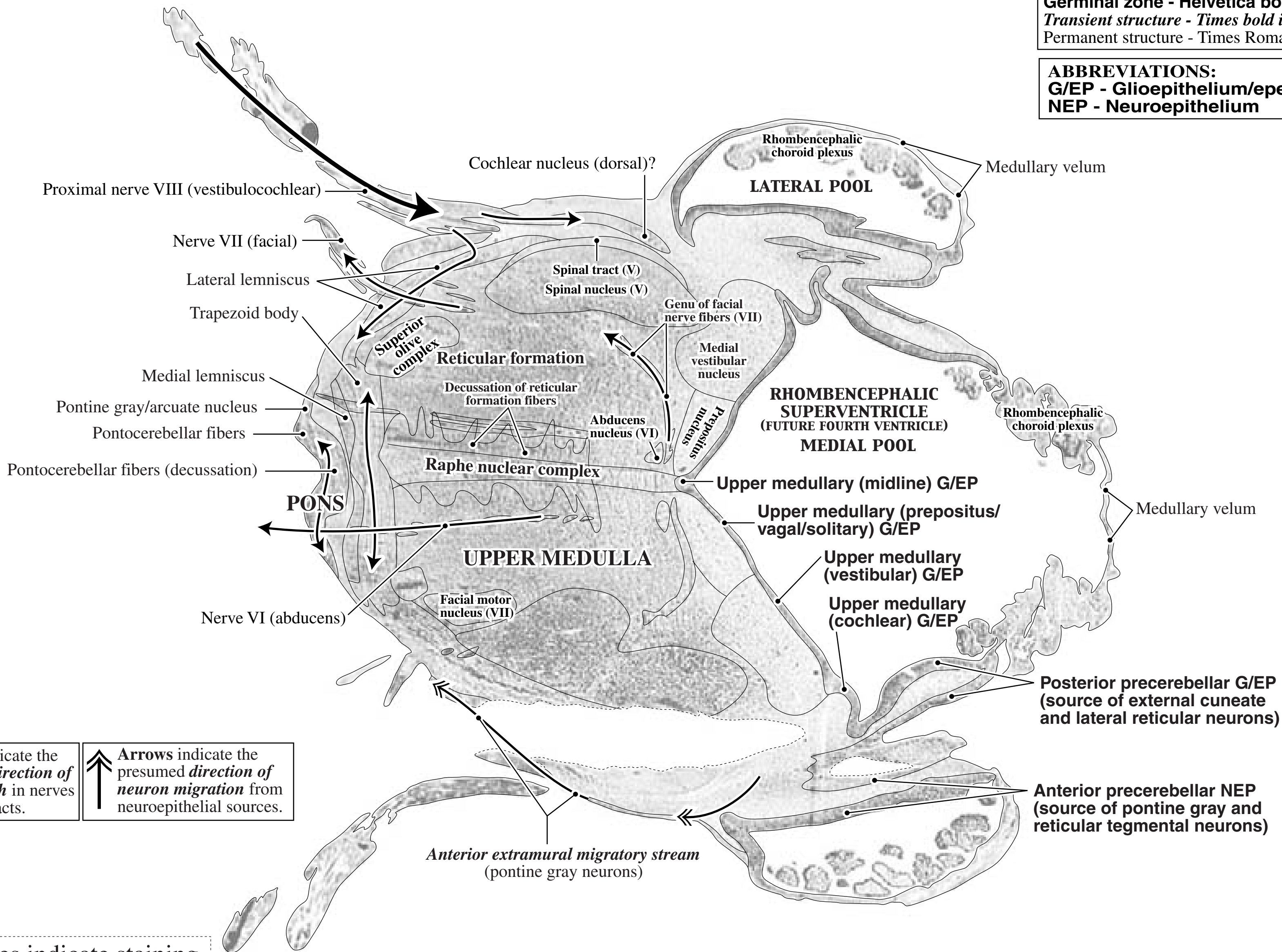


Levels 14 to 21 are only shown at high magnification.

PLATE 51B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium



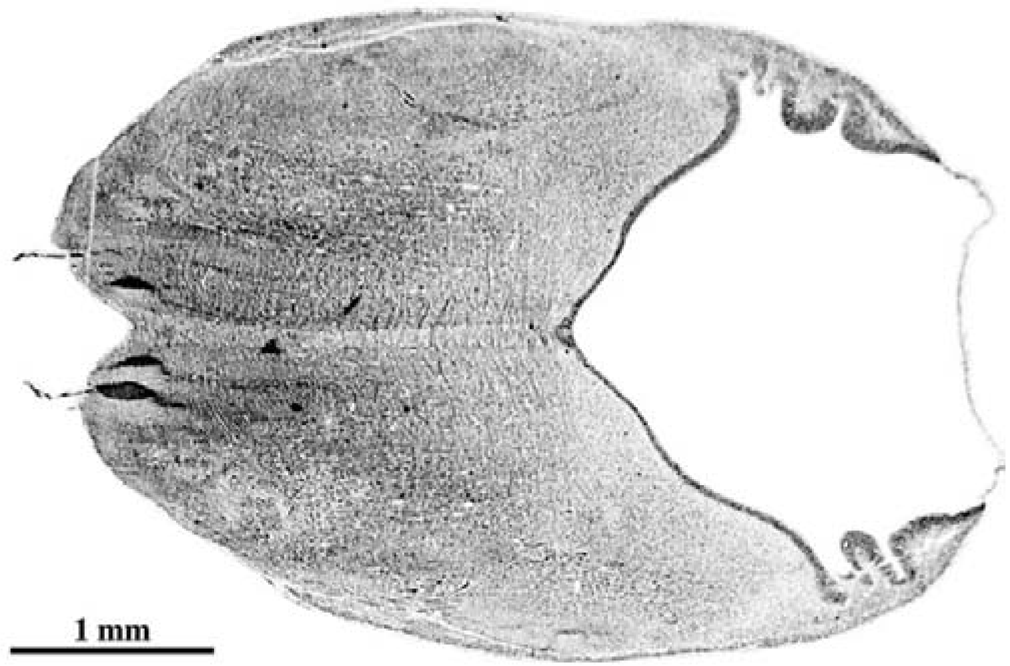
Arrows indicate the presumed ***direction of axon growth*** in nerves and fiber tracts.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 52A

GW11 Horizontal
CR 57 mm, C1500
Level 17: Section 1926

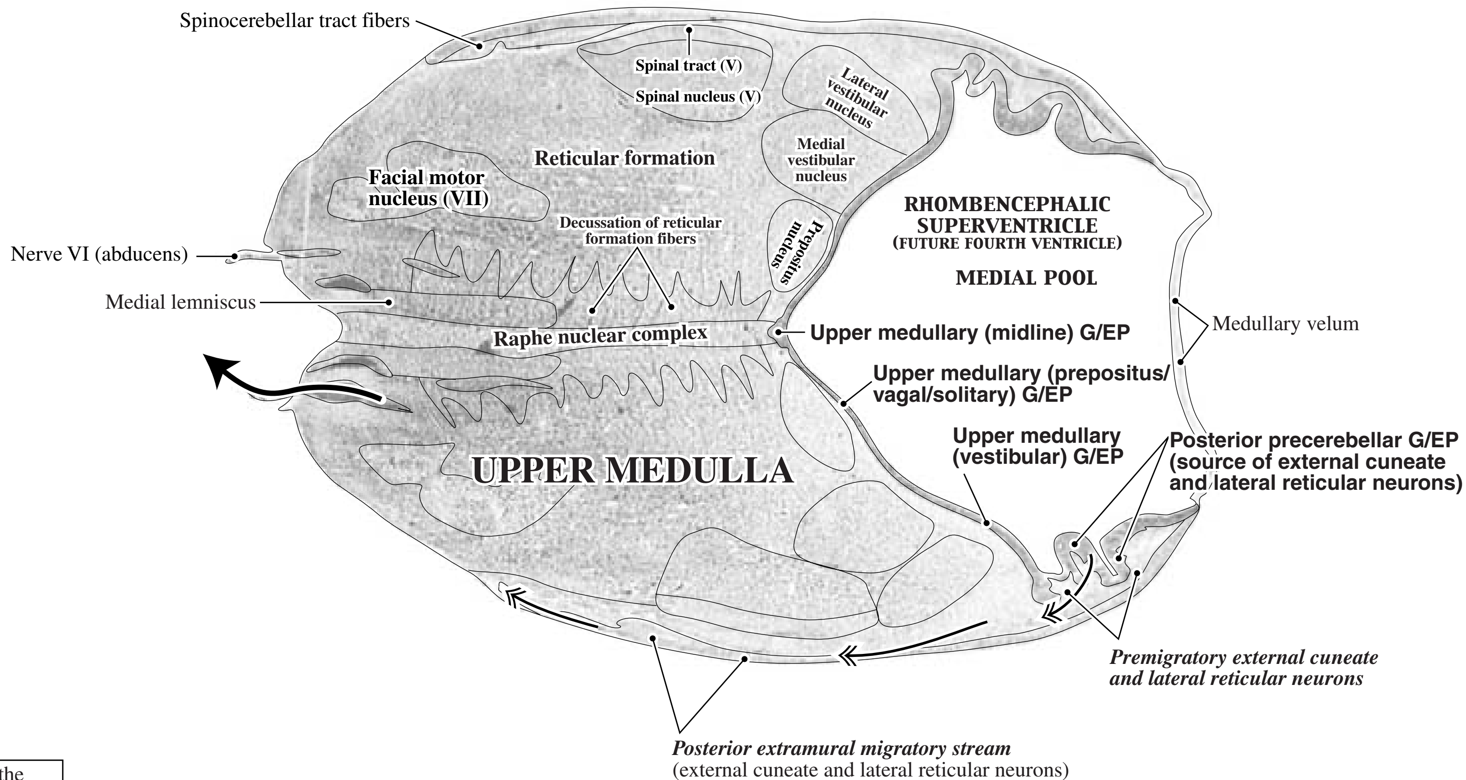


Levels 14 to 21 are only shown at high magnification.

PLATE 52B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

G/EP - Glioepithelium/ependyma

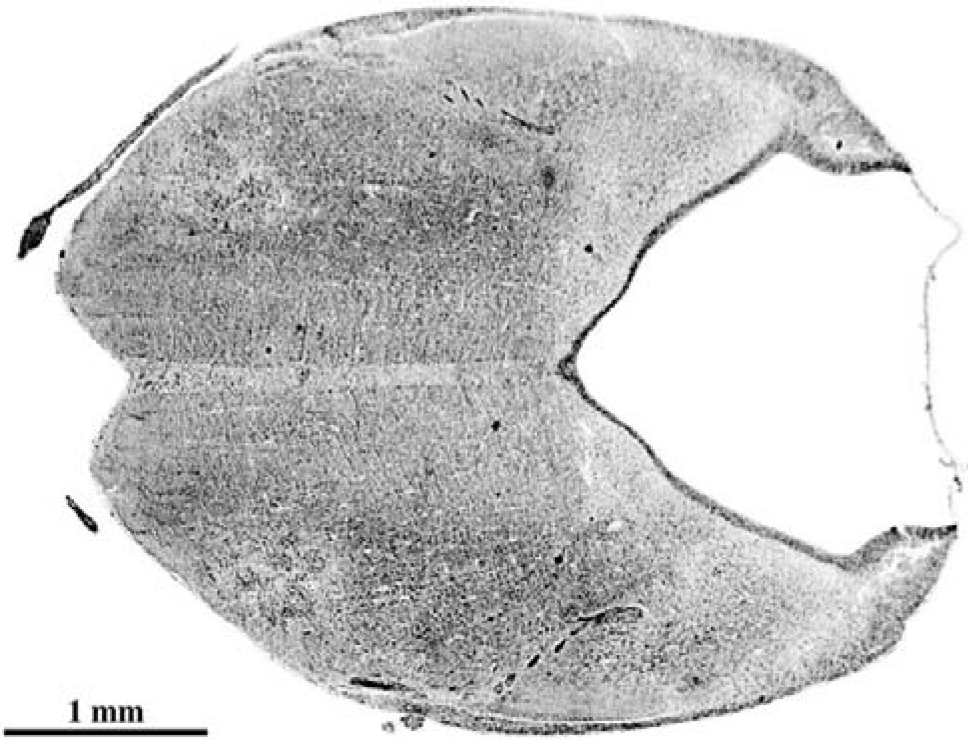


Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in nerves and fiber tracts.

PLATE 53A

GW11 Horizontal
CR 57 mm, C1500
Level 18: Section 1962

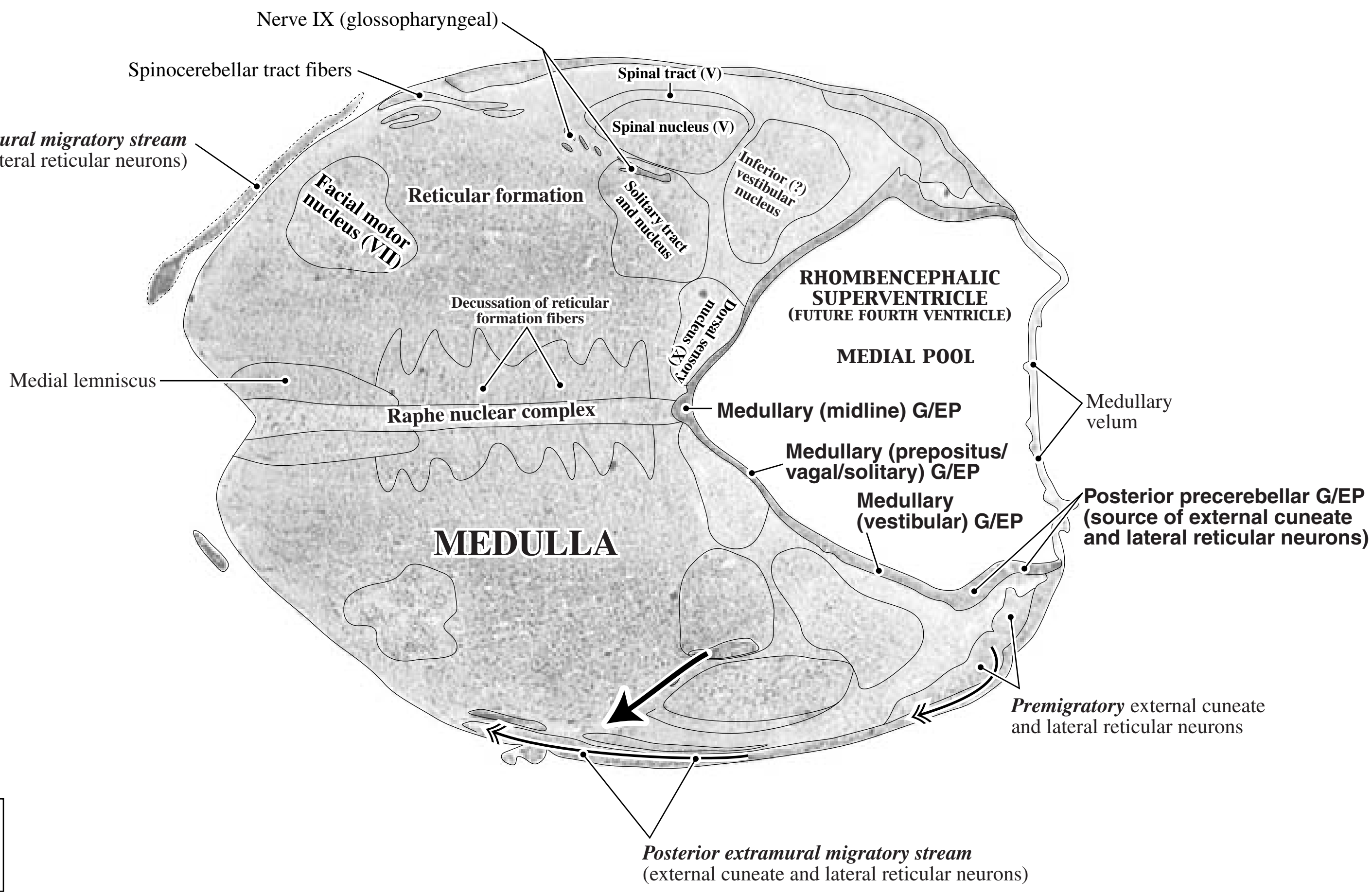


Levels 14 to 21 are only shown at high magnification.

PLATE 53B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

G/EP - Glioepithelium/ependyma



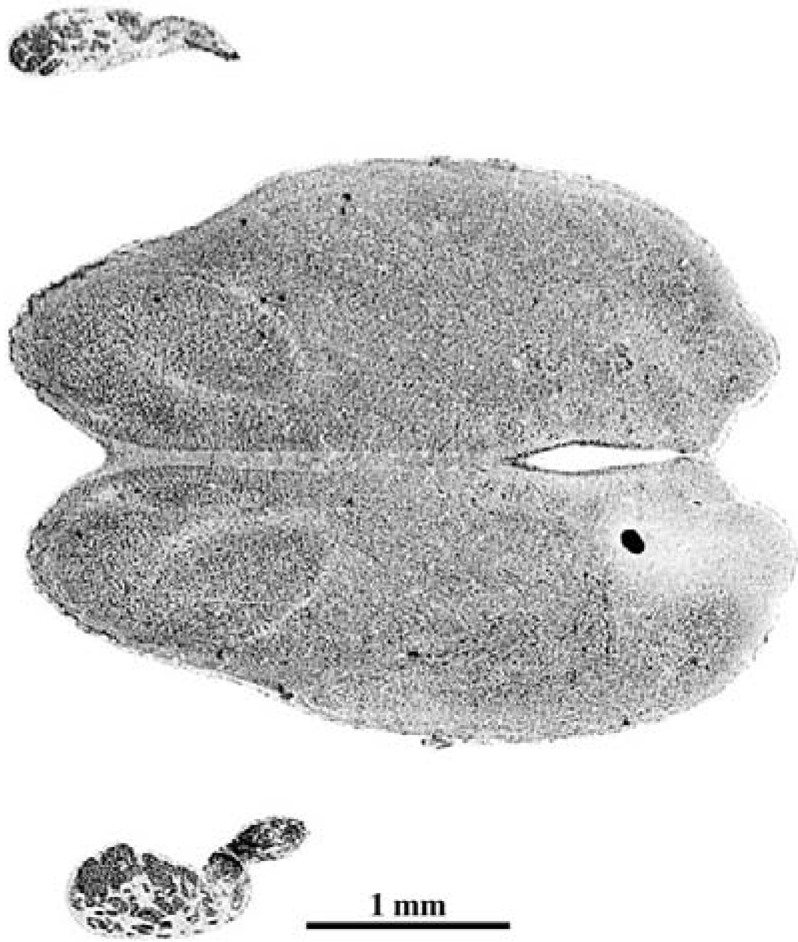
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in nerves and fiber tracts.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 54A

GW11 Horizontal
CR 57 mm, C1500
Level 19: Section 2202

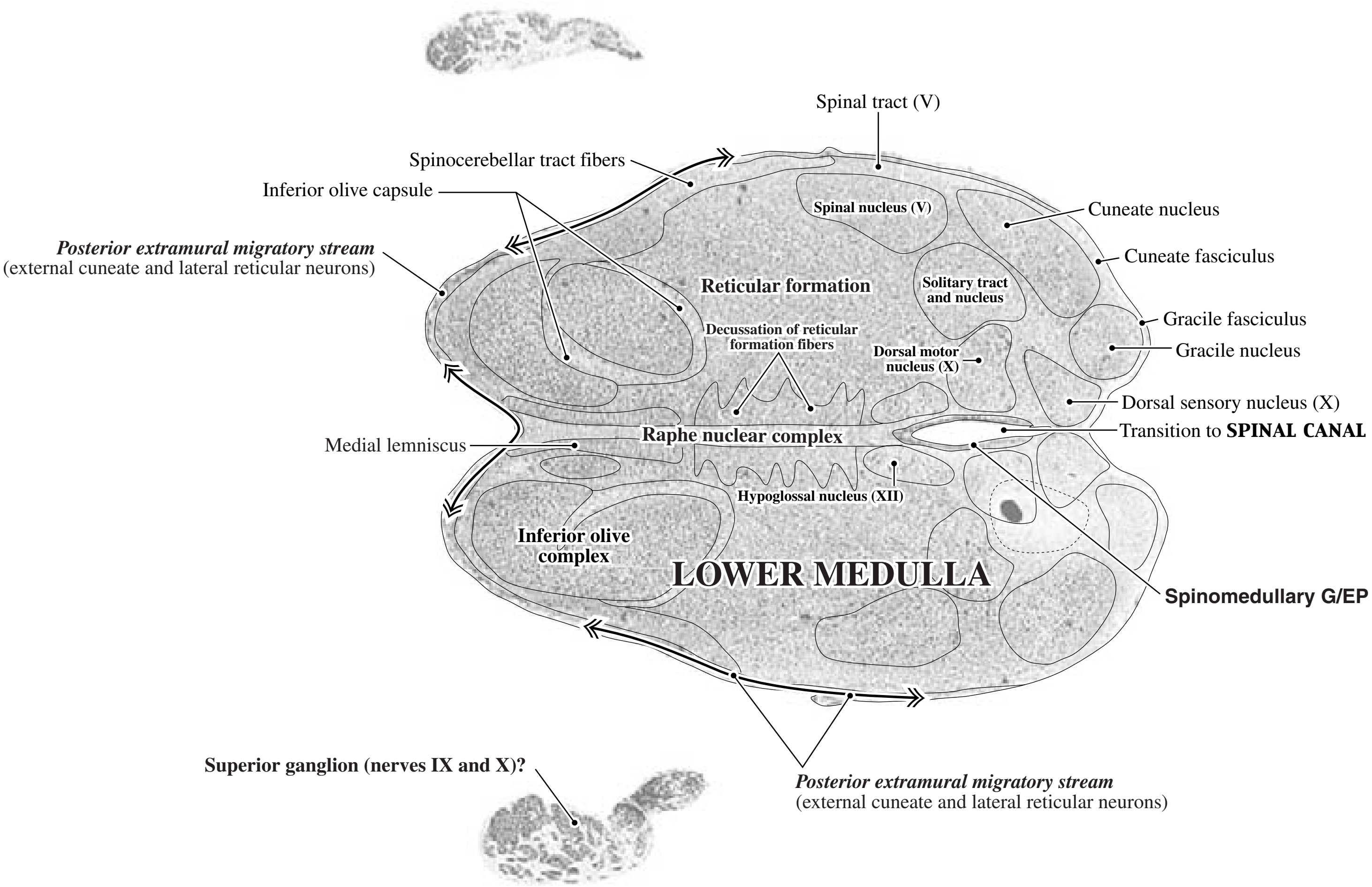


Levels 14 to 21 are only shown at high magnification.

PLATE 54B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

G/EP - Glioepithelium/ependyma

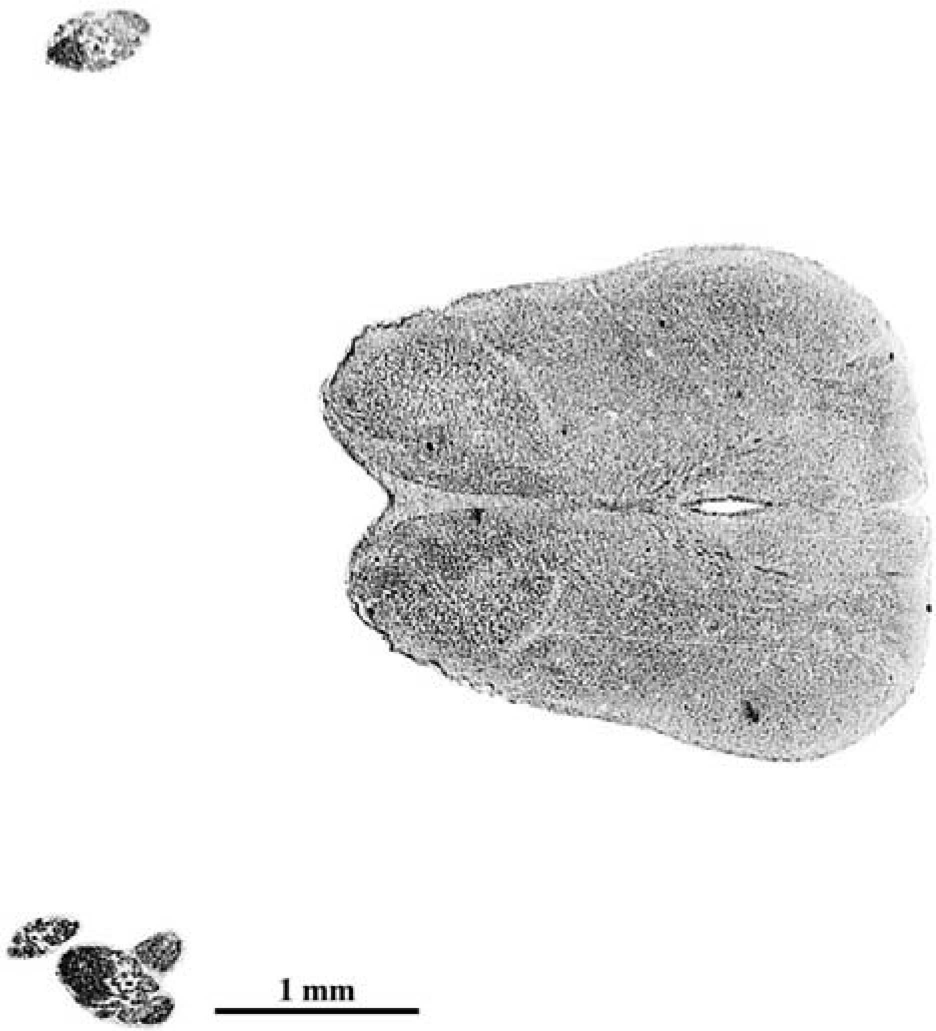


Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Dashed lines indicate staining and/or sectioning artifacts.

PLATE 55A

GW11 Horizontal
CR 57 mm, C1500
Level 20: Section 2322

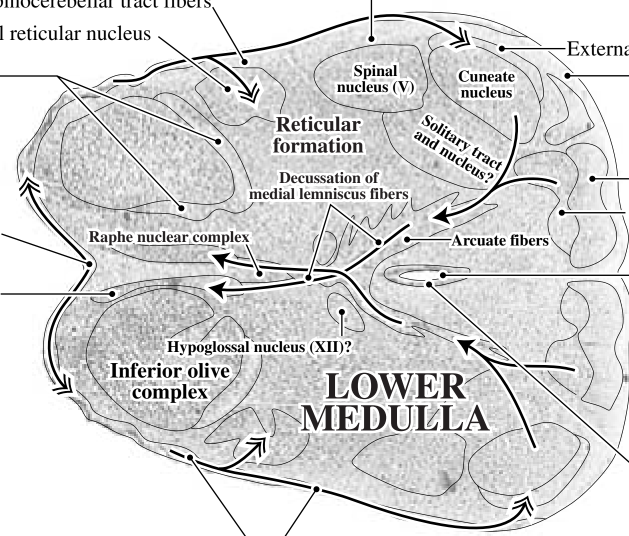


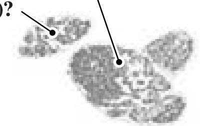
Levels 14 to 21 are only shown at high magnification.

PLATE 55B

FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

G/EP - Glioepithelium/ependyma



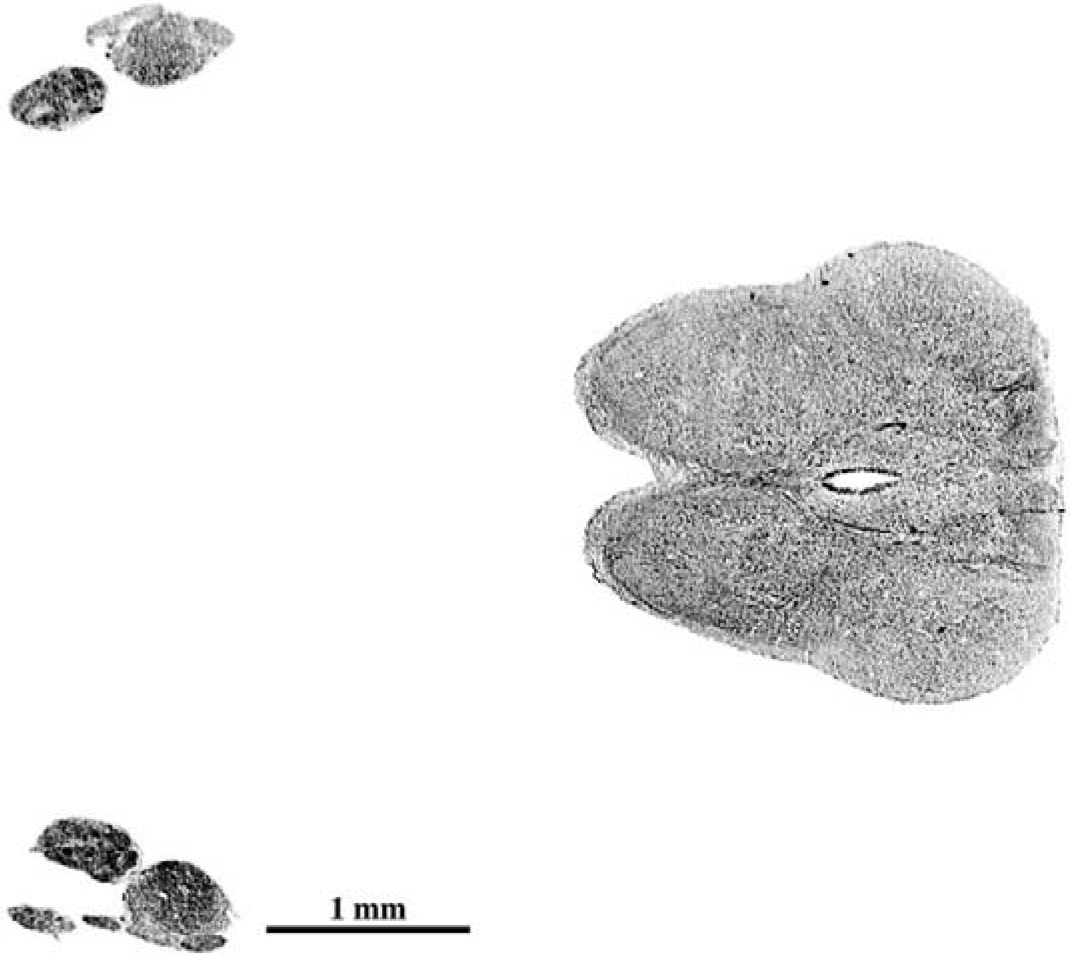


Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

PLATE 56A

GW11 Horizontal
CR 57 mm, C1500
Level 21: Section 2402

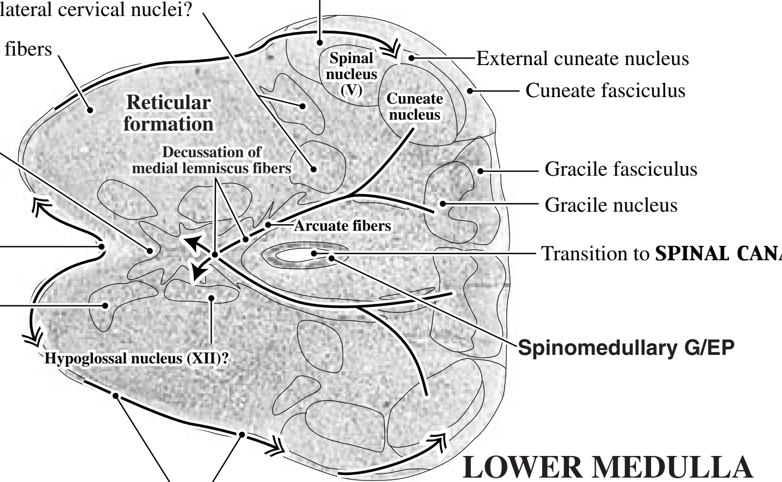


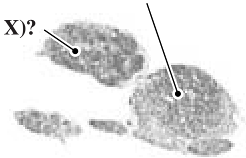
Levels 14 to 21 are only shown at high magnification.

PLATE 56B

FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

G/EP - Glioepithelium/ependyma





Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

PART IV: GW9 SAGITTAL

PART IV: GW9 SAGITTAL

This is specimen number 6658 in the Carnegie Collection, designated here as C6658, a female with a crown-rump length (CR) of 40 mm estimated to be at gestational week (GW) 9. The entire fetus was cut in the sagittal plane in 40 µm sections and stained with hematoxylin and eosin. Information on the date of specimen collection, fixative, and embedding medium (appears to be celloidin) was not available to us. The histology is excellent, and this is one of the best preserved specimens in any of the Collections at the National Museum of Health and Medicine. Since there is no photograph of this specimen's brain before histological processing, a specimen from Hochstetter (1919) that is comparable in age to C6658 is used to show external brain features at GW9 (**A**, **Figure 3**). C6658's brain structures are more difficult to understand because the sections are not cut parallel to the midline; **Figure 3** shows the approximate rotations in horizontal (**B**) and vertical (**C**) dimensions. Photographs of 11 sections (**Levels 1-11**) are illustrated at low magnification in four-parts (**Plates 57A-D** through **67A-D**). The **A/B** parts show the brain in place in the skull; the **C/D** parts show only the brain (and some peripheral ganglia) at slightly higher magnification. **Plates 68-83** show high-magnification views of various parts of the brain at different levels from the cerebral cortex (**Plate 68**) to the pons and sensory ganglia (**Plates 82-83**). All of the high-magnification plates are rotated 90˚ (landscape orientation) to more efficiently use page space.

C6658 is considerably less mature than the GW11 specimens. Throughout the cerebral cortex, the ***neuroepithelium*** is prominent and appears to be without a subventricular zone. The ***stratified transitional field (STF)*** contains ***STF1*** and ***STF5*** throughout; with ***STF4*** only in lateral areas. The most prominent developmental feature of the cerebral cortex is that both the ***STF*** layers and the cortical plate have a pronounced anterolateral (thicker) to dorsomedial (thinner) maturation gradient. The olfactory bulb is just beginning to evaginate in front of the basal telencephalic neuroepithelium. In anterolateral parts of the cerebral cortex, streams of neurons and glia appear to leave ***STF4*** and enter the ***lateral migratory stream***. The hippocampus contains ***ammonic and dentate migrations***, but there is no evidence of a pyramidal in Ammon's horn or a dentate gyrus. A massive ***neuroepithelium/subventricular zone*** overlies the amygdala, nucleus accumbens, and striatum (caudate and putamen) where neurons (and glia) are being generated.

The cerebellum is a thick, smooth plate overlying the posterior pons and medulla, and a definite ***neuroepithelium*** at the ventricular surface, indicating some Purkinje cells are still being generated. Many Purkinje cells are sojourning in a dense layer outside the neuroepithelium, and others are migrating upward. Many of the deep neurons are superificial in the cerebellum, but some are migrating downward to intermingle with upwardly migrating Purkinje cells. The cortical surface is partially covered by an ***external germinal layer (egl)*** that is actively producing neuronal stem cells, as it grows over the surface of the cerebellar cortex.

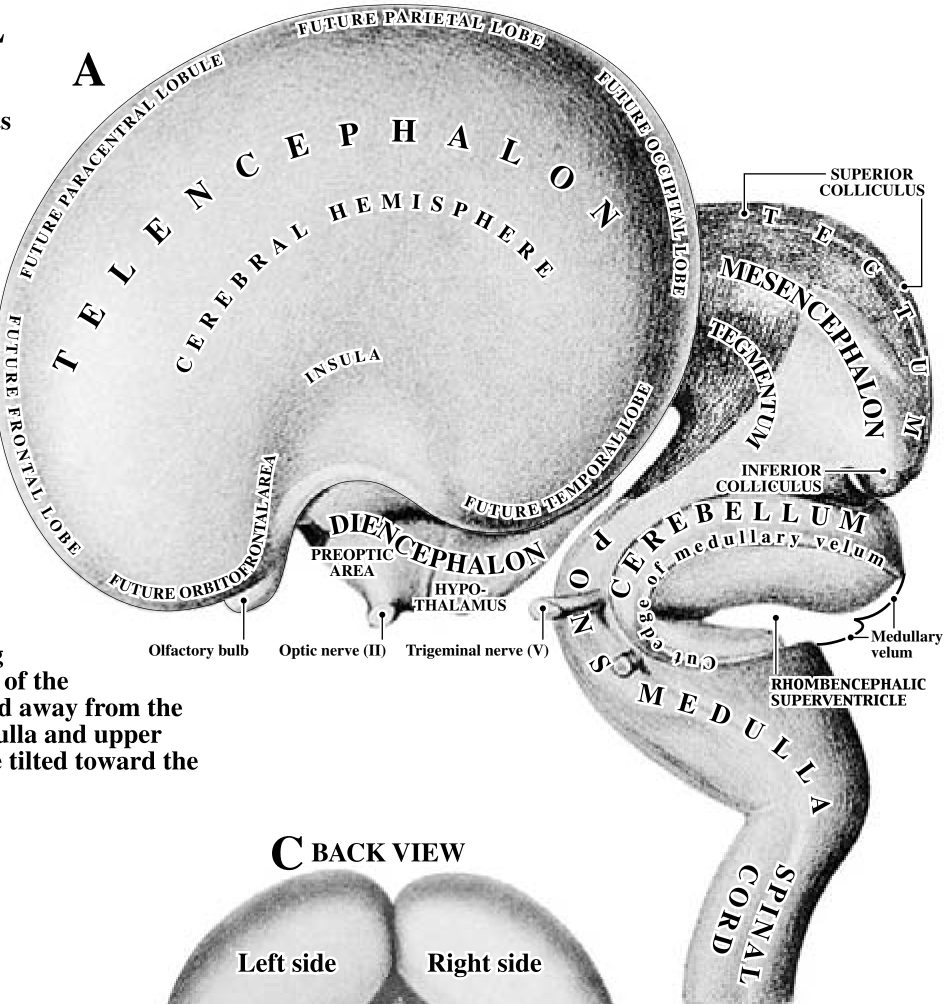
The third ventricle, aqueduct, and fourth ventricle are lined by thin ***neuroepithelia***. The midbrain tegmentum, pons, and medulla have the thinnest neuroepithelia indicating that only the latest generated neurons are being produced at this time. The thick precerebellar neuroepithelium is an exception in the medulla. Thicker neuroepithelia are in the cerebellum (see above) and midbrain tectum, indicating many neurons are still being generated, although the majority of the neurons in these sites are already postmitotic. The neuroepithelium is still thicker in the hypothalamus and thalamus, in accordance with the later maturation of the diencephalon compared to the rest of the brainstem.

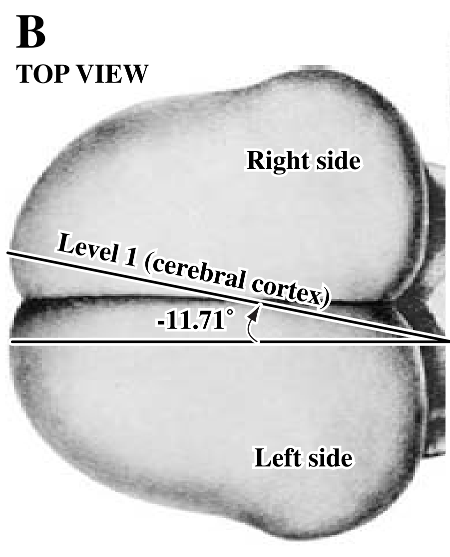
Neurons throughout the diencephalon, midbrain tegmentum, pons, and medulla are migrating and settling. Nuclear divisions are very indistinct throughout the diencephalon. More definition is seen in the midbrain tegmentum, pons, and medulla. The large ***anterior extramural***, ***posterior extramural, and intramural migratory streams*** are prominent in the medulla and pons.

GW9 SAGITTAL

A perfect sagittal cut through the brain bisects the cerebral cortex into two separate hemispheres by passing through the interhemispheric fissure, and does the same in the brainstem by passing through the midline of the ventricles.

Sections of C6658's brain are not parallel to the midline either horizontally (-11.71˚, top view) or vertically (-6.64˚, back view). In each of the illustrated sections on the following pages, the anterior edge of the cortex (top right) is tilted away from the observer, while the medulla and upper spinal cord (bottom) are tilted toward the observer.





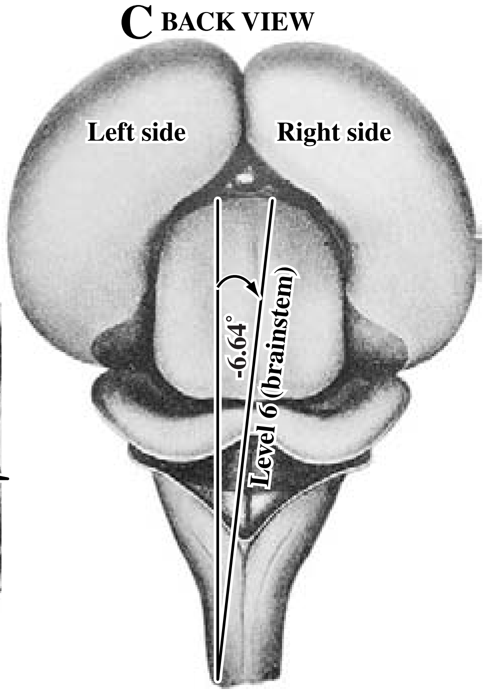
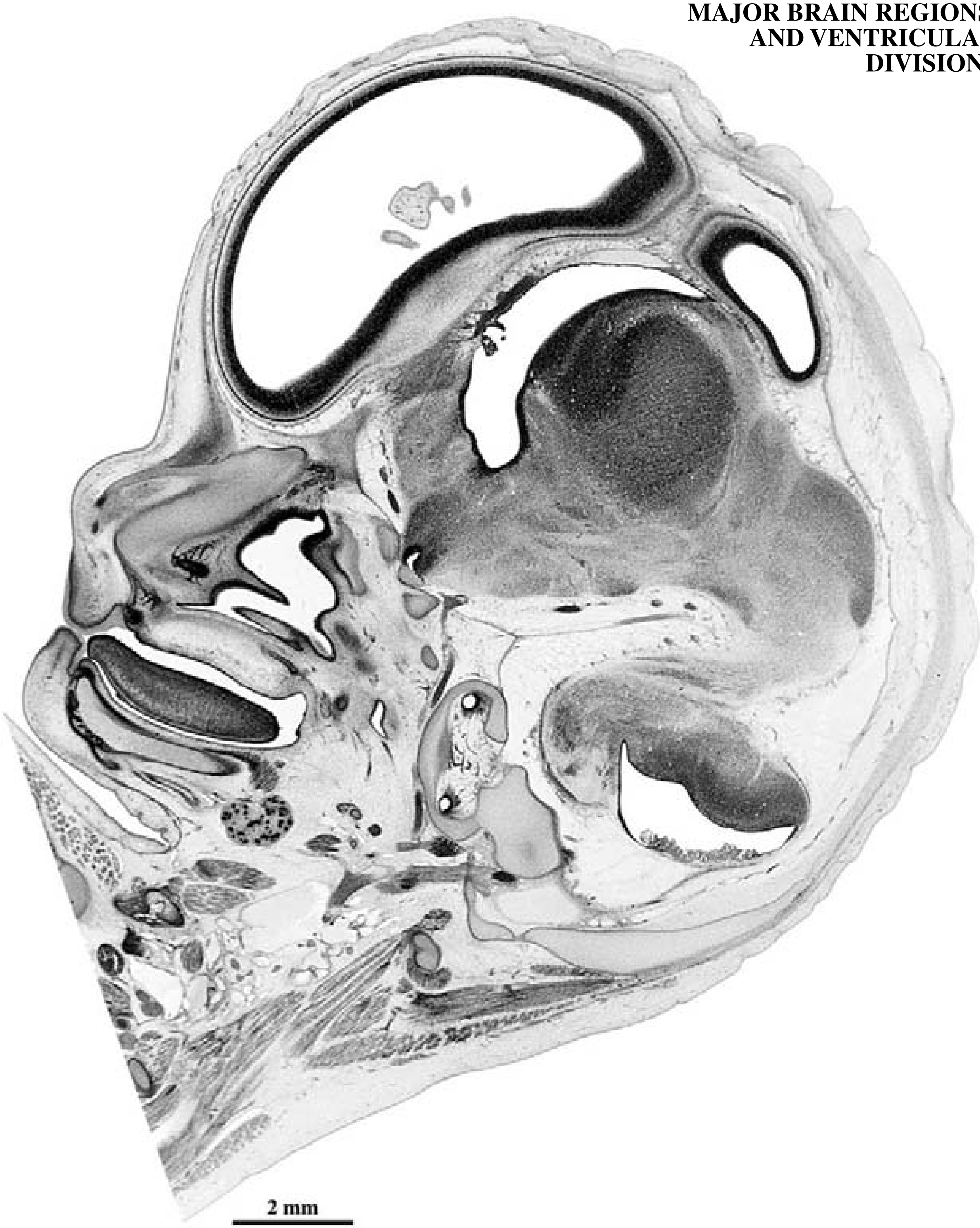


Figure 3. **A**, Lateral view of the brain and upper cervical spinal cord from a specimen with a crown-rump length of 38 mm (modified from Figure 43, Table VII, Hochstetter, 1919) identifies external features of a brain similar to C6658 (CR 40 mm). **B**, Top view of the brain in **A** (modified from Figure 45, Table VIII, Hochstetter, 1919) shows how C6658's sections rotate from a line parallel to the horizontal midline in the interhemispheric fissure. **C**, Back view of the brain in **A** (modified from Figure 44, Table VIII, Hochstetter, 1919) shows how C6658's sections rotate from a line parallel to the vertical midline in the brainstem and upper cervical spinal cord.

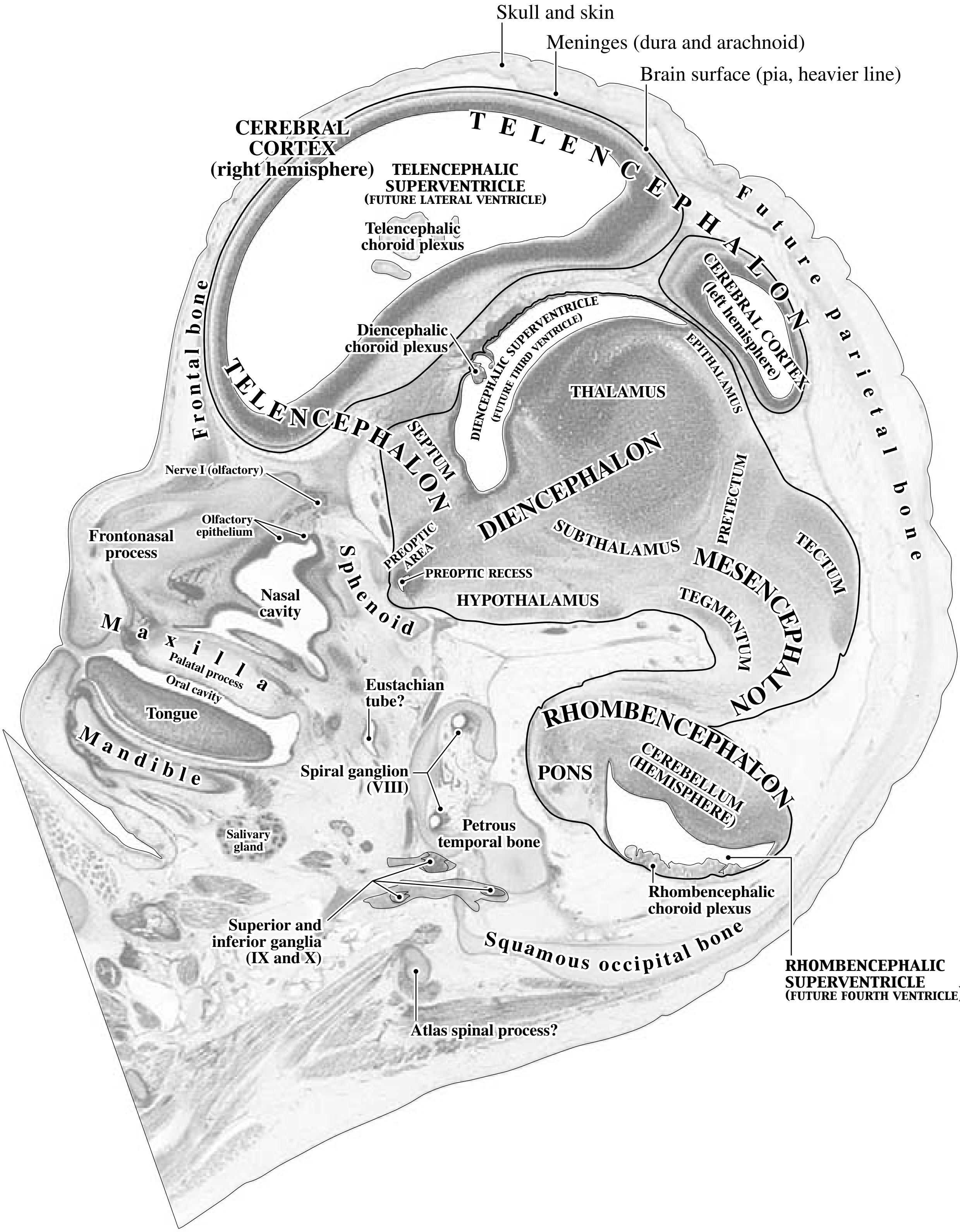
PLATE 57A

GW9 Sagittal
CR 40 mm, C6658
Level 1: Slide 53, Section 1
HEAD STRUCTURES, MAJOR BRAIN REGIONS, AND VENTRICULAR DIVISIONS



Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

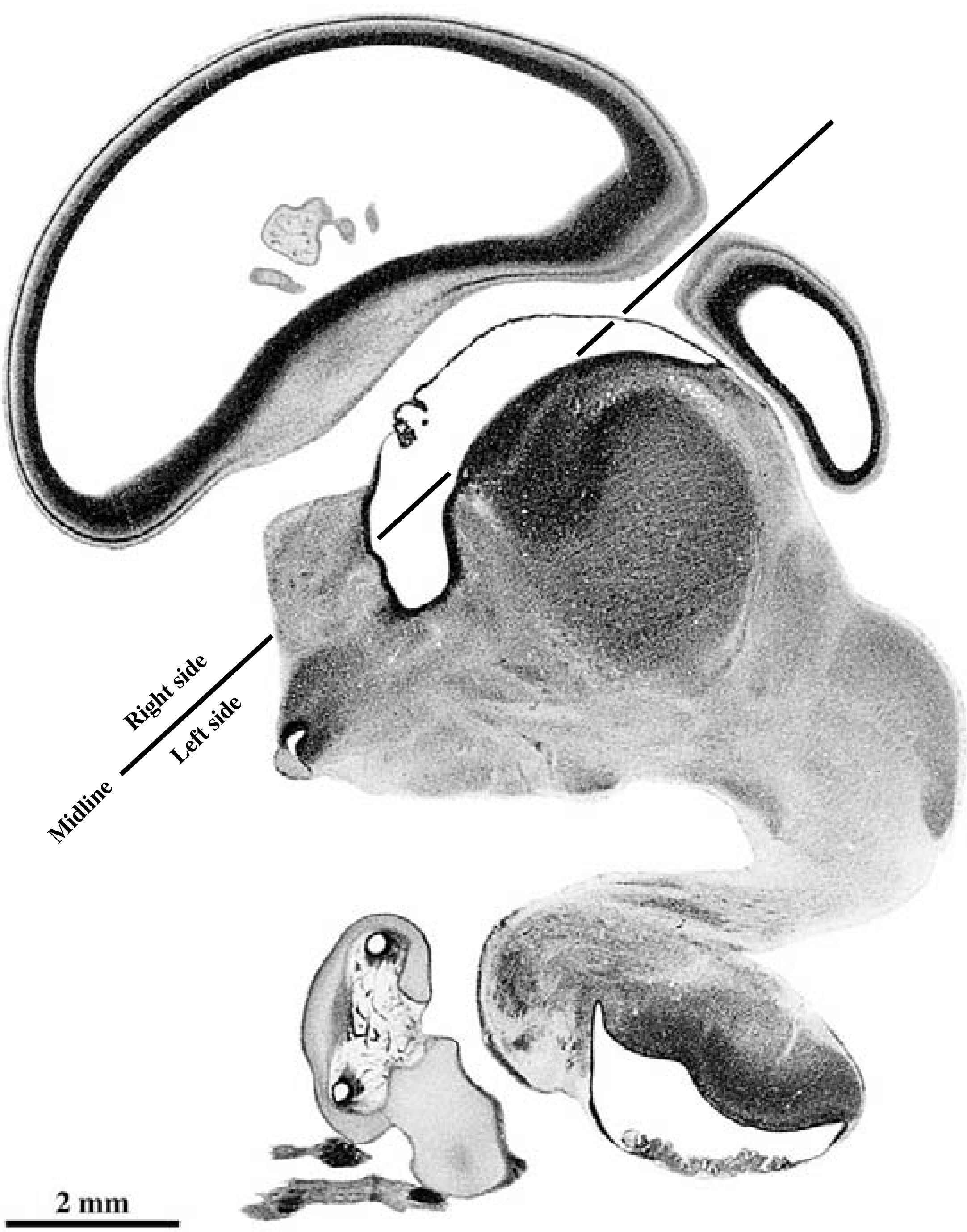
PLATE 57B



FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

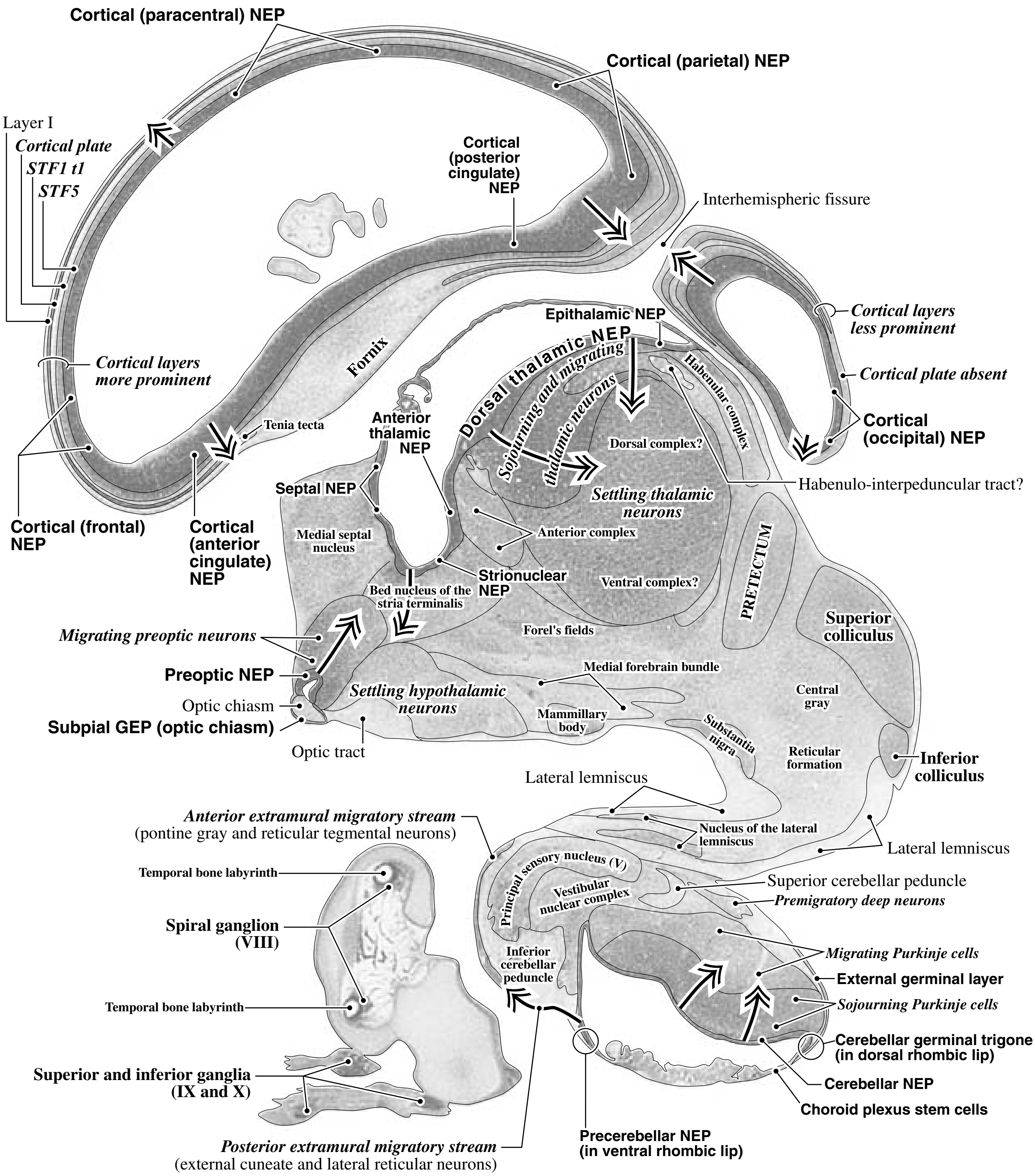
PLATE 57C

GW9 Sagittal
CR 40 mm, C6658
Level 1: Slide 53, Section 1
NEUROEPITHELIAL/GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES



The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 57D



FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field

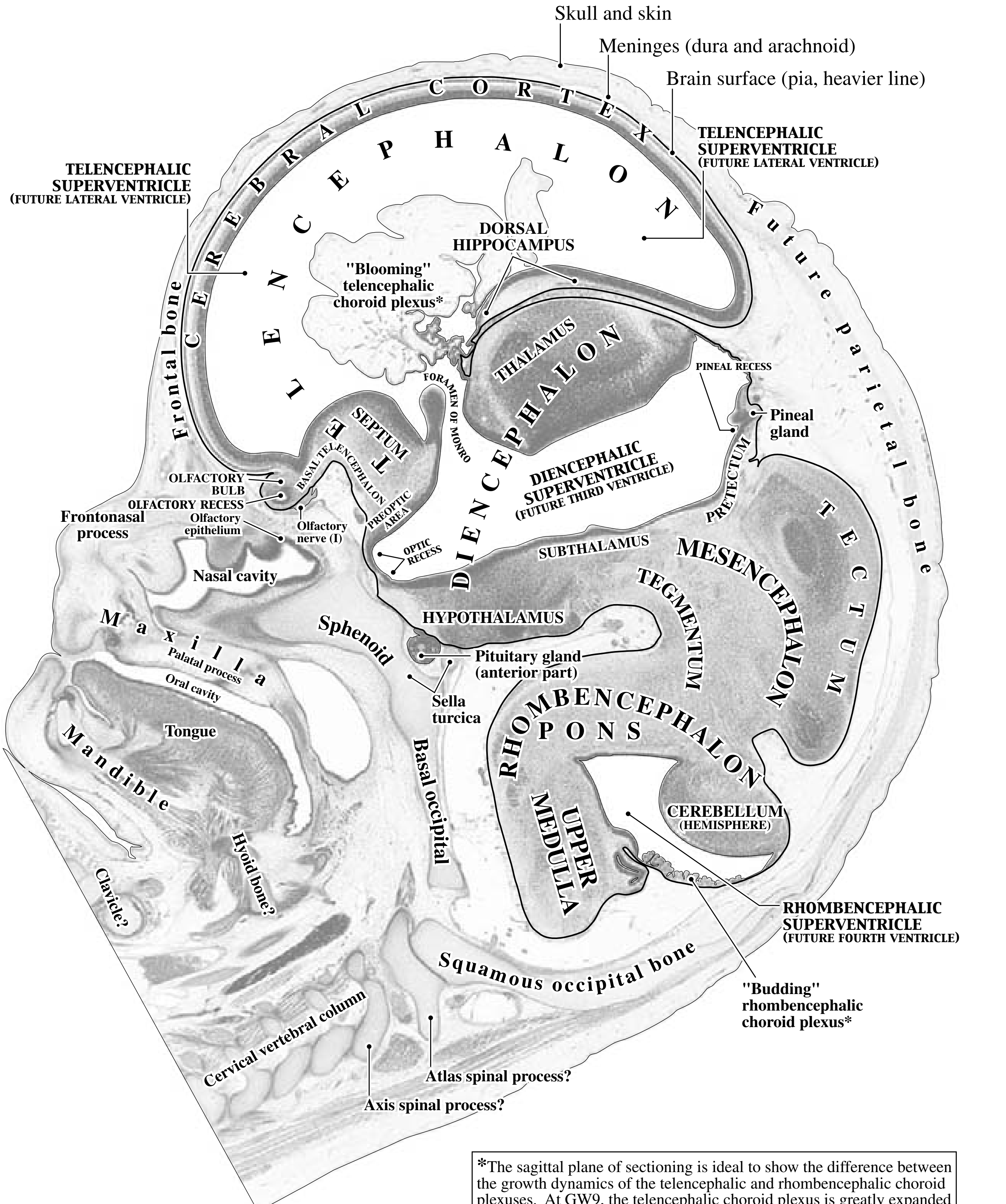
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 58A

GW9 Sagittal
CR 40 mm, C6658
Level 2: Slide 63, Section 1
HEAD STRUCTURES, MAJOR BRAIN REGIONS, AND VENTRICULAR DIVISIONS

Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

PLATE 58B



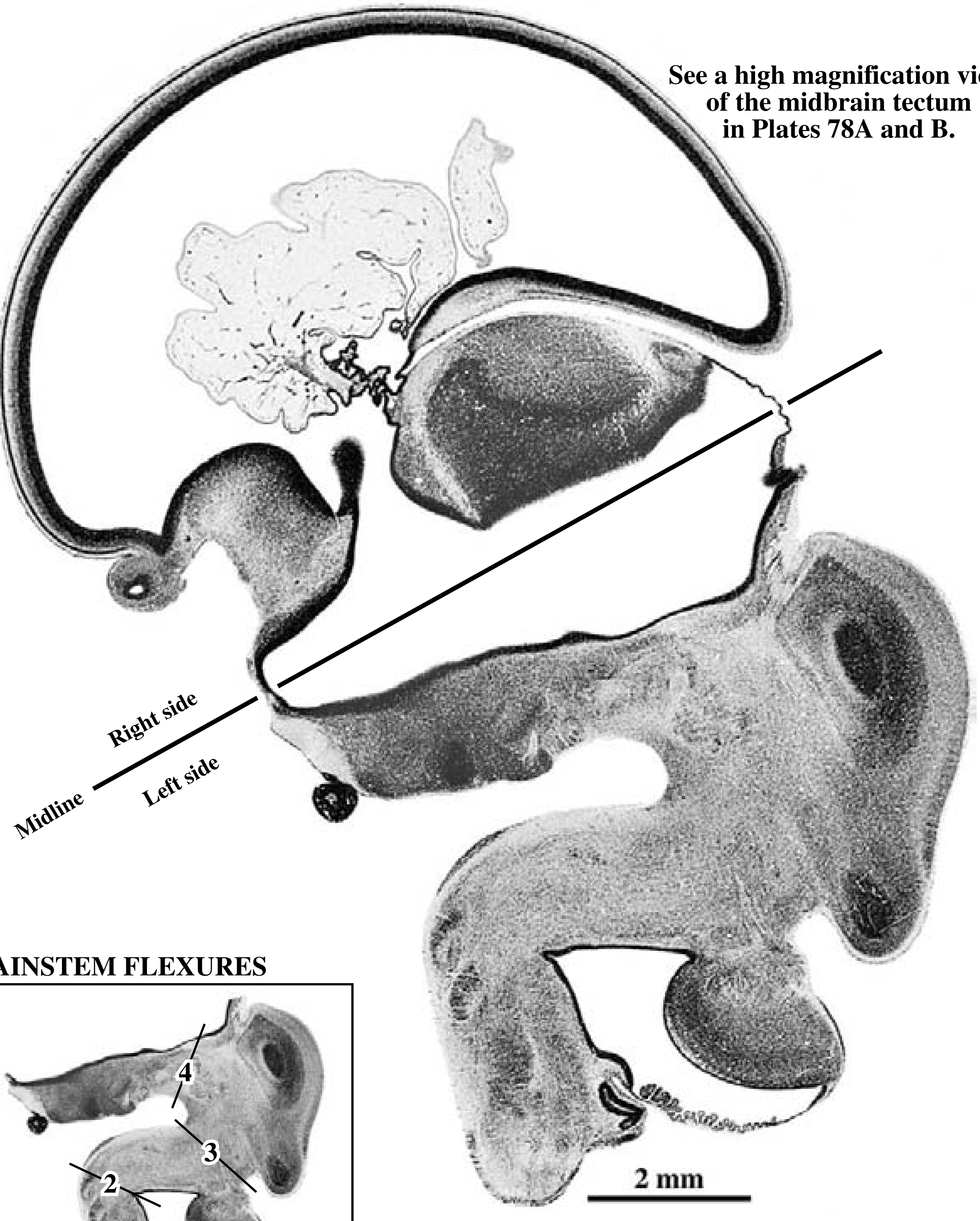
*The sagittal plane of sectioning is ideal to show the difference between the growth dynamics of the telencephalic and rhombencephalic choroid plexuses. At GW9, the telencephalic choroid plexus is greatly expanded ("blooming") but the rhombencephalic choroid plexus is still small ("budding"). The rhombencephalic choroid plexus "blooms" during the second and third trimesters (see Volumes 3 and 2).

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

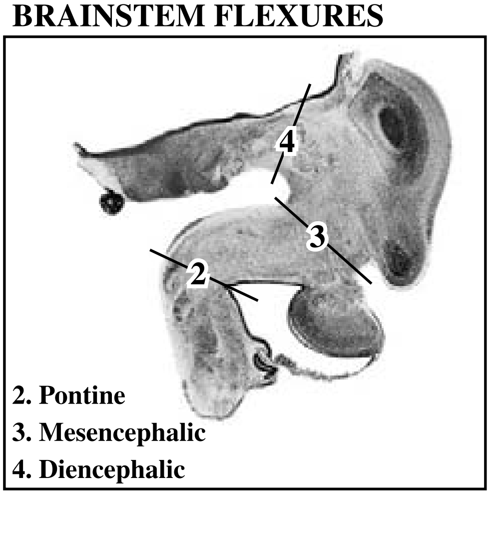
PLATE 58C

GW9 Sagittal
CR 40 mm, C6658
Level 2: Slide 63, Section 1
NEUROEPITHELIAL/GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES

See a high magnification view of the midbrain tectum in Plates 78A and B.

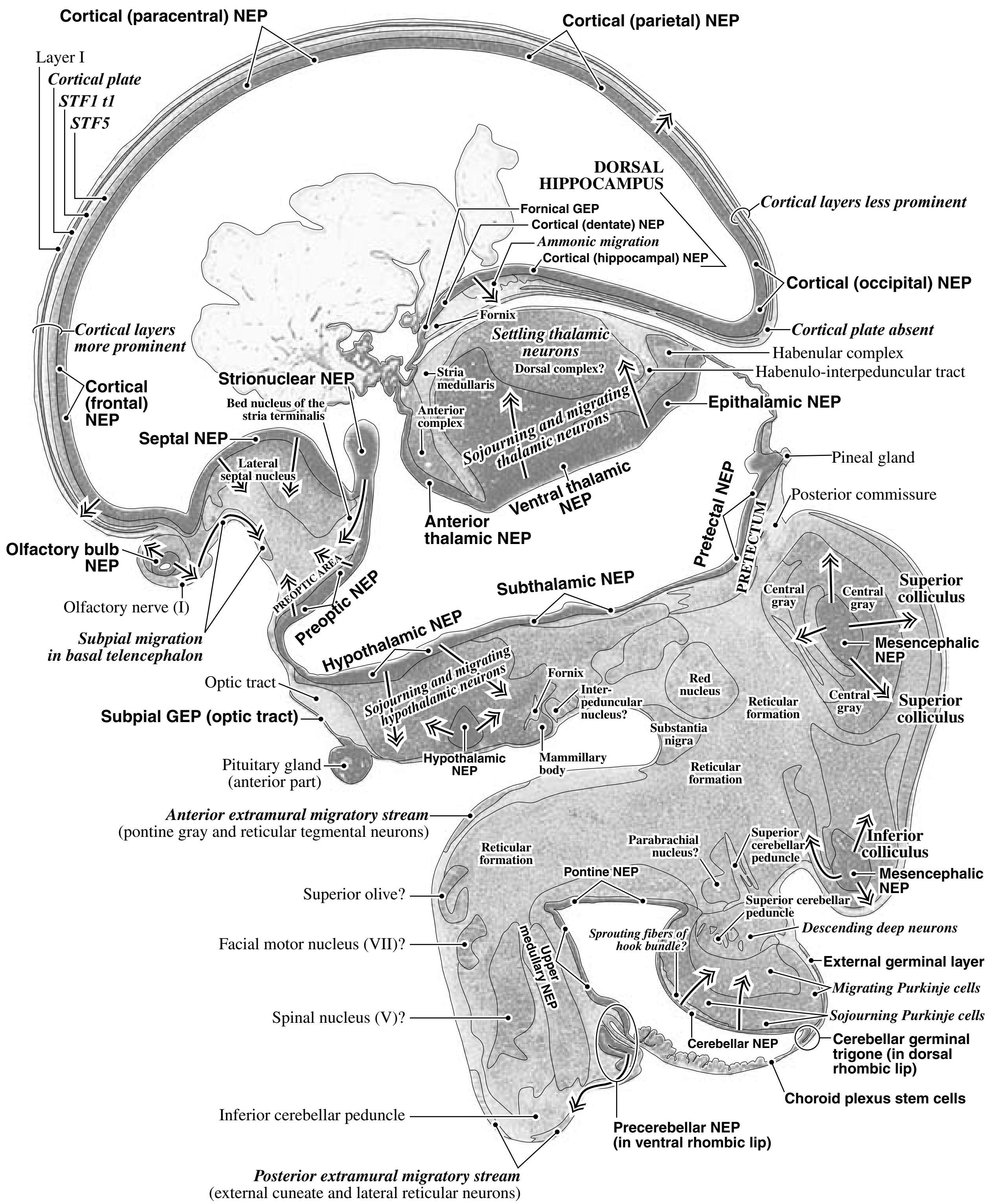


BRAINSTEM FLEXURES



The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 58D



FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field

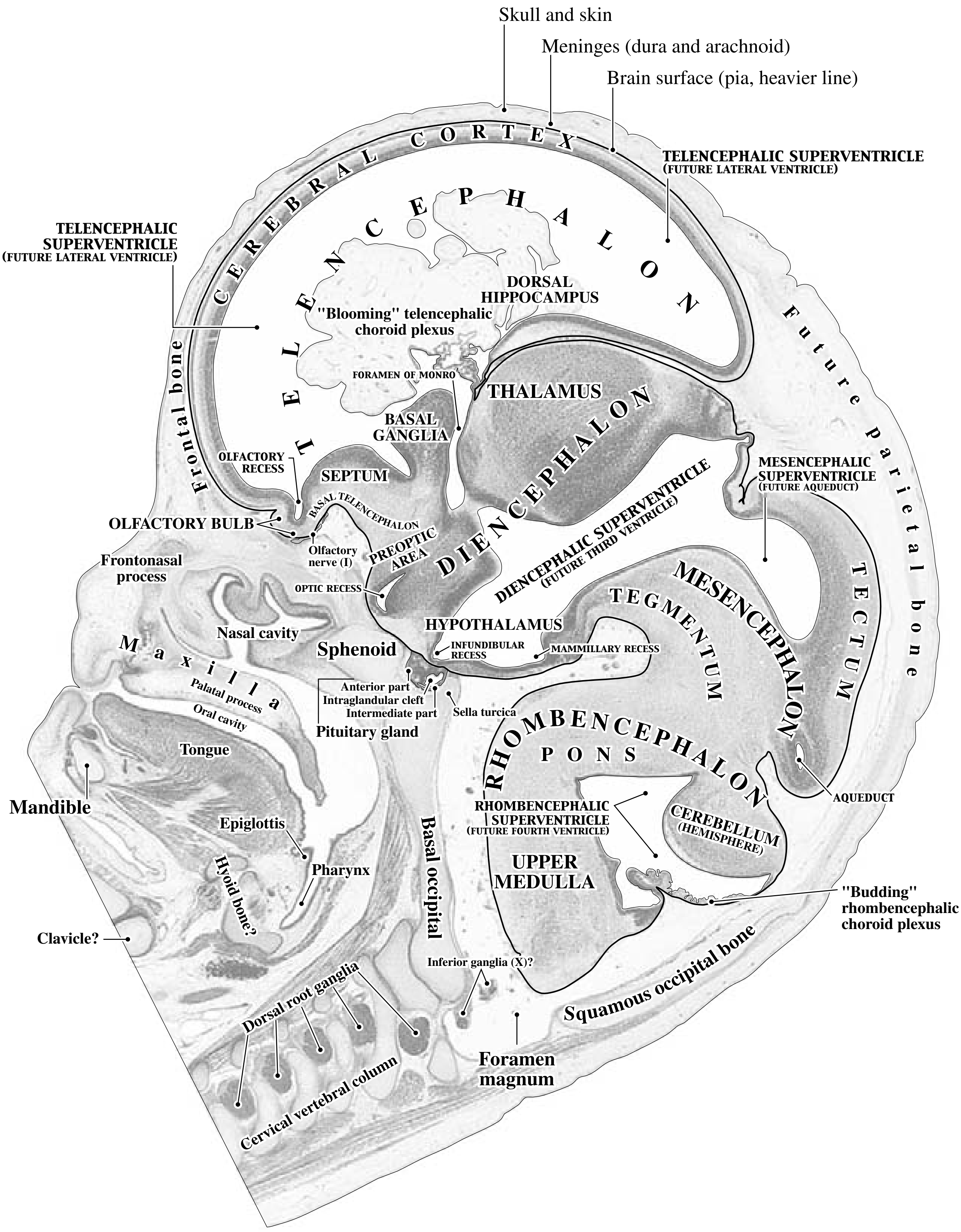
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 59A

GW9 Sagittal
CR 40 mm, C6658
Level 3: Slide 67, Section 1
HEAD STRUCTURES, MAJOR BRAIN REGIONS, AND VENTRICULAR DIVISIONS

Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

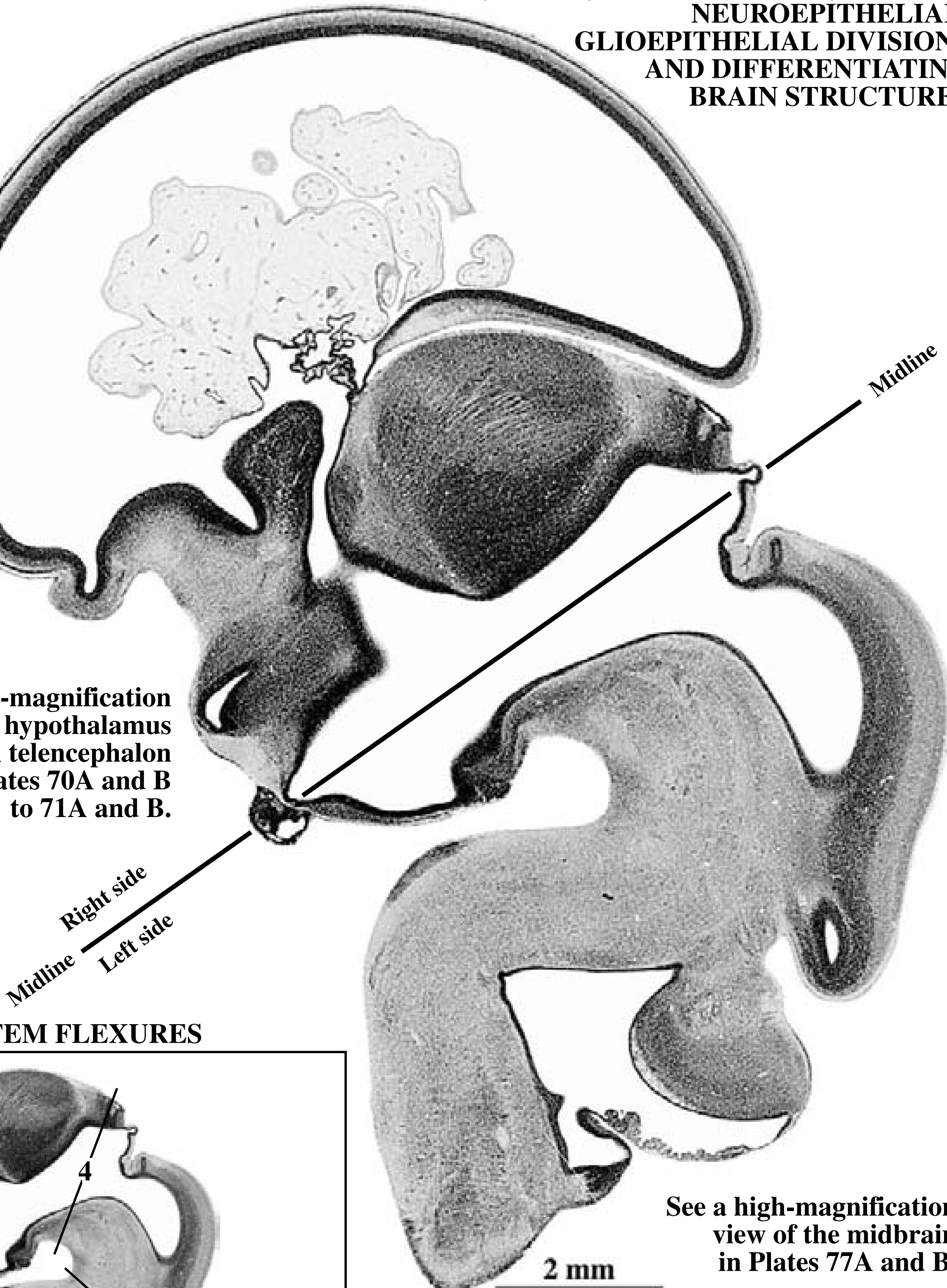
PLATE 59B



FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 59C

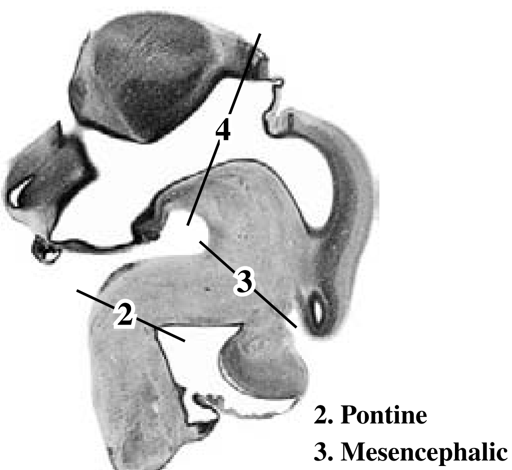
GW9 Sagittal
CR 40 mm, C6658, Level 3: Slide 67, Section 1
NEUROEPITHELIAL/ GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES



See a high-magnification view of the hypothalamus and basal telencephalon in Plates 70A and B to 71A and B.

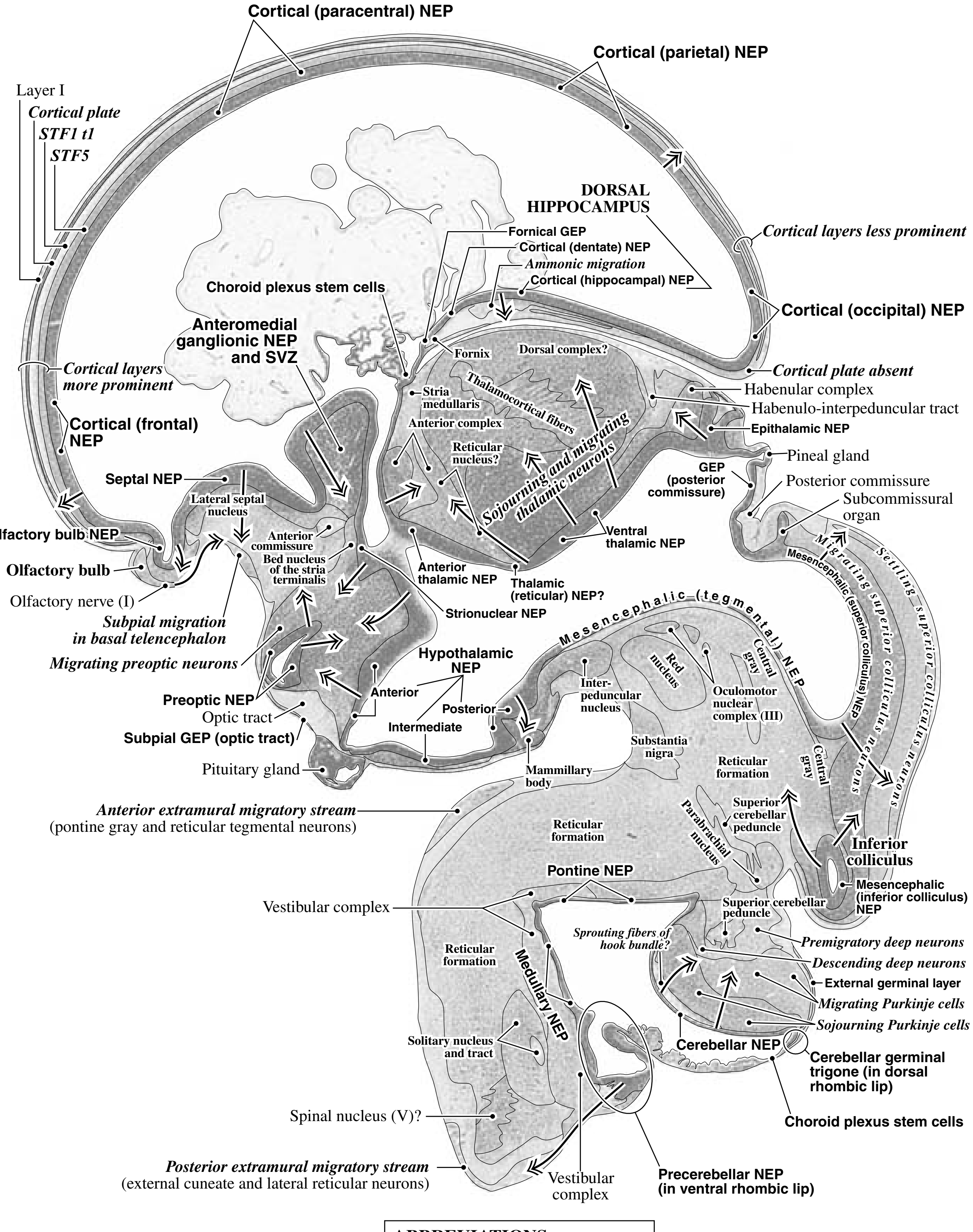
See a high-magnification view of the midbrain in Plates 77A and B.

BRAINSTEM FLEXURES



The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 59D



FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field
SVZ - Subventricular zone

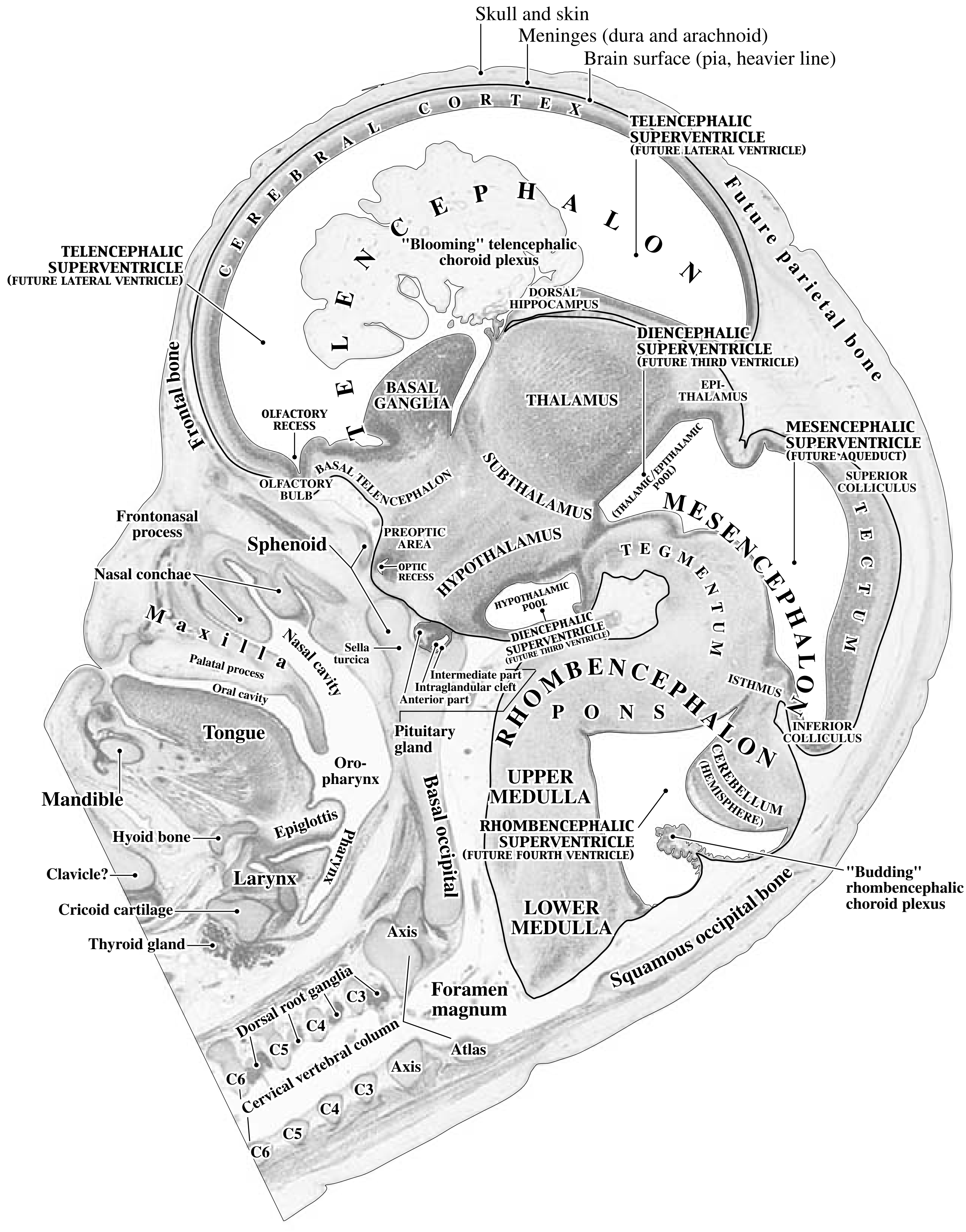
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 60A

GW9 Sagittal, CR 40 mm, C6658
Level 4: Slide 71, Section 2
HEAD STRUCTURES, MAJOR BRAIN REGIONS, AND VENTRICULAR DIVISIONS

Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

PLATE 60B

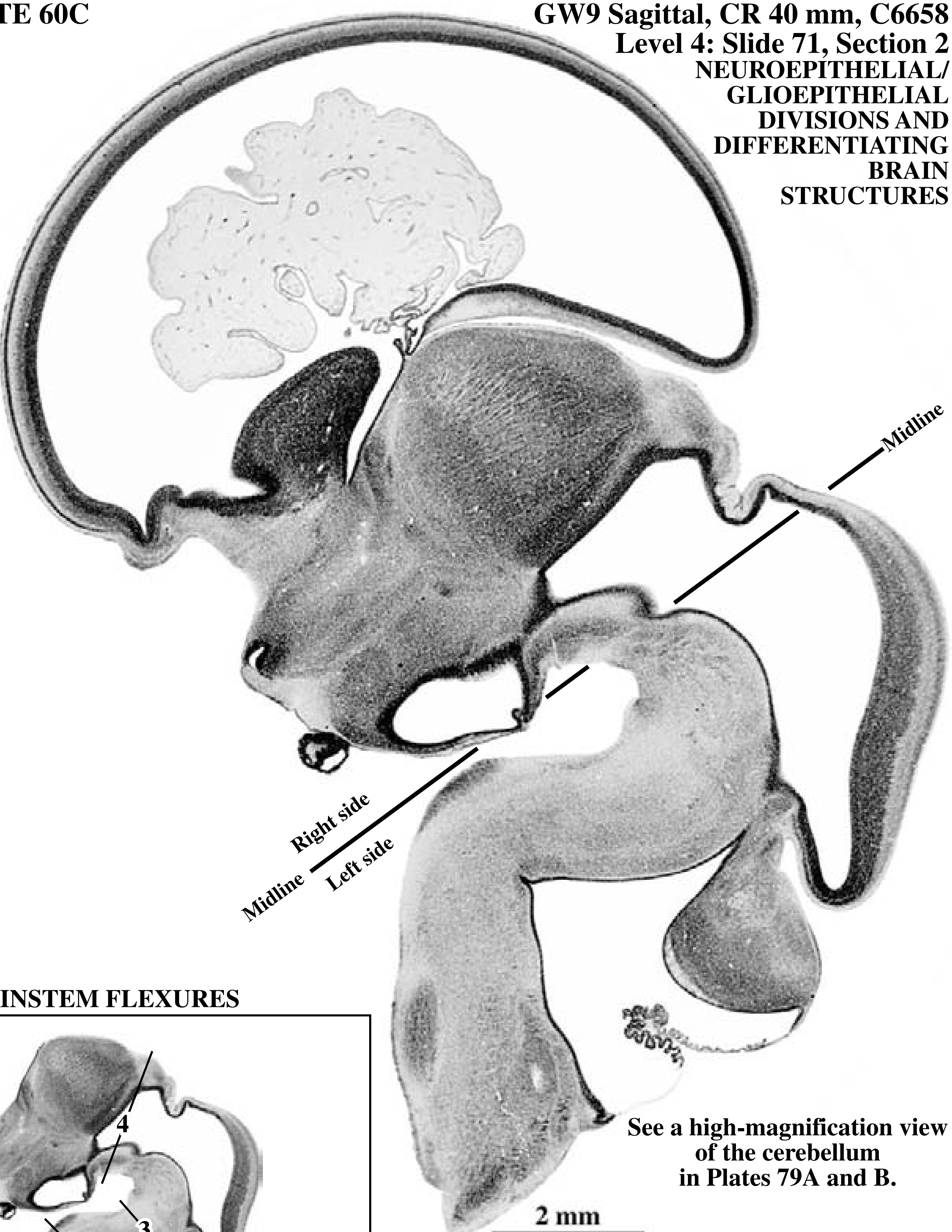


FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 60C

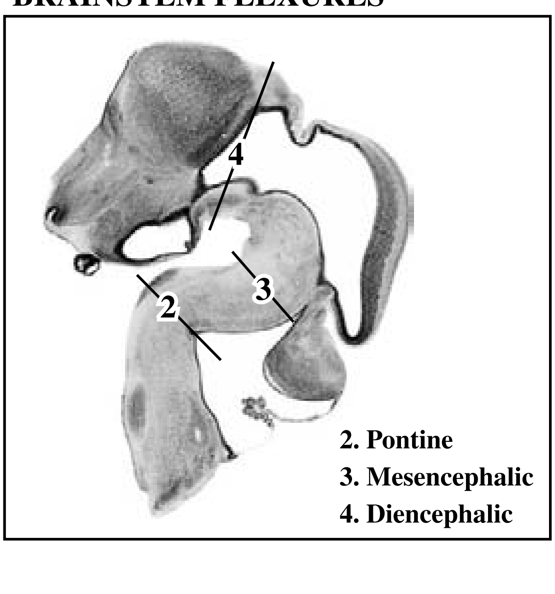
GW9 Sagittal, CR 40 mm, C6658
Level 4: Slide 71, Section 2

**NEUROEPITHELIAL/
GLIOEPITHELIAL
DIVISIONS AND
DIFFERENTIATING
BRAIN
STRUCTURES**



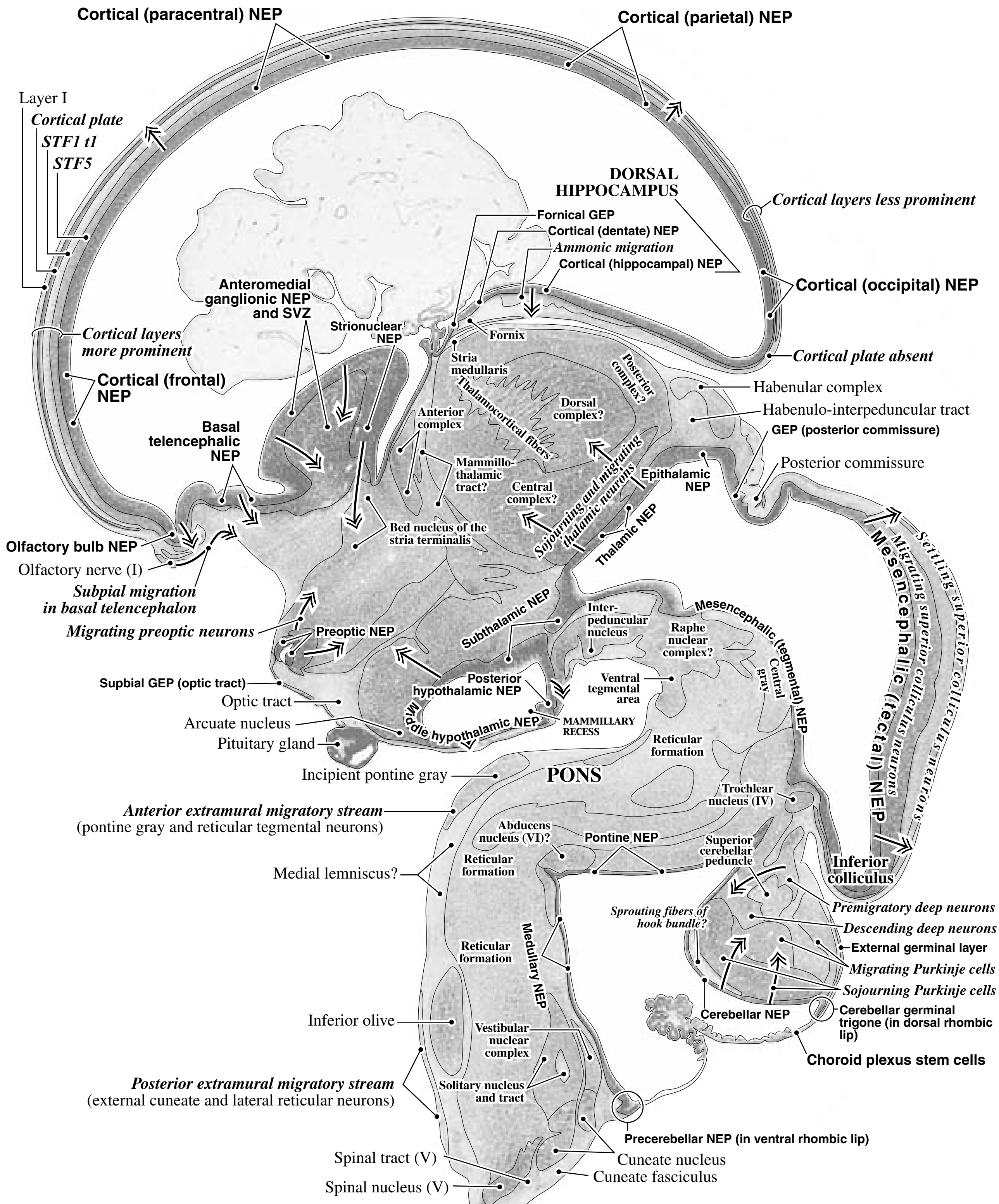
See a high-magnification view of the cerebellum in Plates 79A and B.

BRAINSTEM FLEXURES



The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 60D



FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field
SVZ - Subventricular zone

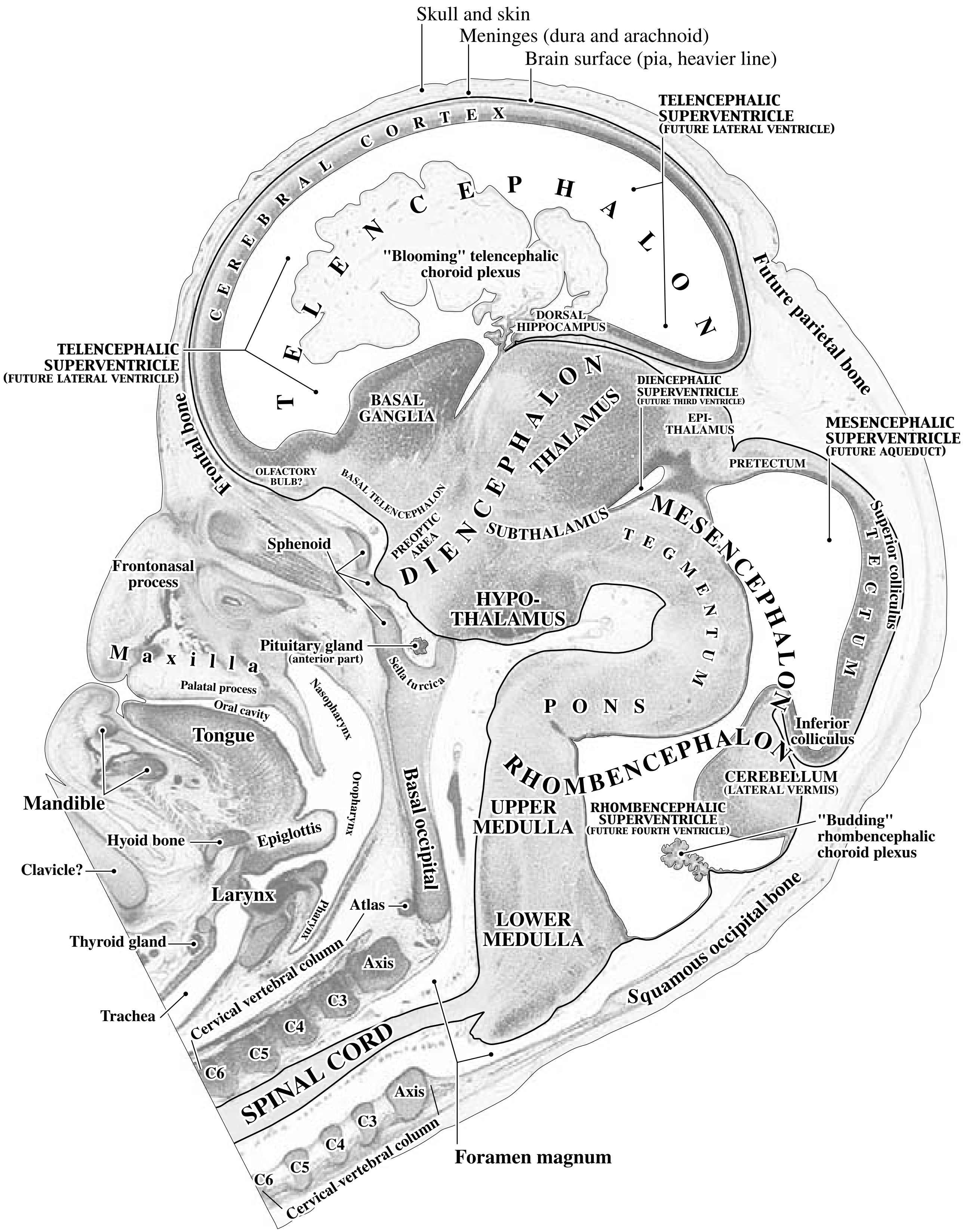
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 61A

GW9 Sagittal, CR 40 mm, C6658
Level 5: Slide 75, Section 2
HEAD STRUCTURES, MAJOR BRAIN REGIONS, AND VENTRICULAR DIVISIONS

Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

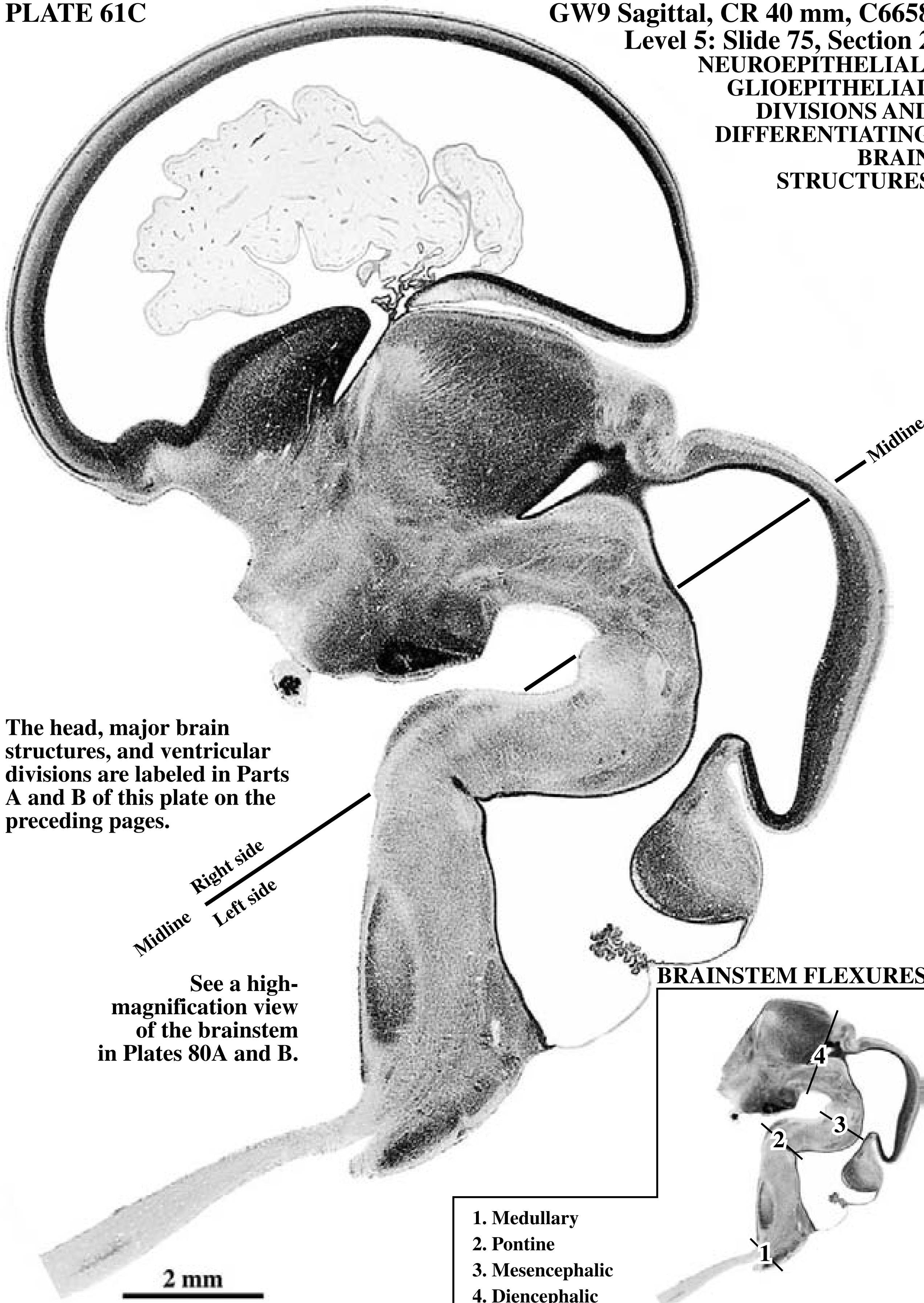
PLATE 61B



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 61C

GW9 Sagittal, CR 40 mm, C6658
Level 5: Slide 75, Section 2
NEUROEPITHELIAL/ GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES



The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

See a high-magnification view of the brainstem in Plates 80A and B.

BRAINSTEM FLEXURES

1. Medullary
2. Pontine
3. Mesencephalic
4. Diencephalic

PLATE 61D

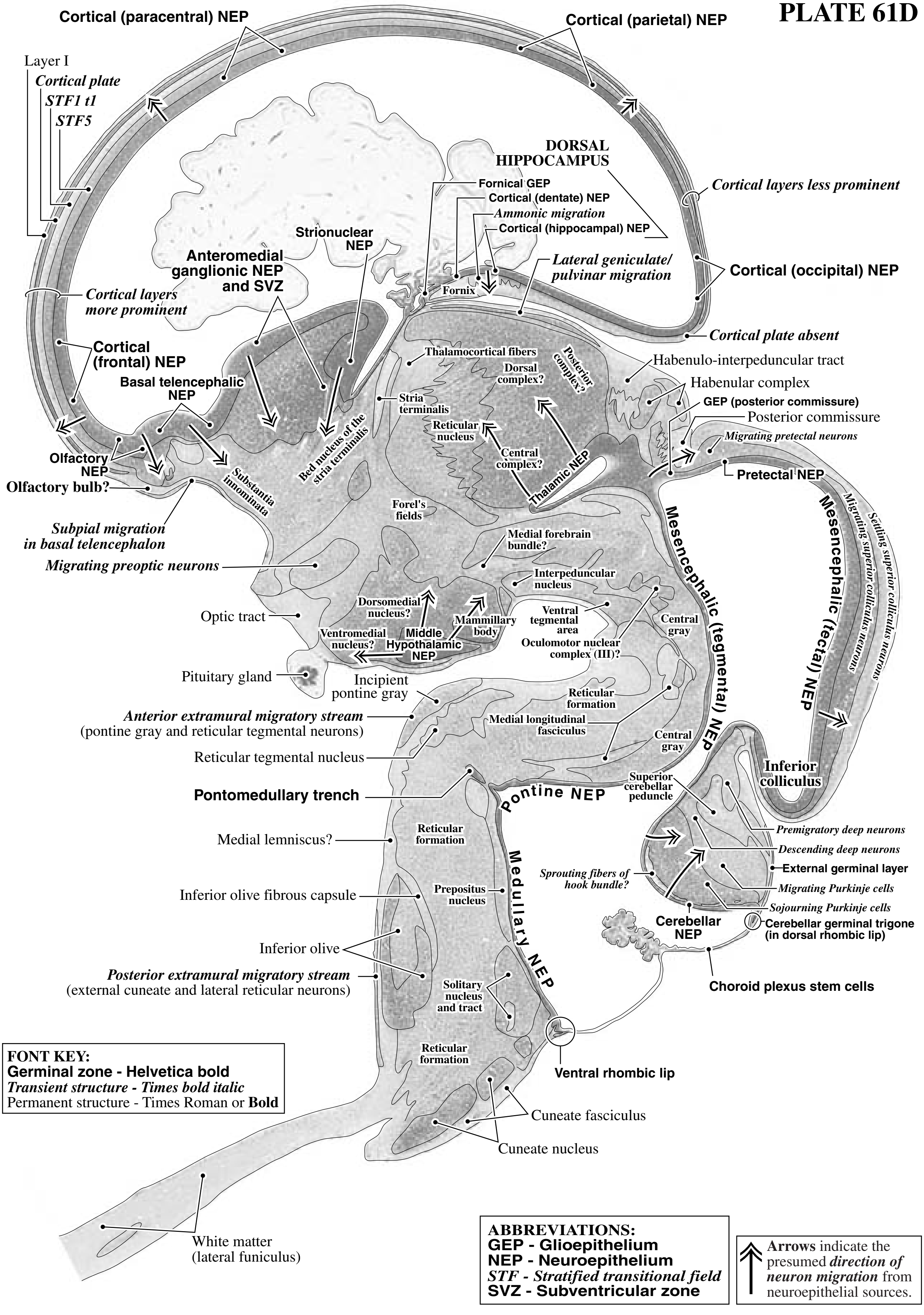
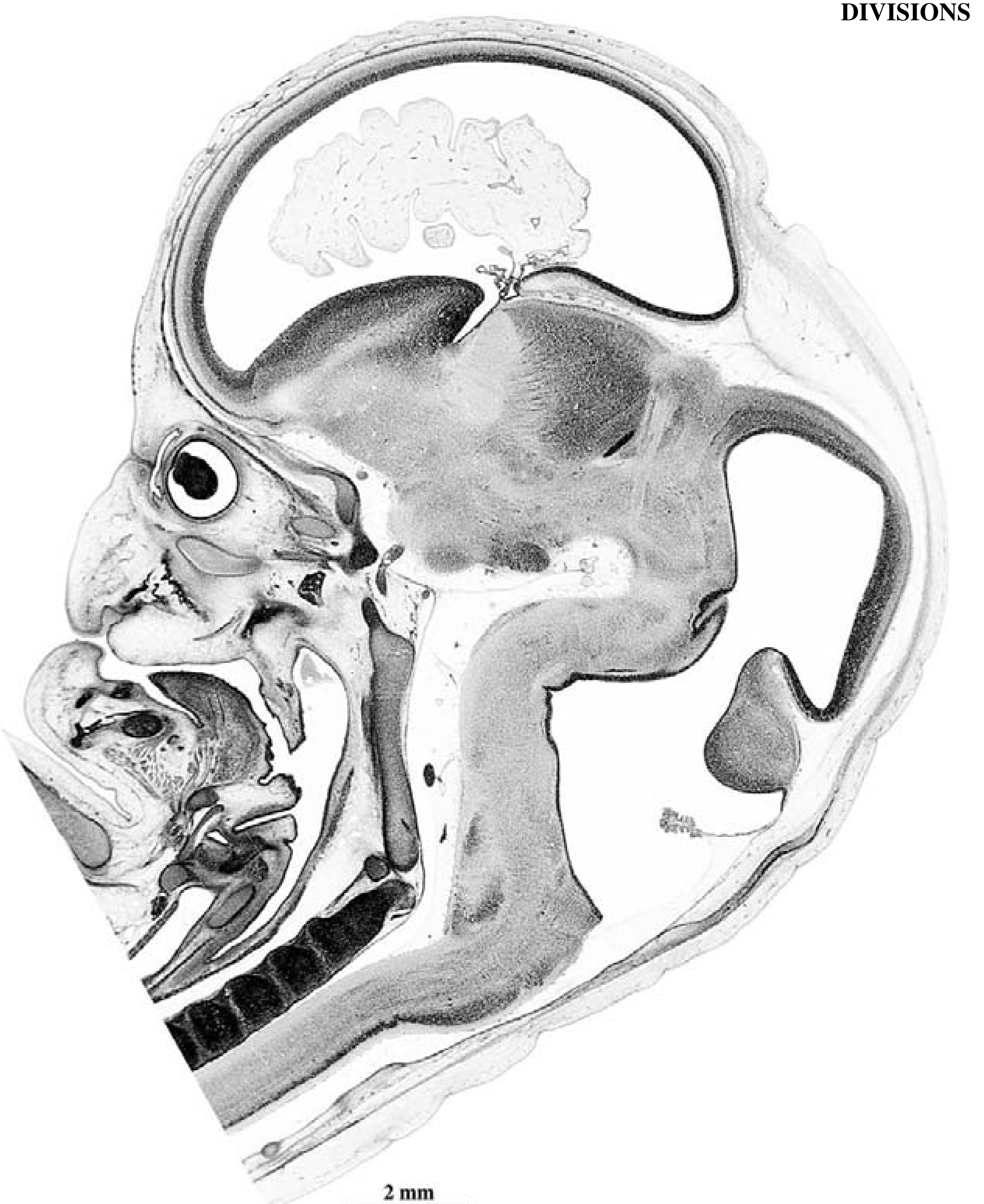

Cortical (paracentral) NEP
Cortical (parietal) NEP
Layer I
Cortical plate
STF1 t1
STF5
DORSAL HIPPOCAMPUS
Cortical layers less prominent
Fornical GEP
Cortical (dentate) NEP
Ammonic migration
Cortical (hippocampal) NEP
Strionuclear NEP
Anteromedial ganglionic NEP and SVZ
Lateral geniculate/ pulvinar migration
Cortical (occipital) NEP
Fornix
Cortical layers more prominent
Cortical plate absent
Cortical (frontal) NEP
Thalamocortical fibers
Posterior complex?
Dorsal complex?
Habenulo-interpeduncular tract
Basal telencephalic NEP
Habenular complex
Stria terminalis
GEP (posterior commissure)
Posterior commissure
Reticular nucleus
Bed nucleus of the stria terminalis
Migrating pretectal neurons
Olfactory NEP
Central complex?
Thalamic NEP
Pretectal NEP
Olfactory bulb?
Substantia innominata
Forel's fields
Mesencephalic (tegmental) NEP
Mesencephalic (tectal) NEP
Migrating superior colliculus neurons
Settling superior colliculus neurons
Subpial migration in basal telencephalon
Medial forebrain bundle?
Migrating preoptic neurons
Interpeduncular nucleus
Dorsomedial nucleus?
Ventral tegmental area
Central gray
Optic tract
Mammillary body
Ventromedial nucleus?
Middle Hypothalamic NEP
Oculomotor nuclear complex (III)?
Pituitary gland
Incipient pontine gray
Reticular formation
Anterior extramural migratory stream (pontine gray and reticular tegmental neurons)
Medial longitudinal fasciculus
Central gray
Reticular tegmental nucleus
Inferior colliculus
Superior cerebellar peduncle
Pontomedullary trench
Pontine NEP
Premigratory deep neurons
Reticular formation
Medial lemniscus?
Descending deep neurons
External germinal layer
Sprouting fibers of hook bundle?
Migrating Purkinje cells
Inferior olive fibrous capsule
Prepositus nucleus
Medullary NEP
Sojourning Purkinje cells
Cerebellar NEP
Cerebellar germinal trigone (in dorsal rhombic lip)
Inferior olive
Posterior extramural migratory stream (external cuneate and lateral reticular neurons)
Solitary nucleus and tract
Choroid plexus stem cells
Reticular formation
Ventral rhombic lip
FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
Cuneate fasciculus
Cuneate nucleus
White matter (lateral funiculus)
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field
SVZ - Subventricular zone
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.

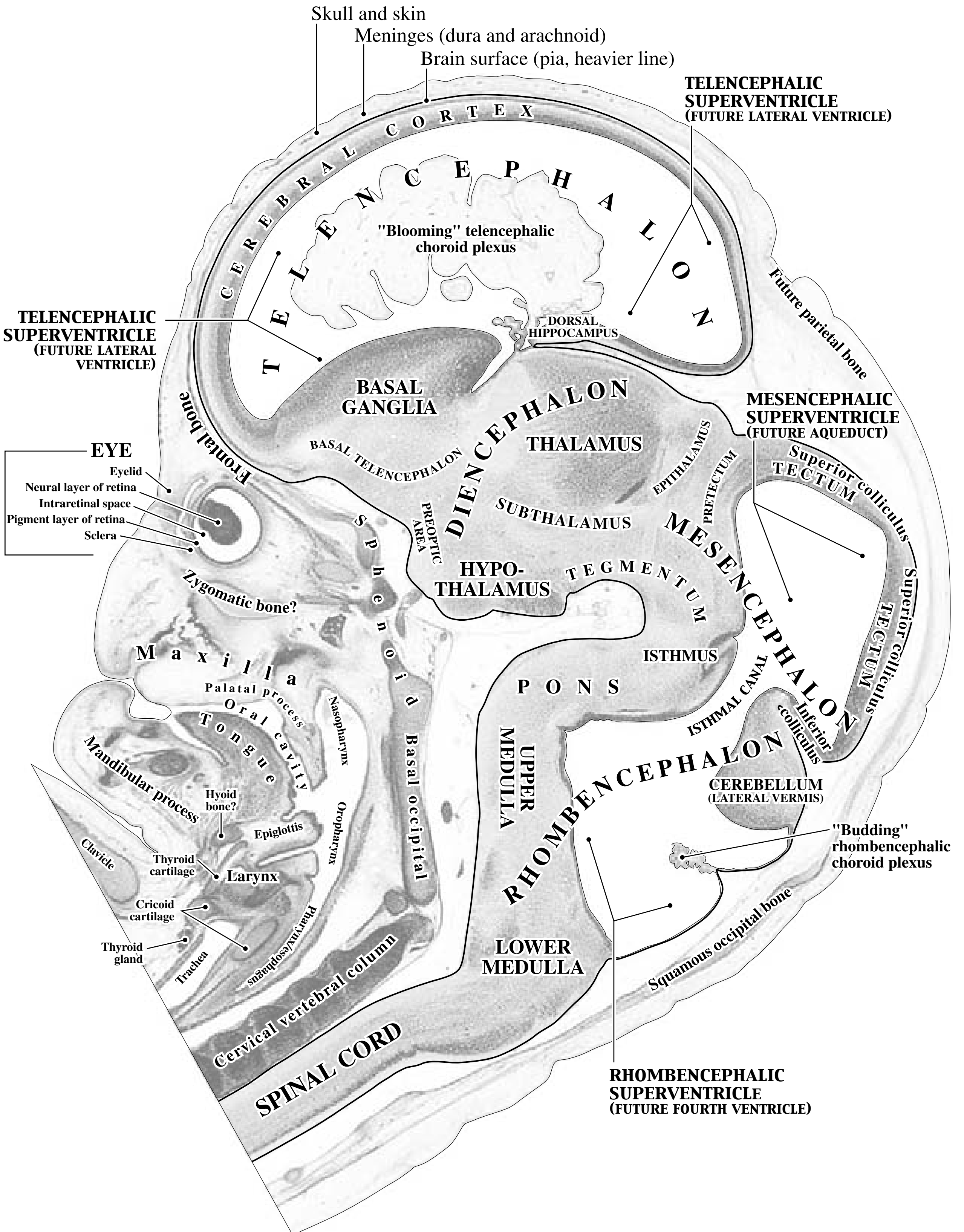
PLATE 62A

GW9 Sagittal, CR 40 mm, C6658
Level 6: Slide 79, Section 2
HEAD STRUCTURES, MAJOR BRAIN REGIONS, AND VENTRICULAR DIVISIONS



Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

PLATE 62B

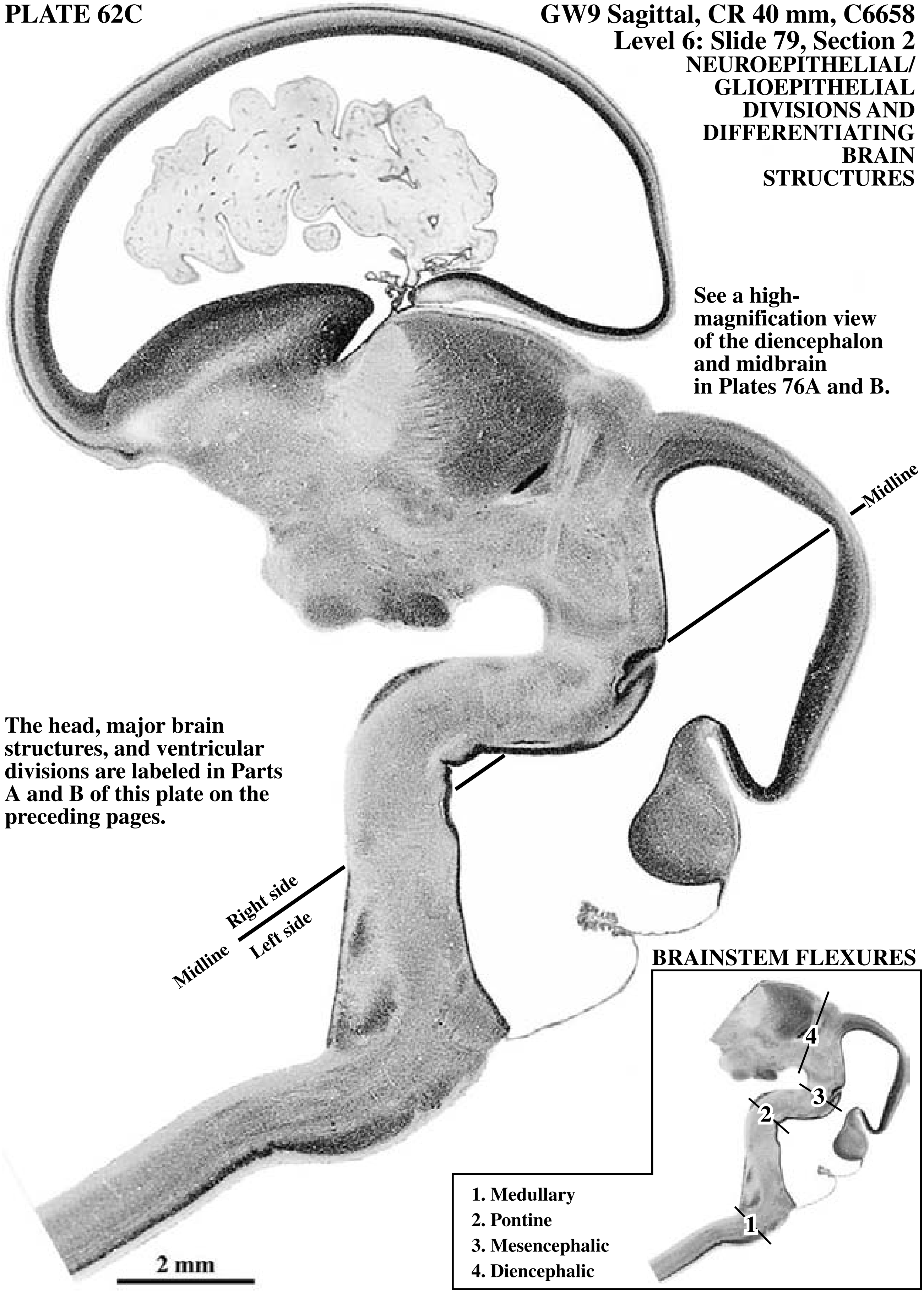


FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 62C

GW9 Sagittal, CR 40 mm, C6658
Level 6: Slide 79, Section 2
NEUROEPITHELIAL/ GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES

See a high-magnification view of the diencephalon and midbrain in Plates 76A and B.



The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

BRAINSTEM FLEXURES

1. Medullary
2. Pontine
3. Mesencephalic
4. Diencephalic

PLATE 62D

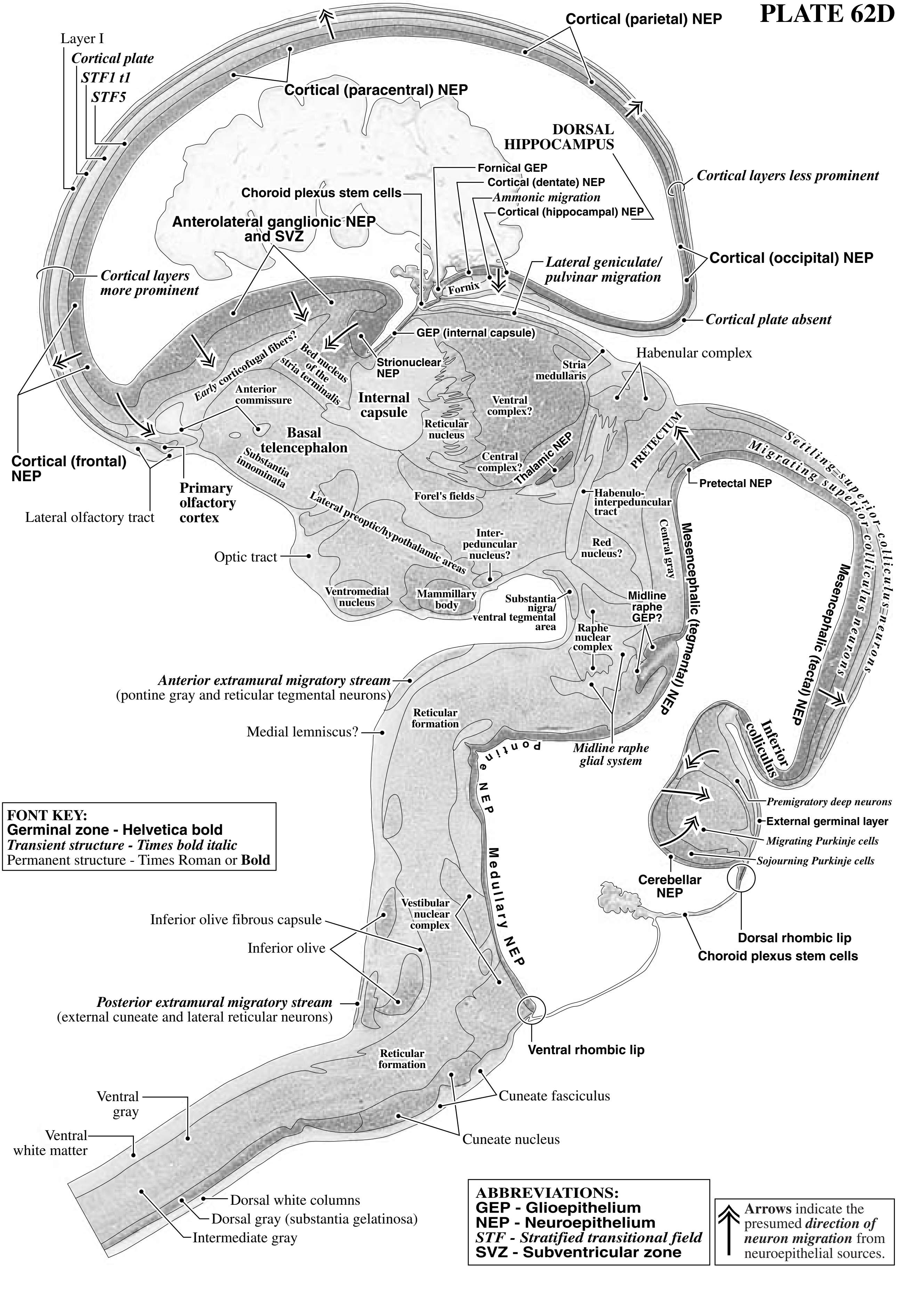
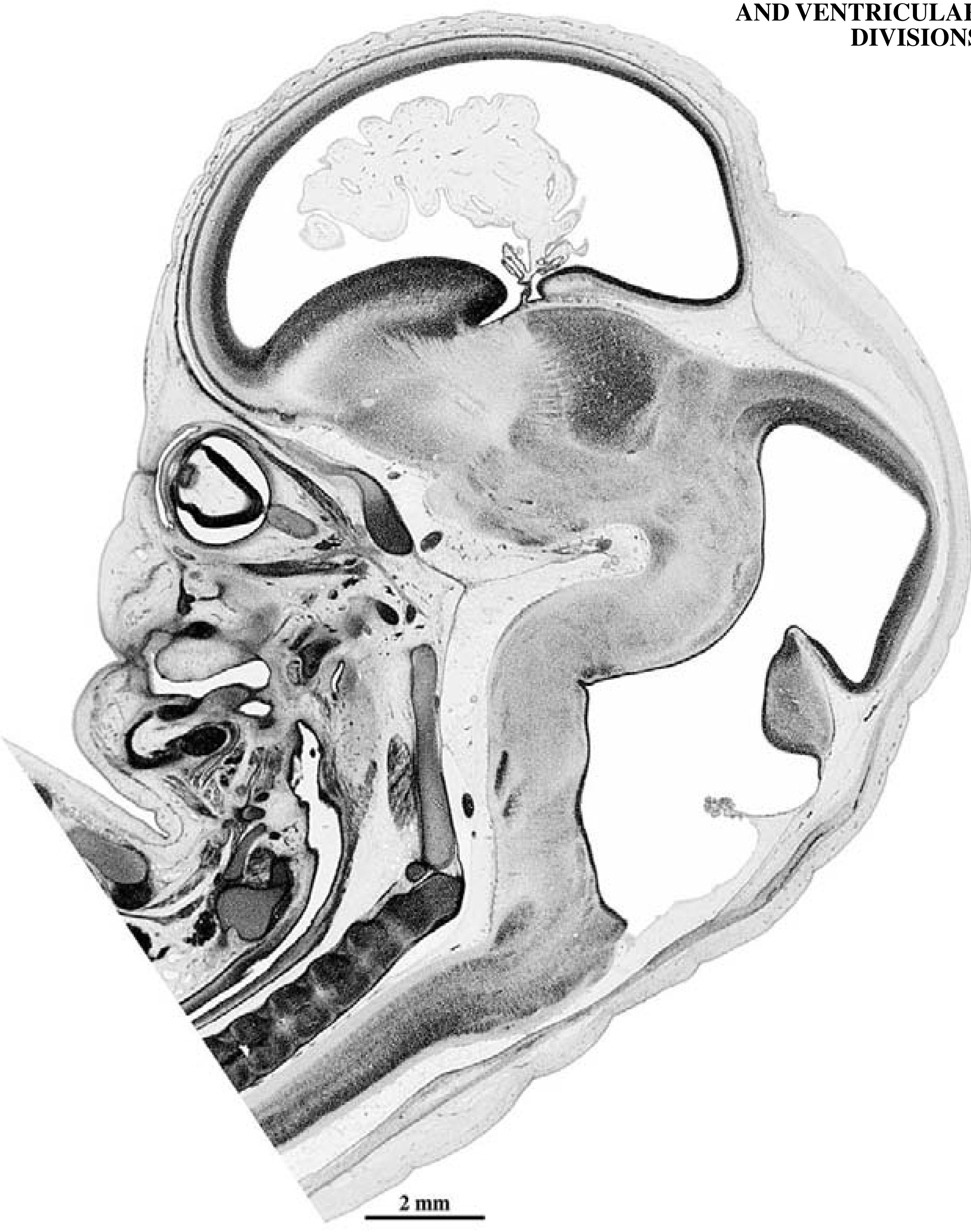

Layer I
Cortical plate
STF1 t1
STF5
Cortical (paracentral) NEP
Cortical (parietal) NEP
DORSAL HIPPOCAMPUS
Cortical layers less prominent
Fornical GEP
Cortical (dentate) NEP
Ammonic migration
Cortical (hippocampal) NEP
Choroid plexus stem cells
Anterolateral ganglionic NEP and SVZ
Cortical (occipital) NEP
Lateral geniculate/ pulvinar migration
Cortical layers more prominent
Fornix
Cortical plate absent
GEP (internal capsule)
Habenular complex
Early corticofugal fibers?
Bed nucleus of the stria terminalis
Strionuclear NEP
Stria medullaris
Anterior commissure
Internal capsule
Ventral complex?
Basal telencephalon
Reticular nucleus
PRETECTUM
Settling superior colliculus neurons
Migrating superior colliculus neurons
Cortical (frontal) NEP
Substantia innominata
Central complex?
Thalamic NEP
Pretectal NEP
Primary olfactory cortex
Forel's fields
Habenulo-interpeduncular tract
Lateral olfactory tract
Lateral preoptic/hypothalamic areas
Central gray
Mesencephalic (tegmental) NEP
Mesencephalic (tectal) NEP
Inter-peduncular nucleus?
Red nucleus?
Optic tract
Ventromedial nucleus
Mammillary body
Substantia nigra/ ventral tegmental area
Midline raphe GEP?
Raphe nuclear complex
Anterior extramural migratory stream
(pontine gray and reticular tegmental neurons)
Reticular formation
Inferior colliculus
Medial lemniscus?
Pontine NEP
Midline raphe glial system
Premigratory deep neurons
External germinal layer
Migrating Purkinje cells
Sojourning Purkinje cells
FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
Medullary NEP
Cerebellar NEP
Vestibular nuclear complex
Inferior olive fibrous capsule
Inferior olive
Dorsal rhombic lip
Choroid plexus stem cells
Posterior extramural migratory stream
(external cuneate and lateral reticular neurons)
Ventral rhombic lip
Reticular formation
Ventral gray
Cuneate fasciculus
Ventral white matter
Cuneate nucleus
Dorsal white columns
Dorsal gray (substantia gelatinosa)
Intermediate gray
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field
SVZ - Subventricular zone
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.

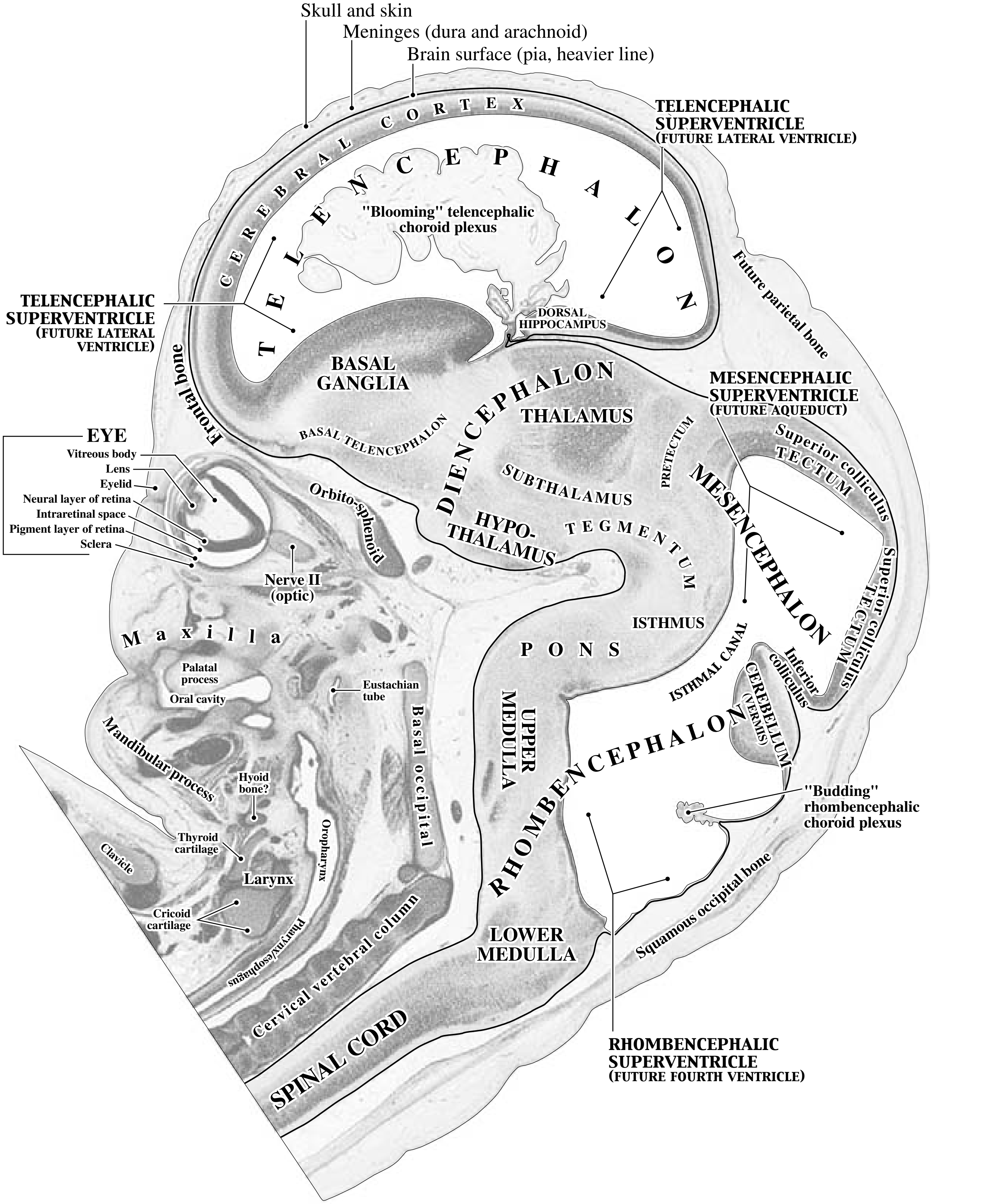
PLATE 63A

GW9 Sagittal, CR 40 mm, C6658
Level 7: Slide 83, Section 1
HEAD STRUCTURES, MAJOR BRAIN REGIONS, AND VENTRICULAR DIVISIONS



Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

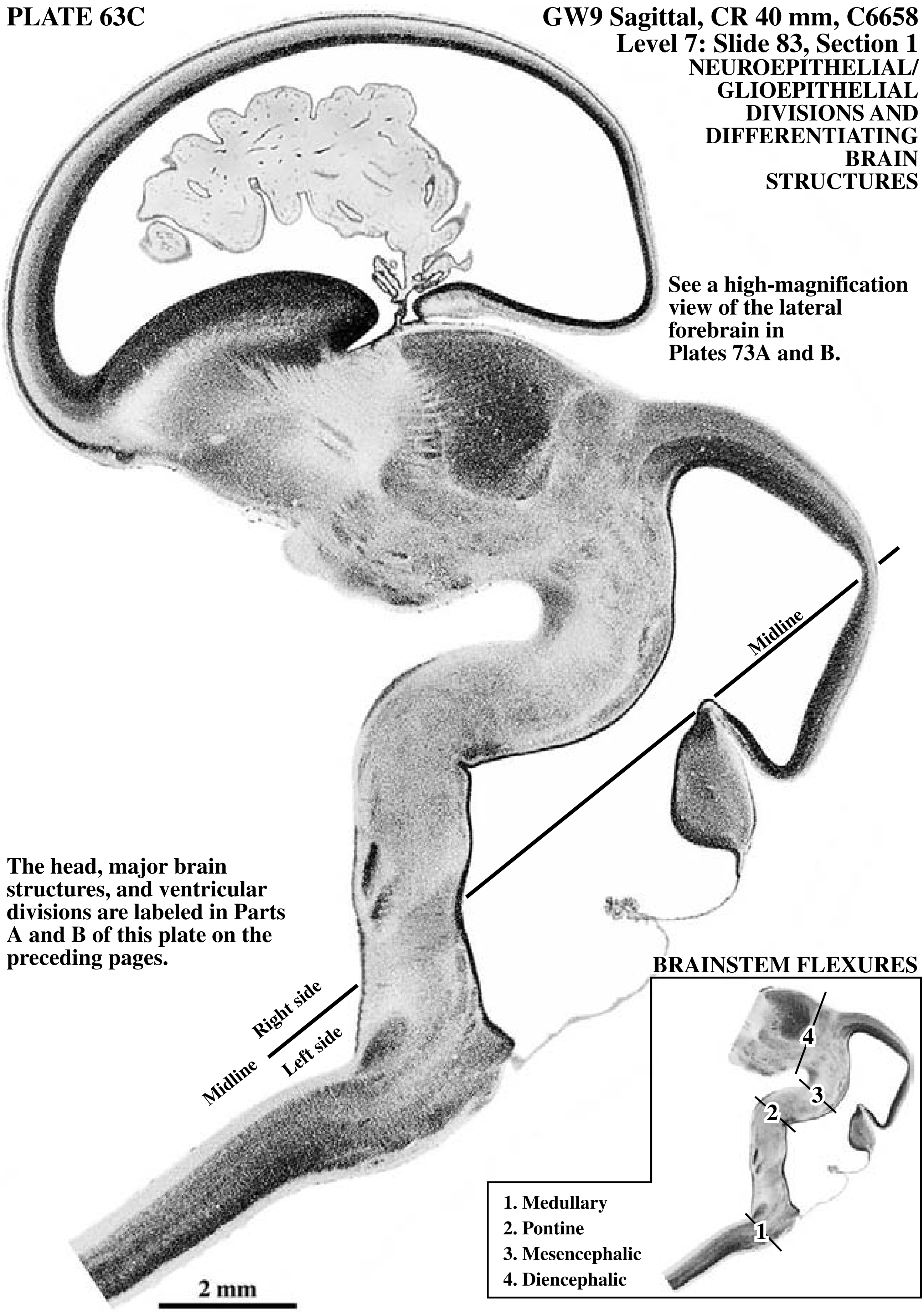
PLATE 63B



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 63C

GW9 Sagittal, CR 40 mm, C6658
Level 7: Slide 83, Section 1
NEUROEPITHELIAL/ GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES



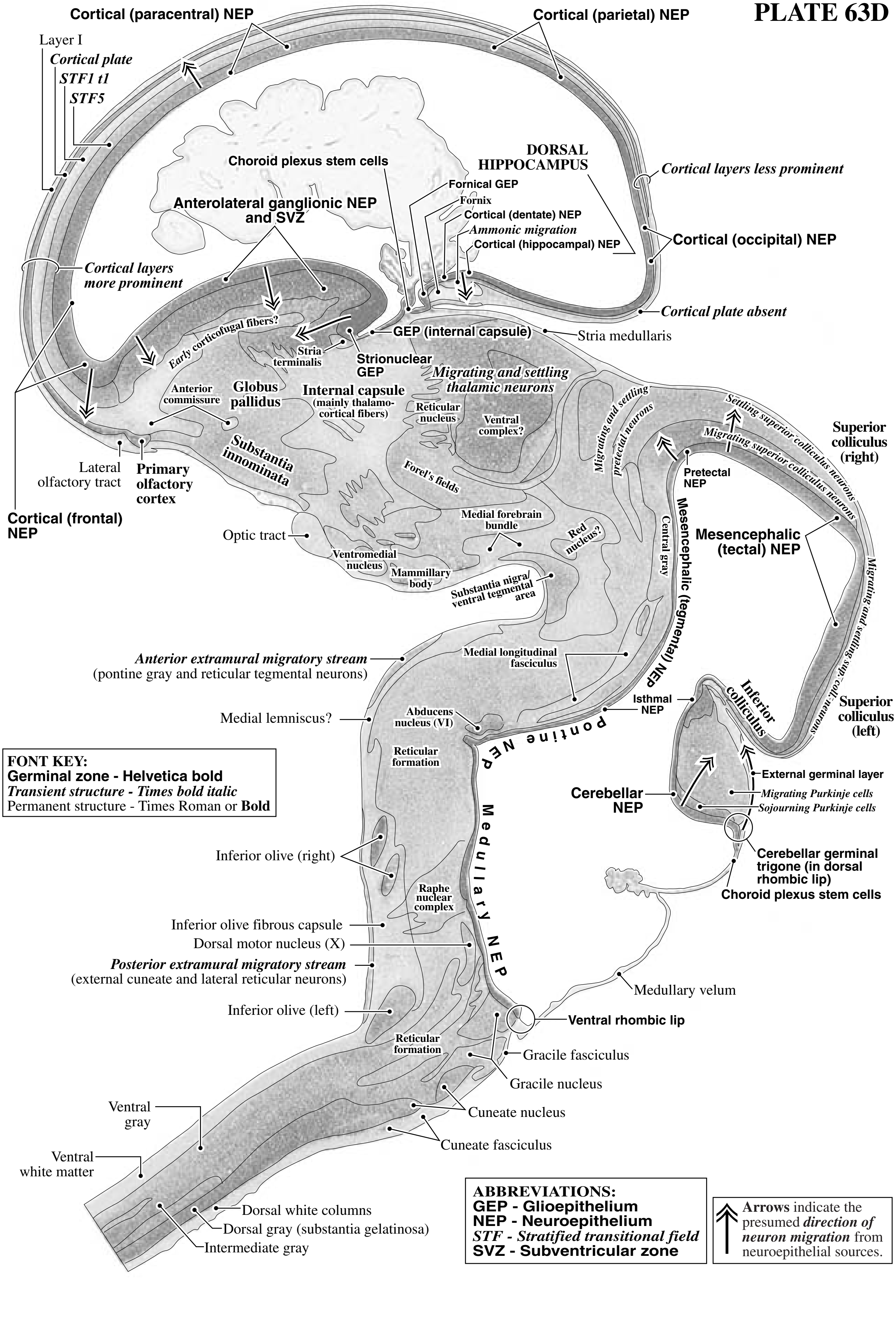
See a high-magnification view of the lateral forebrain in Plates 73A and B.

The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

BRAINSTEM FLEXURES

1. Medullary
2. Pontine
3. Mesencephalic
4. Diencephalic

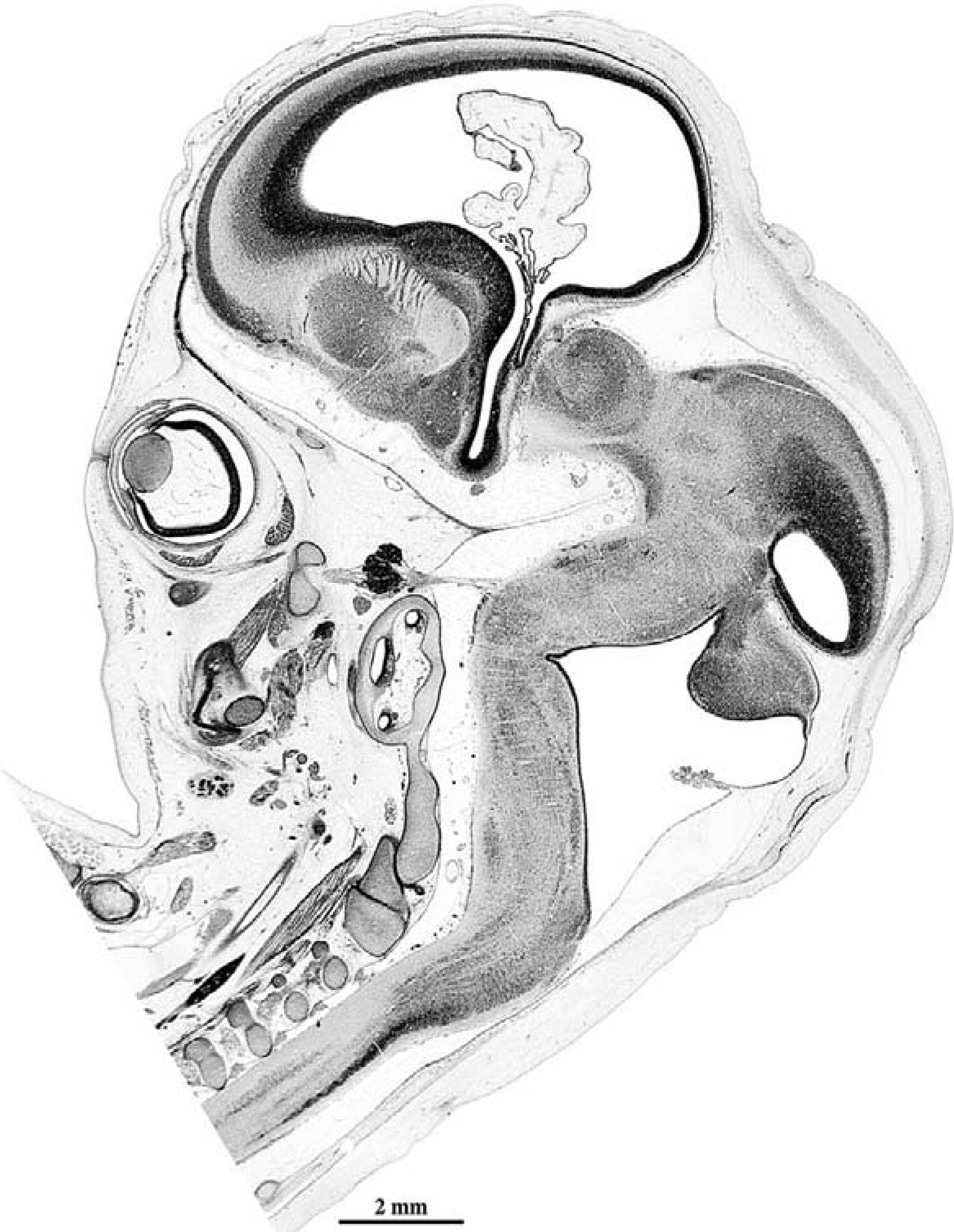
PLATE 63D



Cortical (paracentral) NEP
Cortical (parietal) NEP
Layer I
Cortical plate
STF1 t1
STF5
Choroid plexus stem cells
DORSAL HIPPOCAMPUS
Cortical layers less prominent
Fornical GEP
Fornix
Cortical (dentate) NEP
Ammonic migration
Cortical (hippocampal) NEP
Cortical (occipital) NEP
Anterolateral ganglionic NEP and SVZ
Cortical layers more prominent
Cortical plate absent
Early corticofugal fibers?
GEP (internal capsule)
Stria medullaris
Stria terminalis
Strionuclear GEP
Migrating and settling thalamic neurons
Anterior commissure
Globus pallidus
Internal capsule
(mainly thalamo-cortical fibers)
Reticular nucleus
Ventral complex?
Migrating and settling pretectal neurons
Settling superior colliculus neurons
Migrating superior colliculus neurons
Superior colliculus (right)
Substantia innominata
Forel's fields
Pretectal NEP
Lateral olfactory tract
Primary olfactory cortex
Cortical (frontal) NEP
Medial forebrain bundle
Red nucleus?
Central gray
Mesencephalic (tegmental) NEP
Mesencephalic (tectal) NEP
Optic tract
Ventromedial nucleus
Mammillary body
Substantia nigra/ ventral tegmental area
Migrating and settling sup. colli. neurons
Anterior extramural migratory stream
(pontine gray and reticular tegmental neurons)
Medial longitudinal fasciculus
Inferior colliculus
Isthmal NEP
Superior colliculus (left)
Medial lemniscus?
Abducens nucleus (VI)
Pontine NEP
Reticular formation
FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
External germinal layer
Cerebellar NEP
Migrating Purkinje cells
Sojourning Purkinje cells
Medullary NEP
Inferior olive (right)
Cerebellar germinal trigone (in dorsal rhombic lip)
Choroid plexus stem cells
Raphe nuclear complex
Inferior olive fibrous capsule
Dorsal motor nucleus (X)
Posterior extramural migratory stream
(external cuneate and lateral reticular neurons)
Medullary velum
Inferior olive (left)
Ventral rhombic lip
Reticular formation
Gracile fasciculus
Gracile nucleus
Cuneate nucleus
Ventral gray
Cuneate fasciculus
Ventral white matter
Dorsal white columns
Dorsal gray (substantia gelatinosa)
Intermediate gray
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field
SVZ - Subventricular zone
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.

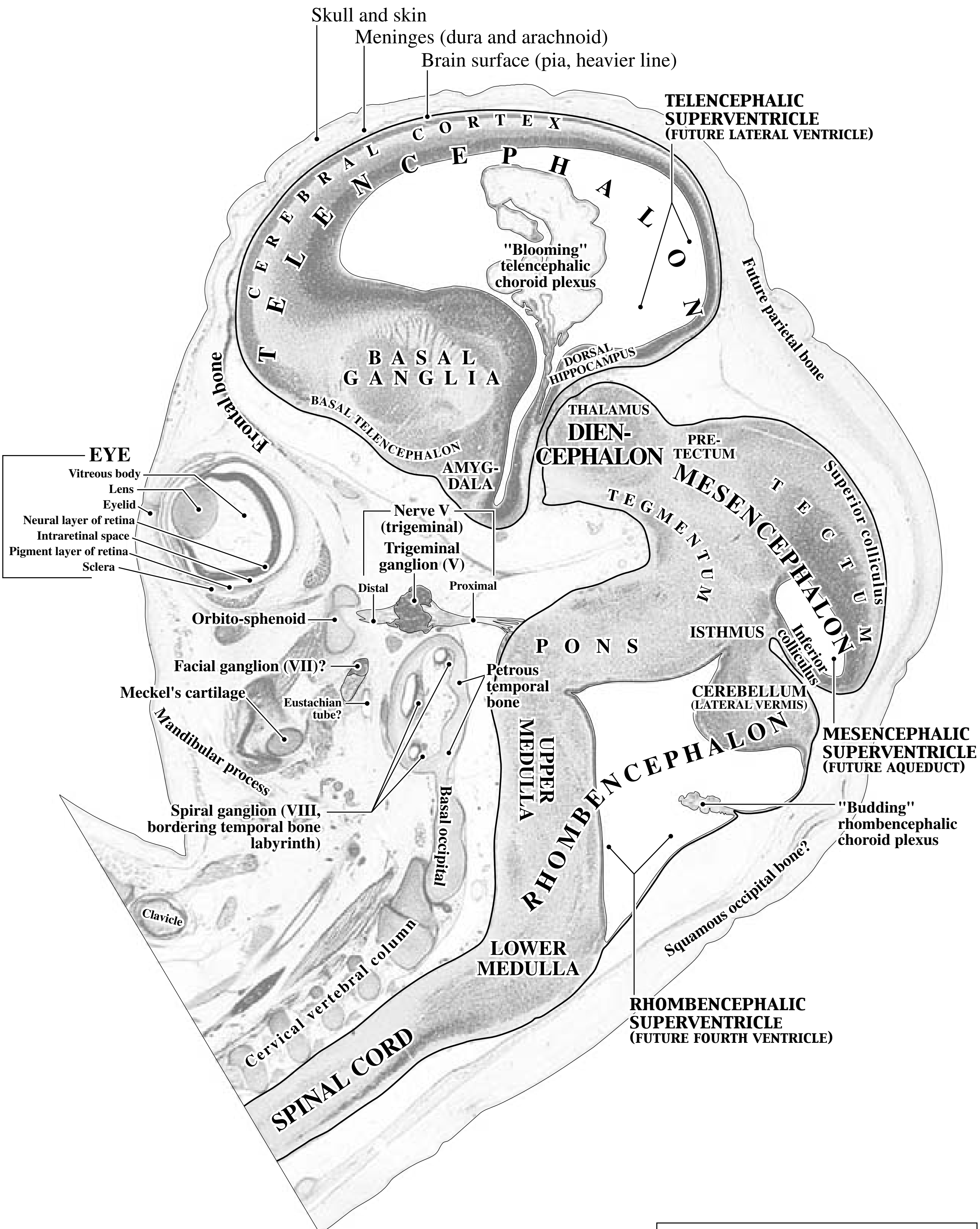
PLATE 64A

GW9 Sagittal, CR 40 mm, C6658
Level 8: Slide 95, Section 1
HEAD STRUCTURES, MAJOR BRAIN REGIONS, AND VENTRICULAR DIVISIONS



Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

PLATE 64B

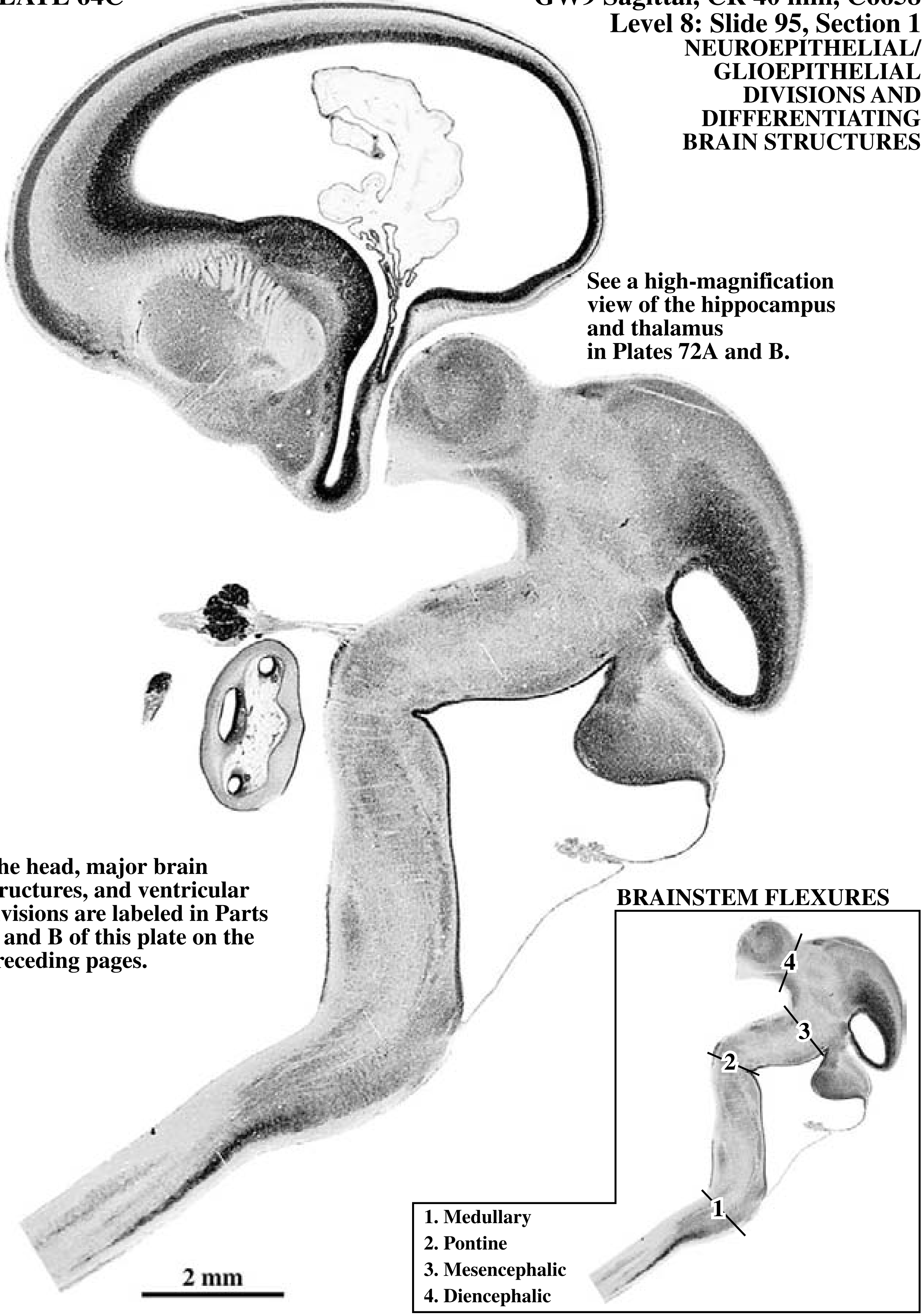


FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 64C

GW9 Sagittal, CR 40 mm, C6658
Level 8: Slide 95, Section 1

NEUROEPITHELIAL/ GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES

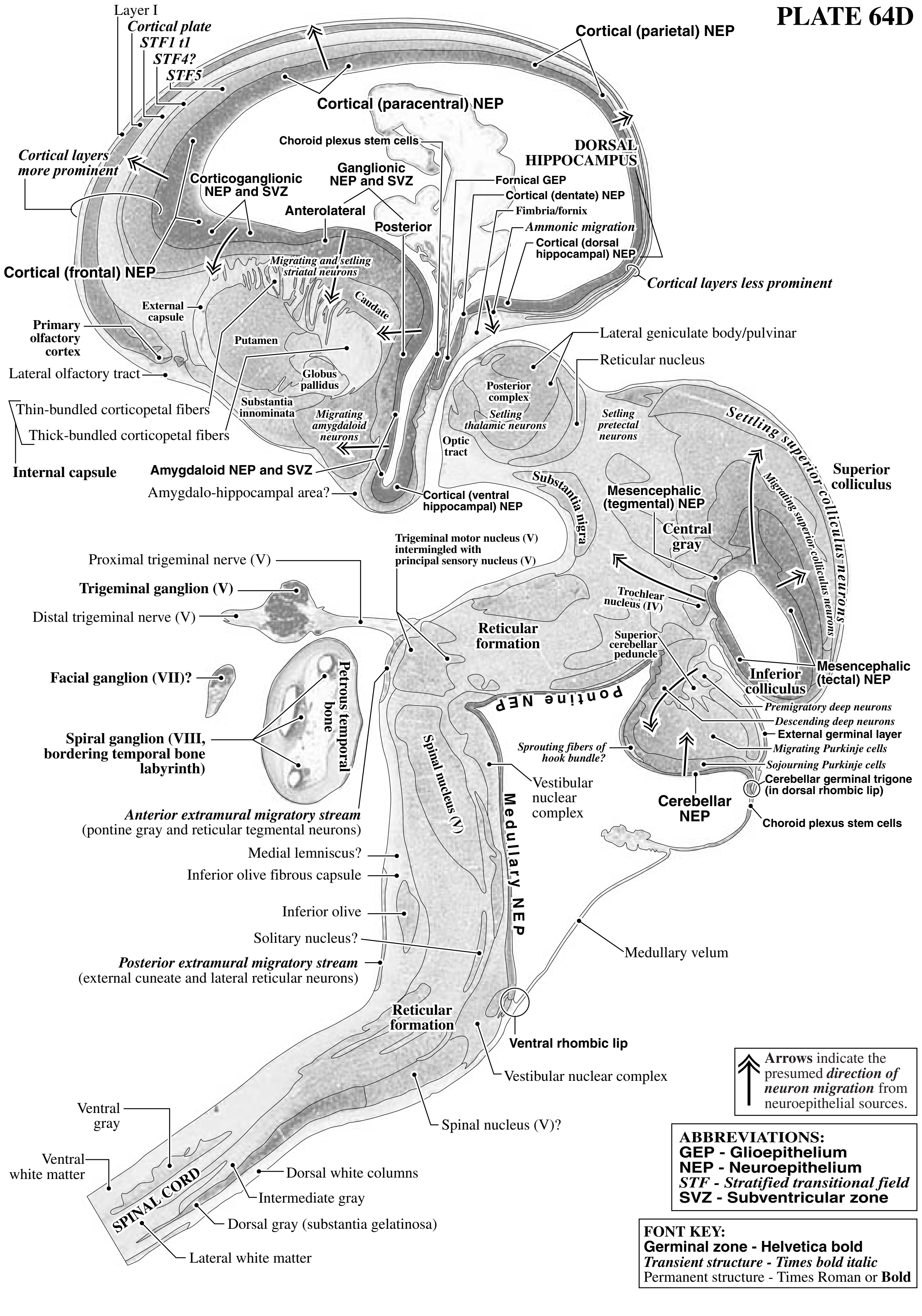


See a high-magnification view of the hippocampus and thalamus in Plates 72A and B.

The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

BRAINSTEM FLEXURES

PLATE 64D



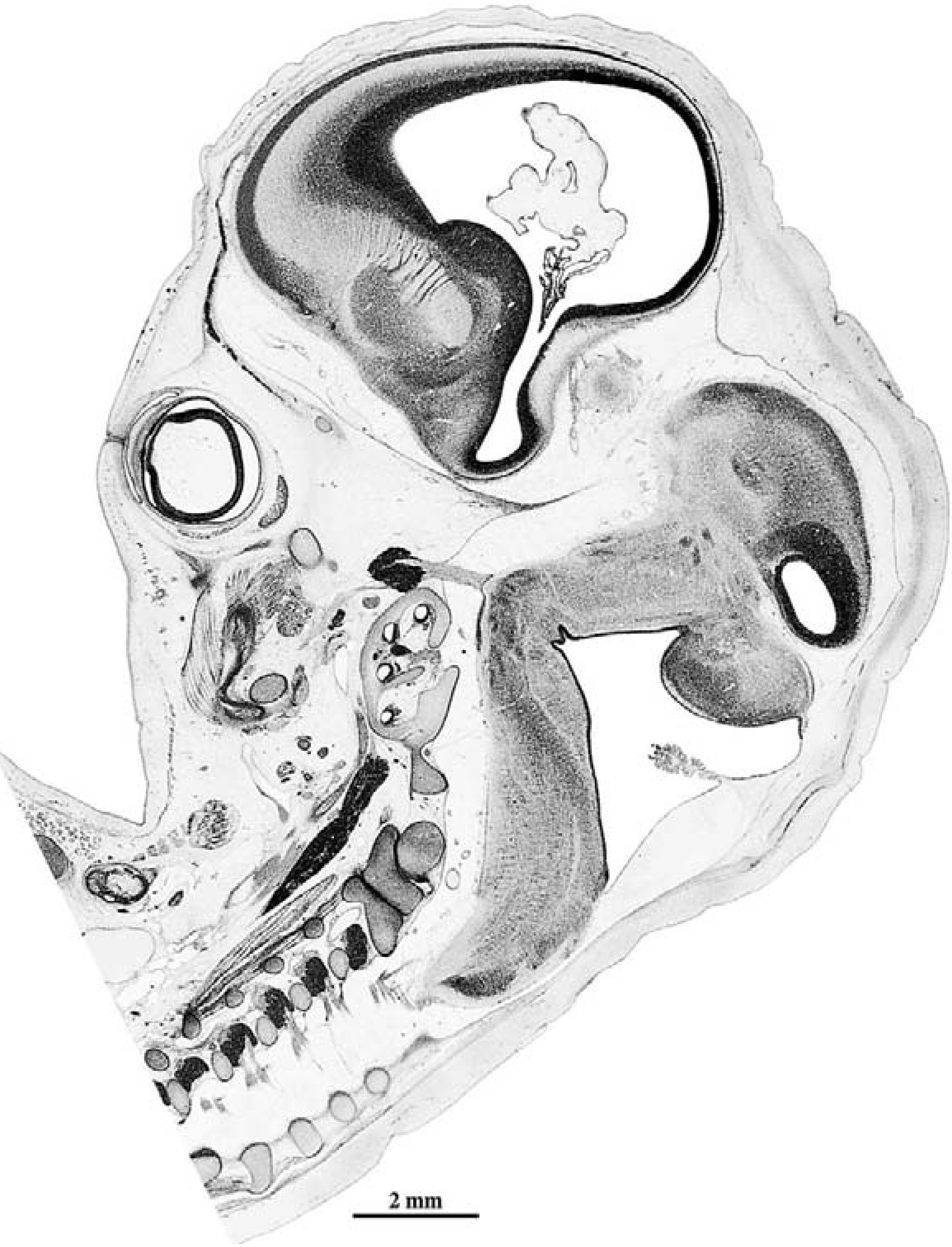
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field
SVZ - Subventricular zone

FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

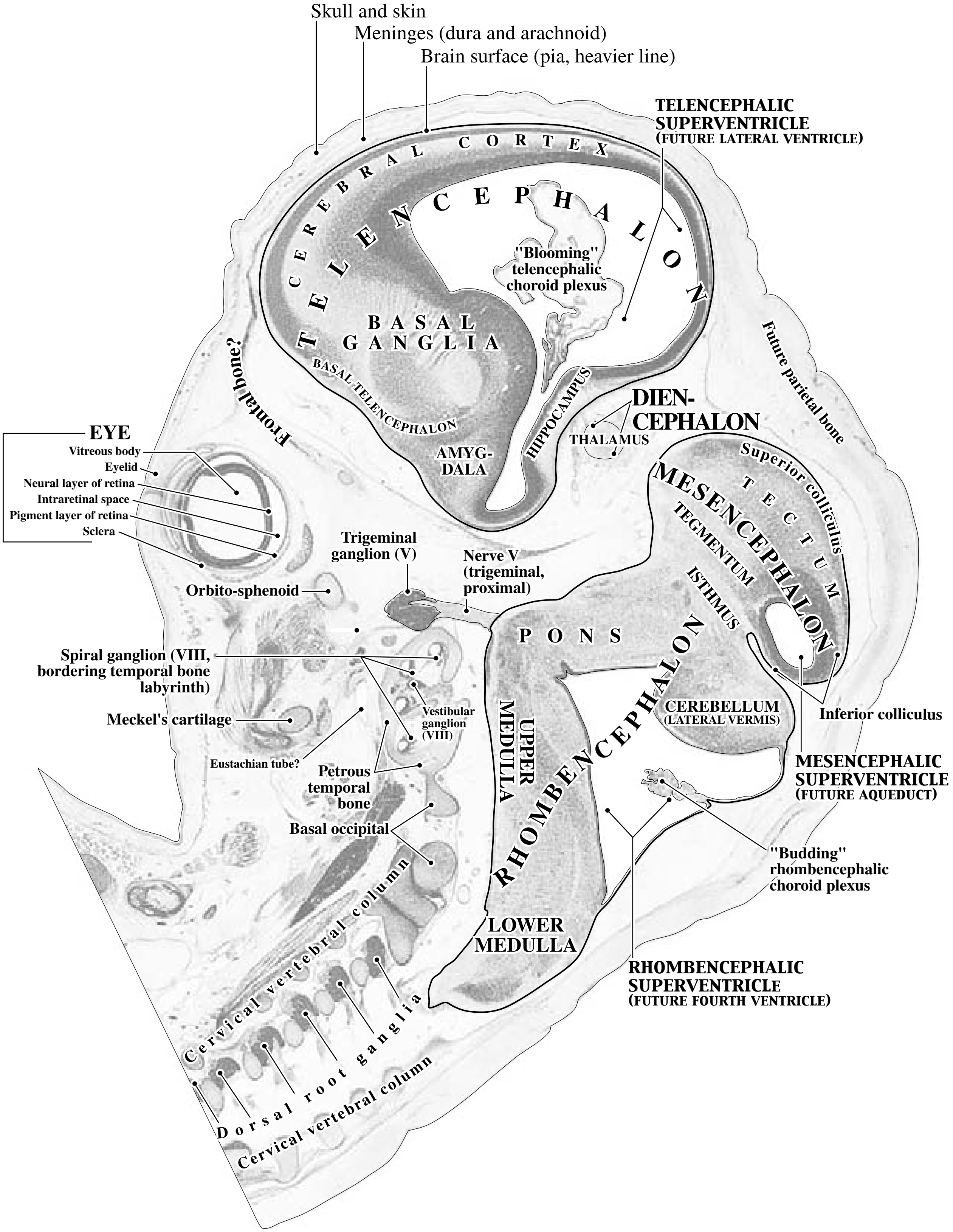
PLATE 65A

GW9 Sagittal, CR 40 mm, C6658
Level 9: Slide 99, Section 1
HEAD STRUCTURES,
MAJOR BRAIN REGIONS,
AND VENTRICULAR DIVISIONS



Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

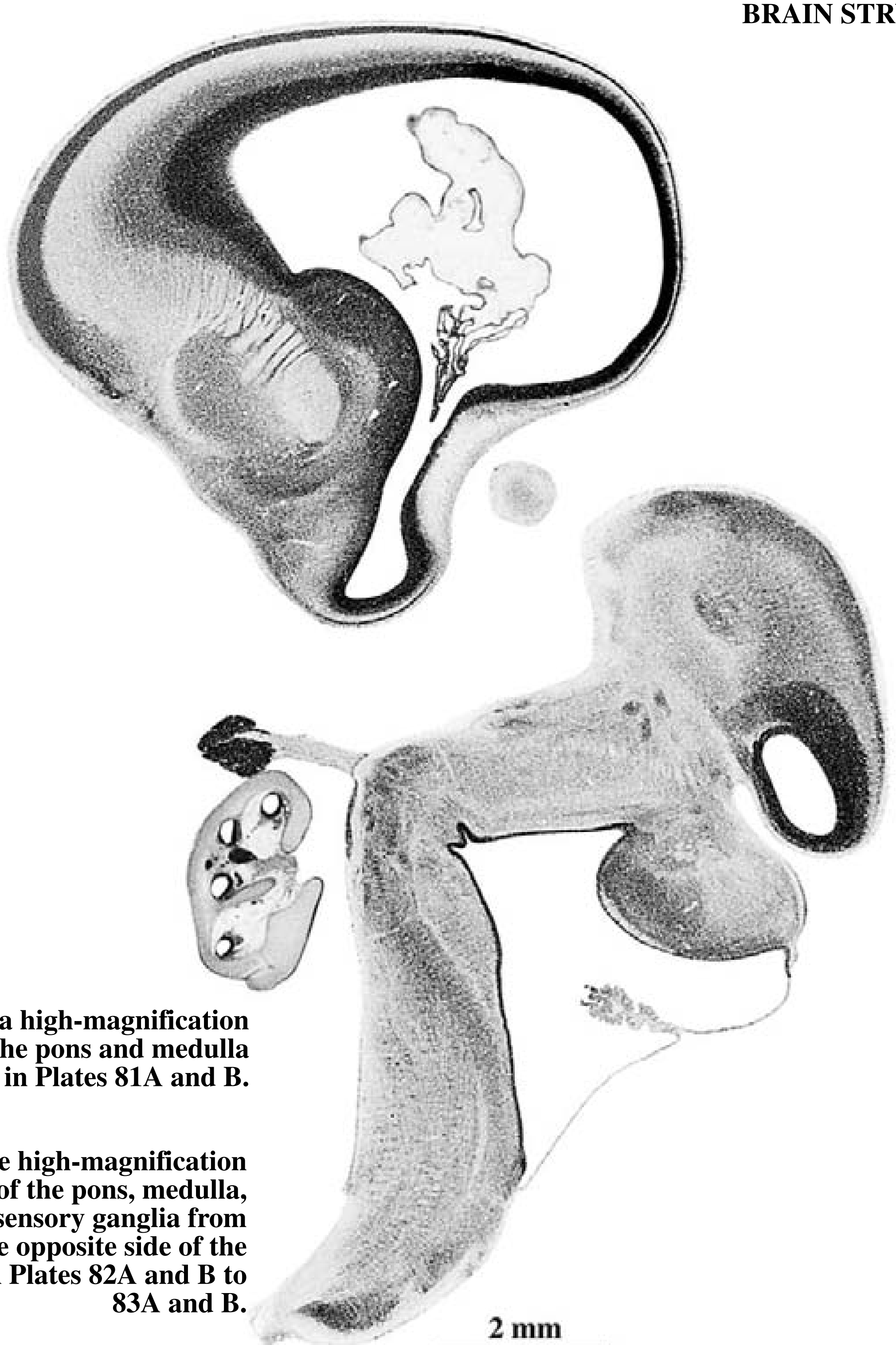
PLATE 65B



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 65C

GW9 Sagittal, CR 40 mm, C6658
Level 9: Slide 99, Section 1
NEUROEPITHELIAL/GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES

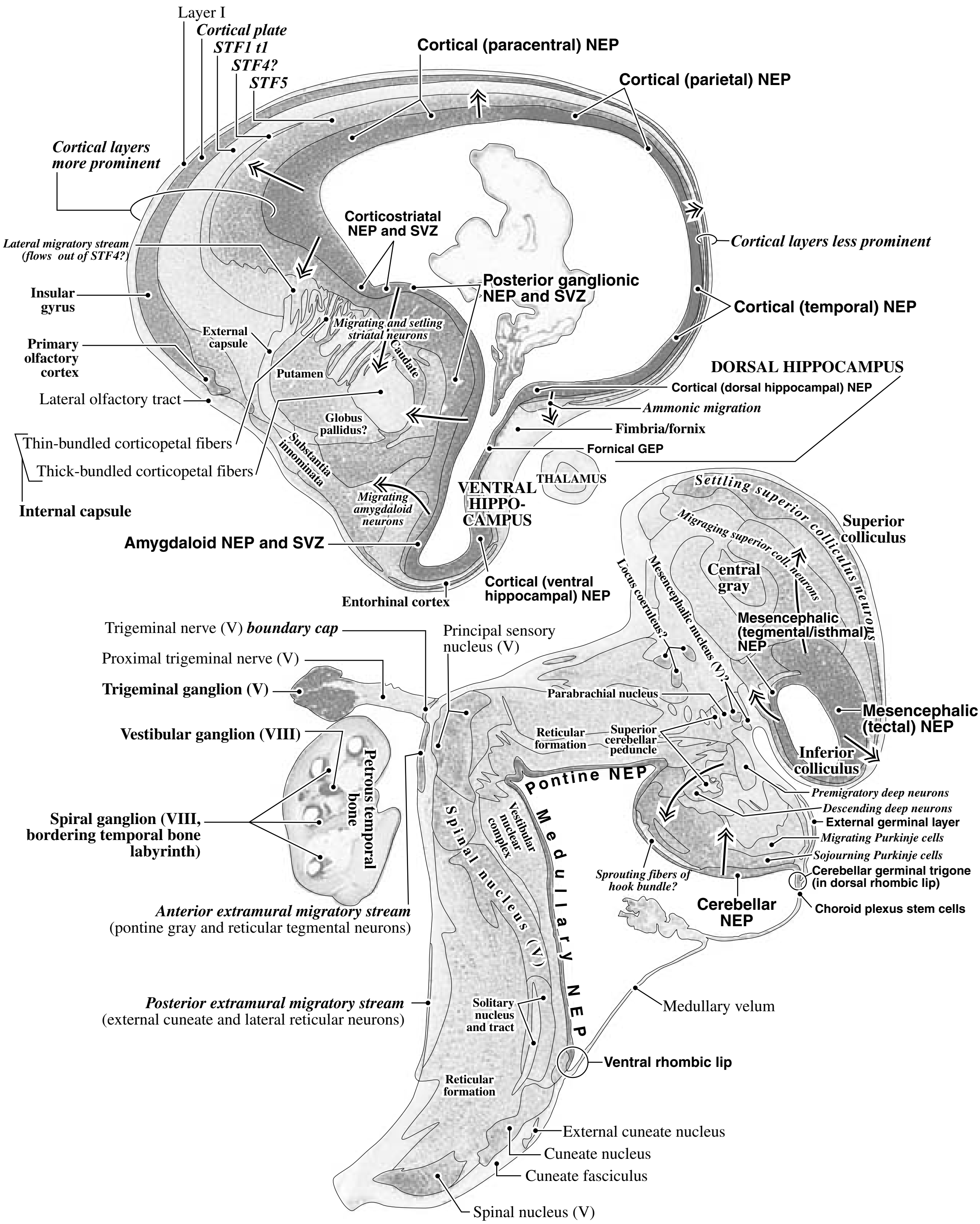


See a high-magnification view of the pons and medulla in Plates 81A and B.

See high-magnification views of the pons, medulla, and sensory ganglia from the opposite side of the brain in Plates 82A and B to 83A and B.

The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 65D



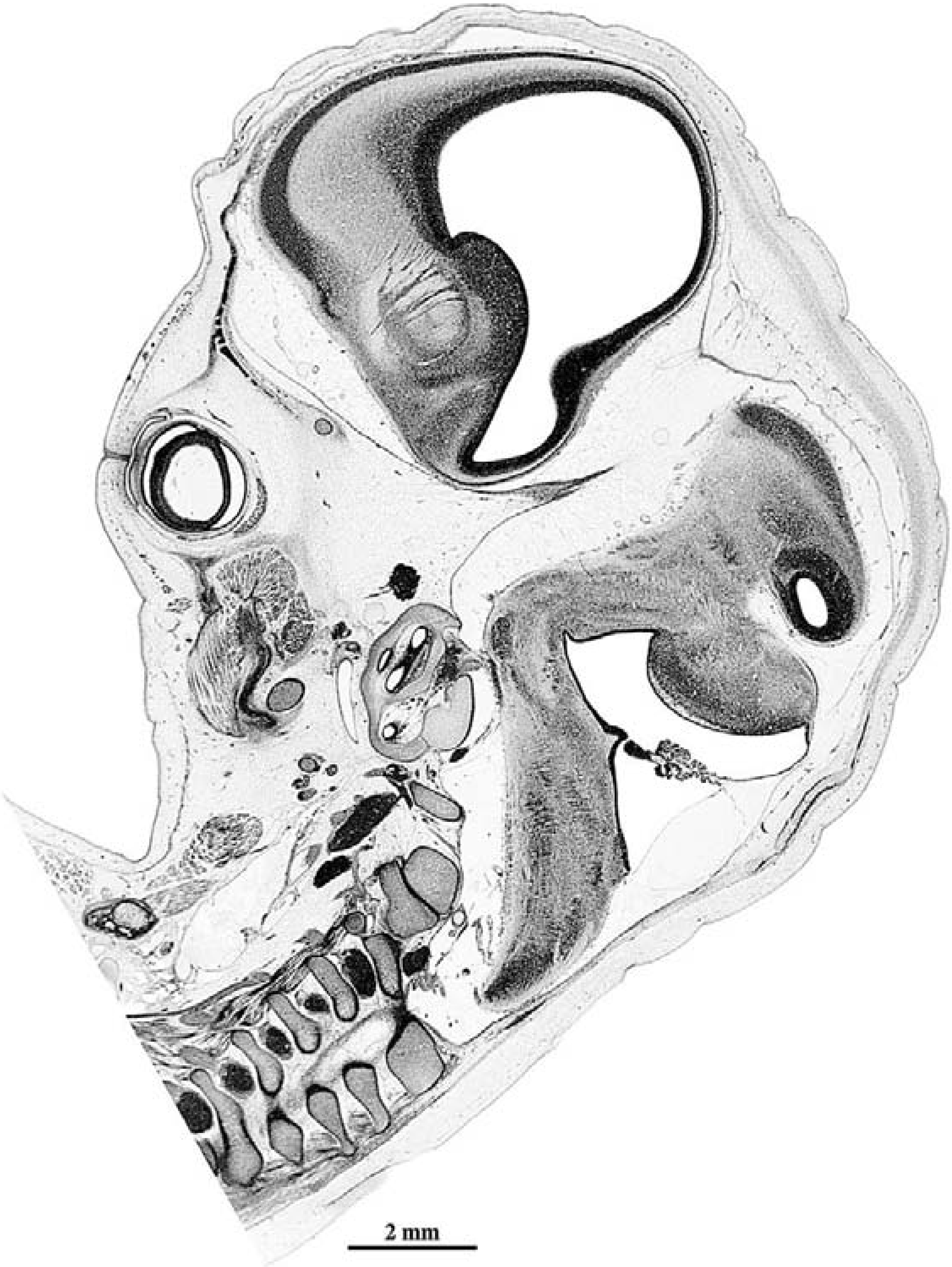
FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

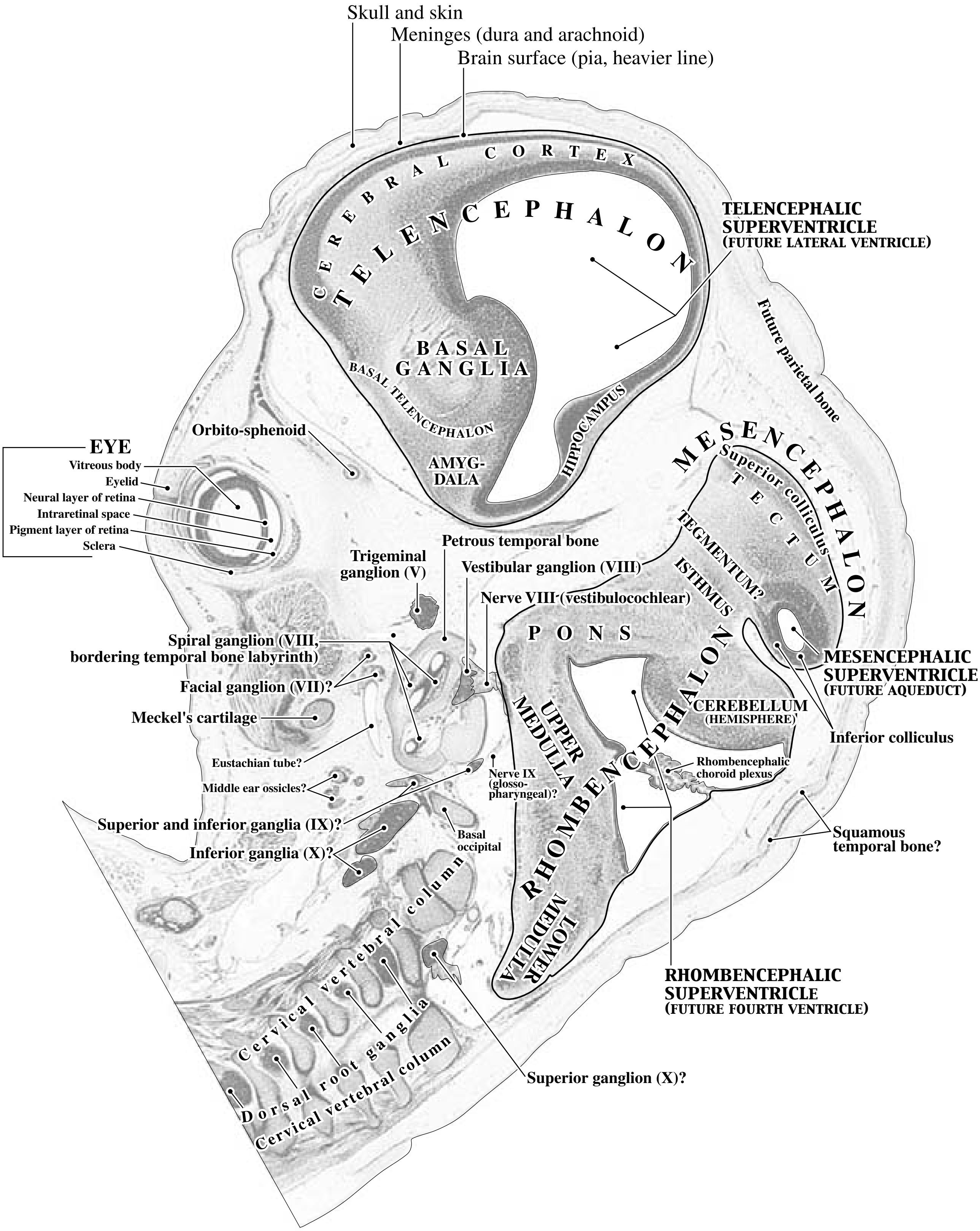
PLATE 66A

GW9 Sagittal, CR 40 mm, C6658
Level 10: Slide 103, Section 1
HEAD STRUCTURES,
MAJOR BRAIN REGIONS,
AND VENTRICULAR DIVISIONS



Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

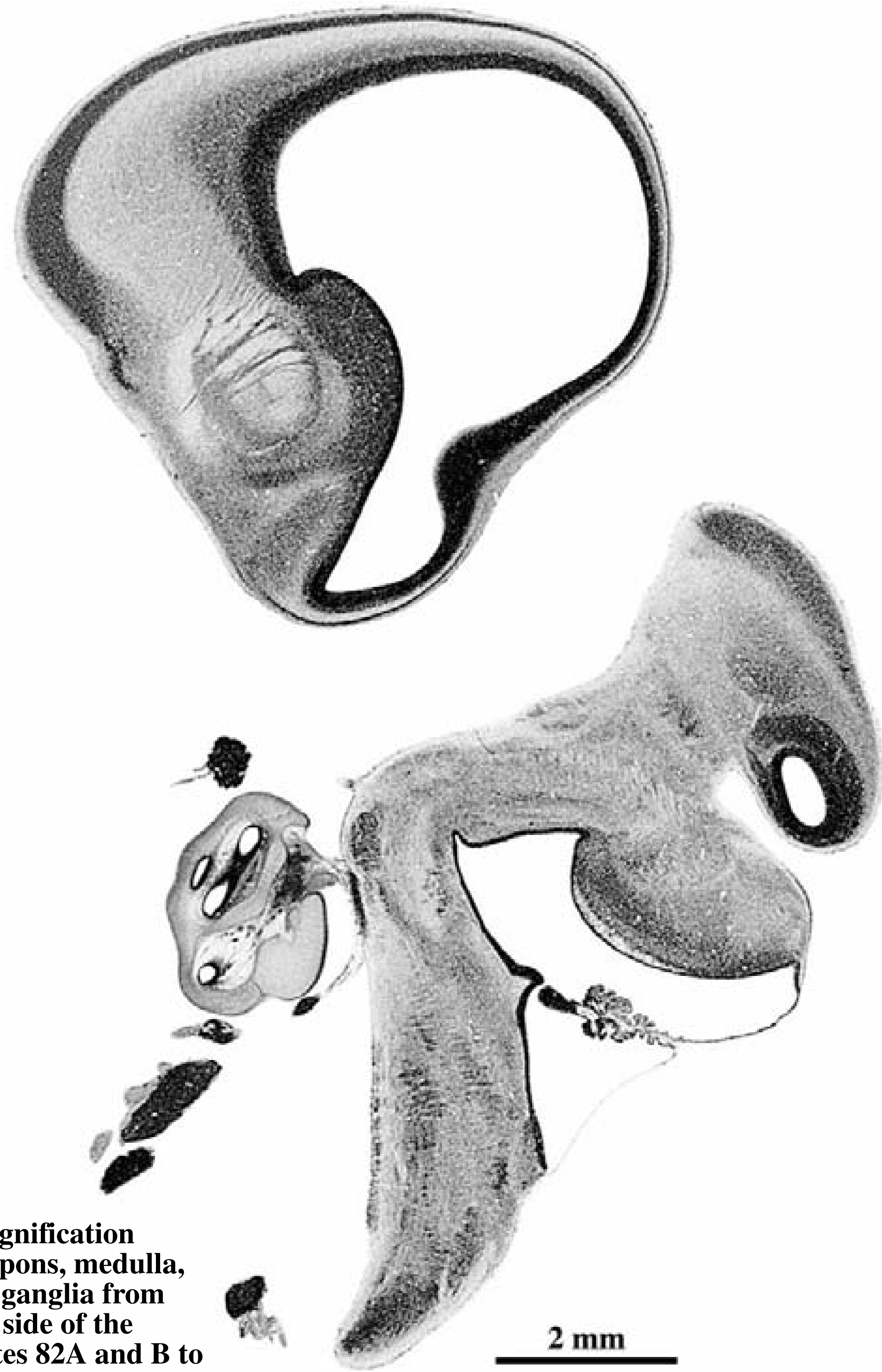
PLATE 66B



FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 66C

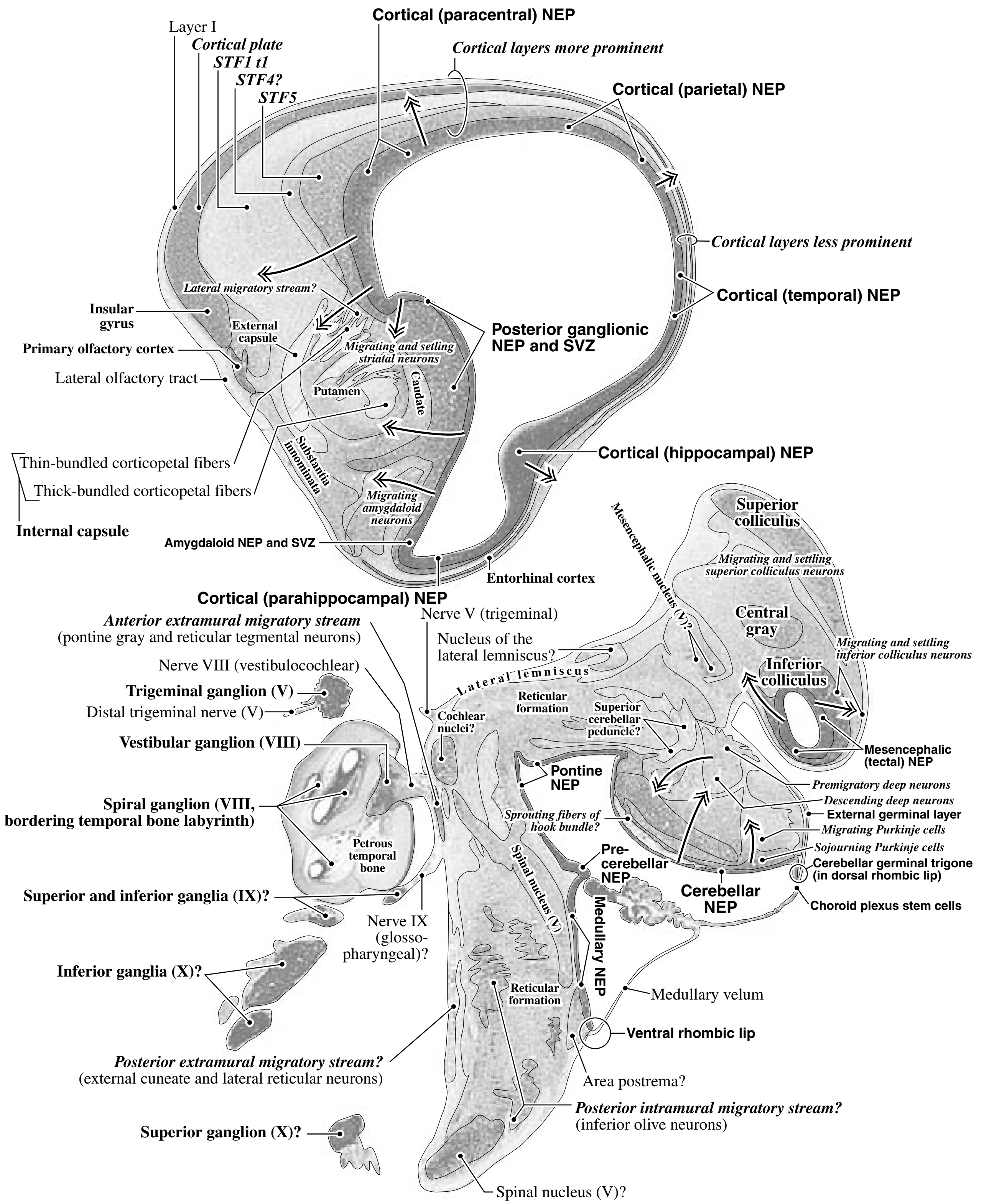
GW9 Sagittal, CR 40 mm, C6658
Level 10: Slide 103, Section 1
NEUROEPITHELIAL/GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES



See high-magnification views of the pons, medulla, and sensory ganglia from the opposite side of the brain in Plates 82A and B to 83A and B.

The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 66D



FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field
SVZ - Subventricular zone

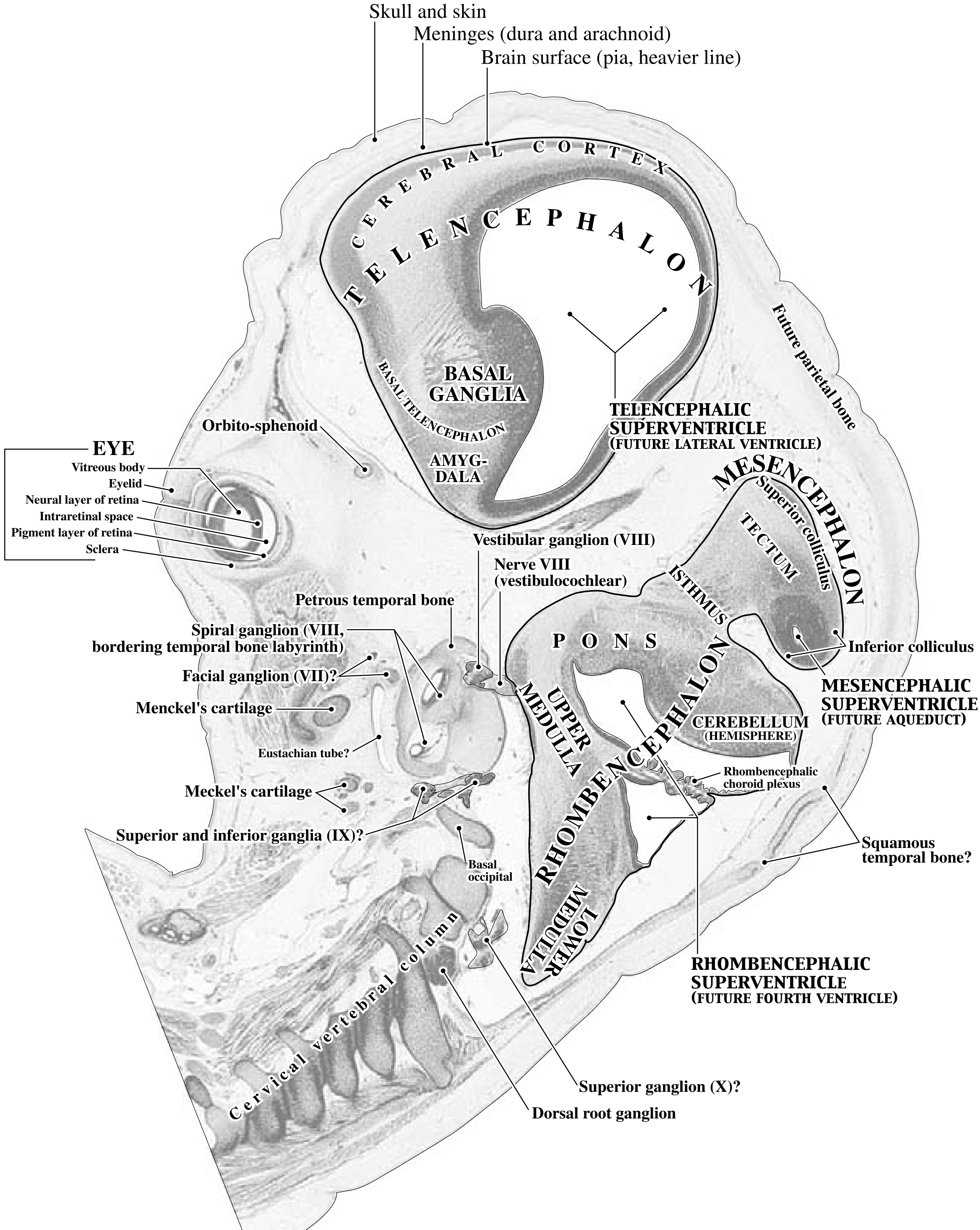
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 67A

GW9 Sagittal, CR 40 mm, C6658
Level 11: Slide 105, Section 2
HEAD STRUCTURES,
MAJOR BRAIN REGIONS,
AND VENTRICULAR DIVISIONS

Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

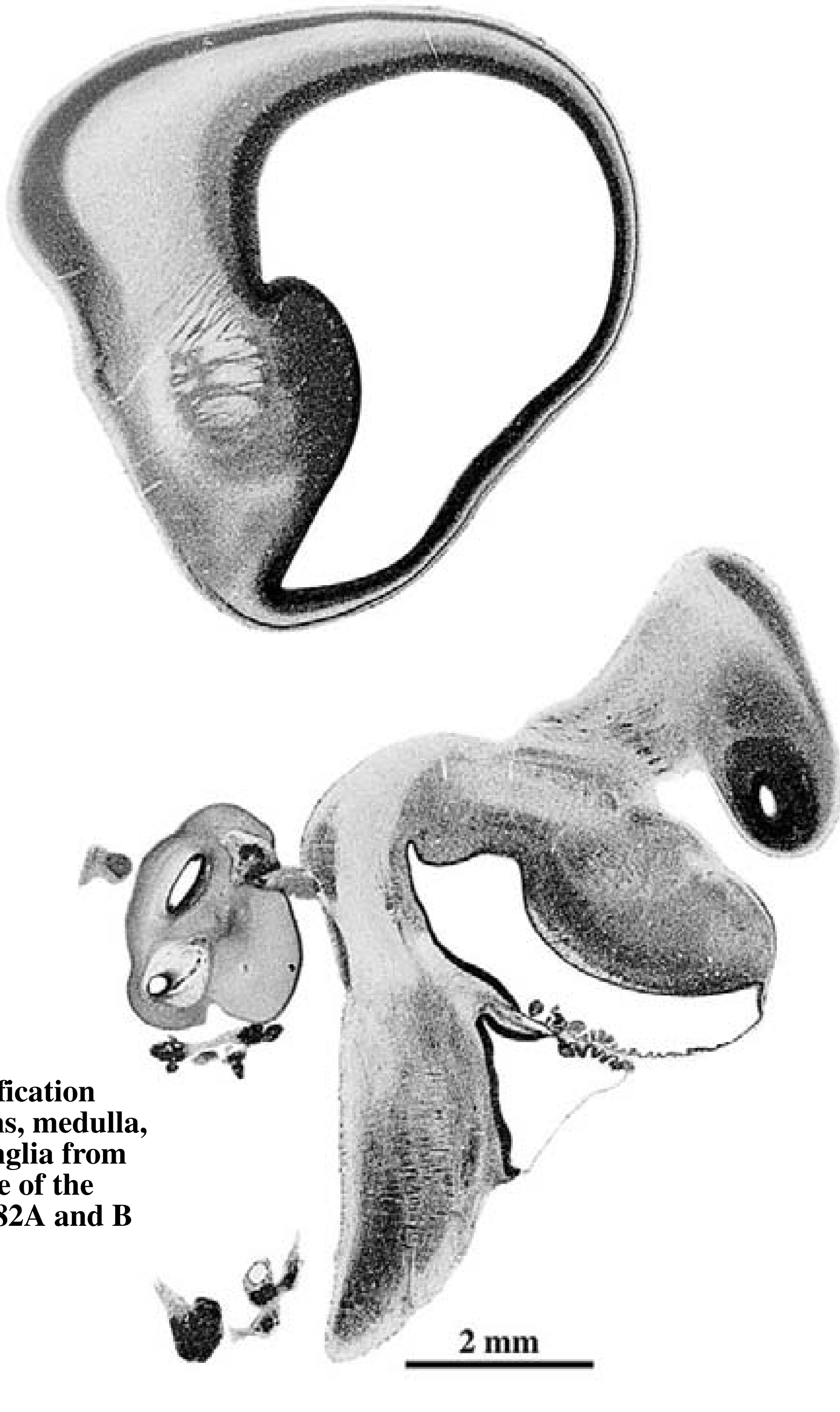
PLATE 67B



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 67C

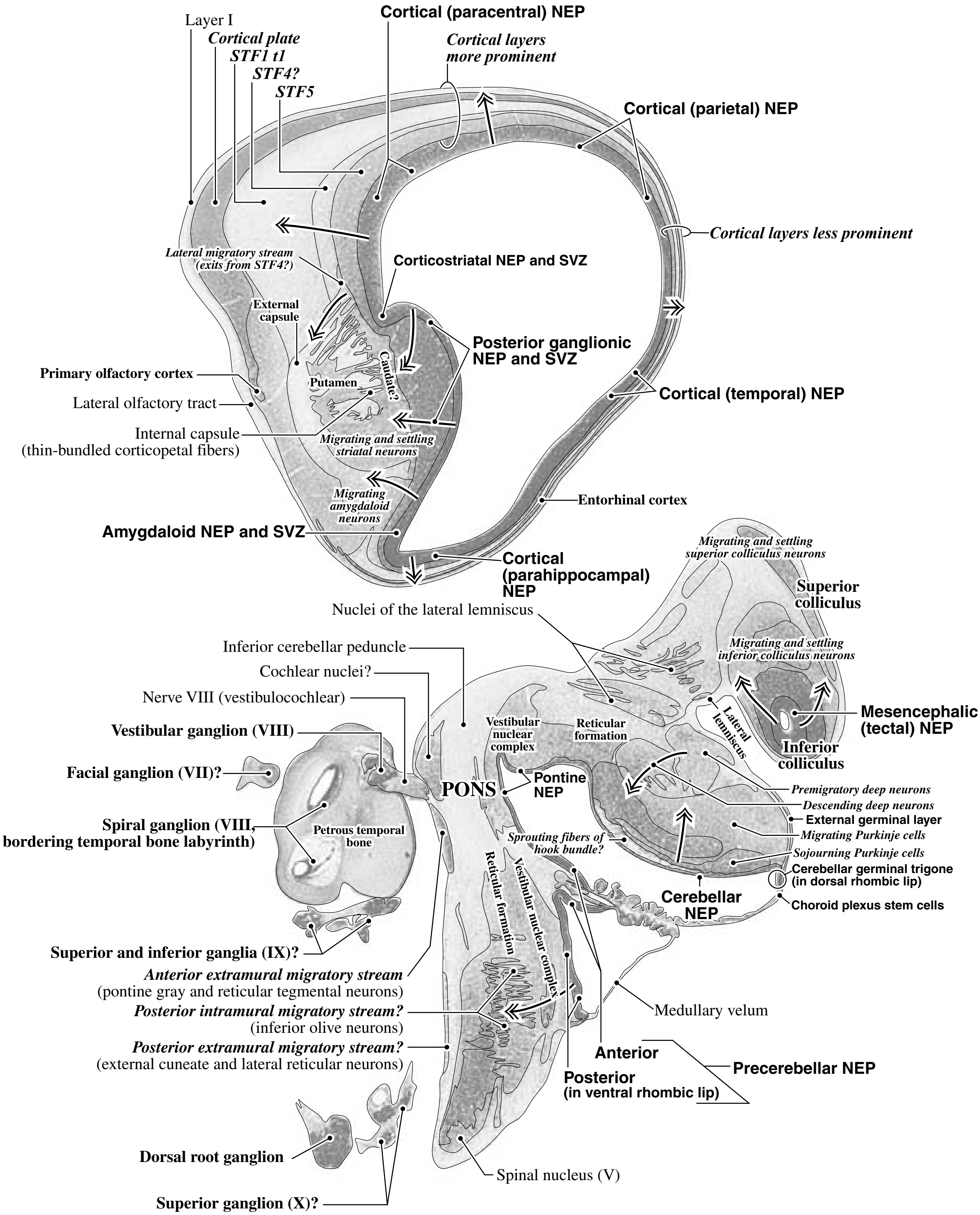
GW9 Sagittal, CR 40 mm, C6658
Level 11: Slide 105, Section 2
NEUROEPITHELIAL/GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES



See high-magnification views of the pons, medulla, and sensory ganglia from the opposite side of the brain in Plates 82A and B to 83A and B.

The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 67D



FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

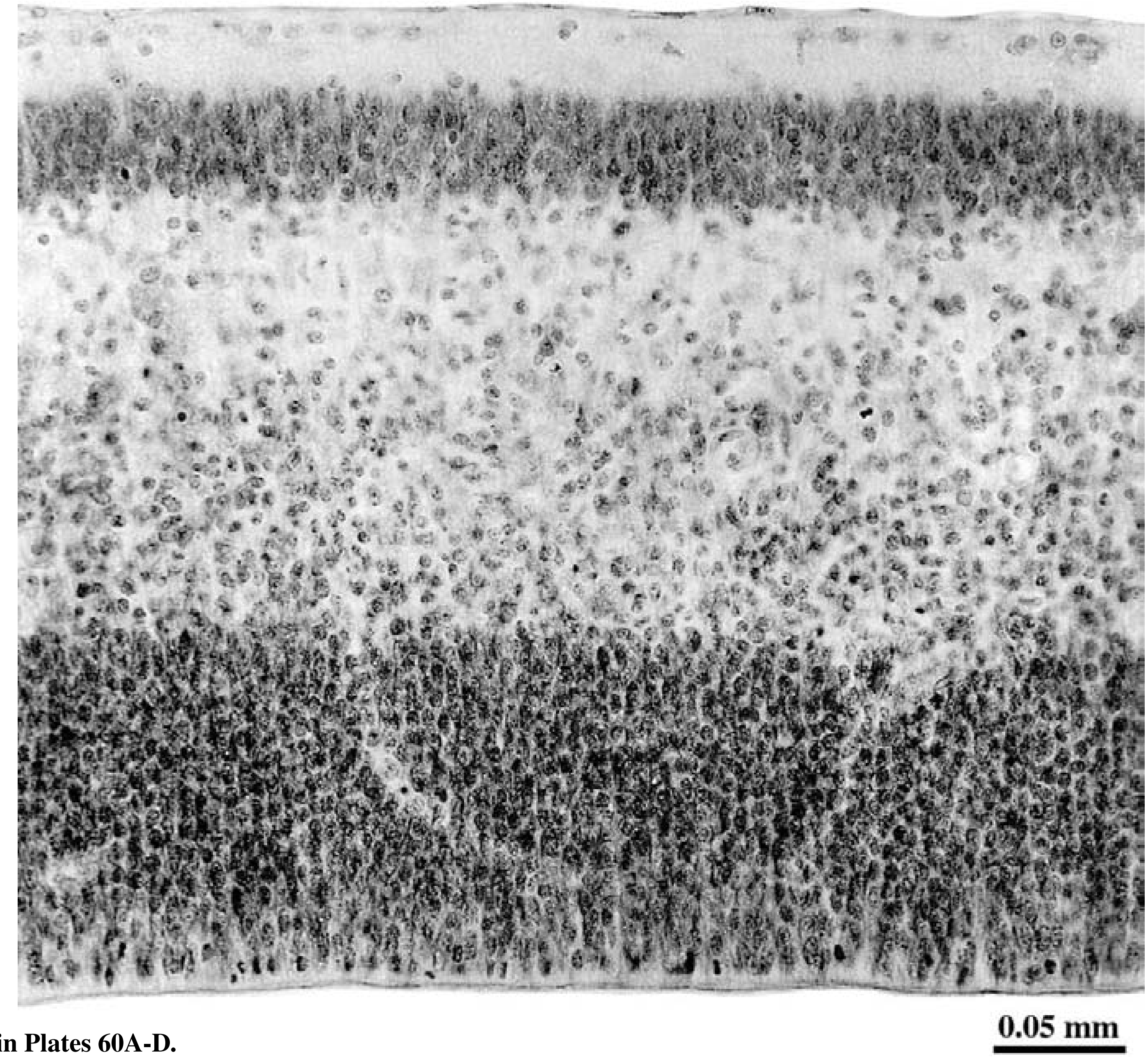
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 68A

GW9 Sagittal
CR 40 mm, C6658
Level 4:
Slide 71, Section 2

DORSAL
CORTEX



See the entire section in Plates 60A-D.

PLATE 68B

Layer I contains Cajal-Retzius cells settled near the pia.

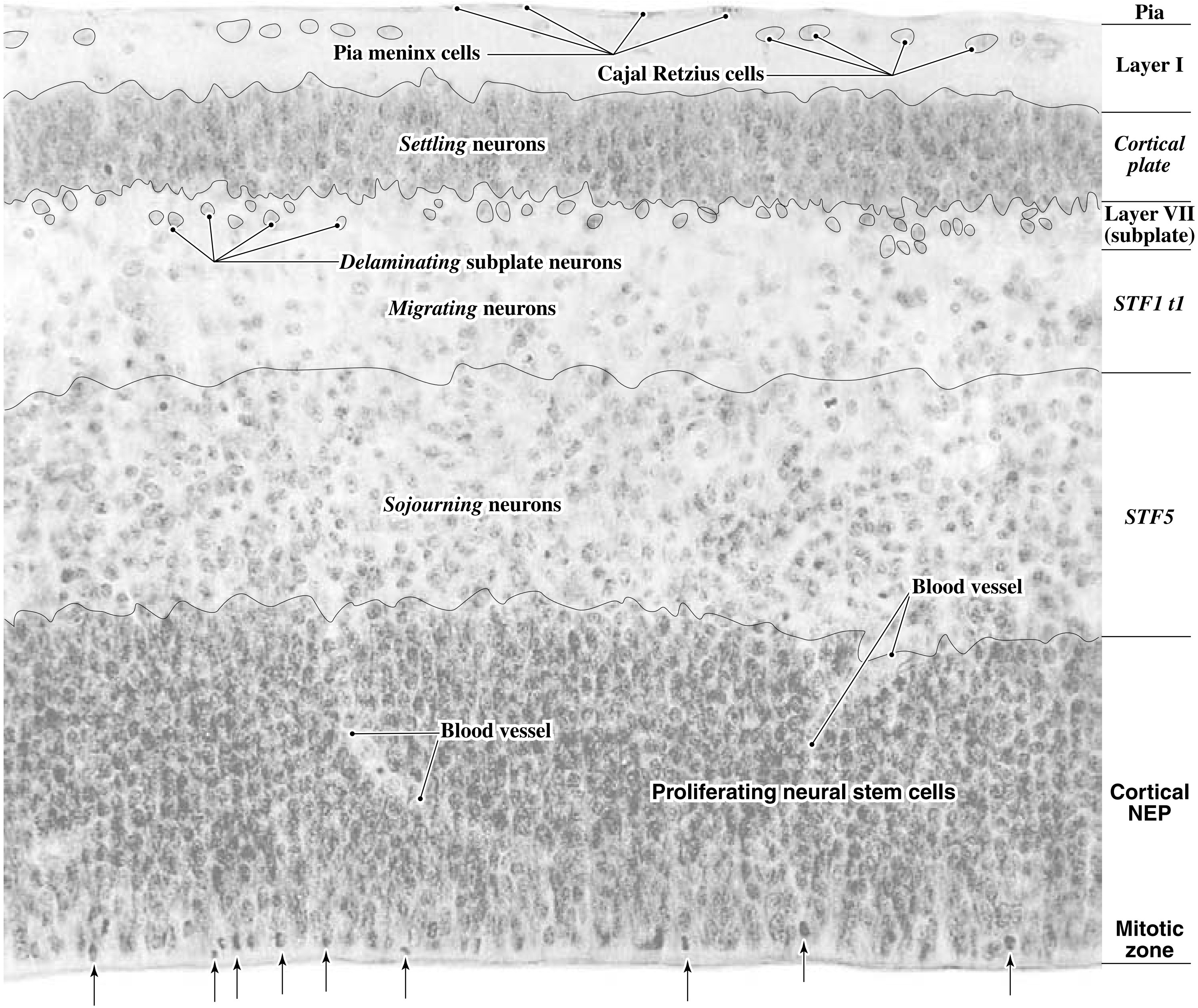
The *cortical plate* contains settling neurons, mainly those in future layer VI and some in layer VII that have not yet migrated downward into the subplate.

The subplate contains neurons that originally resided in the *cortical plate*.

***Stratified transitional field (STF) 1* contains *migrating* neurons, mainly those that will settle in cortical layer VI. *STF1* is in the early *t1* stage when cells are plentiful among the fibers.**

***STF 5* contains *sojourning* neurons, mainly those that will settle in cortical layers V and VI.**

The cortical neuroepithelium (NEP) is a pseudostratified layer of neural stem cells. *Arrows* indicate mitotic figures. The majority are at the ventricular surface, where nuclei migrate to divide within the tall and thin columnar cytoplasm. At this stage of development, large numbers of cortical neurons are being generated.

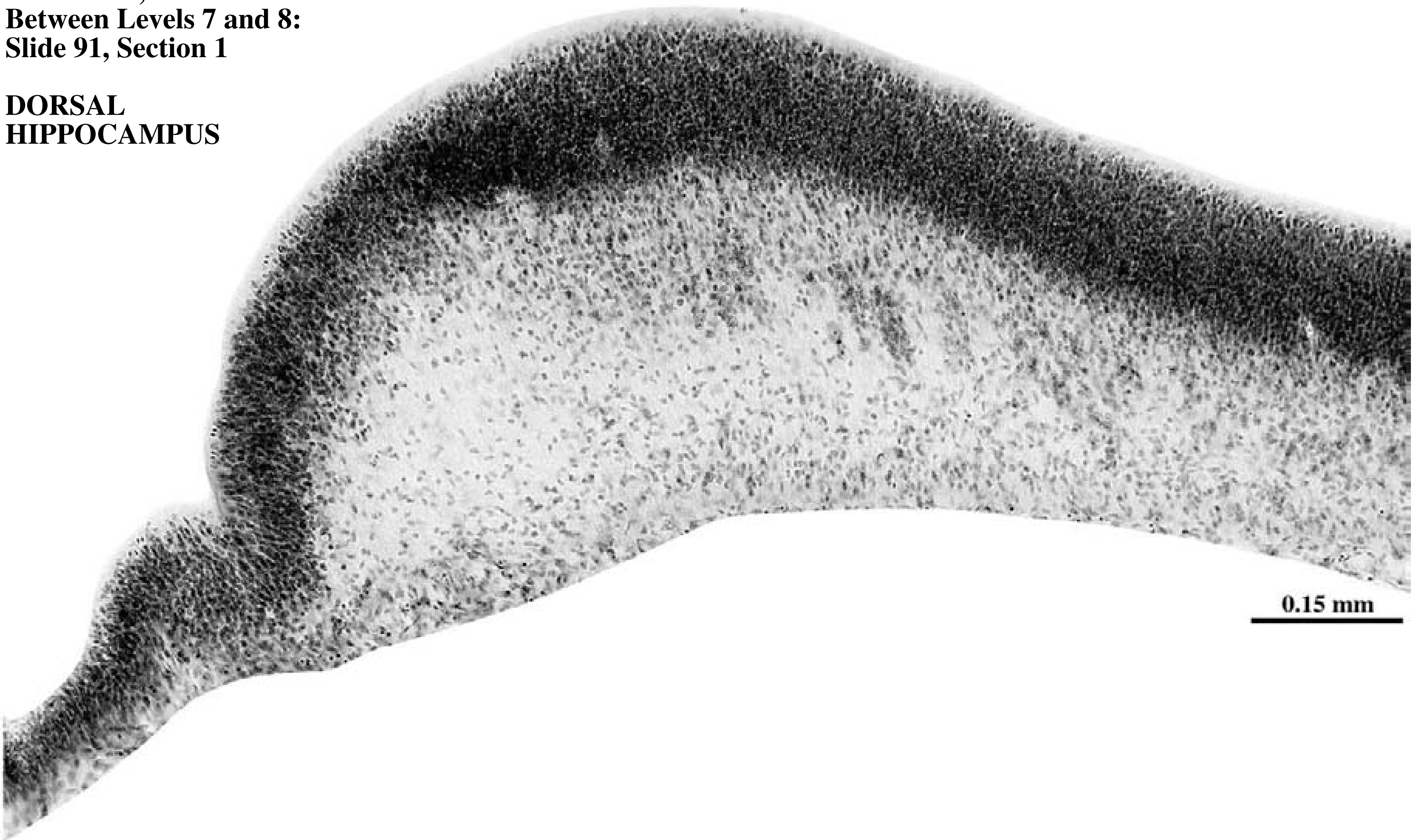


Neural stem cells in mitotic division at the border of the TELENCEPHALIC SUPERVENTRICLE

PLATE 69A

GW9 Sagittal
CR 40 mm, C6658
Between Levels 7 and 8:
Slide 91, Section 1

DORSAL
HIPPOCAMPUS



See a low-magnification view of Level 7 in Plates 63A-D, Level 8 in Plates 64A-D.

PLATE 69B

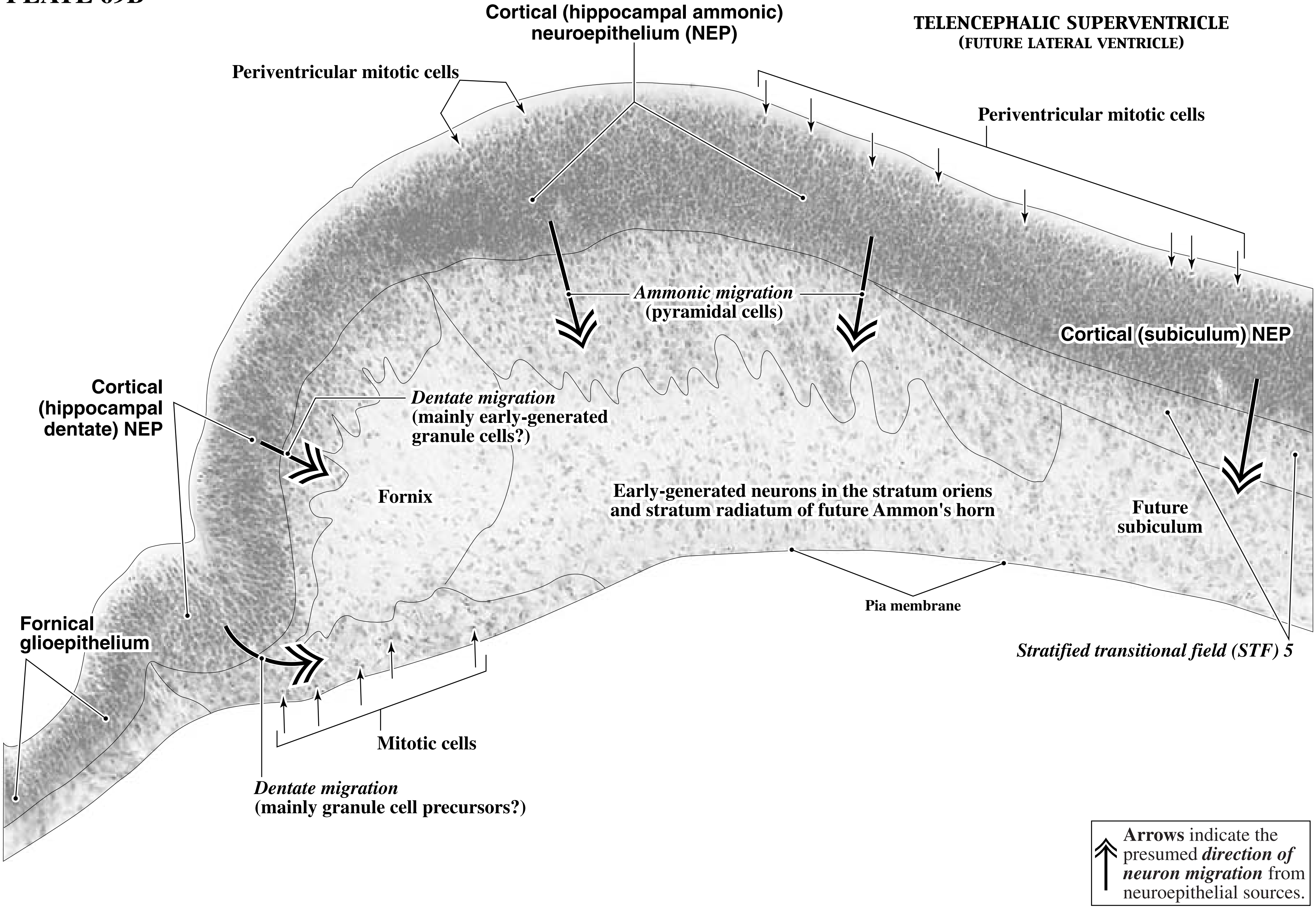
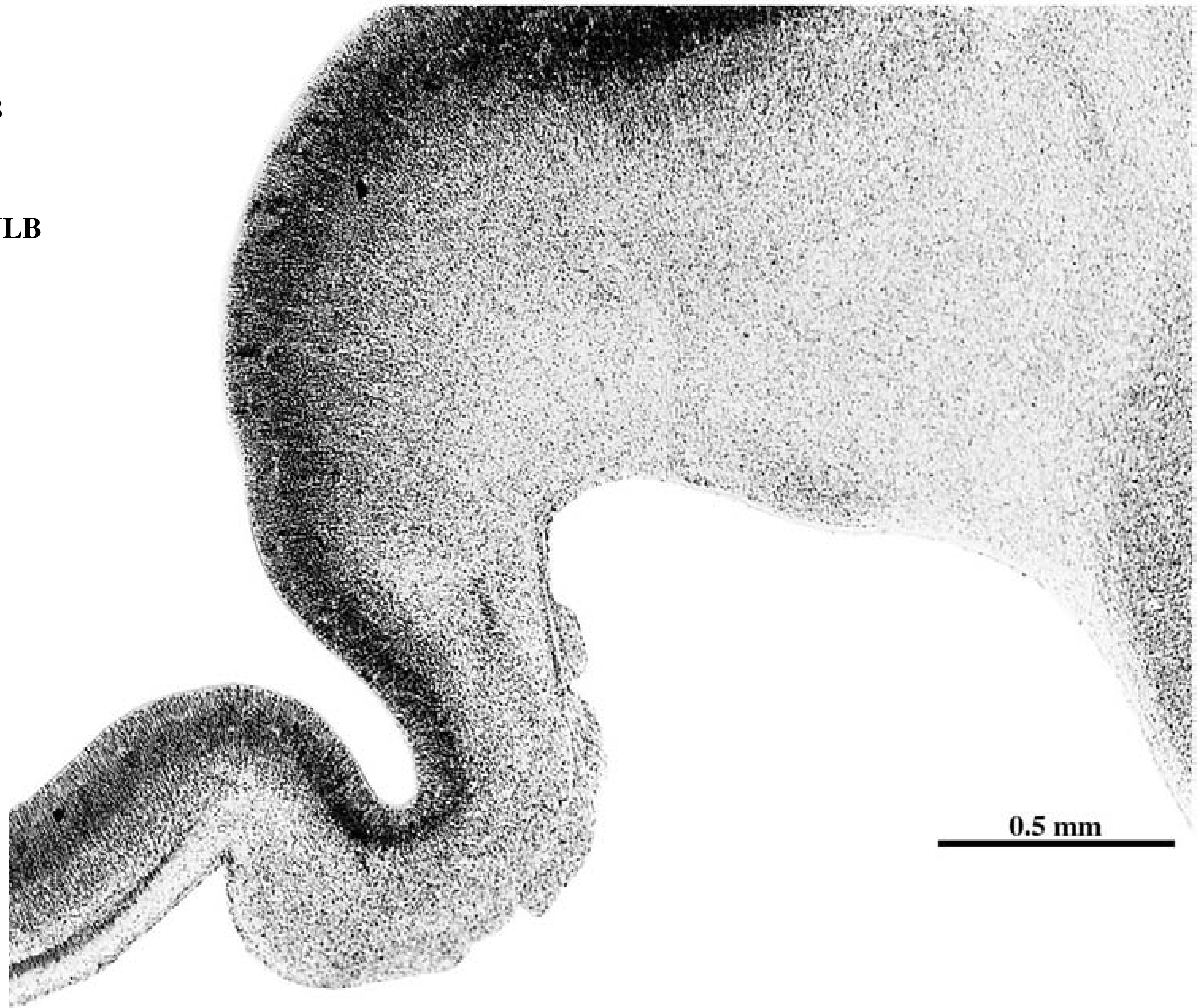

Cortical (hippocampal ammonic) neuroepithelium (NEP)
TELENCEPHALIC SUPERVENTRICLE
(FUTURE LATERAL VENTRICLE)
Periventricular mitotic cells
Periventricular mitotic cells
Ammonic migration
(pyramidal cells)
Cortical (subiculum) NEP
Cortical (hippocampal dentate) NEP
Dentate migration
(mainly early-generated granule cells?)
Fornix
Early-generated neurons in the stratum oriens and stratum radiatum of future Ammon's horn
Future subiculum
Pia membrane
Fornical glioepithelium
Stratified transitional field (STF) 5
Mitotic cells
Dentate migration
(mainly granule cell precursors?)
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.

PLATE 70A

GW9 Sagittal
CR 40 mm, C6658
Level 3:
Slide 67, Section 1

OLFACTORY BULB
AND SEPTUM



See the entire section
in Plates 59A-D.

PLATE 70B

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field

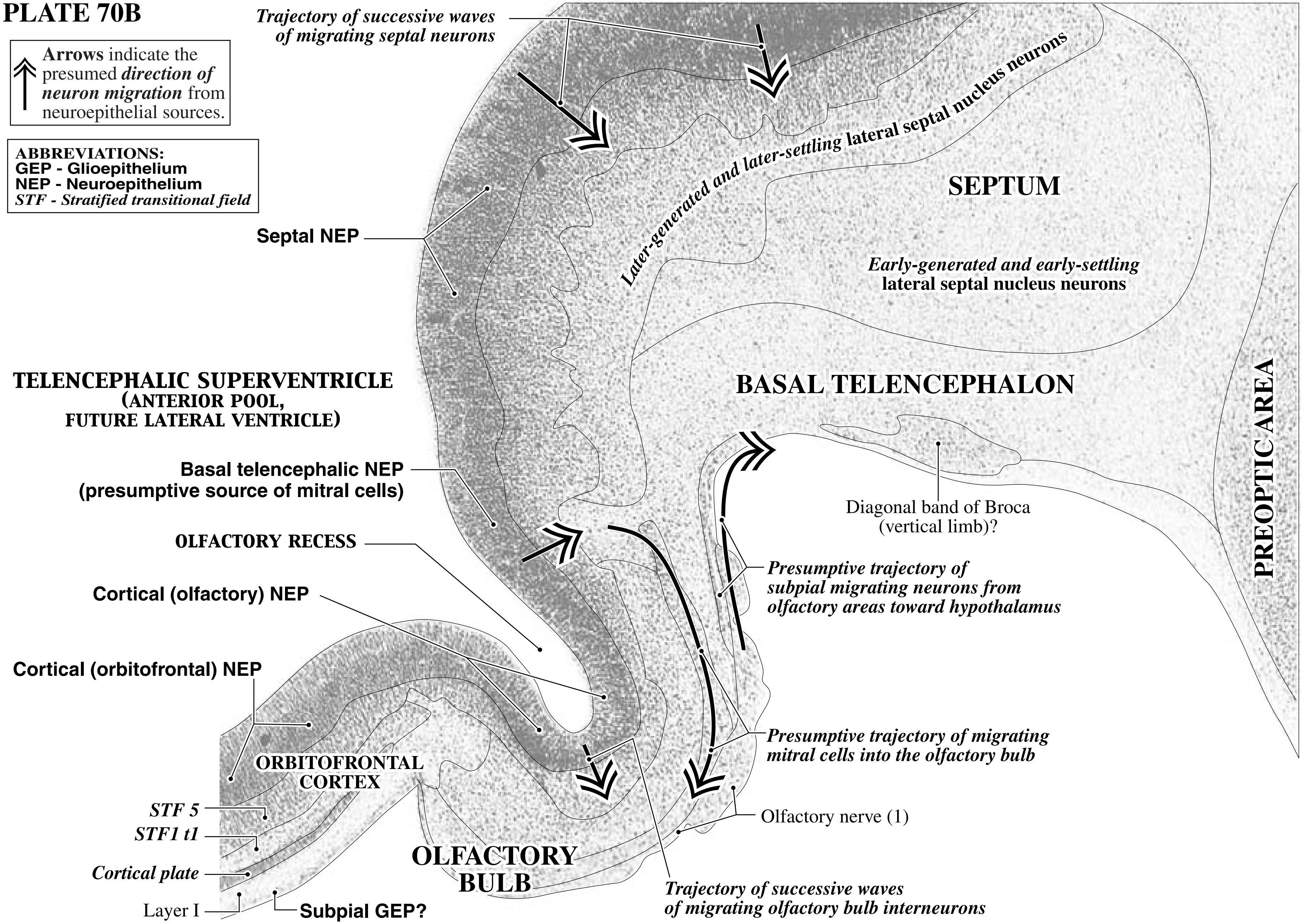
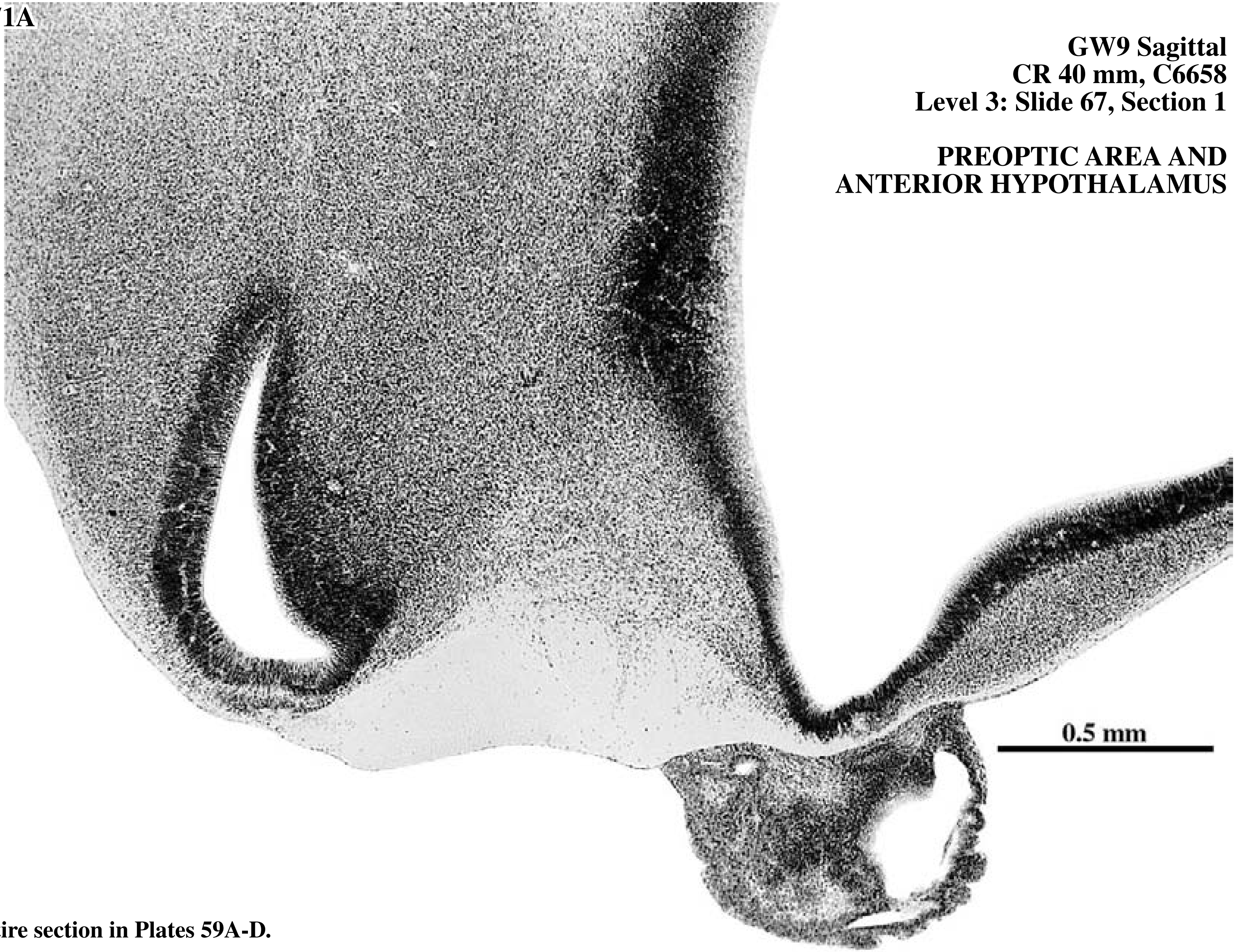


PLATE 71A

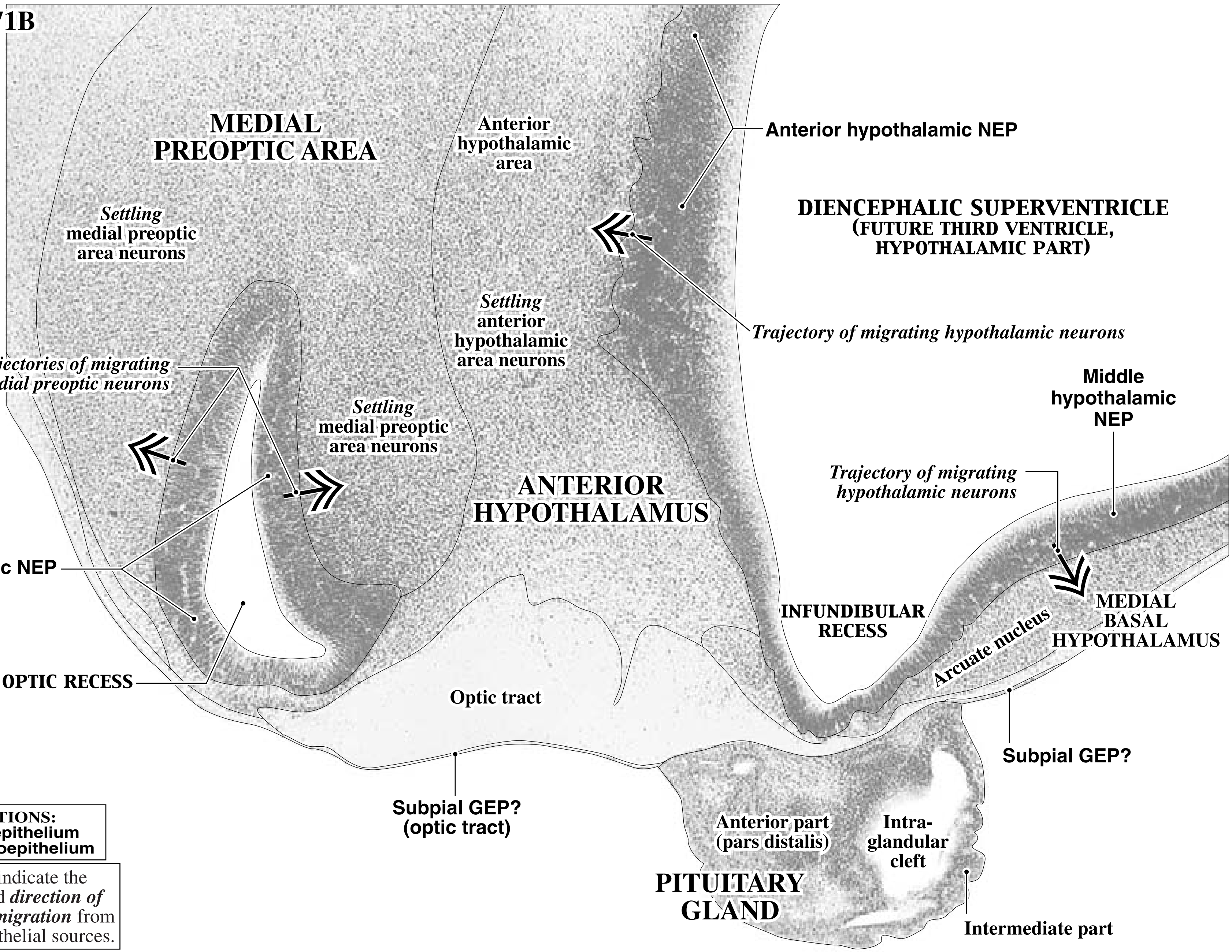
GW9 Sagittal
CR 40 mm, C6658
Level 3: Slide 67, Section 1

PREOPTIC AREA AND
ANTERIOR HYPOTHALAMUS



See the entire section in Plates 59A-D.

PLATE 71B

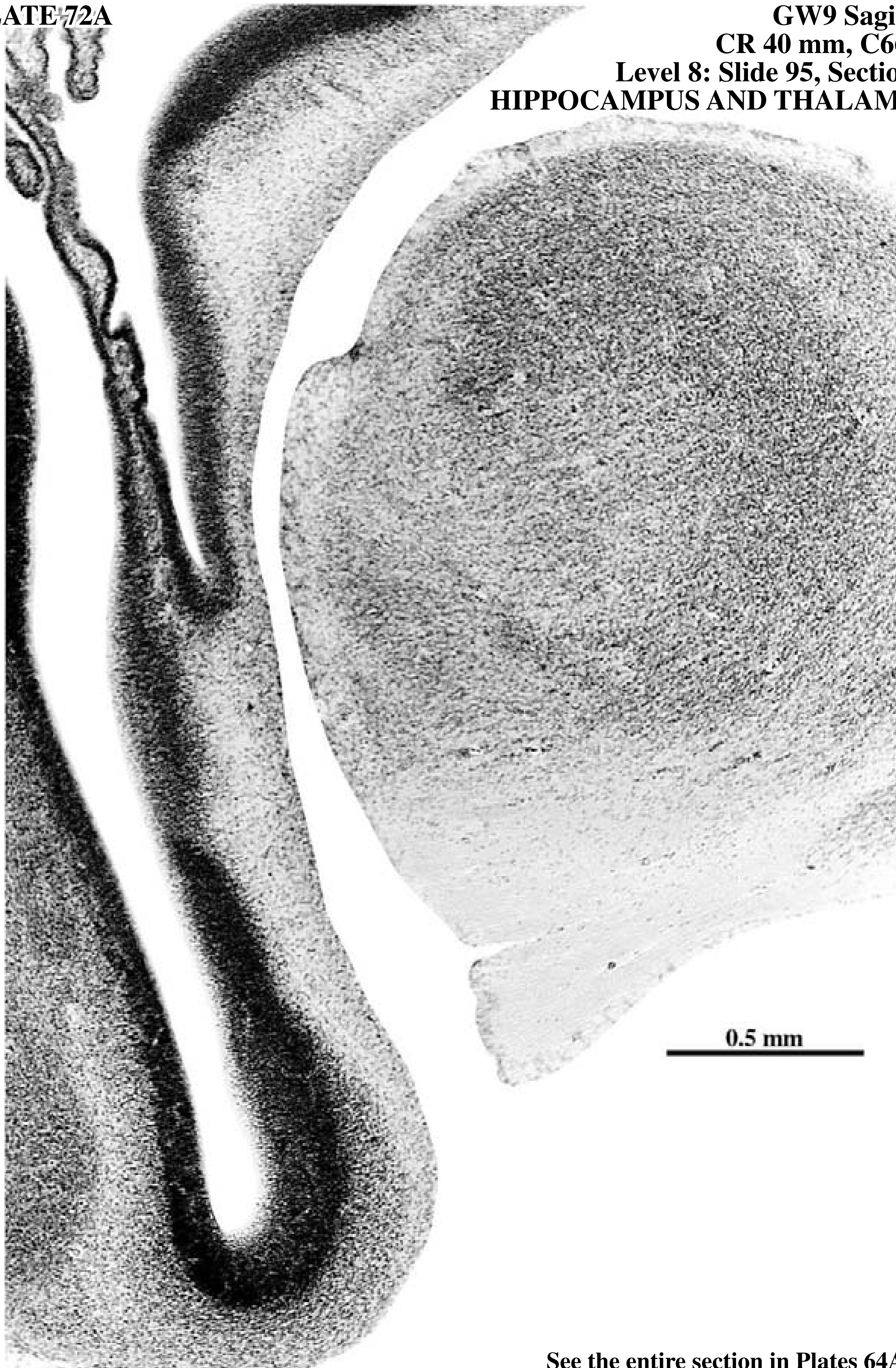


ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

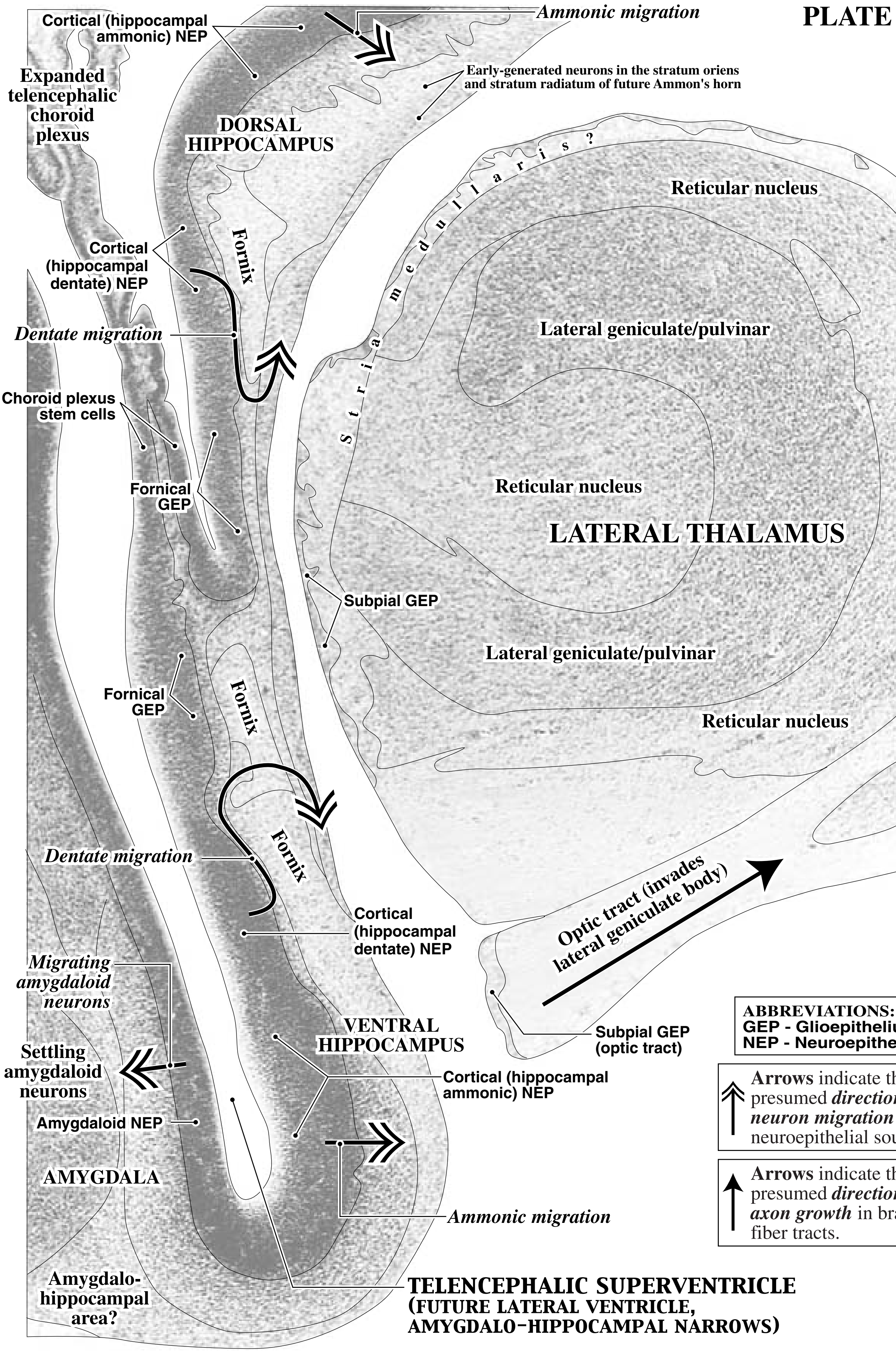
PLATE 72A

GW9 Sagittal
CR 40 mm, C6658
Level 8: Slide 95, Section 1
HIPPOCAMPUS AND THALAMUS



See the entire section in Plates 64A-D.

PLATE 72B



ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

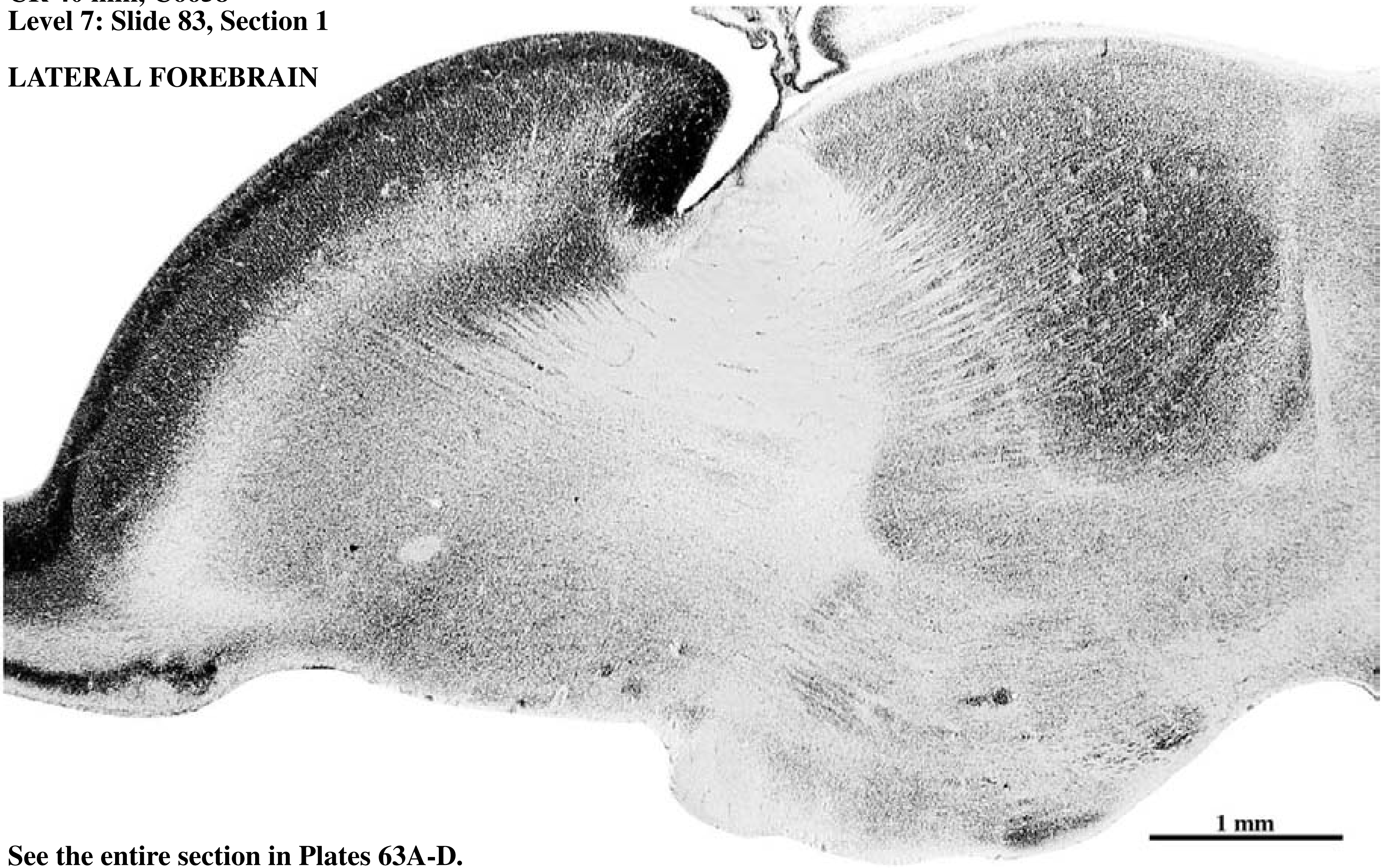
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

PLATE 73A

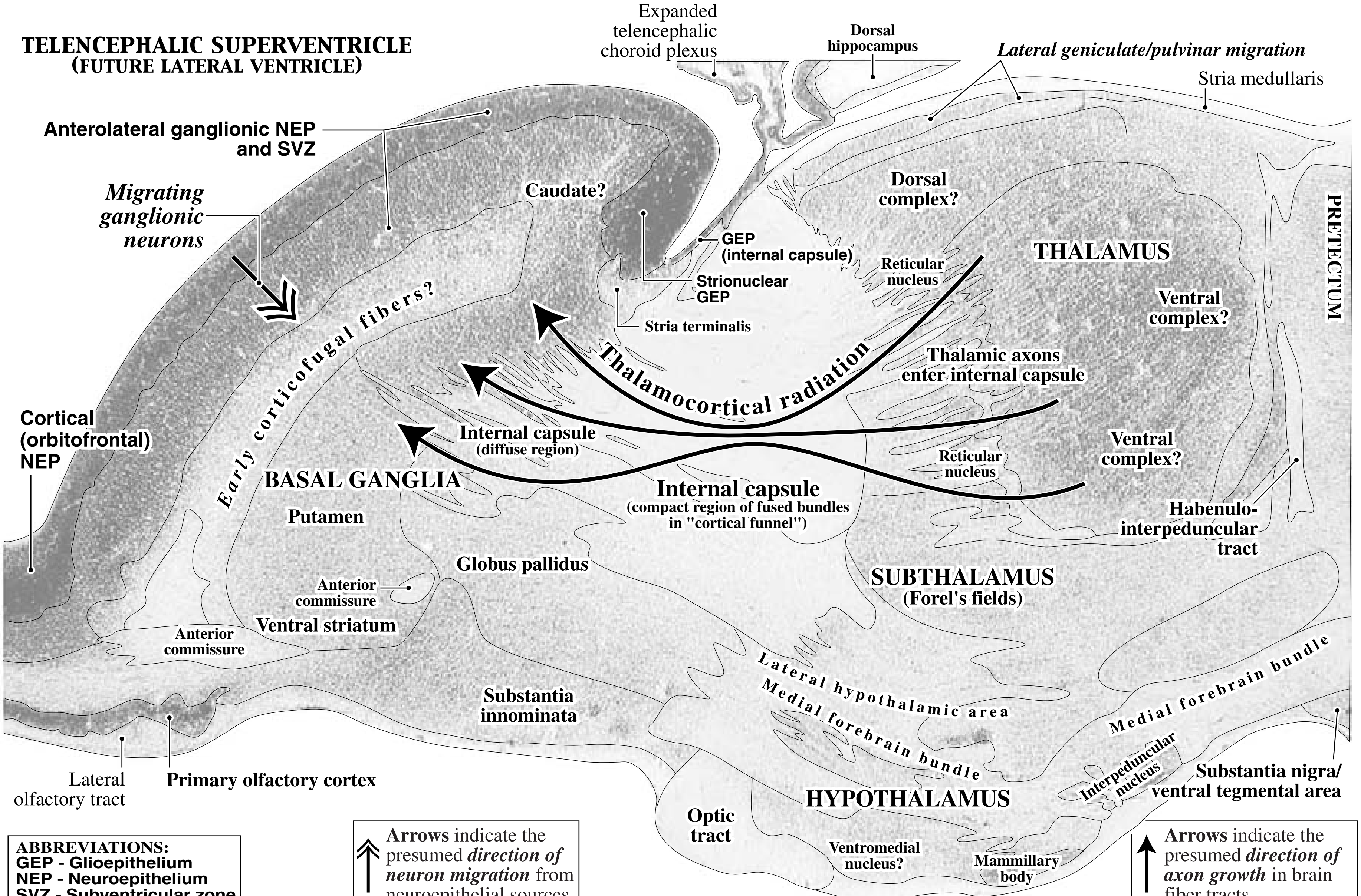
GW9 Sagittal
CR 40 mm, C6658
Level 7: Slide 83, Section 1

LATERAL FOREBRAIN



See the entire section in Plates 63A-D.

PLATE 73B



ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

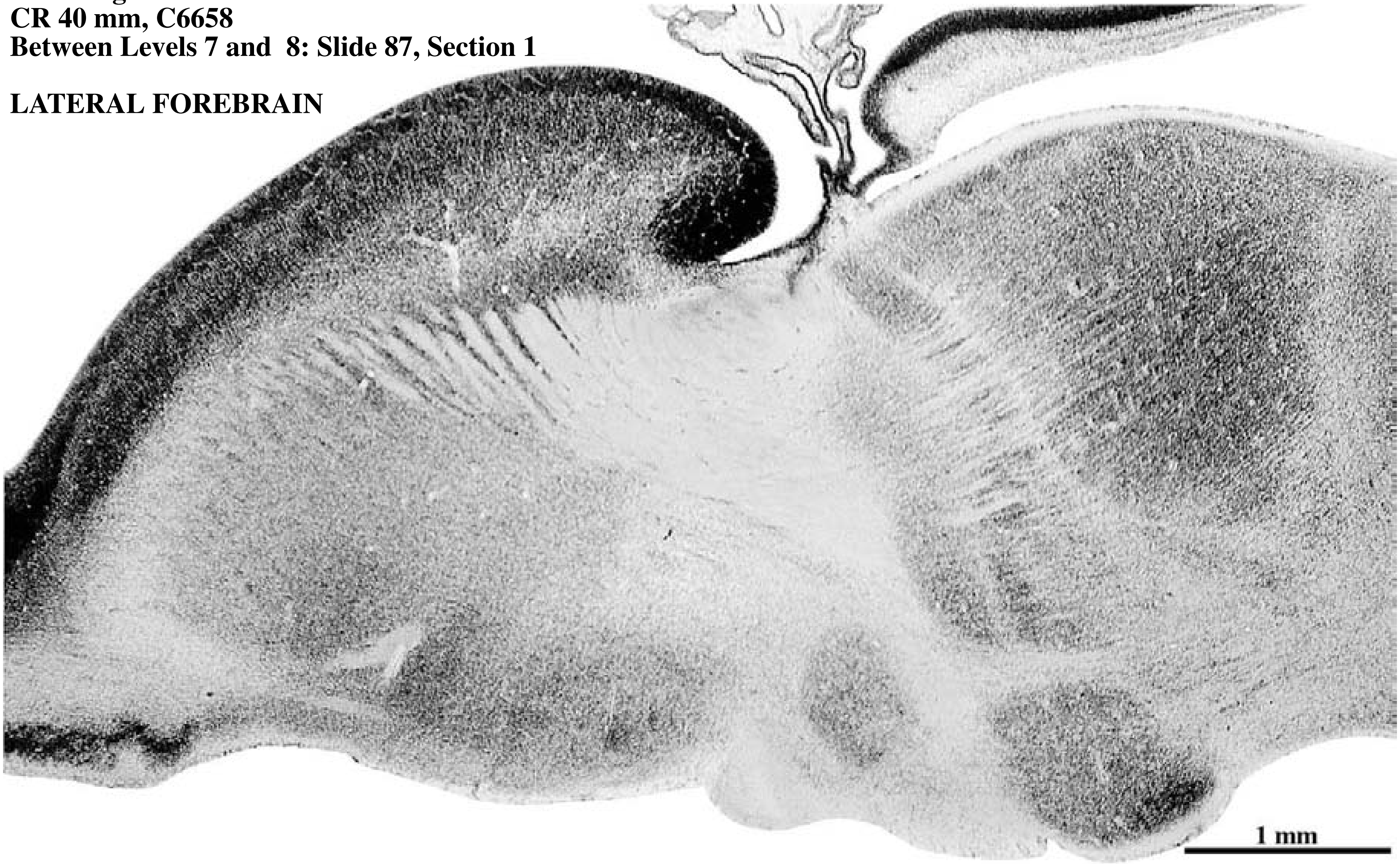
Arrows indicate the presumed *direction of neuron migration* from neuroepithelial sources.

Arrows indicate the presumed *direction of axon growth* in brain fiber tracts.

PLATE 74A

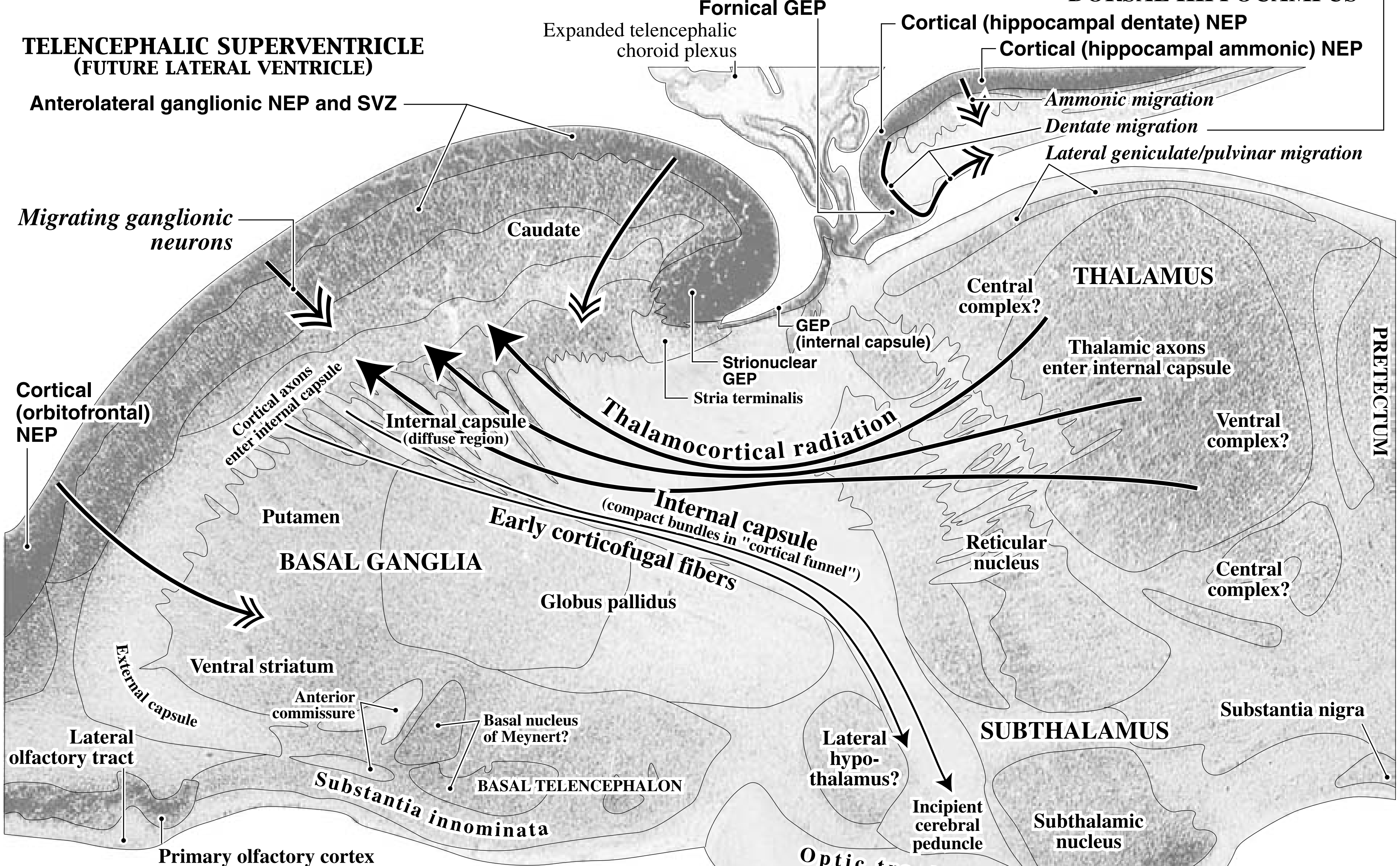
GW9 Sagittal
CR 40 mm, C6658
Between Levels 7 and 8: Slide 87, Section 1

LATERAL FOREBRAIN



See a low-magnification view of Level 7 in Plates 63A-D, Level 8 in Plates 64A-D.

PLATE 74B



ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

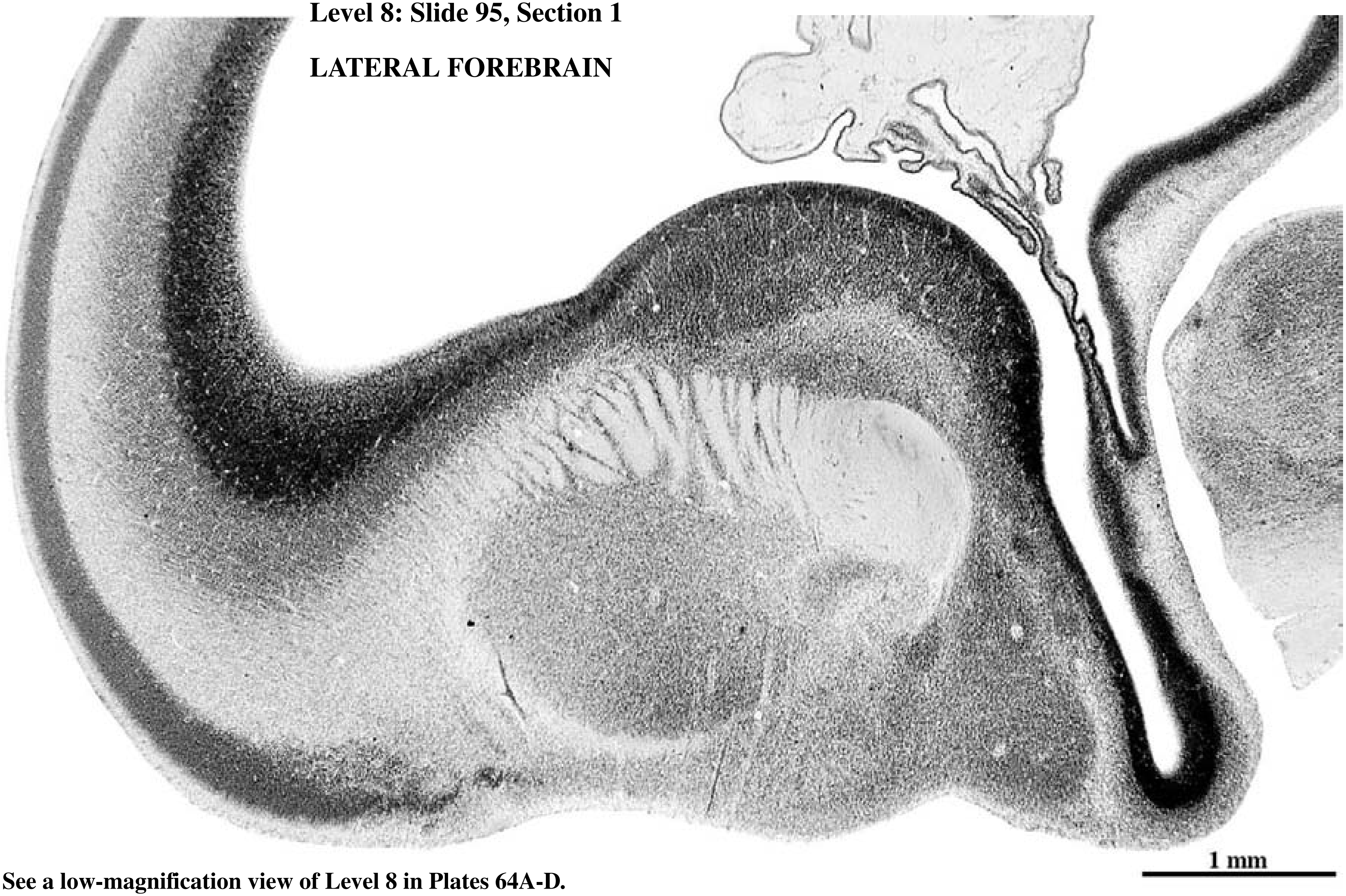
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

PLATE 75A

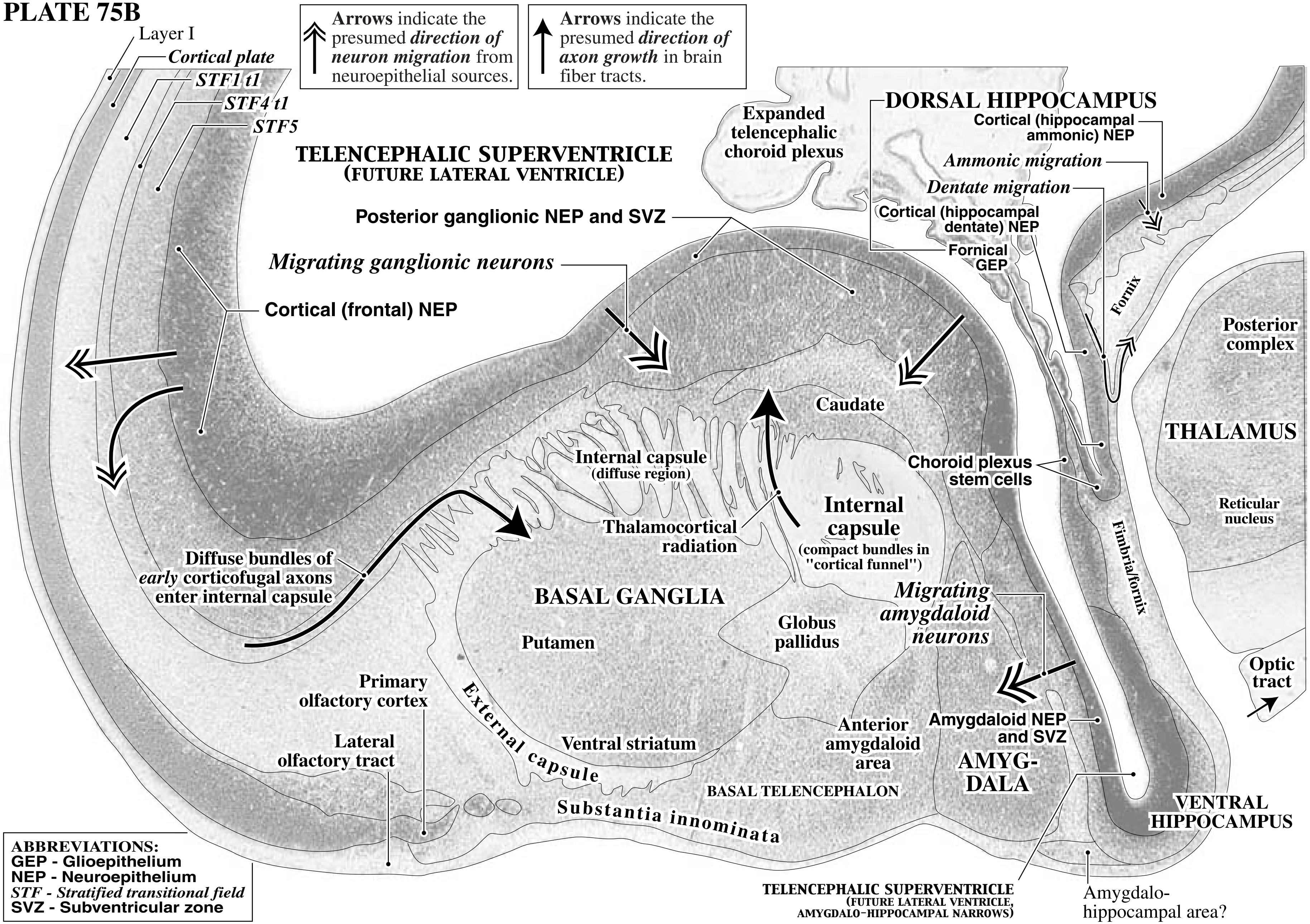
GW9 Sagittal
CR 40 mm, C6658
Level 8: Slide 95, Section 1

LATERAL FOREBRAIN



See a low-magnification view of Level 8 in Plates 64A-D.

PLATE 75B

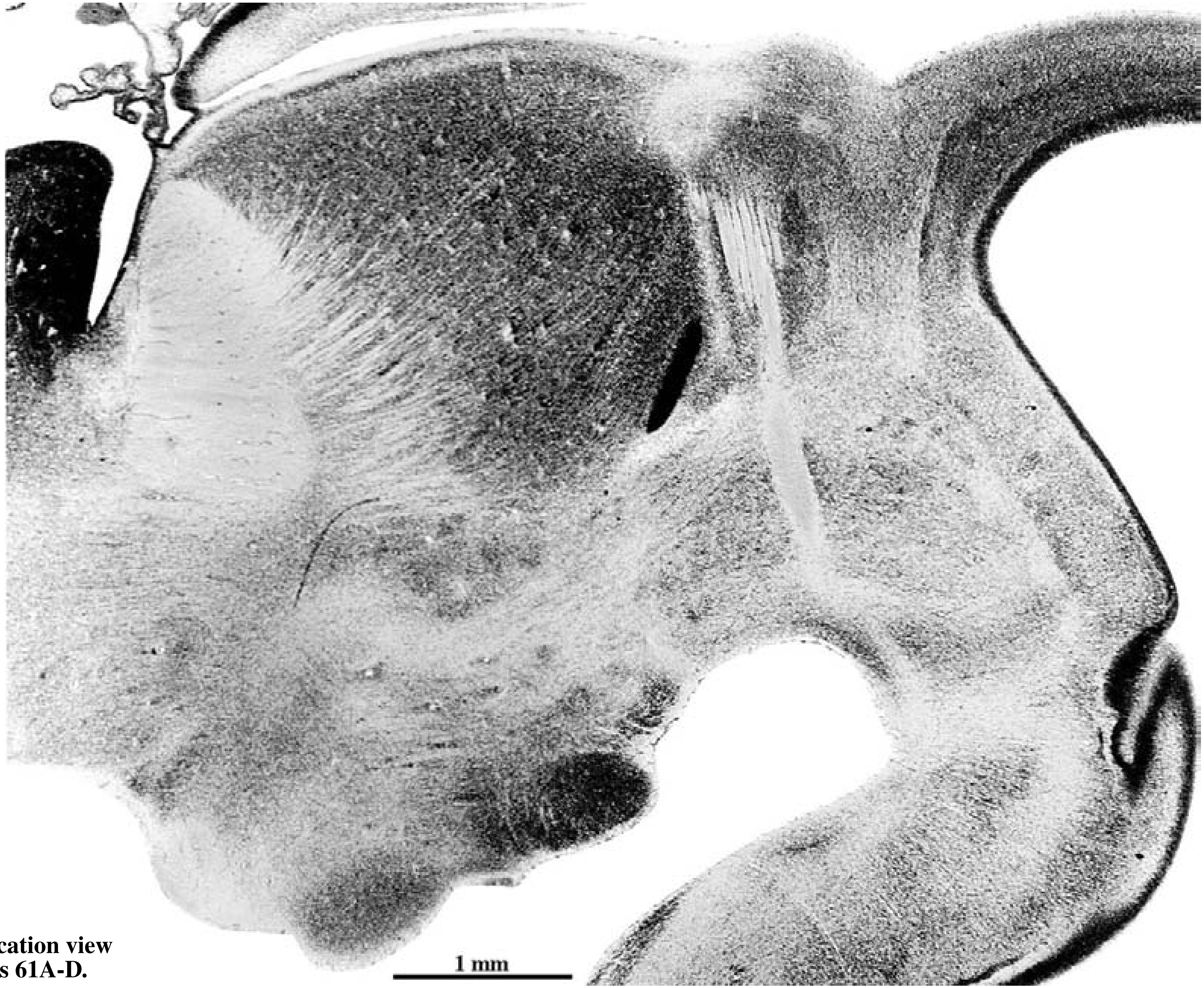


Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Arrows indicate the presumed direction of axon growth in brain fiber tracts.
Layer I
Cortical plate
STF1 t1
STF4 t1
STF5
TELENCEPHALIC SUPERVENTRICLE
(FUTURE LATERAL VENTRICLE)
Posterior ganglionic NEP and SVZ
Migrating ganglionic neurons
Cortical (frontal) NEP
Expanded telencephalic choroid plexus
DORSAL HIPPOCAMPUS
Cortical (hippocampal ammonic) NEP
Ammonic migration
Dentate migration
Cortical (hippocampal dentate) NEP
Fornical GEP
Fornix
Posterior complex
THALAMUS
Reticular nucleus
Caudate
Choroid plexus stem cells
Internal capsule
(diffuse region)
Thalamocortical radiation
Internal capsule
(compact bundles in "cortical funnel")
Fimbria/fornix
Diffuse bundles of early corticofugal axons enter internal capsule
BASAL GANGLIA
Putamen
Globus pallidus
Migrating amygdaloid neurons
Optic tract
Primary olfactory cortex
External capsule
Amygdaloid NEP and SVZ
Lateral olfactory tract
Ventral striatum
Anterior amygdaloid area
AMYG-DALA
BASAL TELENCEPHALON
Substantia innominata
VENTRAL HIPPOCAMPUS
TELENCEPHALIC SUPERVENTRICLE
(FUTURE LATERAL VENTRICLE, AMYGDALO-HIPPOCAMPAL NARROWS)
Amygdalo-hippocampal area?
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field
SVZ - Subventricular zone

PLATE 76A

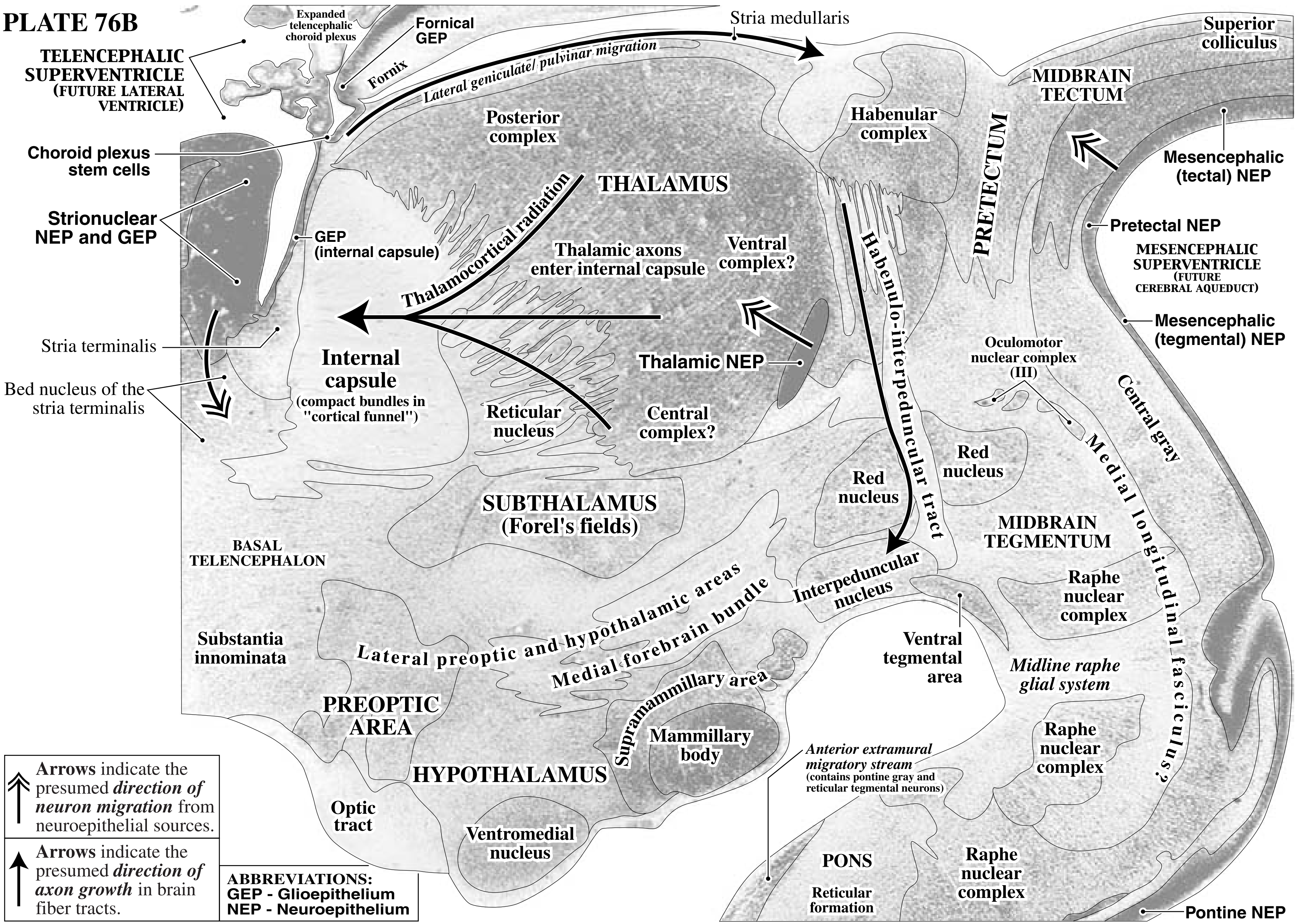
GW9 Sagittal
CR 40 mm
C6658
Level 5:
Slide 79,
Section 2

DIEN-
CEPHALON
AND
MIDBRAIN



See a low-magnification view of Level 5 in Plates 61A-D.

PLATE 76B



TELENCEPHALIC SUPERVENTRICLE (FUTURE LATERAL VENTRICLE)
Expanded telencephalic choroid plexus
Fornical GEP
Fornix
Stria medullaris
Lateral geniculate/ pulvinar migration
Superior colliculus
MIDBRAIN TECTUM
Choroid plexus stem cells
Posterior complex
Habenular complex
PRETECTUM
Mesencephalic (tectal) NEP
Strionuclear NEP and GEP
GEP (internal capsule)
Thalamocortical radiation
THALAMUS
Pretectal NEP
Thalamic axons enter internal capsule
Ventral complex?
Habenulo-interpeduncular tract
MESENCEPHALIC SUPERVENTRICLE (FUTURE CEREBRAL AQUEDUCT)
Mesencephalic (tegmental) NEP
Stria terminalis
Internal capsule (compact bundles in "cortical funnel")
Thalamic NEP
Oculomotor nuclear complex (III)
Bed nucleus of the stria terminalis
Reticular nucleus
Central complex?
Central gray
Red nucleus
Red nucleus
Medial longitudinal fasciculus?
SUBTHALAMUS (Forel's fields)
MIDBRAIN TEGMENTUM
BASAL TELENCEPHALON
Interpeduncular nucleus
Raphe nuclear complex
Lateral preoptic and hypothalamic areas
Medial forebrain bundle
Substantia innominata
Ventral tegmental area
Midline raphe glial system
Supramammillary area
PREOPTIC AREA
Mammillary body
Raphe nuclear complex
HYPOTHALAMUS
Anterior extramural migratory stream (contains pontine gray and reticular tegmental neurons)
Optic tract
Ventromedial nucleus
PONS
Reticular formation
Raphe nuclear complex
Pontine NEP
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Arrows indicate the presumed direction of axon growth in brain fiber tracts.
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

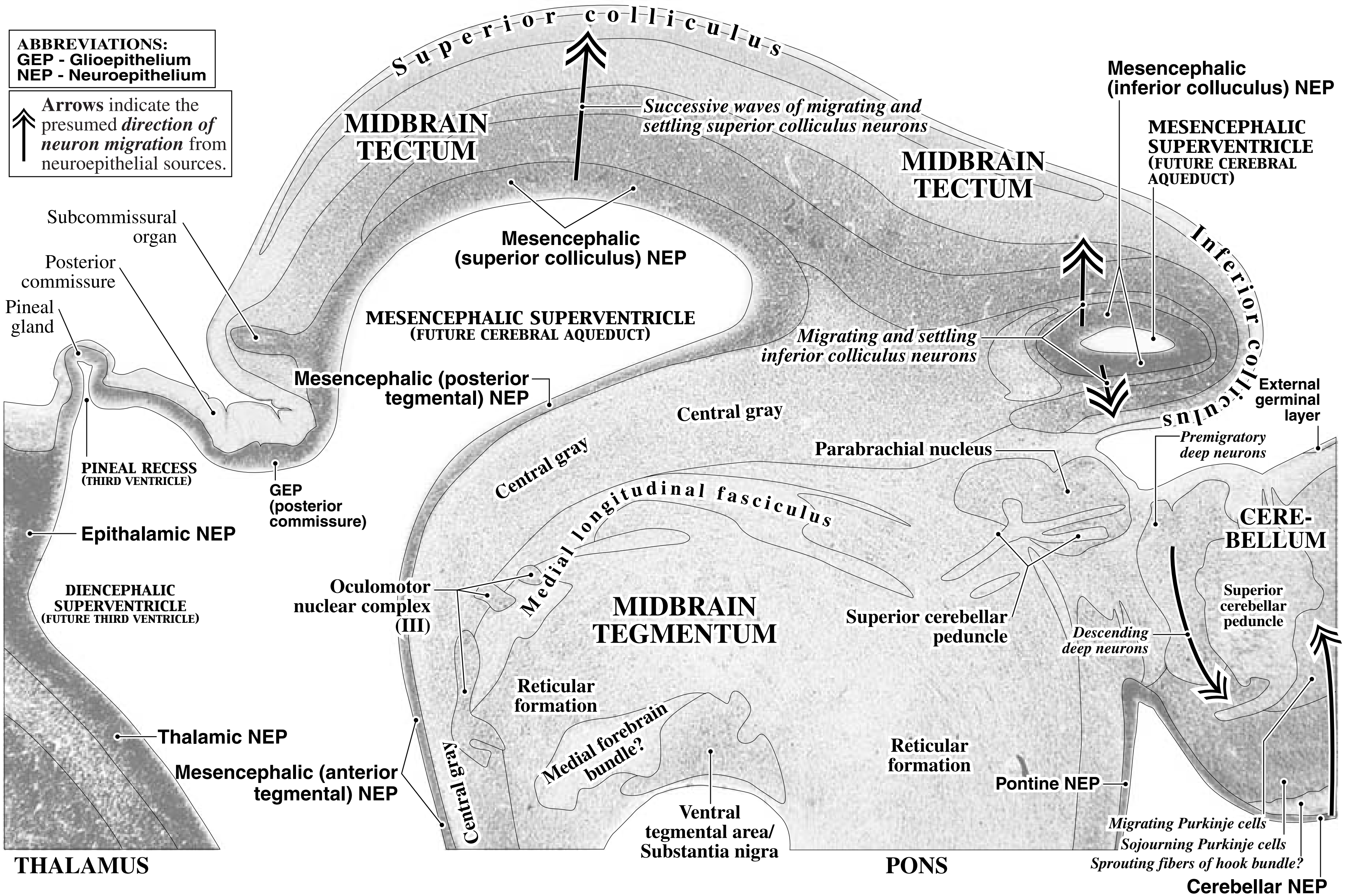
PLATE 77A

GW9 Sagittal
CR 40 mm, C6658
Level 3:
Slide 67, Section 1

MIDBRAIN

See a low-magnification view of Level 3 in Plates 59A-D.

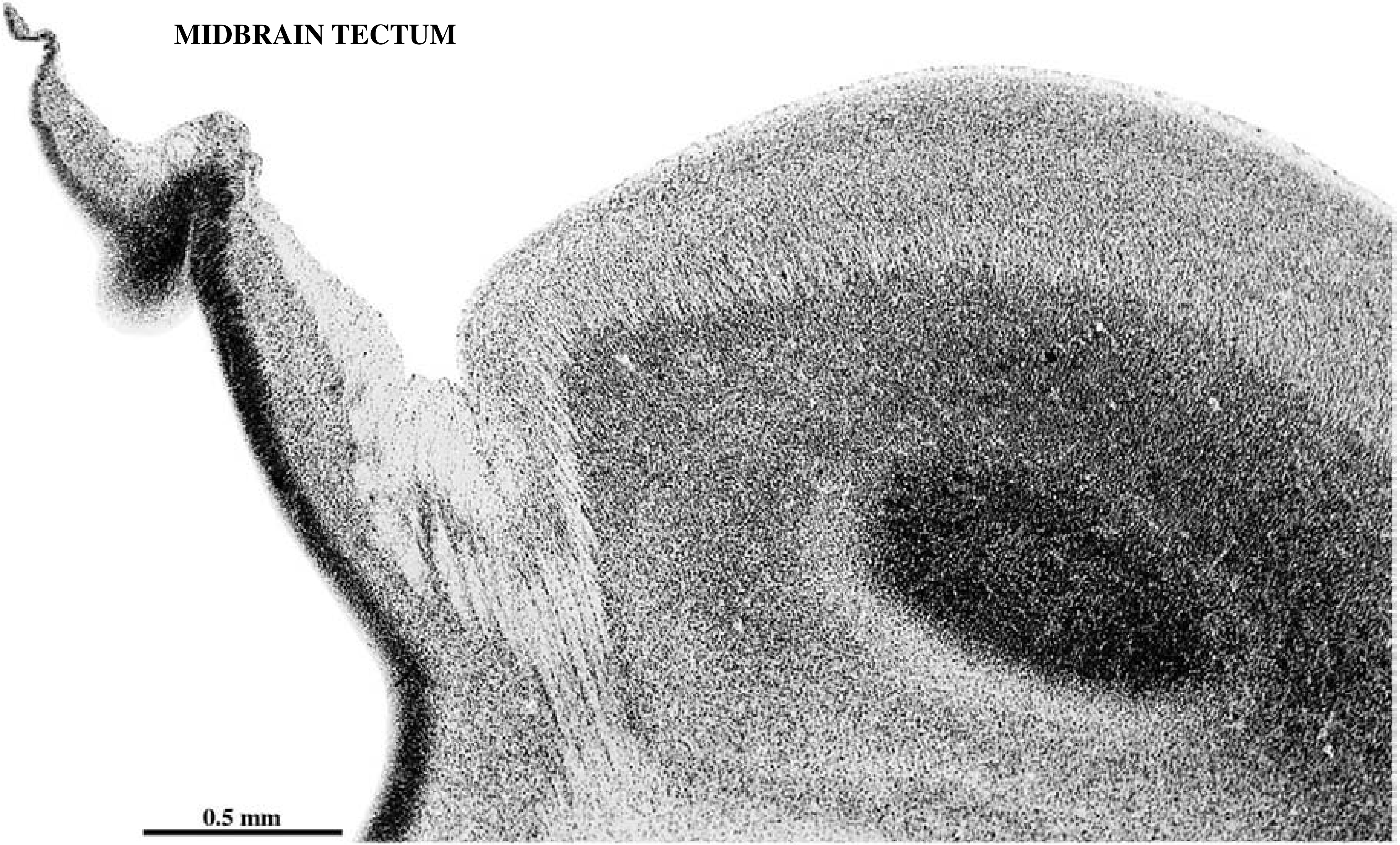
PLATE 77B



ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Superior colliculus
Successive waves of migrating and settling superior colliculus neurons
MIDBRAIN TECTUM
Mesencephalic (inferior colluculus) NEP
MESENCEPHALIC SUPERVENTRICLE (FUTURE CEREBRAL AQUEDUCT)
MIDBRAIN TECTUM
Subcommissural organ
Posterior commissure
Pineal gland
Mesencephalic (superior colliculus) NEP
MESENCEPHALIC SUPERVENTRICLE (FUTURE CEREBRAL AQUEDUCT)
Inferior colliculus
Migrating and settling inferior colliculus neurons
Mesencephalic (posterior tegmental) NEP
Central gray
External germinal layer
PINEAL RECESS (THIRD VENTRICLE)
GEP (posterior commissure)
Parabrachial nucleus
Premigratory deep neurons
Central gray
Medial longitudinal fasciculus
Epithalamic NEP
CERE-BELLUM
DIENCEPHALIC SUPERVENTRICLE (FUTURE THIRD VENTRICLE)
Oculomotor nuclear complex (III)
MIDBRAIN TEGMENTUM
Superior cerebellar peduncle
Superior cerebellar peduncle
Descending deep neurons
Reticular formation
Medial forebrain bundle?
Thalamic NEP
Reticular formation
Mesencephalic (anterior tegmental) NEP
Central gray
Pontine NEP
Ventral tegmental area/ Substantia nigra
Migrating Purkinje cells
Sojourning Purkinje cells
Sprouting fibers of hook bundle?
THALAMUS
PONS
Cerebellar NEP

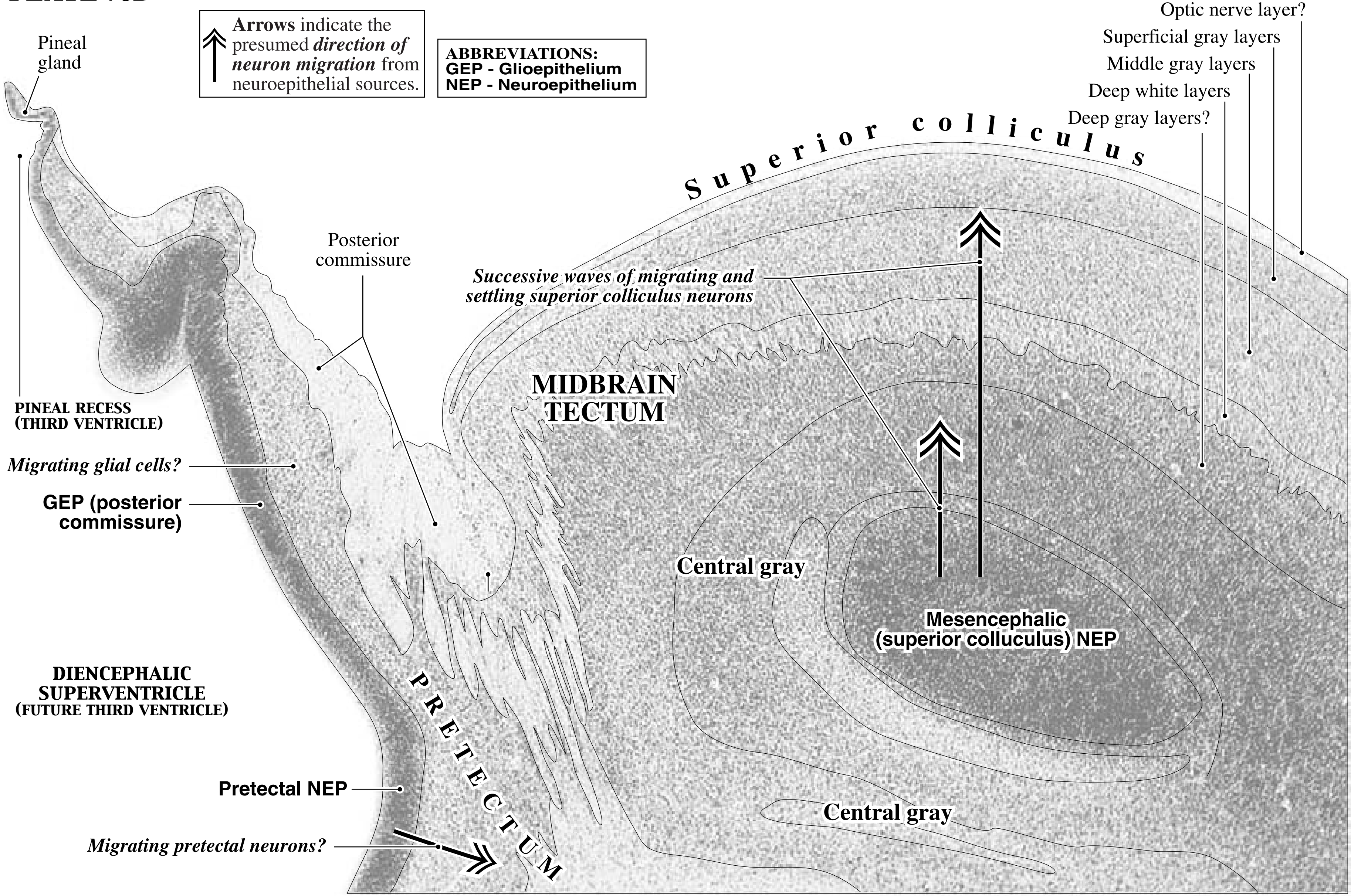
PLATE 78A GW9 Sagittal
CR 40 mm, C6658
Level 2: Slide 63, Section 1

MIDBRAIN TECTUM



See a low-magnification view of Level 2 in Plates 58A-D.

PLATE 78B

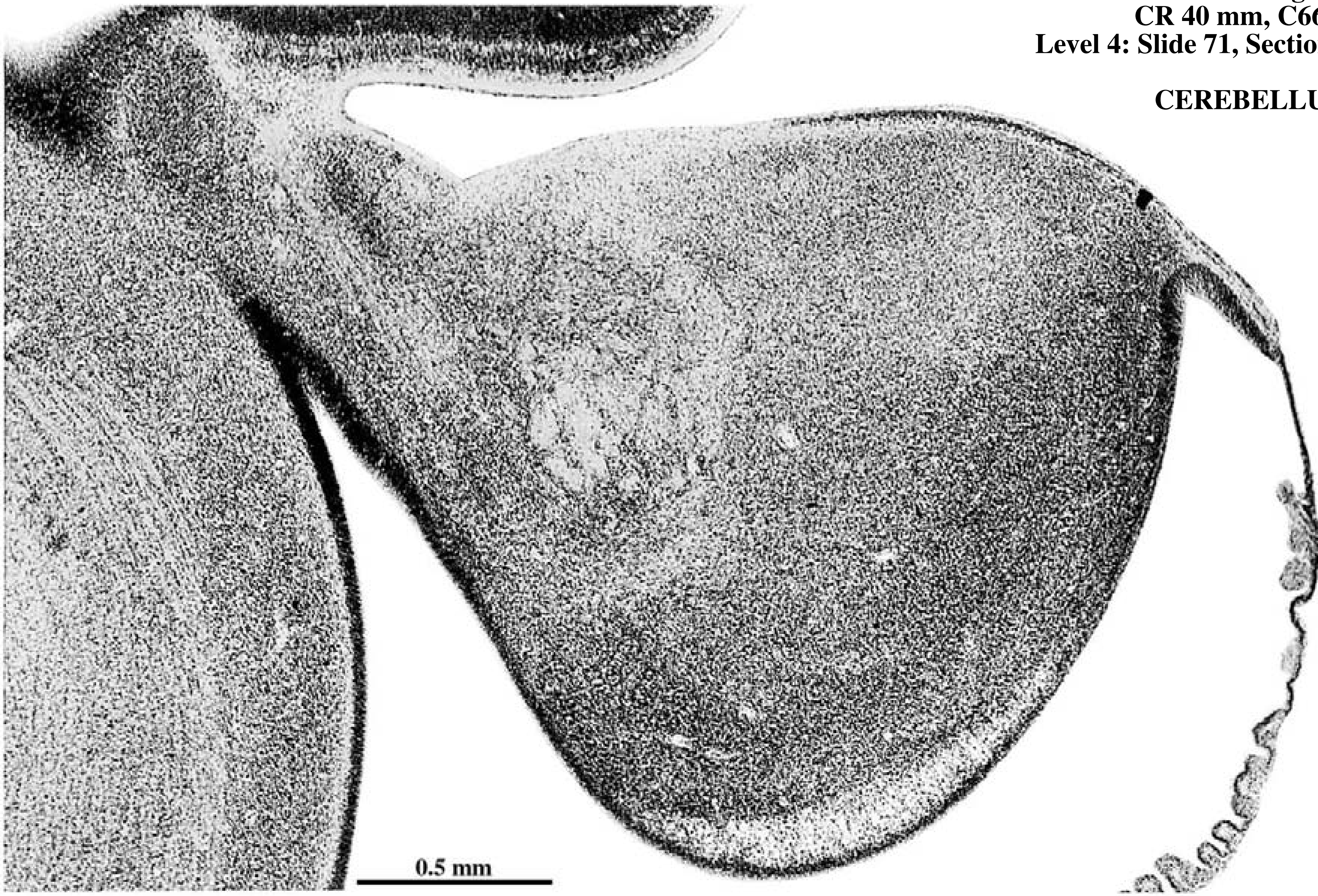


Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
Pineal gland
Posterior commissure
Successive waves of migrating and settling superior colliculus neurons
Superior colliculus
Optic nerve layer?
Superficial gray layers
Middle gray layers
Deep white layers
Deep gray layers?
MIDBRAIN TECTUM
PINEAL RECESS (THIRD VENTRICLE)
Migrating glial cells?
GEP (posterior commissure)
Central gray
Mesencephalic (superior colluculus) NEP
DIENCEPHALIC SUPERVENTRICLE (FUTURE THIRD VENTRICLE)
PRETECTUM
Pretectal NEP
Central gray
Migrating pretectal neurons?

PLATE 79A

GW9 Sagittal
CR 40 mm, C6658
Level 4: Slide 71, Section 2

CEREBELLUM



See a low-magnification view of Level 4 in Plates 60A-D.

PLATE 79B

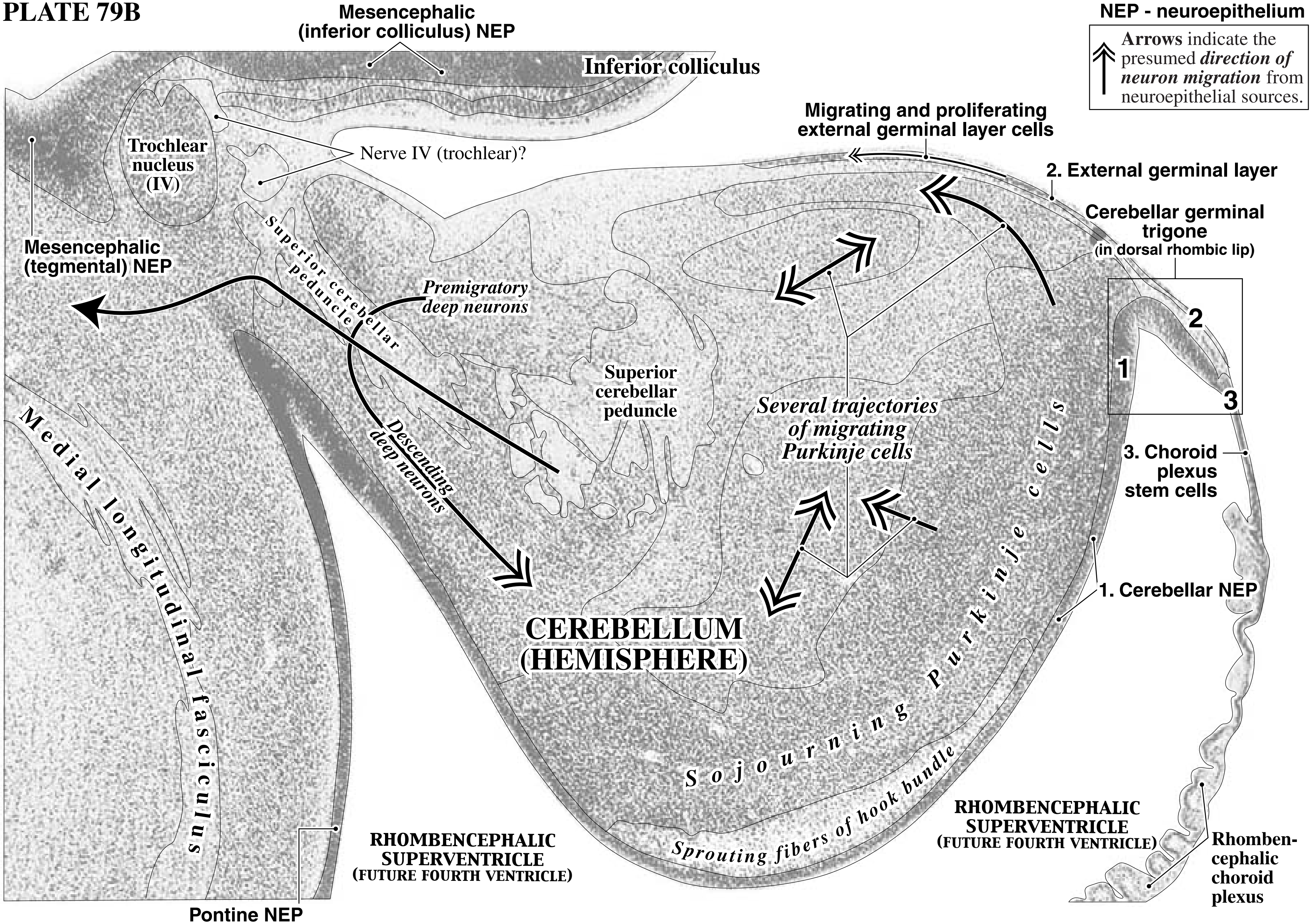
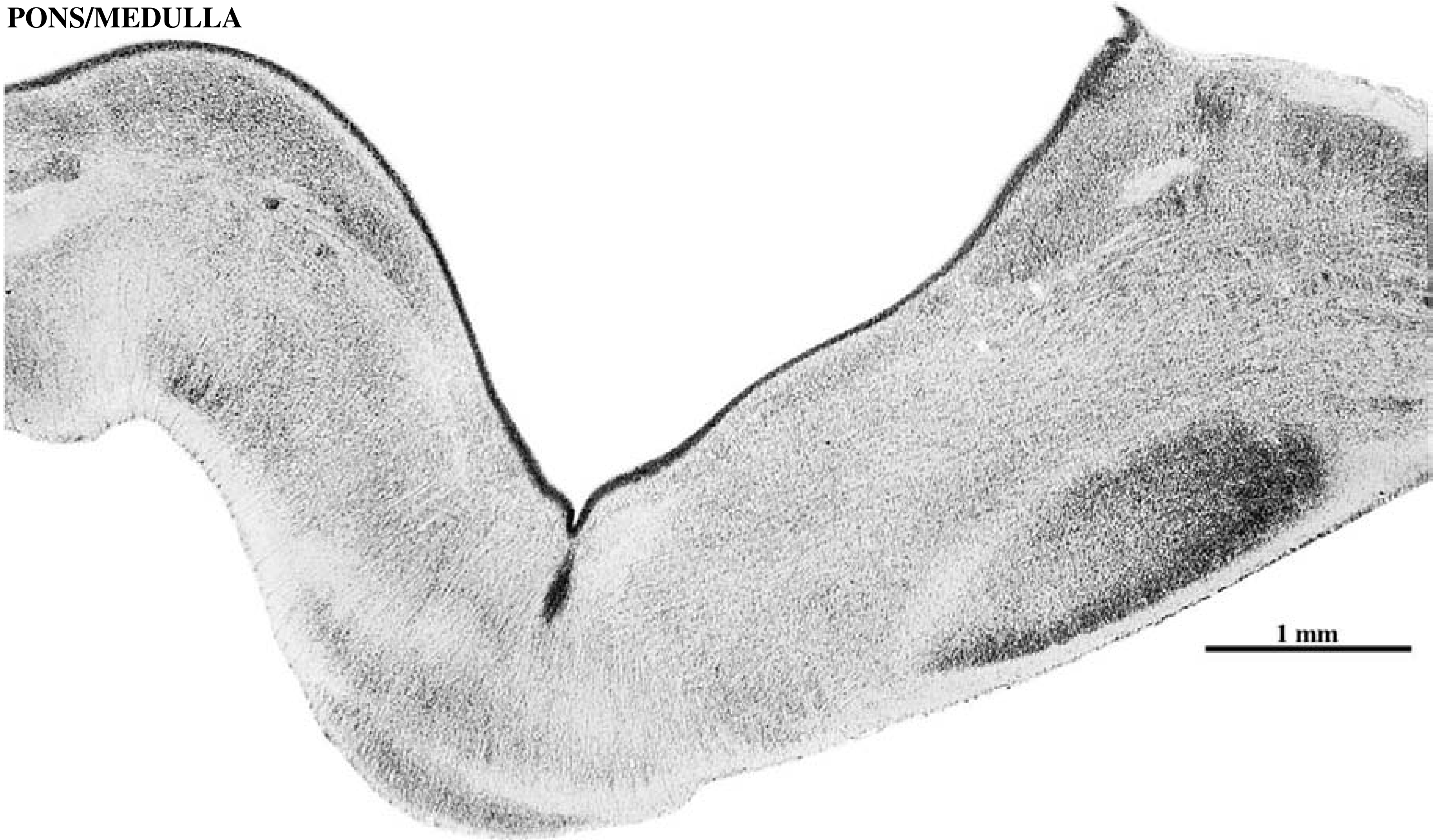

Mesencephalic
(inferior colliculus) NEP
Inferior colliculus
NEP - neuroepithelium
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Migrating and proliferating
external germinal layer cells
Trochlear
nucleus
(IV)
Nerve IV (trochlear)?
2. External germinal layer
Cerebellar germinal
trigone
(in dorsal rhombic lip)
Mesencephalic
(tegmental) NEP
Superior cerebellar
peduncle
Premigratory
deep neurons
2
1
3
Superior
cerebellar
peduncle
Several trajectories
of migrating
Purkinje cells
Medial longitudinal fasciculus
Descending
deep neurons
3. Choroid
plexus
stem cells
1. Cerebellar NEP
CEREBELLUM
(HEMISPHERE)
Sojourning Purkinje cells
Sprouting fibers of hook bundle
RHOMBENCEPHALIC
SUPERVENTRICLE
(FUTURE FOURTH VENTRICLE)
RHOMBENCEPHALIC
SUPERVENTRICLE
(FUTURE FOURTH VENTRICLE)
Rhomben-
cephalic
choroid
plexus
Pontine NEP

PLATE 80A

GW9 Sagittal, CR 40 mm, C6658
Level 5: Slide 75, Section 2

PONS/MEDULLA



See a low-magnification view of Level 5 in Plates 61A-D.

NEP - neuroepithelium

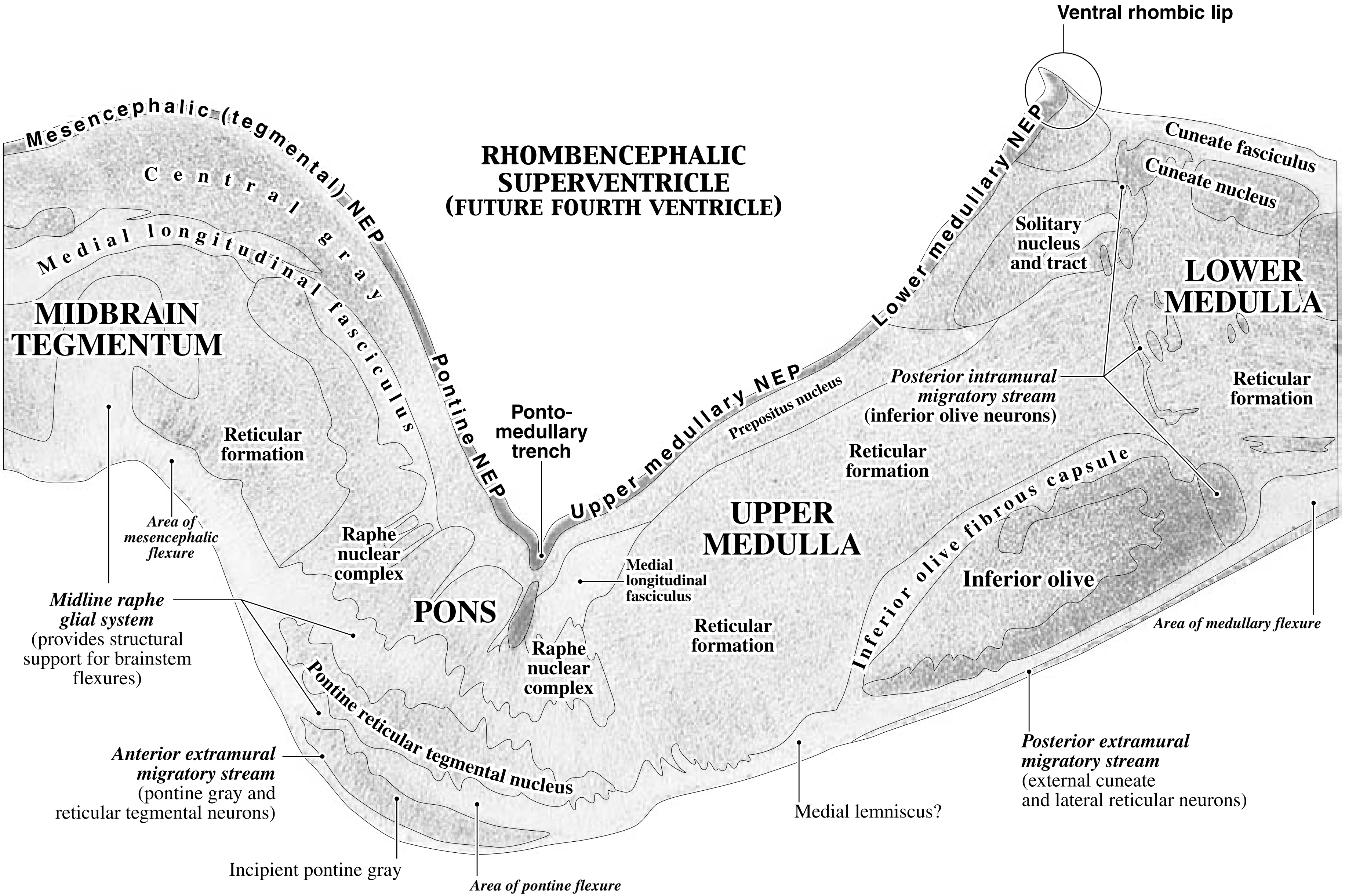
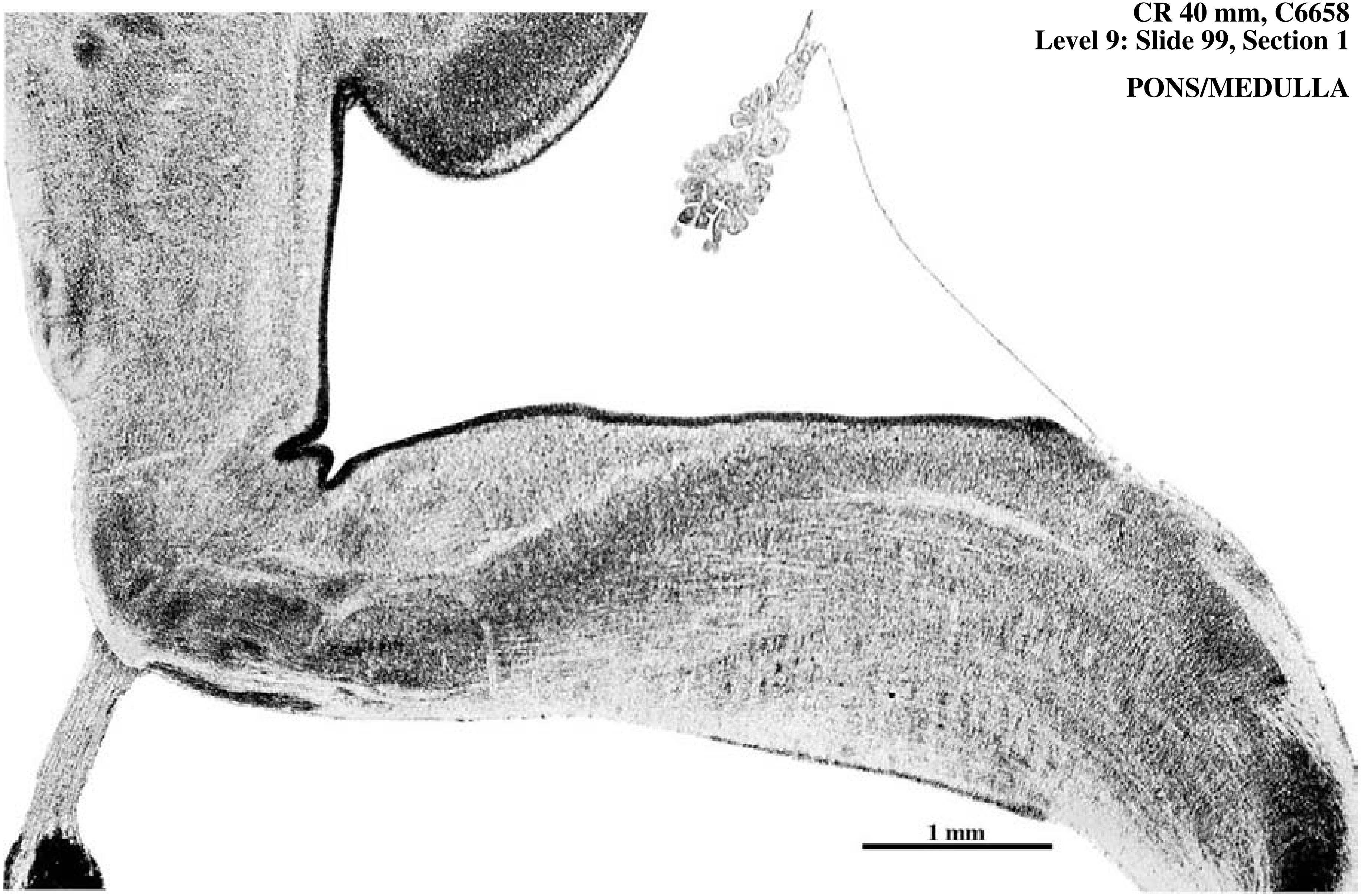


PLATE 81A

GW9 Sagittal
CR 40 mm, C6658
Level 9: Slide 99, Section 1

PONS/MEDULLA



See a low-magnification view of Level 9 in Plates 65A-D.

PLATE 81B

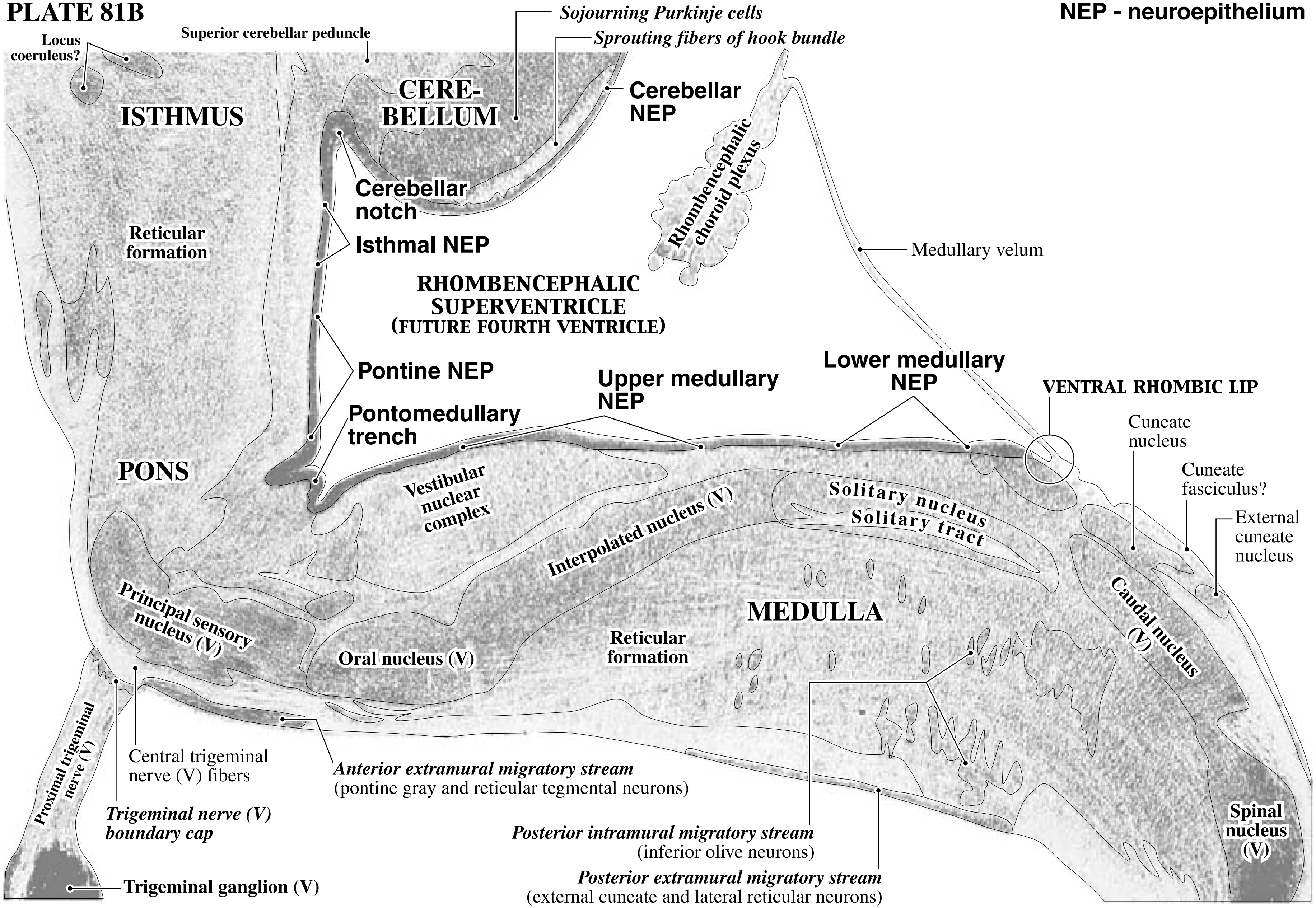
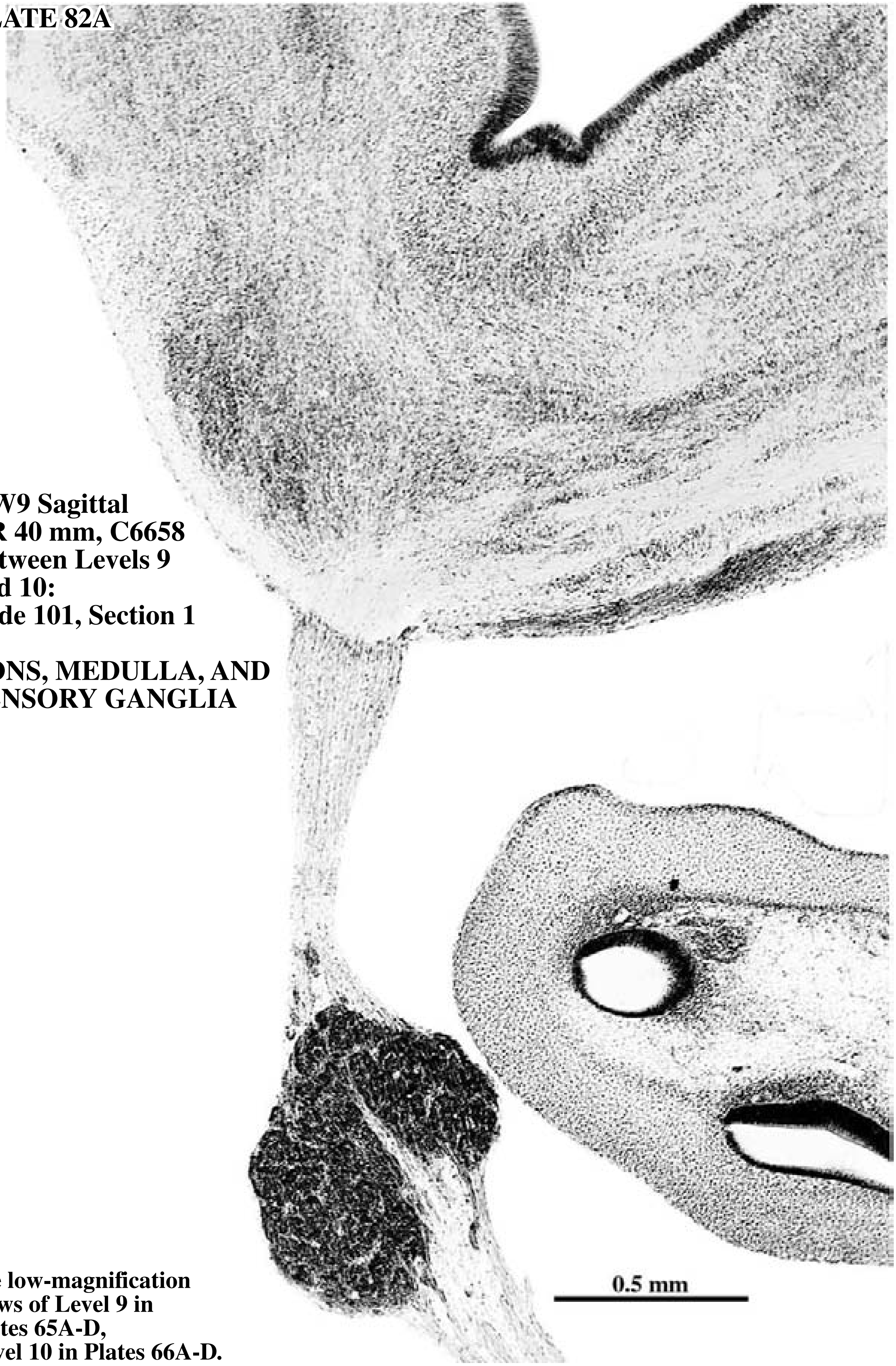

NEP - neuroepithelium
Sojourning Purkinje cells
Sprouting fibers of hook bundle
Locus coeruleus?
Superior cerebellar peduncle
ISTHMUS
CERE-BELLUM
Cerebellar NEP
Cerebellar notch
Isthmal NEP
Rhombencephalic choroid plexus
Medullary velum
Reticular formation
RHOMBENCEPHALIC SUPERVENTRICLE (FUTURE FOURTH VENTRICLE)
Pontine NEP
Pontomedullary trench
Upper medullary NEP
Lower medullary NEP
VENTRAL RHOMBIC LIP
Cuneate nucleus
Cuneate fasciculus?
External cuneate nucleus
PONS
Vestibular nuclear complex
Interpolated nucleus (V)
Solitary nucleus
Solitary tract
MEDULLA
Caudal nucleus (V)
Principal sensory nucleus (V)
Oral nucleus (V)
Reticular formation
Proximal trigeminal nerve (V)
Central trigeminal nerve (V) fibers
Anterior extramural migratory stream
(pontine gray and reticular tegmental neurons)
Trigeminal nerve (V) boundary cap
Posterior intramural migratory stream
(inferior olive neurons)
Posterior extramural migratory stream
(external cuneate and lateral reticular neurons)
Spinal nucleus (V)
Trigeminal ganglion (V)

PLATE 82A

GW9 Sagittal
CR 40 mm, C6658
Between Levels 9 and 10:
Slide 101, Section 1

PONS, MEDULLA, AND SENSORY GANGLIA



See low-magnification views of Level 9 in Plates 65A-D, Level 10 in Plates 66A-D.

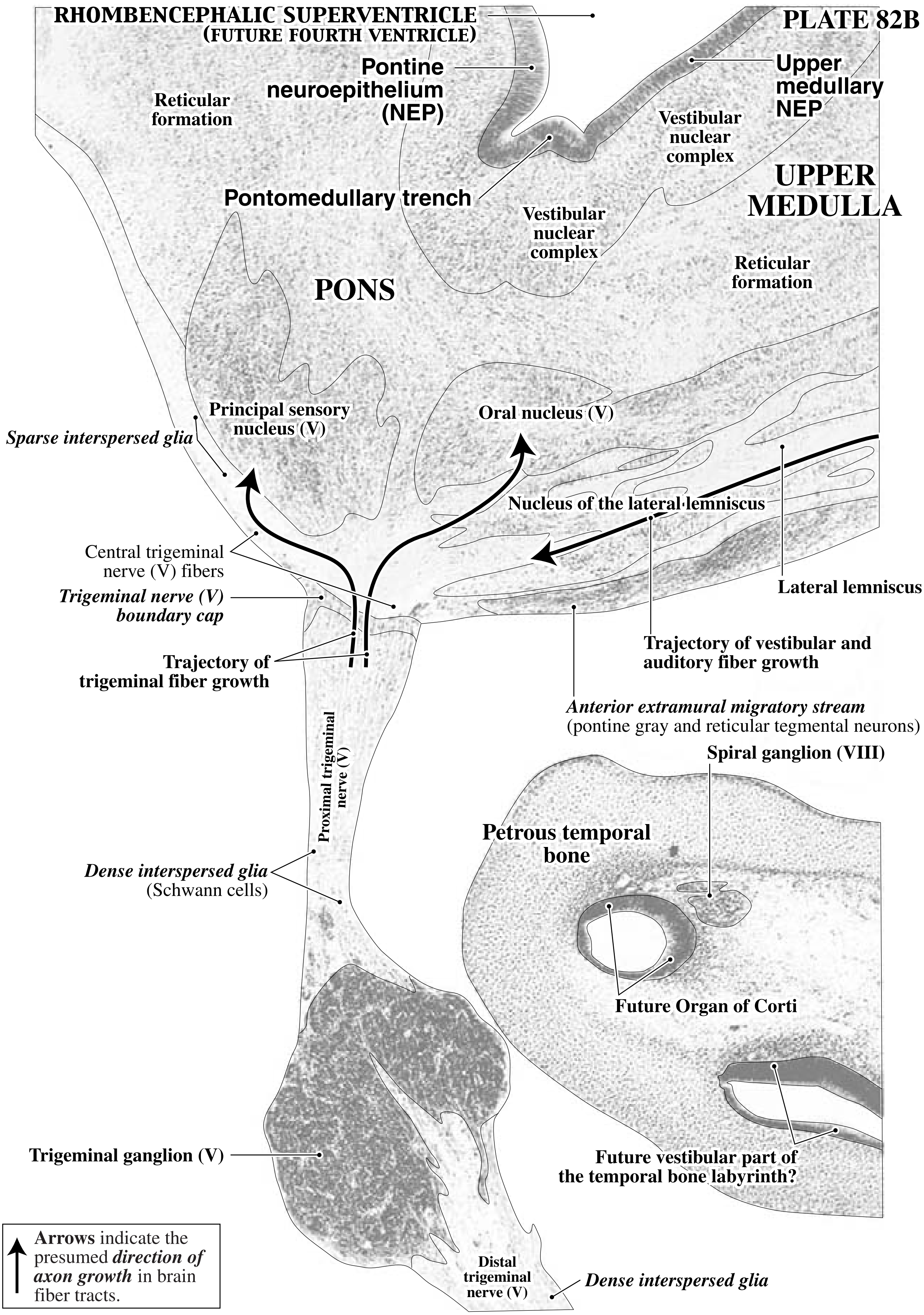
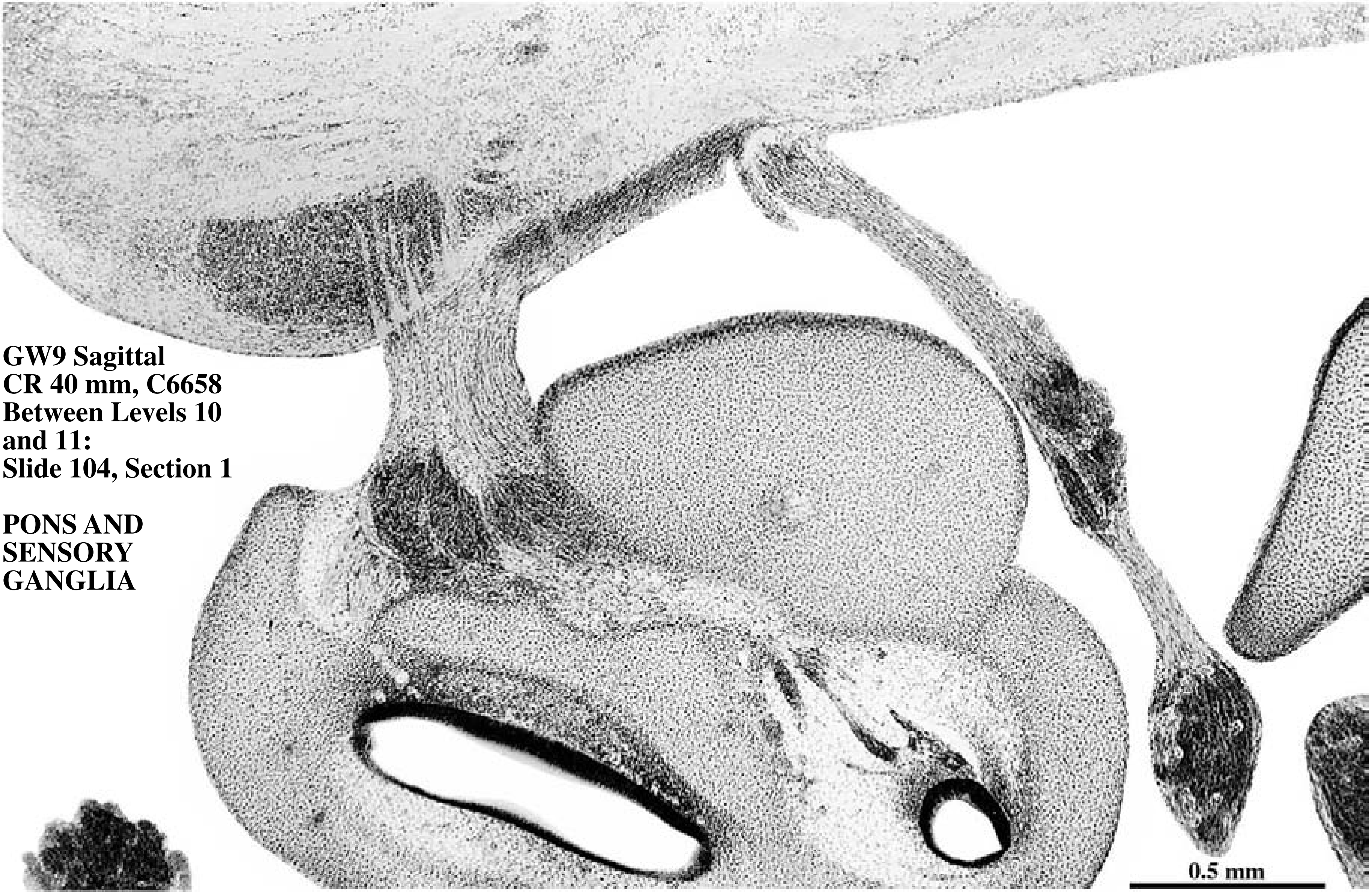

RHOMBENCEPHALIC SUPERVENTRICLE
(FUTURE FOURTH VENTRICLE)
PLATE 82B
Pontine neuroepithelium (NEP)
Upper medullary NEP
Reticular formation
Vestibular nuclear complex
UPPER MEDULLA
Pontomedullary trench
Vestibular nuclear complex
Reticular formation
PONS
Principal sensory nucleus (V)
Oral nucleus (V)
Sparse interspersed glia
Nucleus of the lateral lemniscus
Central trigeminal nerve (V) fibers
Lateral lemniscus
Trigeminal nerve (V) boundary cap
Trajectory of trigeminal fiber growth
Trajectory of vestibular and auditory fiber growth
Anterior extramural migratory stream
(pontine gray and reticular tegmental neurons)
Spiral ganglion (VIII)
Proximal trigeminal nerve (V)
Petrous temporal bone
Dense interspersed glia
(Schwann cells)
Future Organ of Corti
Future vestibular part of the temporal bone labyrinth?
Trigeminal ganglion (V)
Arrows indicate the presumed direction of axon growth in brain fiber tracts.
Distal trigeminal nerve (V)
Dense interspersed glia

PLATE 83A

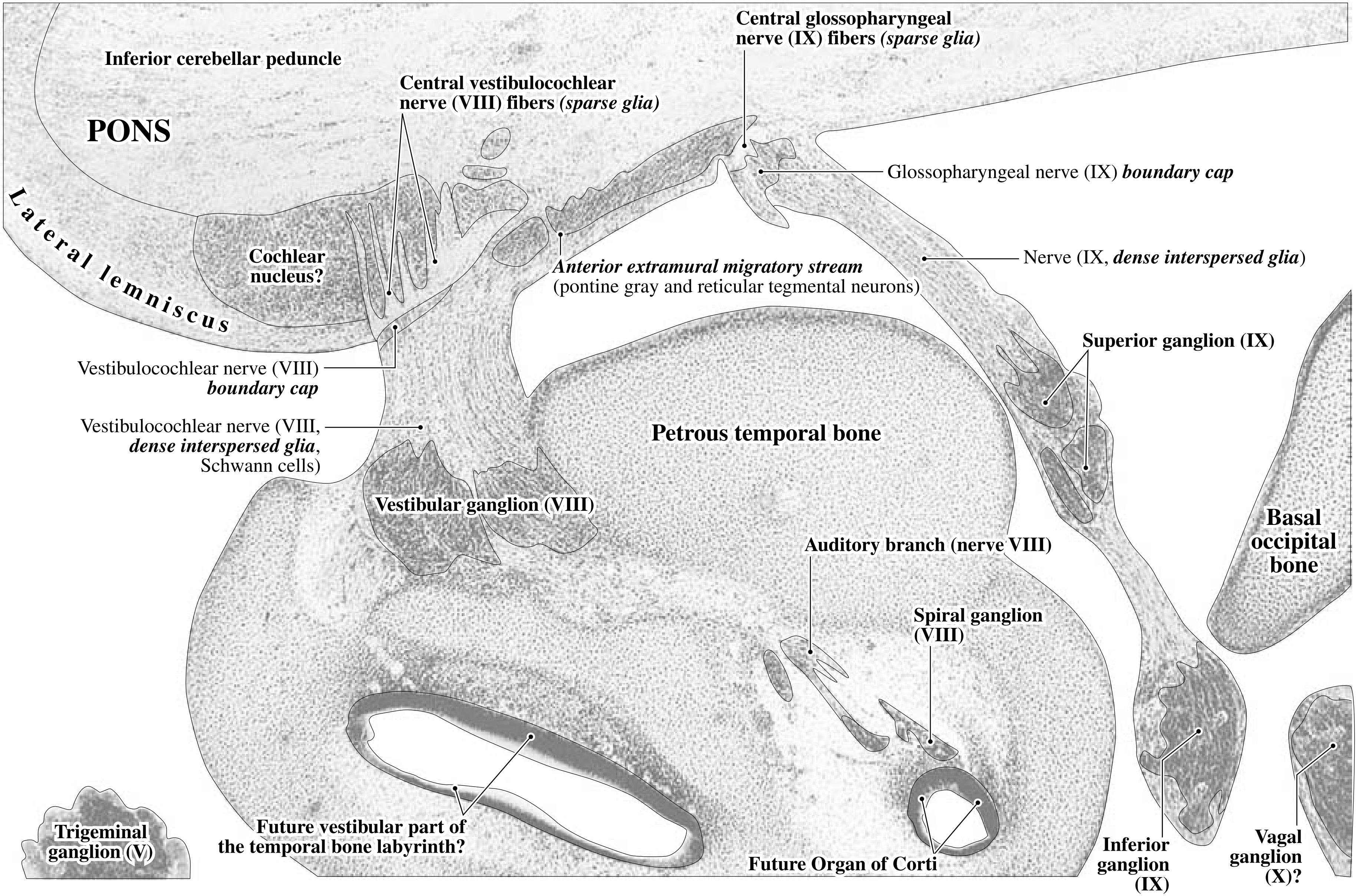
GW9 Sagittal
CR 40 mm, C6658
Between Levels 10
and 11:
Slide 104, Section 1

PONS AND
SENSORY
GANGLIA



See low-magnification views of Level 10 in Plates 66A-D, Level 11 in Plates 67A-D.

PLATE 83B



Inferior cerebellar peduncle
PONS
Lateral lemniscus
Cochlear nucleus?
Central vestibulocochlear nerve (VIII) fibers (sparse glia)
Central glossopharyngeal nerve (IX) fibers (sparse glia)
Glossopharyngeal nerve (IX) boundary cap
Anterior extramural migratory stream (pontine gray and reticular tegmental neurons)
Nerve (IX, dense interspersed glia)
Vestibulocochlear nerve (VIII) boundary cap
Vestibulocochlear nerve (VIII, dense interspersed glia, Schwann cells)
Petrous temporal bone
Superior ganglion (IX)
Vestibular ganglion (VIII)
Basal occipital bone
Auditory branch (nerve VIII)
Spiral ganglion (VIII)
Trigeminal ganglion (V)
Future vestibular part of the temporal bone labyrinth?
Future Organ of Corti
Inferior ganglion (IX)
Vagal ganglion (X)?

PART V: GW9 HORIZONTAL

This is specimen number 886 in the Carnegie Collection, designated here as C886. A normal fetus with a crown-rump length (CR) of 43 mm was collected in 1914 after a hysterectomy due to pelvic inflammation. The fetus is estimated to be at gestational week (GW) 9. The entire fetus was fixed in Bouin's, embedded in celloidin, and 100 µm sections were cut in a plane midway between the horizontal and coronal planes (**Figure 4**). Because many of the sections do not contain the cerebral cortex and the brainstem is cut in a crosswise direction, it more closely resembles a horizontally sectioned brain. All sections were stained with hematoxylin and eosin. Since there is no photograph of C886's brain before it was embedded and cut, a specimen from Hochstetter (1919) is used to show the external features of the brain at GW9 (**Figure 4**). **Levels 1-11**, generally larger sections containing the cerebral hemispheres, are shown at low magnification in **Plates 84A/B-93A/B**. The core parts of the sections in **Levels 3-11** are also shown at high magnification in **Plates 85C/D-93C/D**. **Levels 12-19**, generally smaller sections containing only the brainstem, are shown at a high magnification in **Plates 94A/B-101A/B**. To more efficiently use page space, all plates are in landscape orientation (anterior/ventral: left side of photograph, bottom of page; posterior/dorsal: right side of photograph, top of page).

C886 is similar to C6658 in the level of brain maturation. The chief reason for including this specimen is to provide a different perspective for viewing brain structure at GW9. In the cerebral cortex, the ***neuroepithelium*** is prominent as the sole germinal matrix; the ***stratified transitional field (STF)*** consists of ***STF1***, ***STF5***, and ***STF4*** only in lateral areas. The anterolateral (thicker) to dorsomedial (thinner) maturation gradient in the cortical plate and STF layers are evident. In anterolateral parts of the cerebral cortex, streams of neurons and glia appear to leave ***STF4*** and enter the ***lateral migratory stream***. The hippocampus contains ***ammonic and dentate migrations***, but there is no evidence of a pyramidal in Ammon's horn or a dentate gyrus. A massive ***neuroepithelium/subventricular zone*** overlies the amygdala, nucleus accumbens, and striatum (caudate and putamen) where neurons (and glia) are being generated.

The cerebellum is a thick, smooth plate overlying the posterior pons and medulla, and a definite ***neuroepithelium*** at the ventricular surface, indicating some Purkinje cells are still being generated. Many Purkinje cells are sojourning in a dense layer outside the neuroepithelium, and others are migrating upward. Many of the deep neurons are superificial in the cerebellum, but some are migrating downward to intermingle with upwardly migrating Purkinje cells. The cortical surface is partially covered by an ***external germinal layer (egl)*** that is actively producing neuronal stem cells, as it grows over the surface of the cerebellar cortex.

The third ventricle, aqueduct, and fourth ventricle are lined by thin ***neuroepithelia***. The midbrain tegmentum, pons, and medulla have the thinnest neuroepithelia indicating that only the latest generated neurons are being produced at this time. The thick precerebellar neuroepithelium is an exception in the medulla. Thicker neuroepithelia are in the cerebellum (see above) and midbrain tectum, indicating many neurons are still being generated, although the majority of the neurons in these sites are already postmitotic. The neuroepithelium is still more thick in the hypothalamus and thalamus, in accordance with the later maturation of the diencephalon compared to the rest of the brainstem.

Neurons throughout the diencephalon, midbrain tegmentum, pons, and medulla are migrating and settling. This specimen shows a very prominent migration of subthalamic nucleus neurons from the posterior hypothalamic neuroepithelium. Except for the subthalamic nucleus, nuclear divisions are very indistinct throughout the diencephalon. More definition is seen in the midbrain tegmentum, pons, and medulla. The ***anterior extramural*** and ***posterior extramural migratory streams*** are dense subpial accumulations in the medulla and pons.

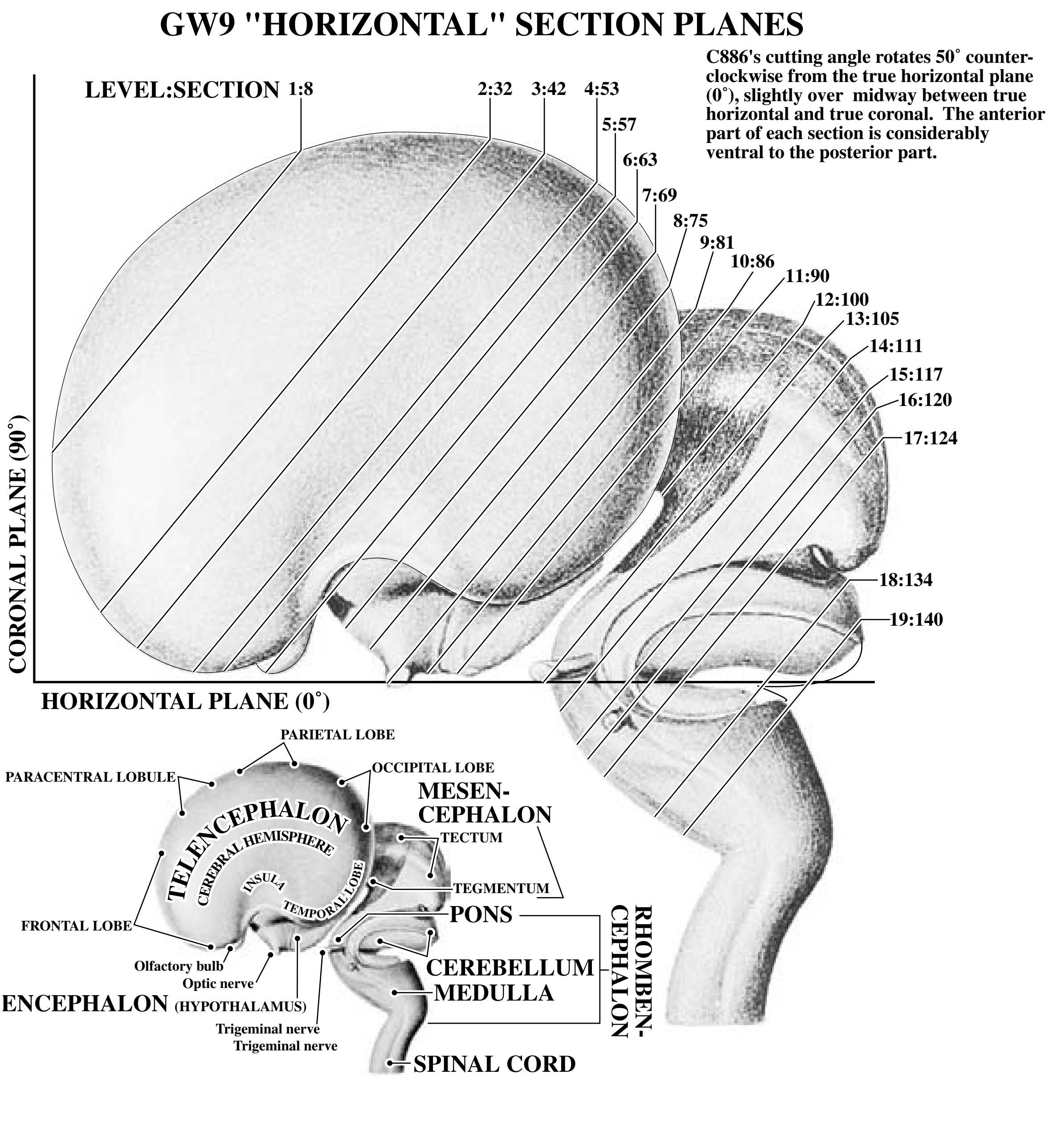
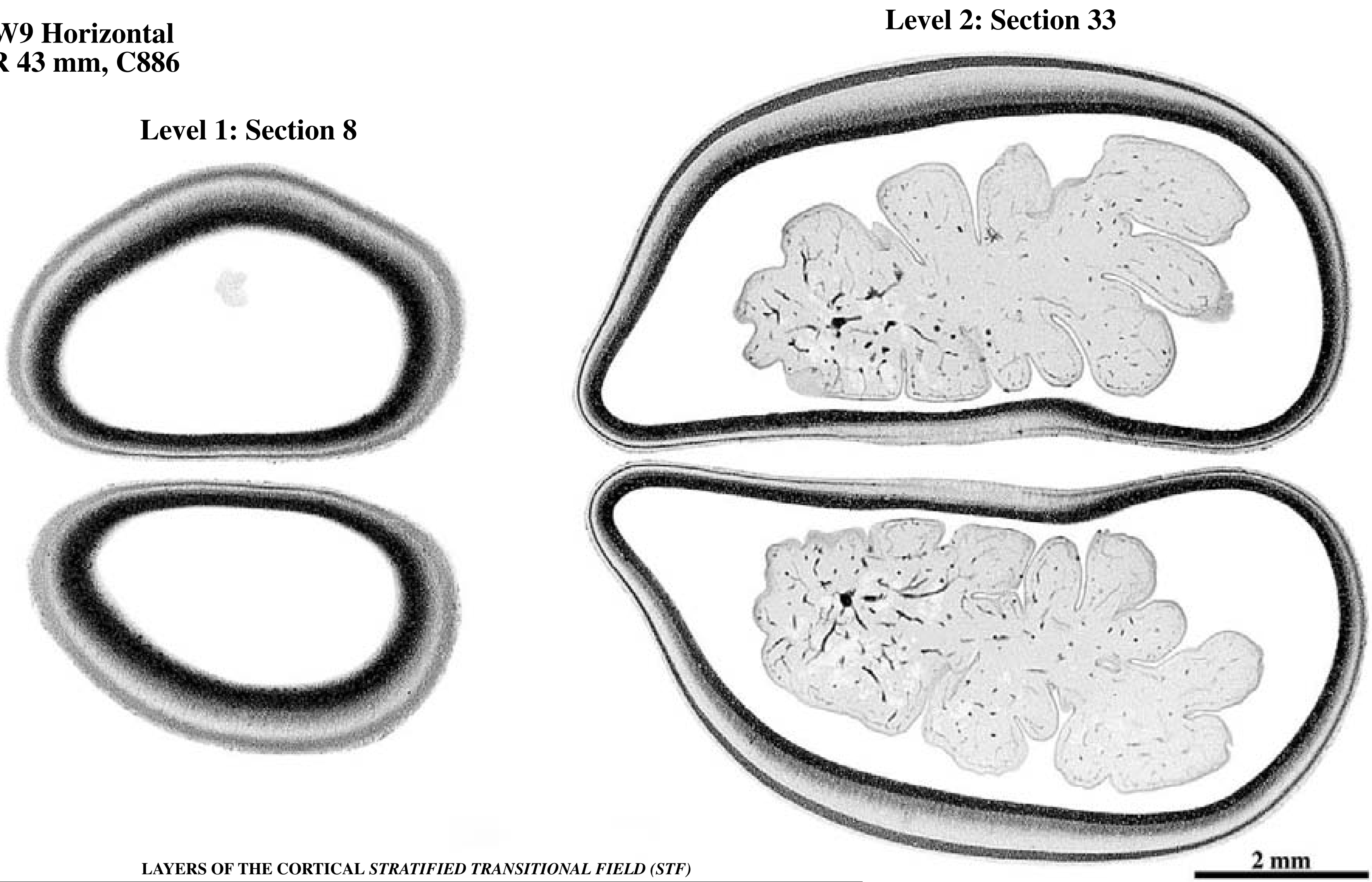


Figure 4. The lateral view of the brain and upper cervical spinal cord from a specimen with a crown-rump length of 38 mm (modified from Figure 43, Table VII, Hochstetter, 1919) serves to show the approximate locations and cutting angles of the illustrated sections of C886 in the following pages. The small inset identifies the major structural features. The line in the cerebellum and dorsal edges of the pons and medulla is the cut edge of the medullary velum.

PLATE 84A

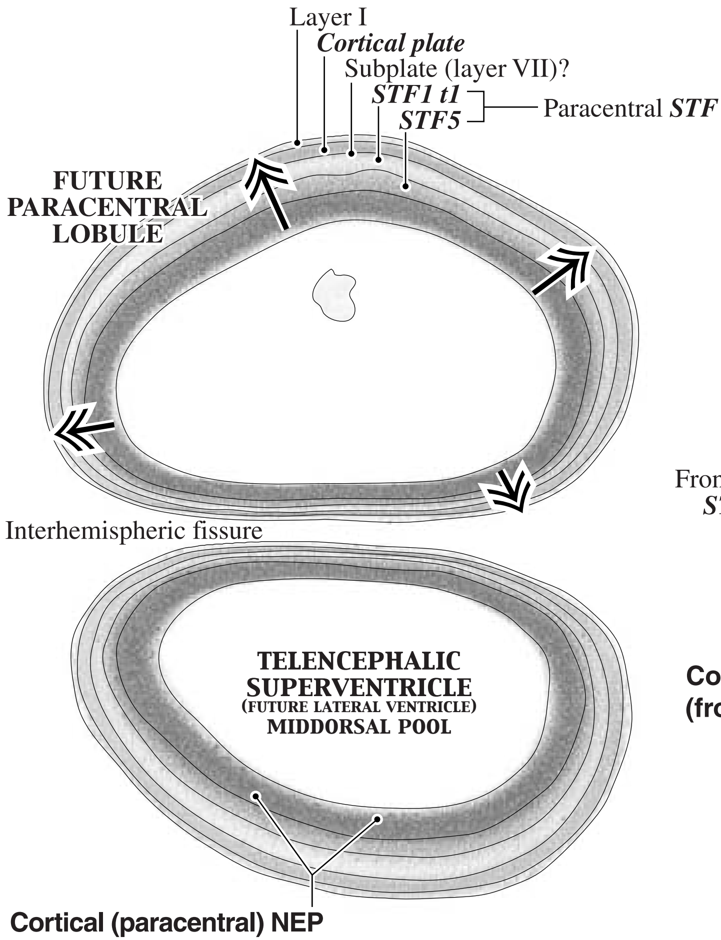
GW9 Horizontal
CR 43 mm, C886

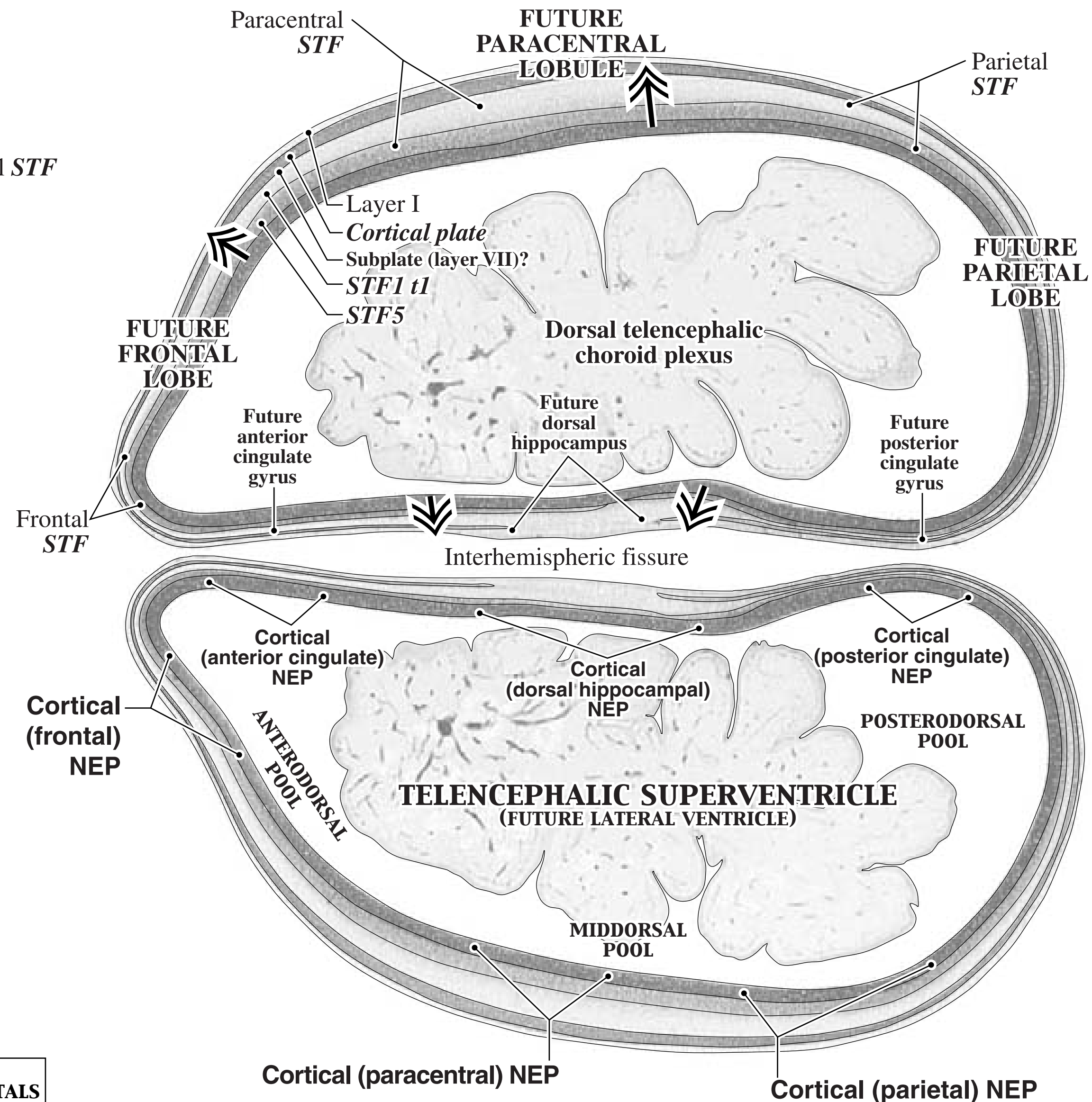


LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 84B





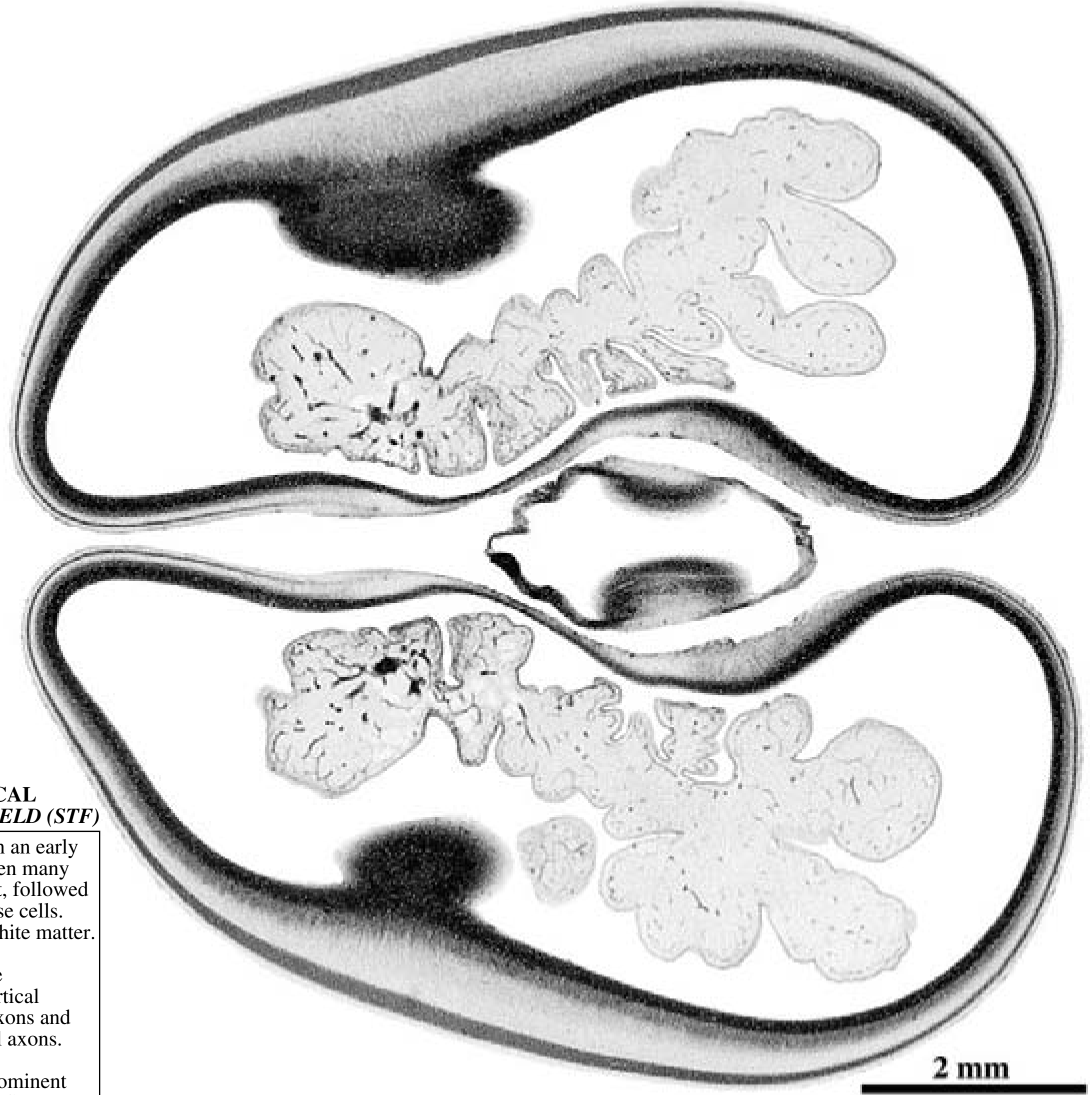
Neuroepithelium - NEP

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 85A

GW9 Horizontal
CR 43 mm, C886
Level 3: Section 42



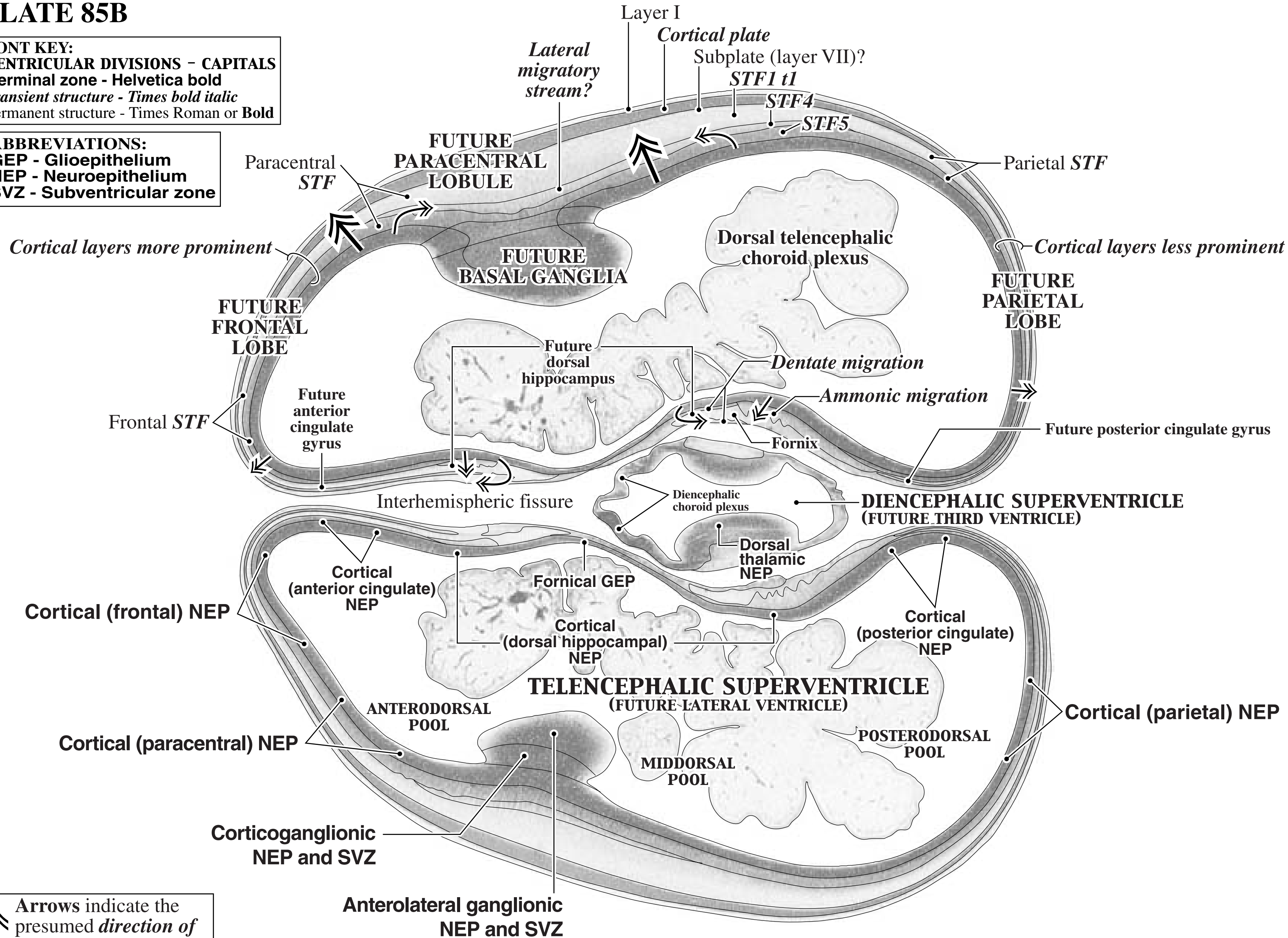
LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 85B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

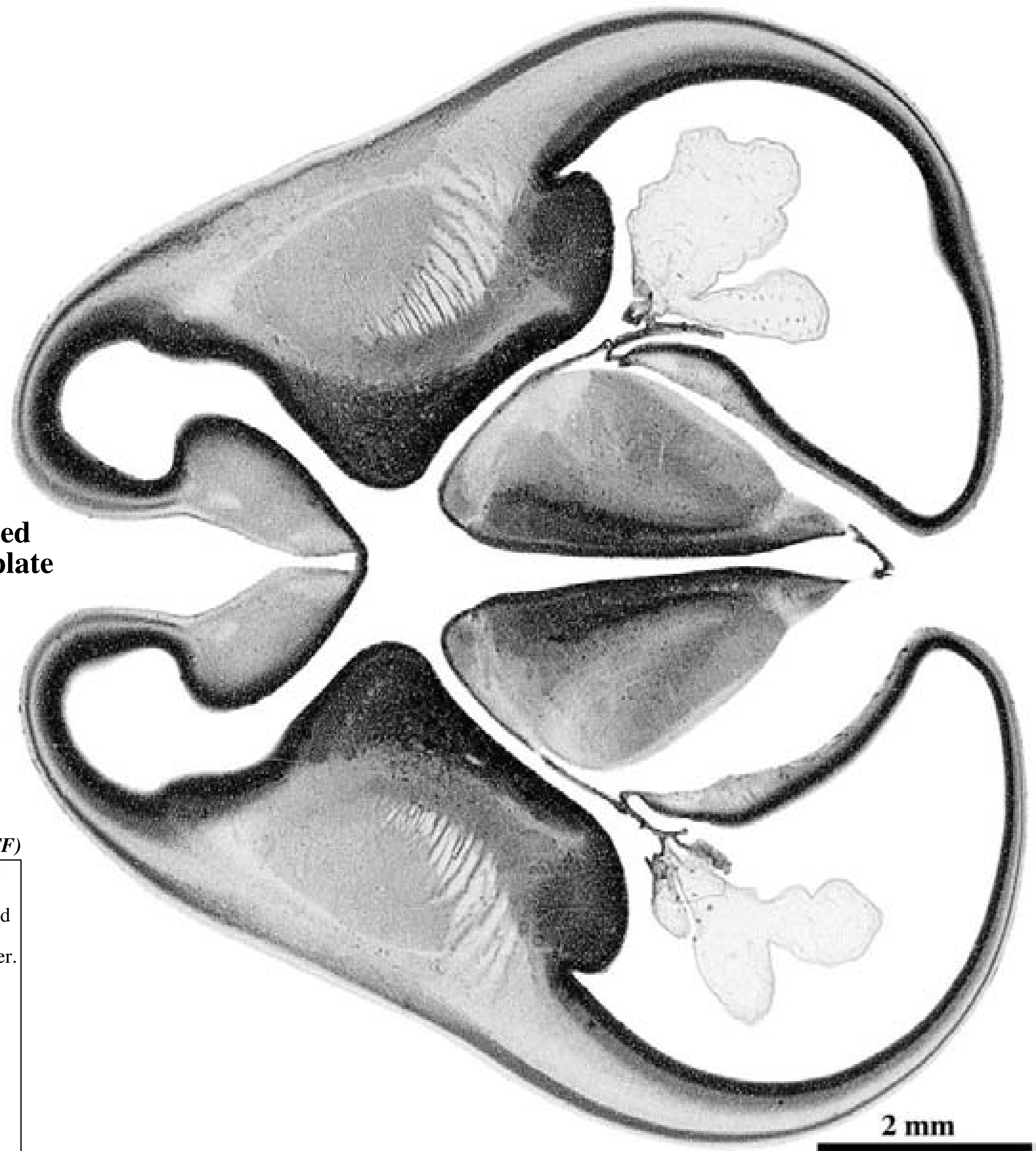
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 86A

GW9 Horizontal
CR 43 mm, C886
Level 4: Section 53



See the brain core enlarged in parts C and D of this plate on the following pages.

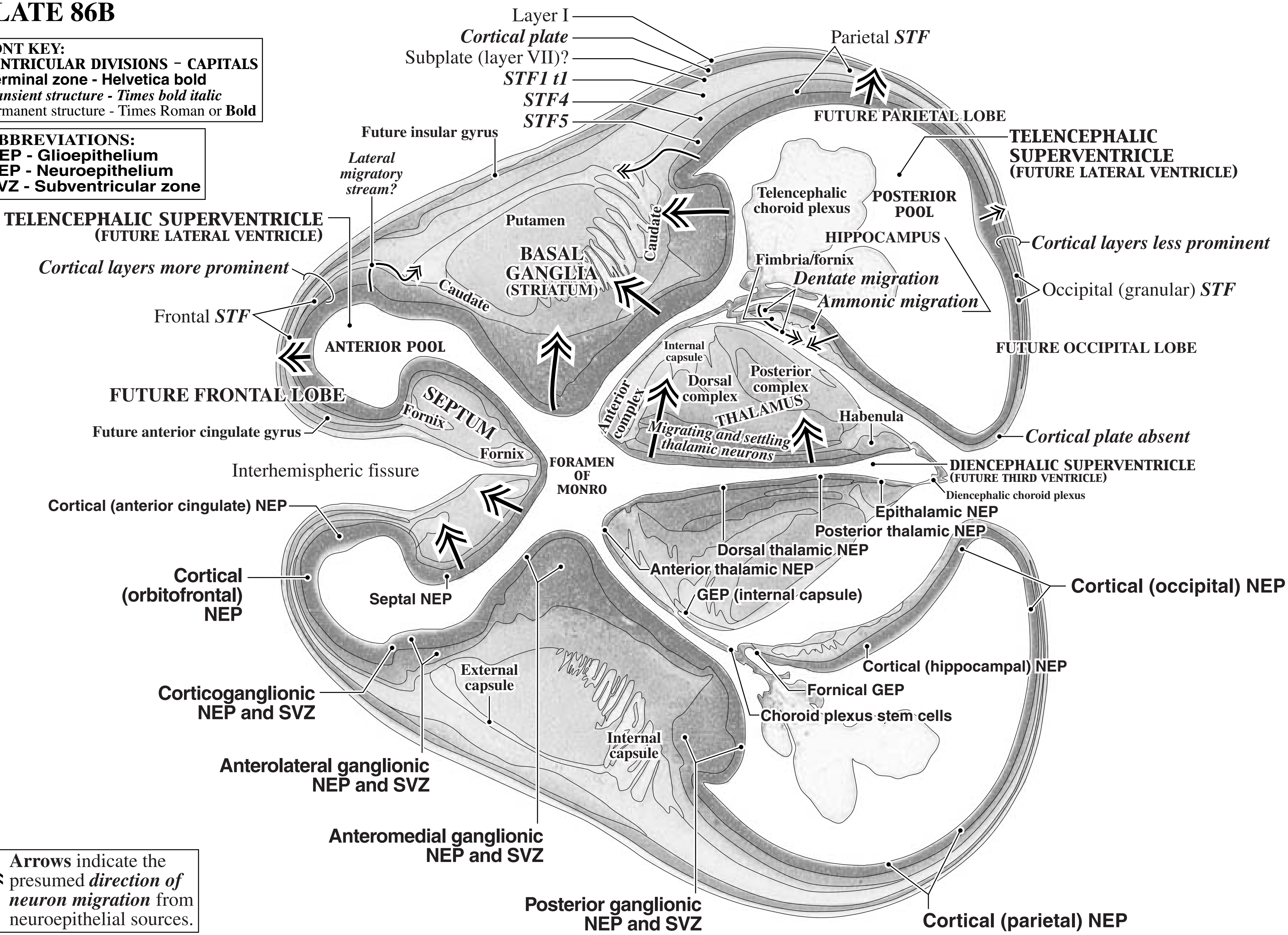
LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 86B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

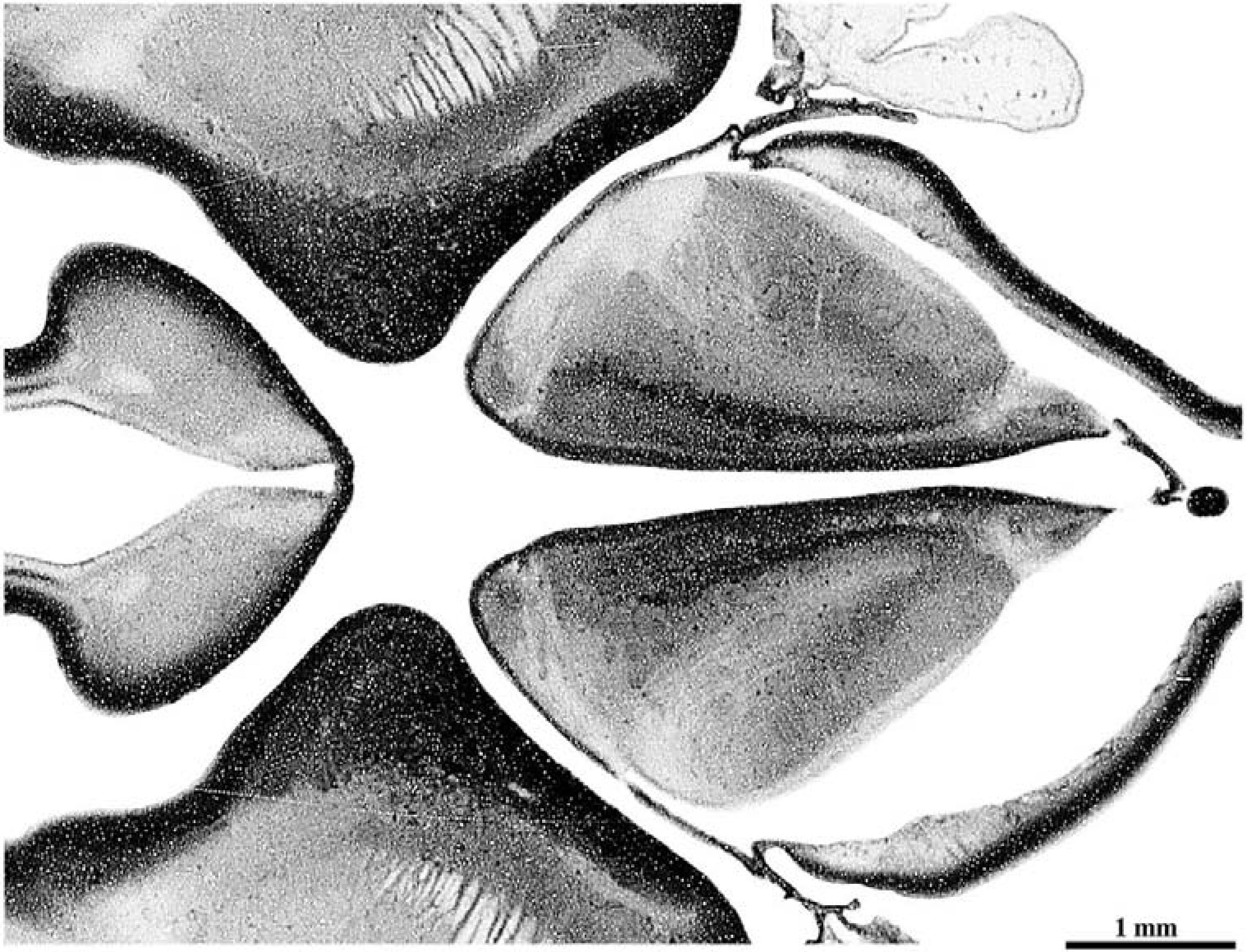
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

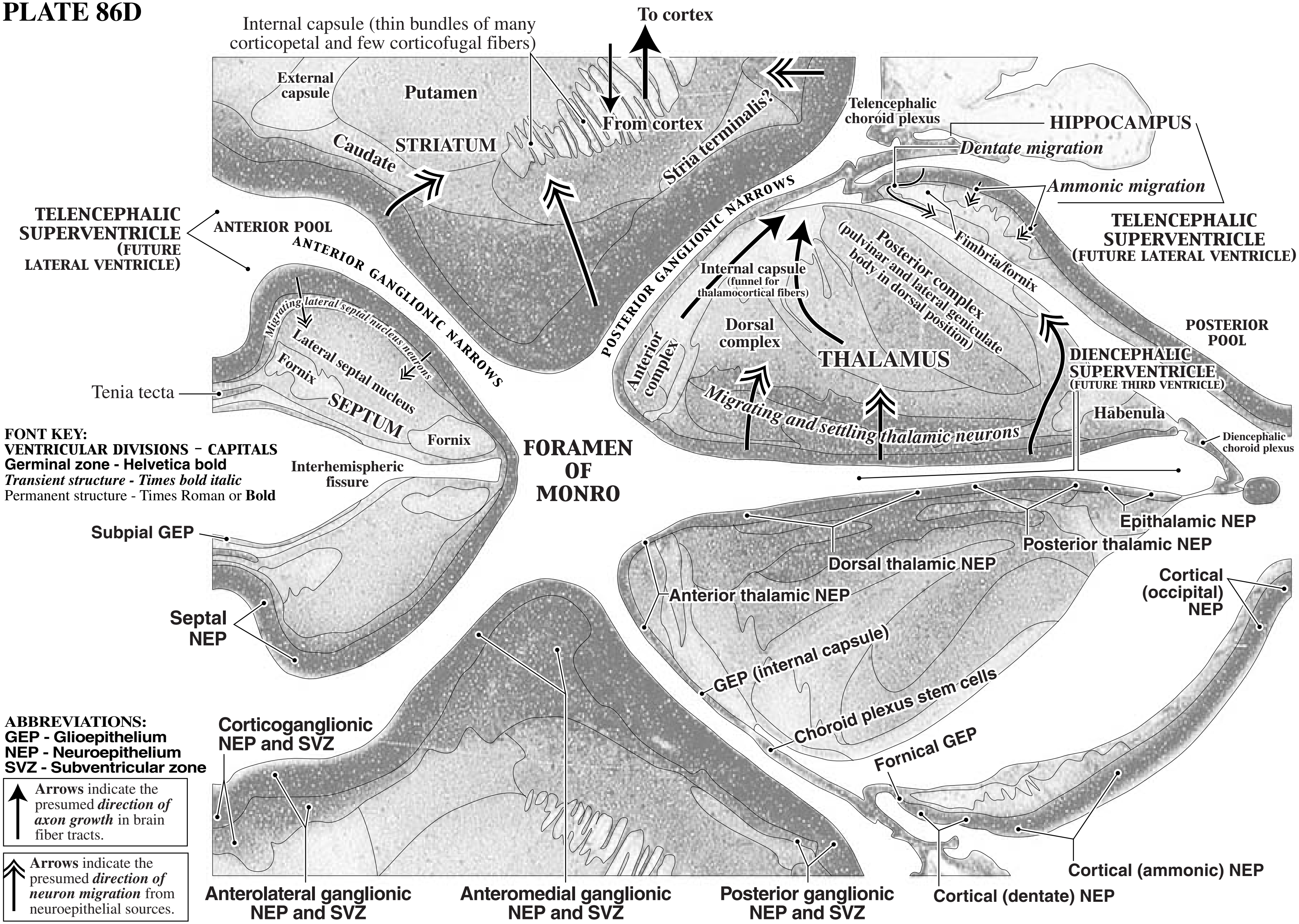
PLATE 86C

GW9 Horizontal
CR 43 mm
C886
Level 4:
Section 53



See the entire section in parts A and B of this plate on the preceding pages.

PLATE 86D



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

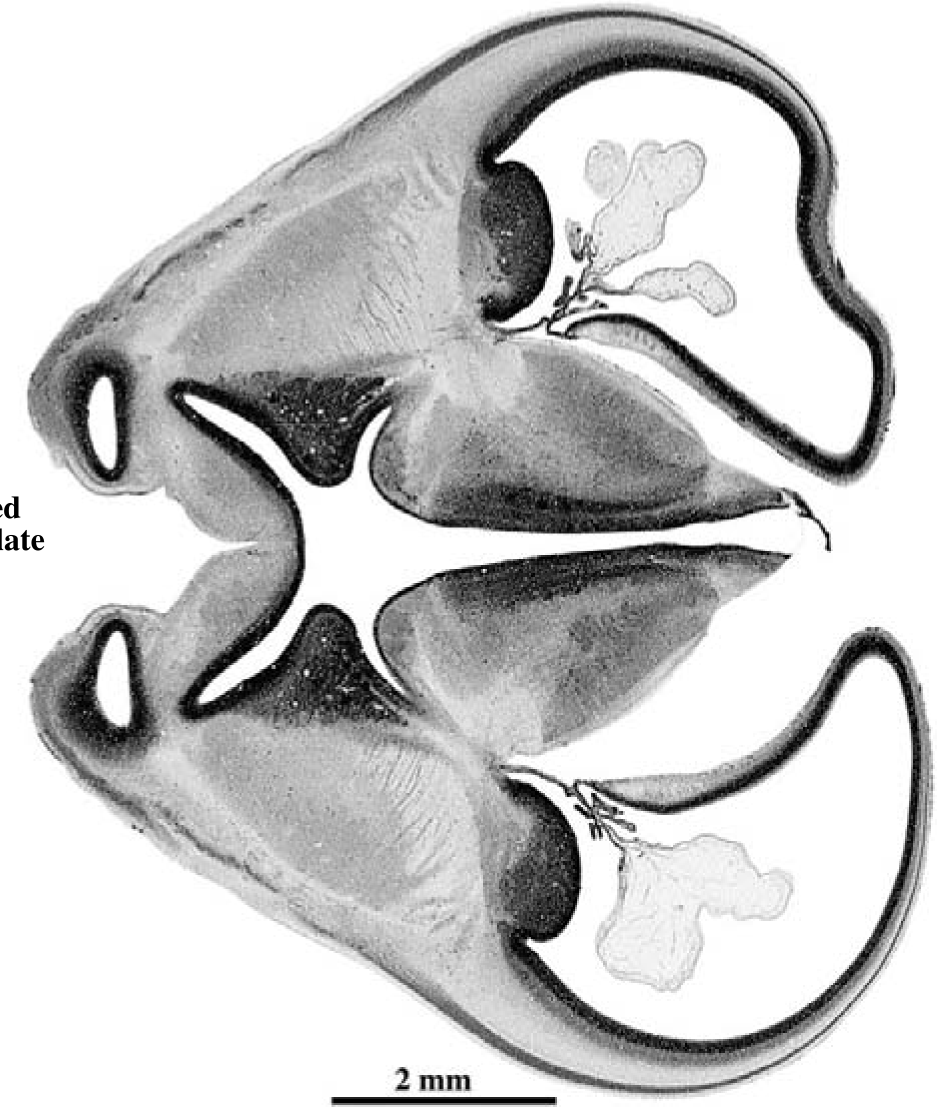
Arrows indicate the presumed *direction of axon growth* in brain fiber tracts.

Arrows indicate the presumed *direction of neuron migration* from neuroepithelial sources.

PLATE 87A

GW9 Horizontal
CR 43 mm, C886
Level 5: Section 57

See the brain core enlarged in parts C and D of this plate on the following pages.



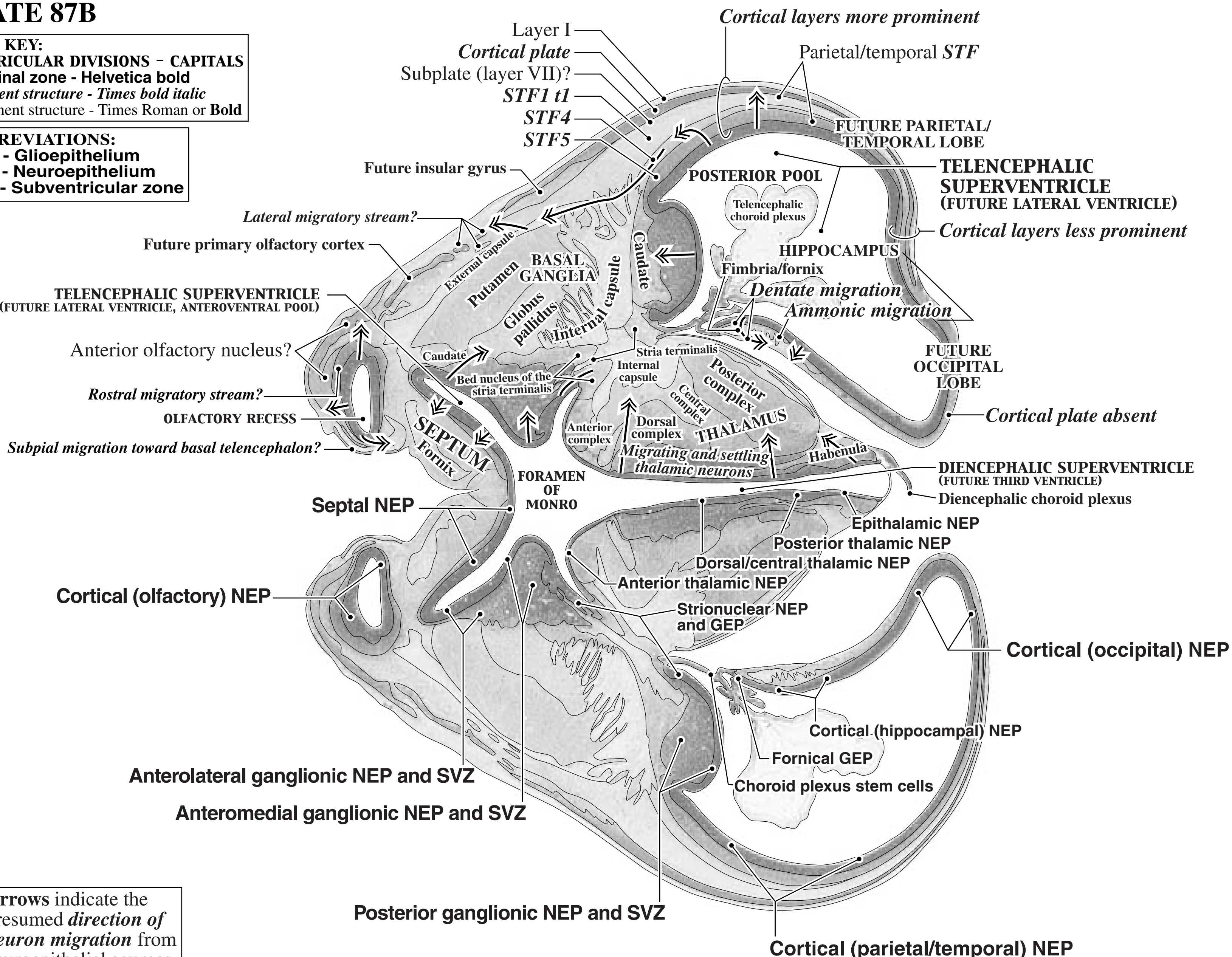
LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 87B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

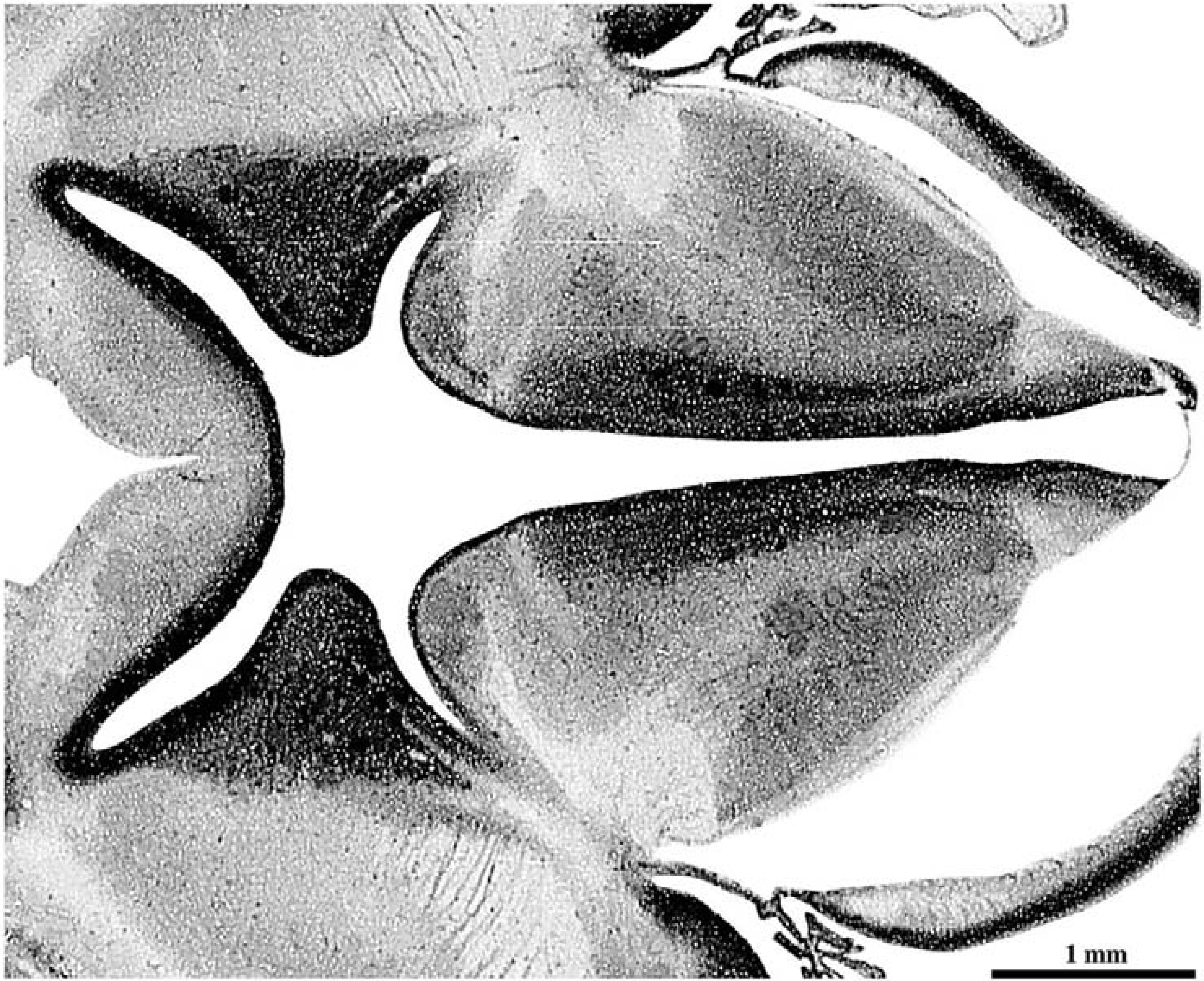
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

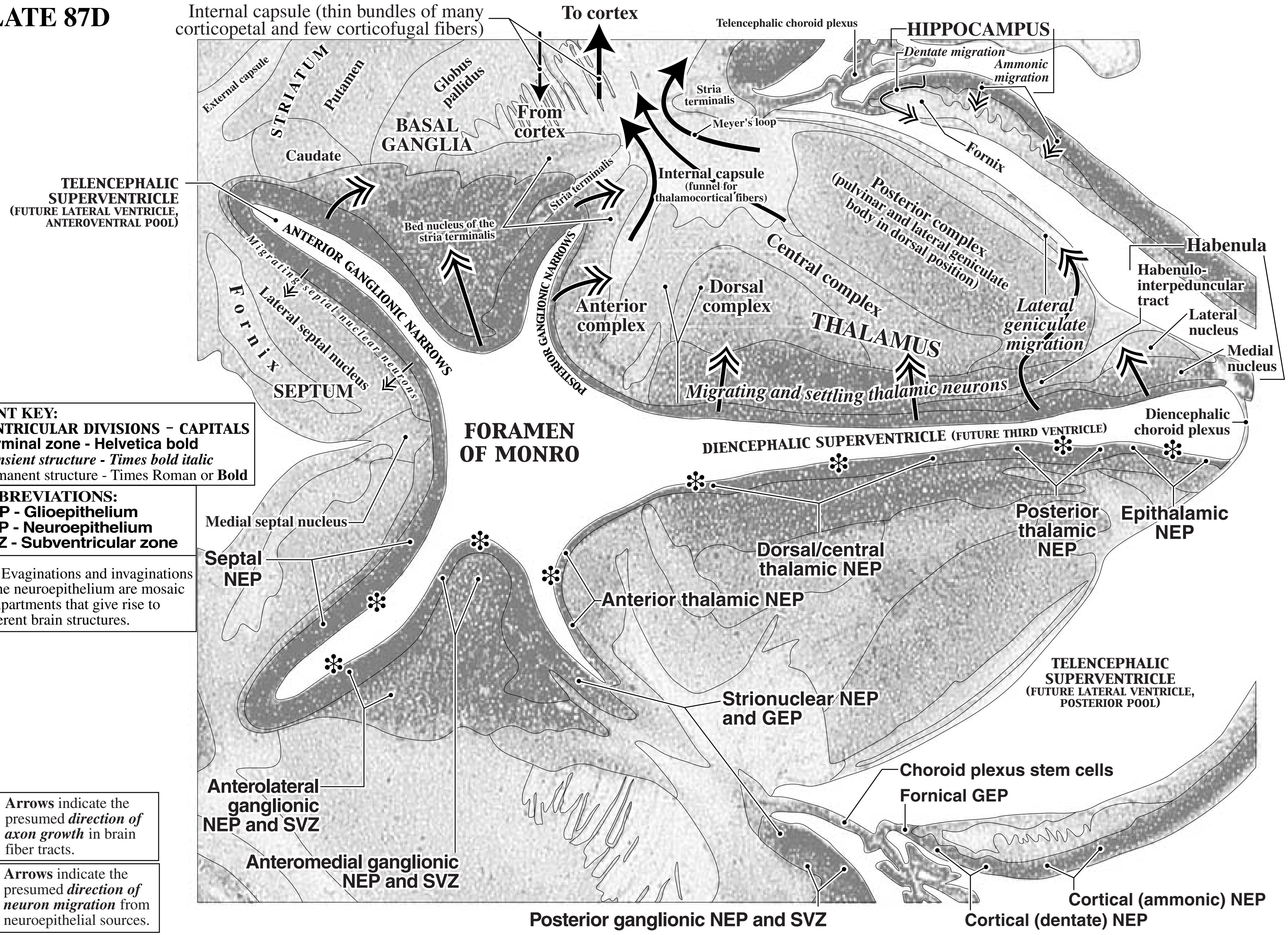
PLATE 87C

GW9 Horizontal
CR 43 mm, C886
Level 5: Section 57



See the entire section in parts A and B of this plate on the preceding pages.

PLATE 87D



FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

Arrows indicate the presumed *direction of axon growth* in brain fiber tracts.

Arrows indicate the presumed *direction of neuron migration* from neuroepithelial sources.

PLATE 88A

GW9 Horizontal
CR 43 mm, C886
Level 6: Section 63

See the brain core enlarged in parts C and D of this plate on the following pages.

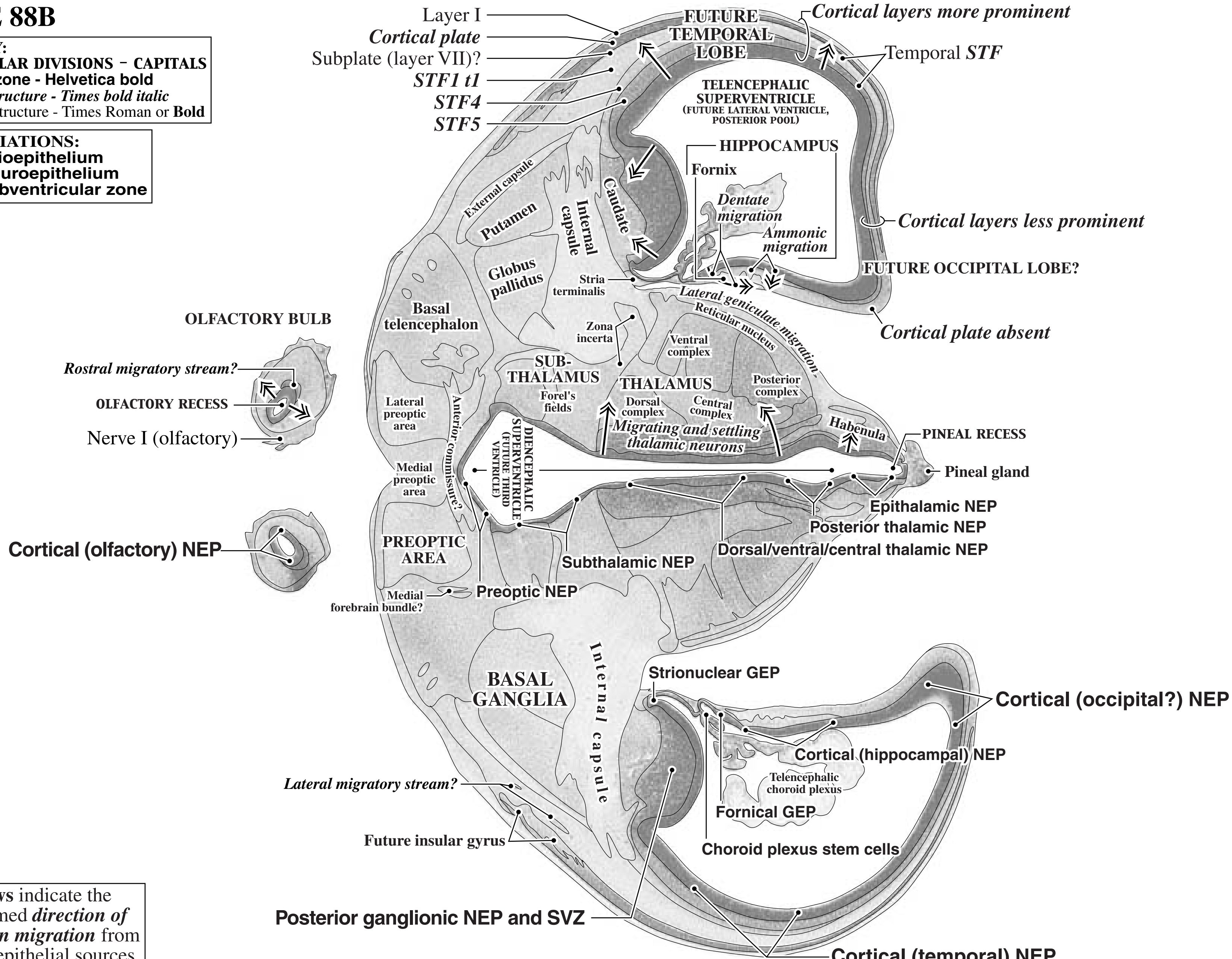
LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 88B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 88C

GW9 Horizontal
CR 43 mm, C886
Level 6: Section 63

See the entire section in parts A and B of this plate on the preceding pages.

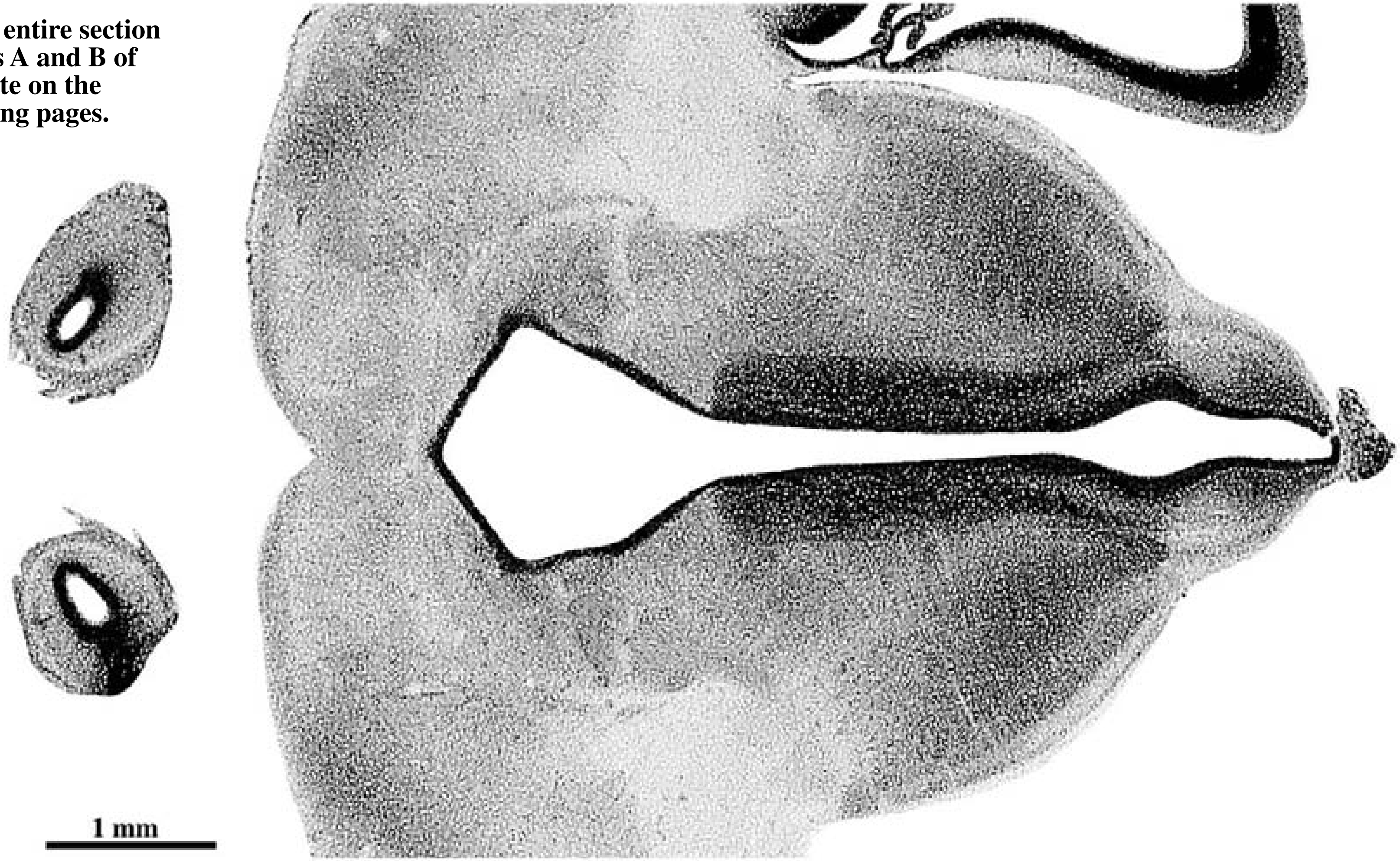
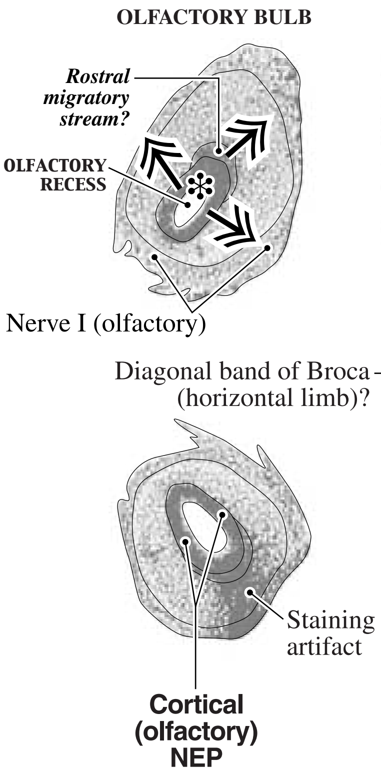


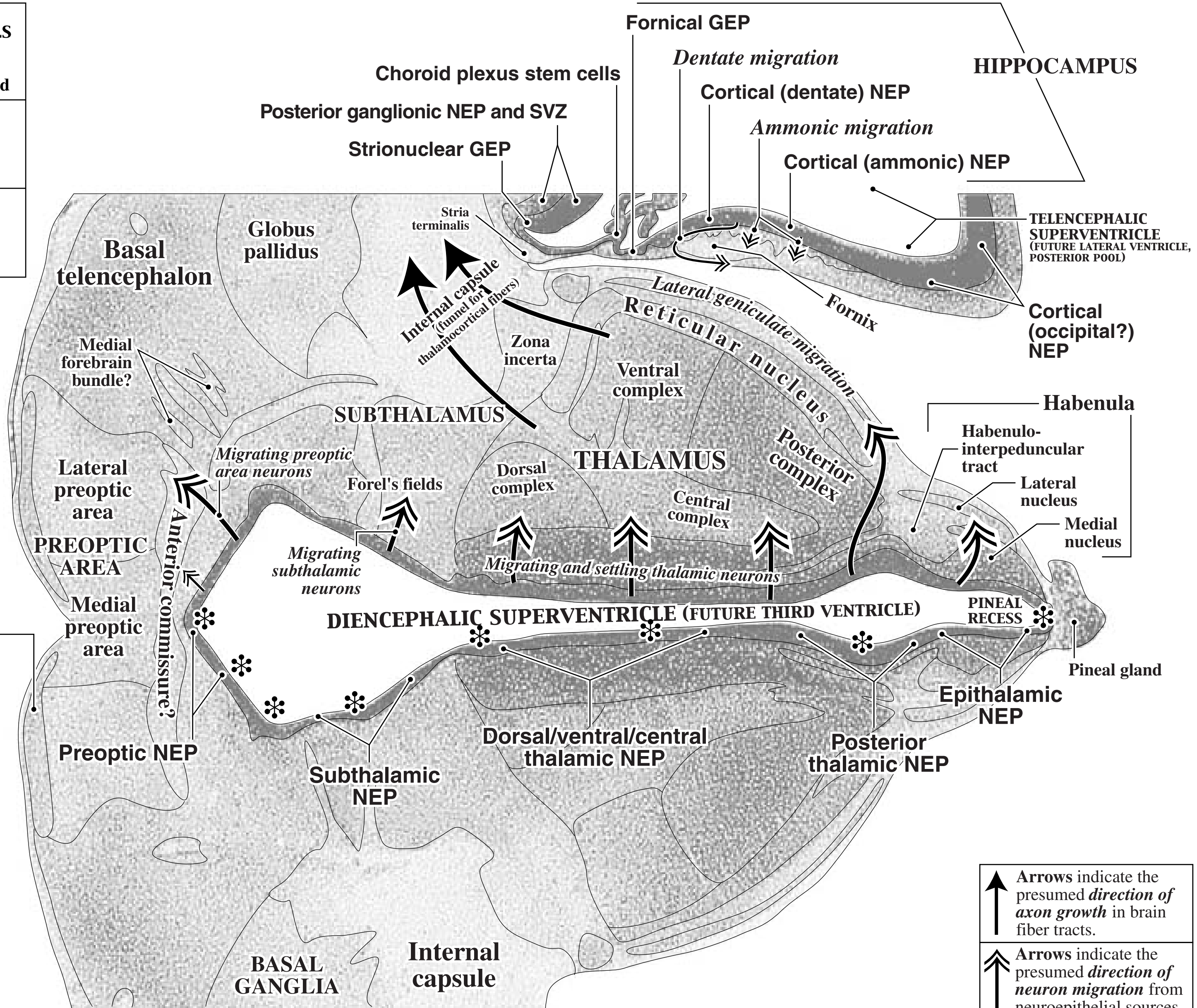
PLATE 88D

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.





Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 89A

GW9 Horizontal
CR 43 mm, C886
Level 7: Section 69

See the brain core enlarged in parts C and D of this plate on the following pages.

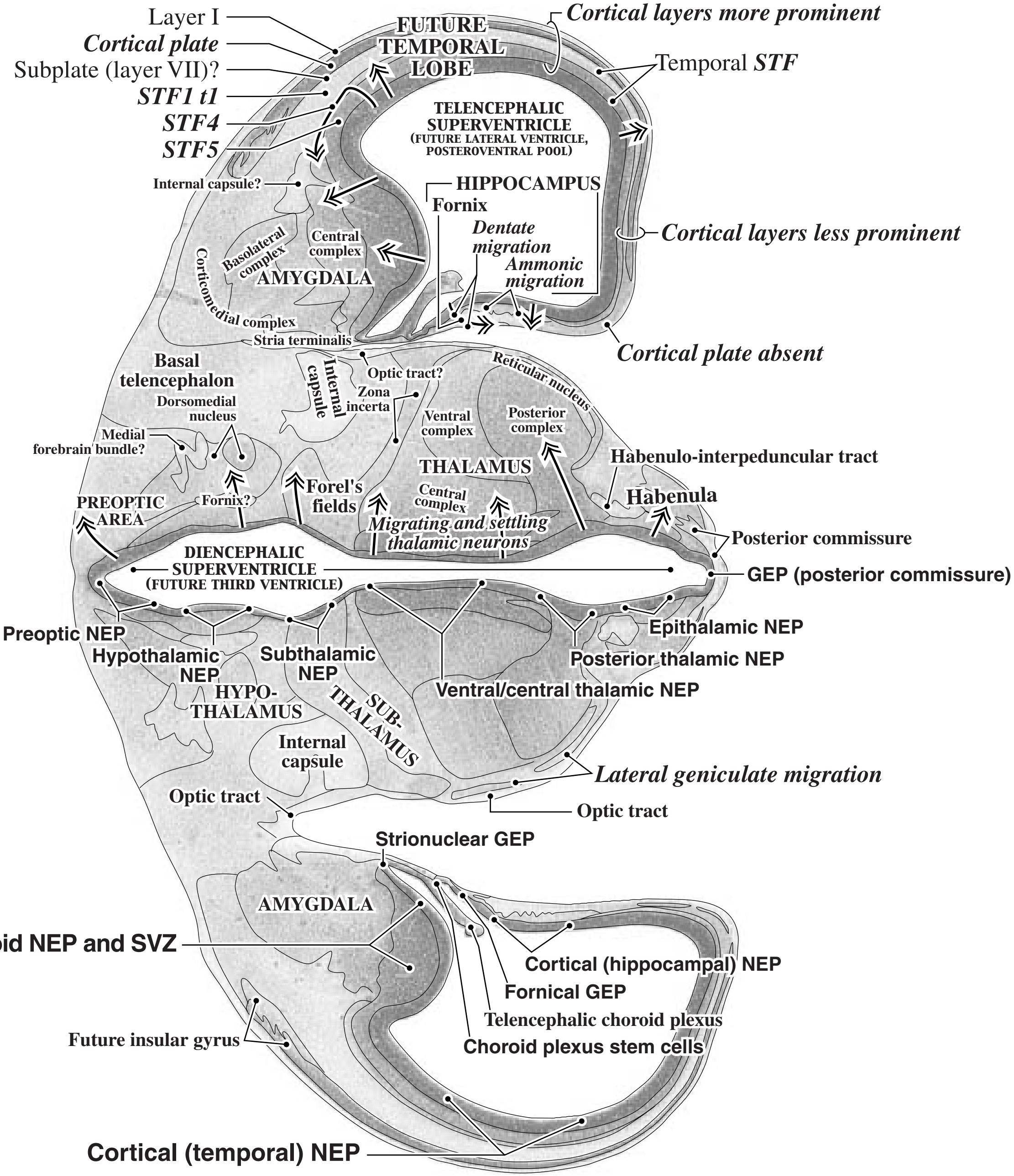
LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 89B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

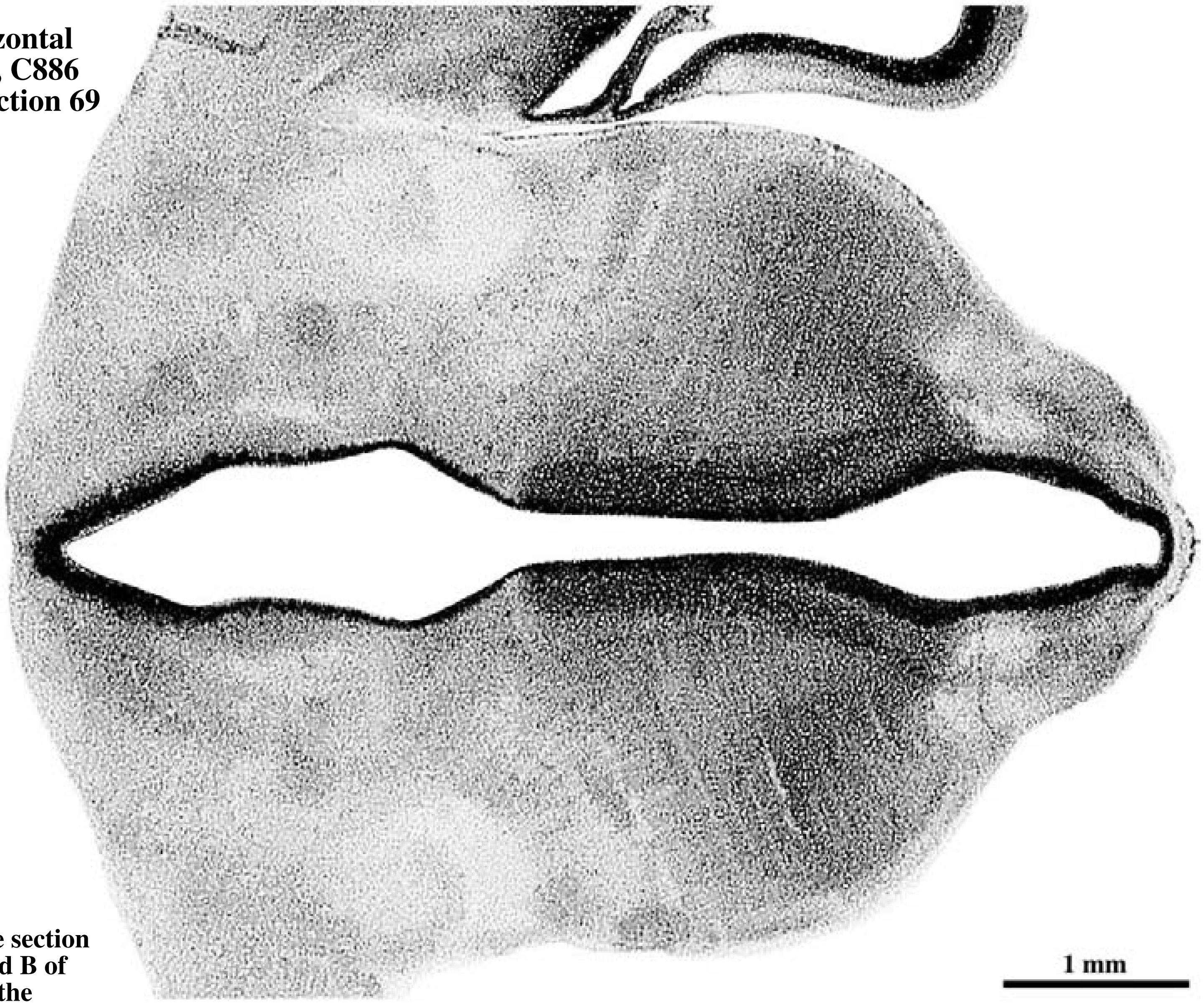
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 89C

GW9 Horizontal
CR 43 mm, C886
Level 7: Section 69



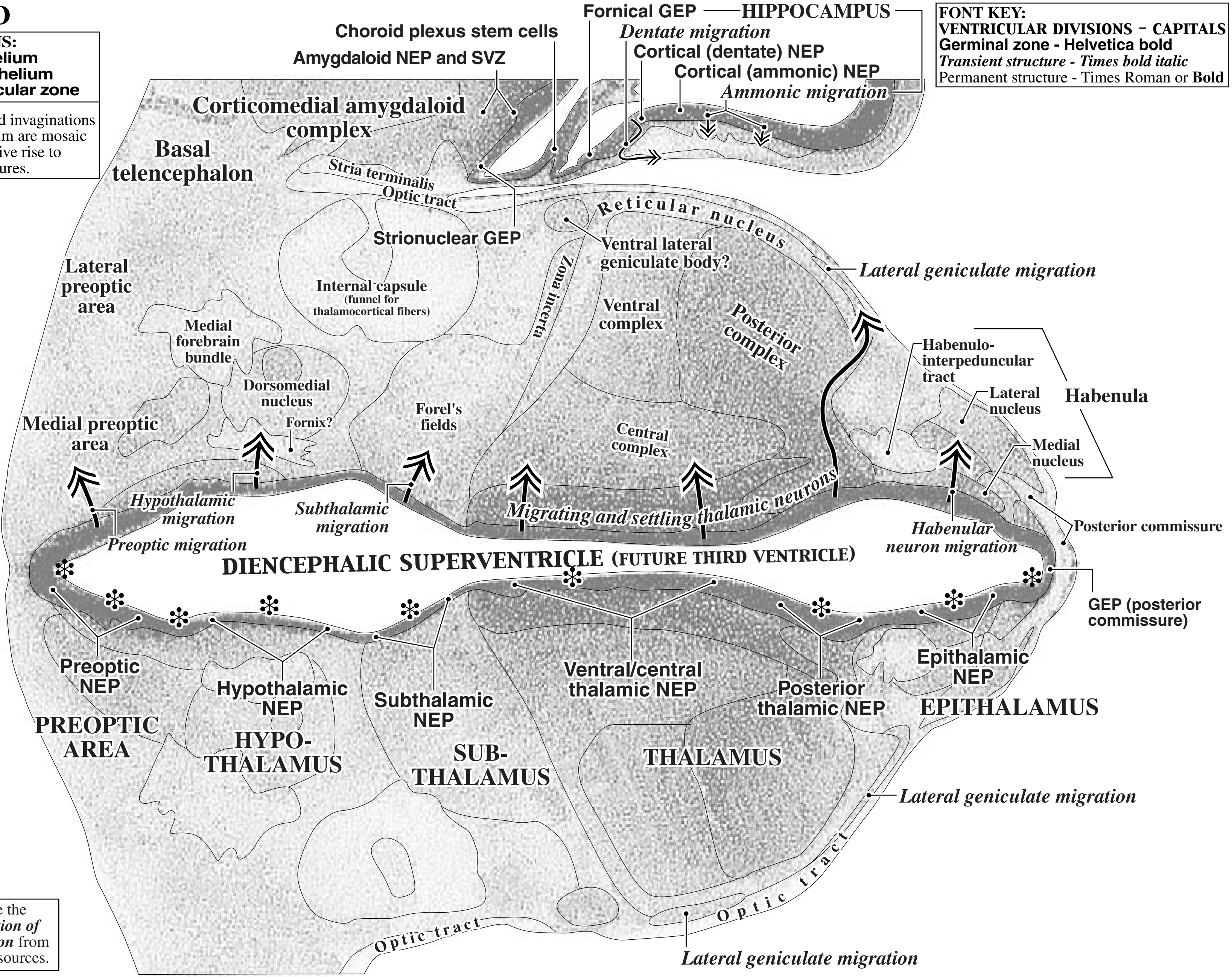
See the entire section in parts A and B of this plate on the preceding pages.

PLATE 89D

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

❋ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

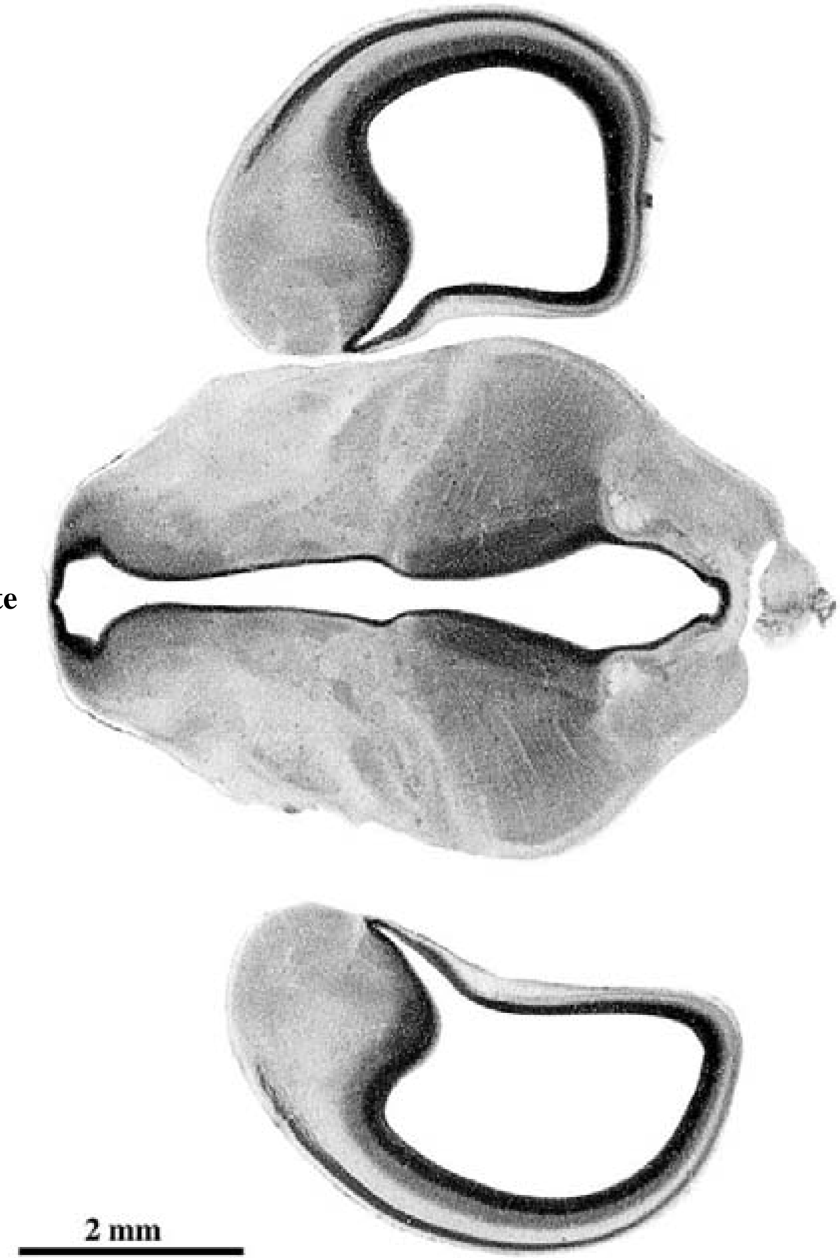


Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 90A

GW9 Horizontal
CR 43 mm, C886
Level 8: Section 75

See the brain core enlarged in parts C and D of this plate on the following pages.



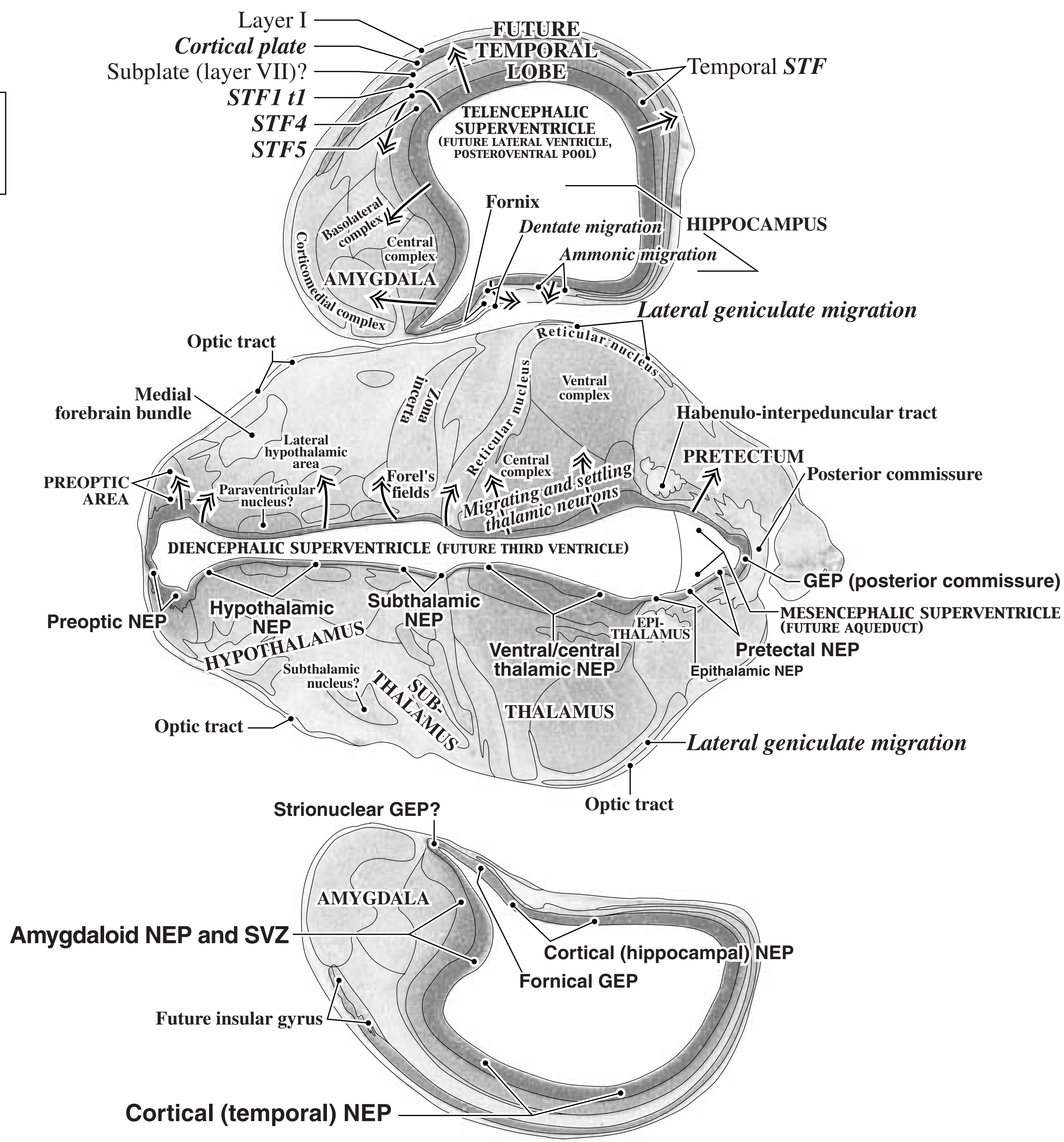
LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 90B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

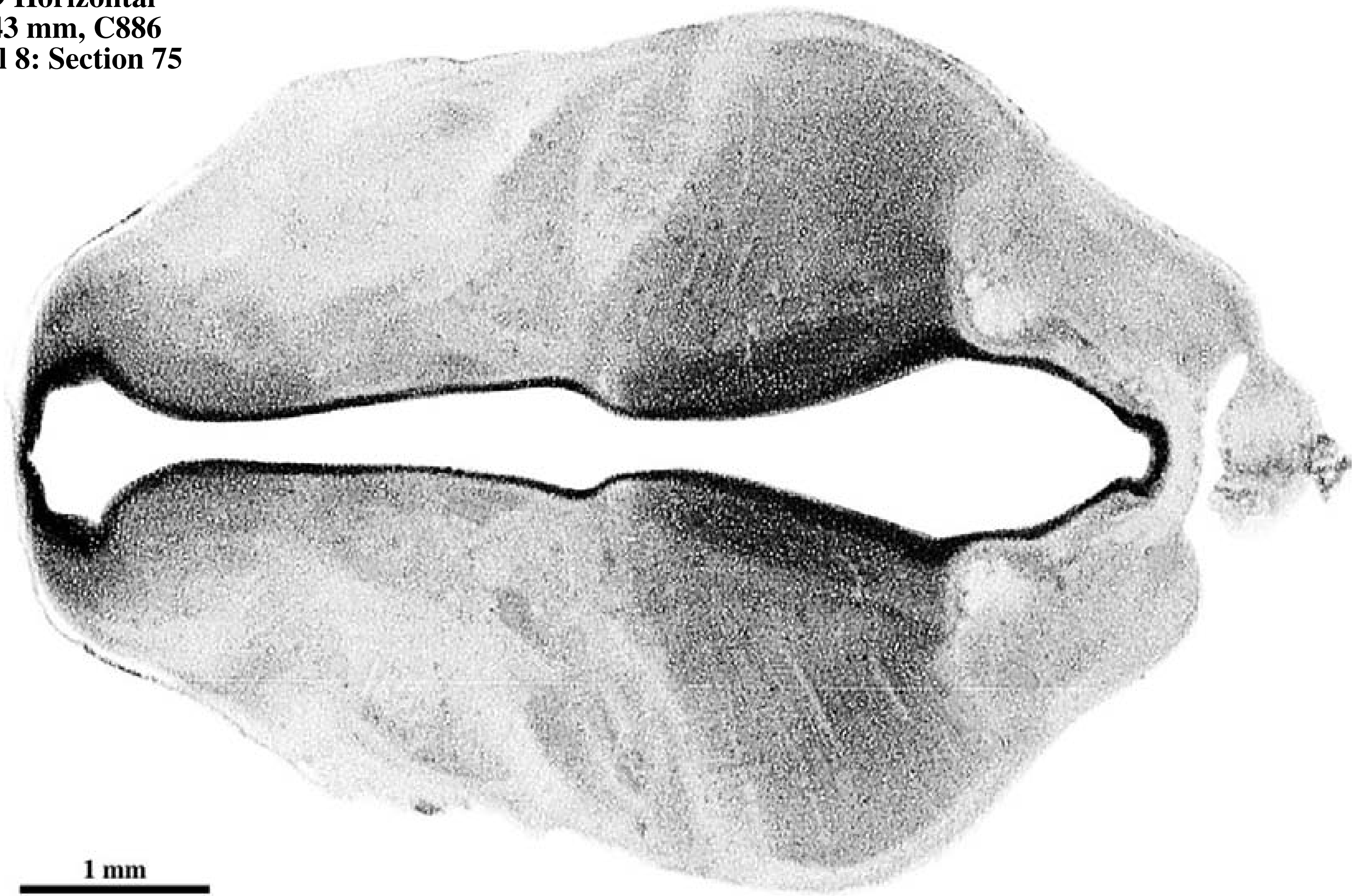
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 90C

GW9 Horizontal
CR 43 mm, C886
Level 8: Section 75



See the entire section in parts A and B of this plate on the preceding pages.

PLATE 90D

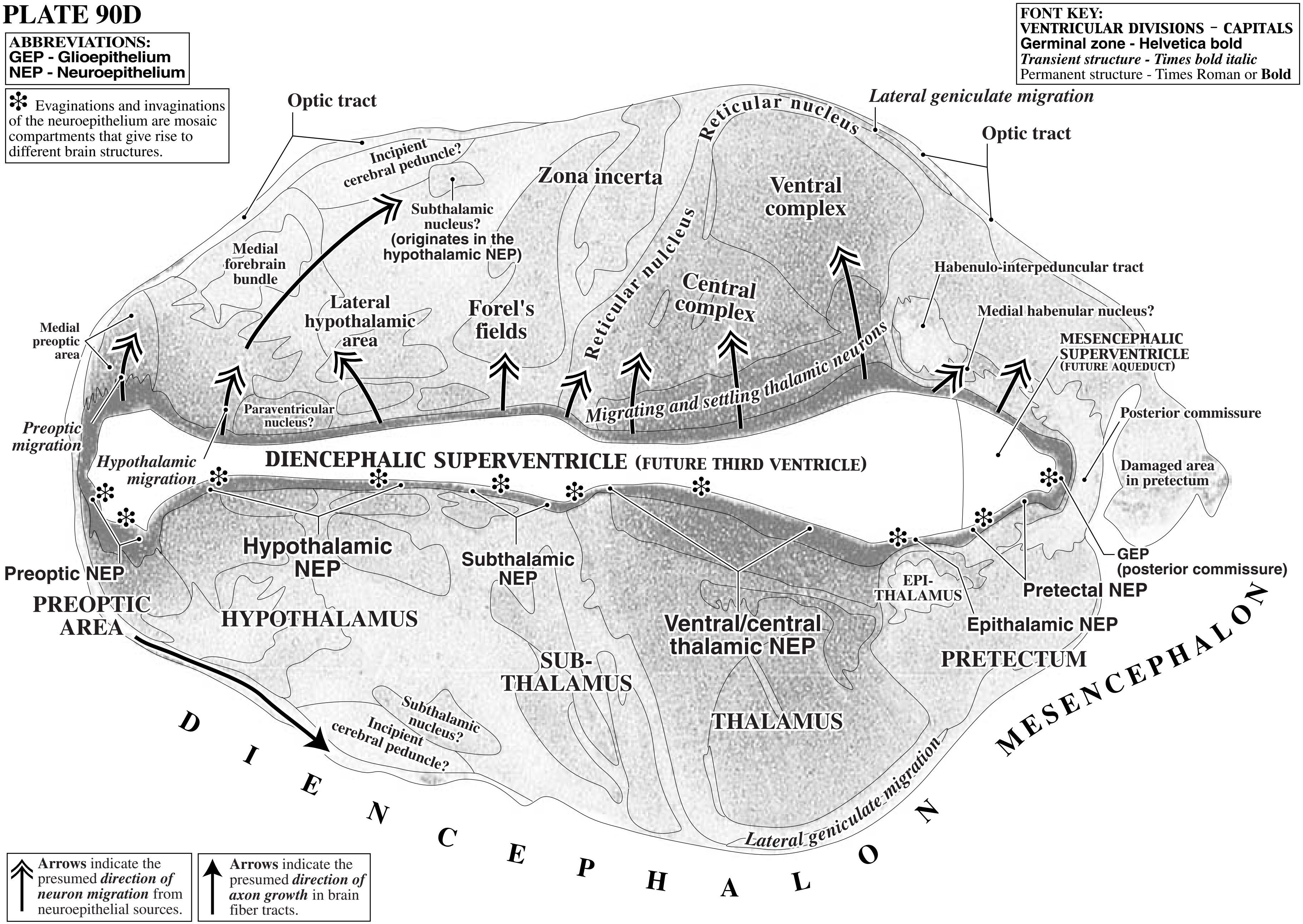
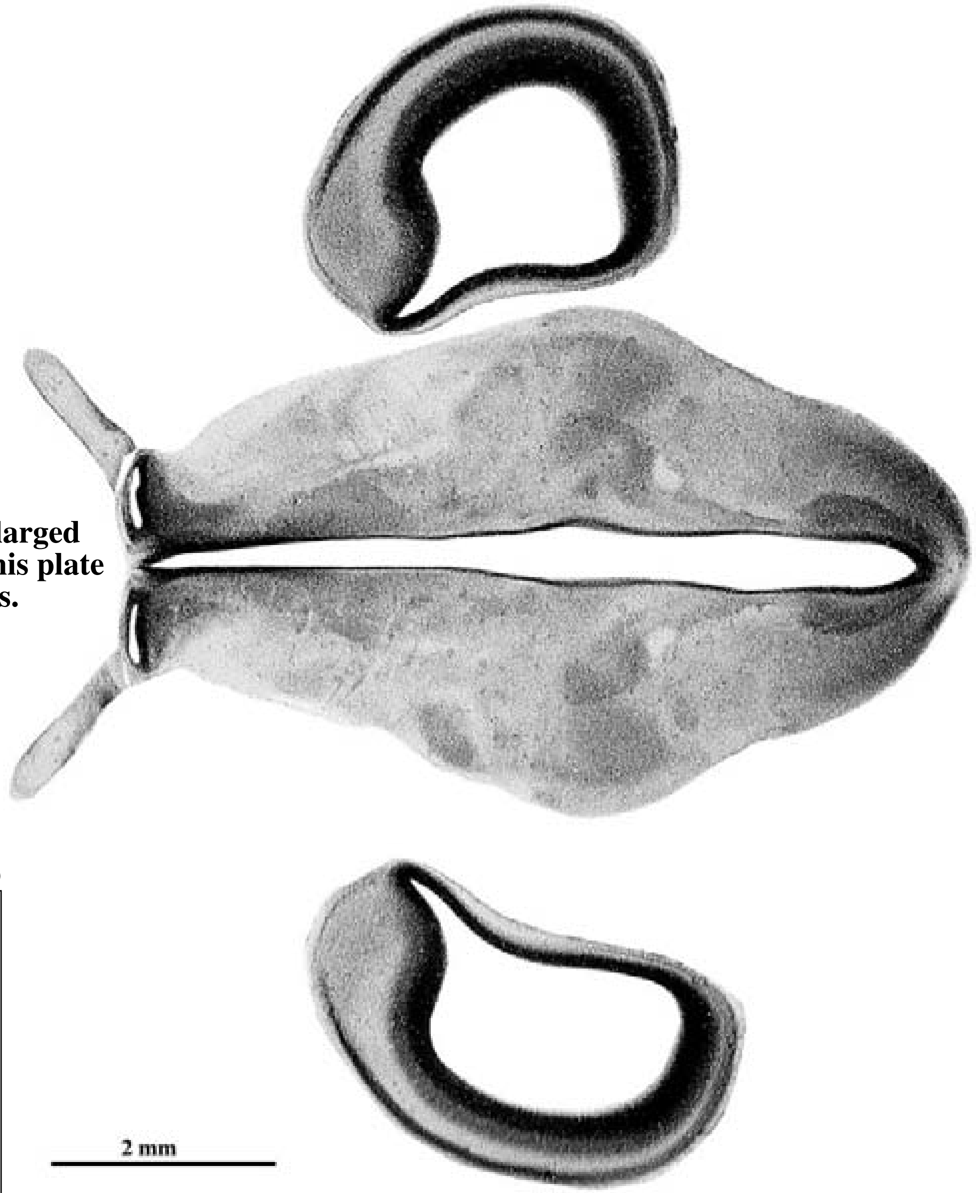

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
Optic tract
Lateral geniculate migration
Reticular nucleus
Optic tract
Incipient cerebral peduncle?
Zona incerta
Ventral complex
Subthalamic nucleus? (originates in the hypothalamic NEP)
Medial forebrain bundle
Reticular nucleus
Central complex
Habenulo-interpeduncular tract
Medial preoptic area
Lateral hypothalamic area
Forel's fields
Medial habenular nucleus?
Migrating and settling thalamic neurons
MESENCEPHALIC SUPERVENTRICLE (FUTURE AQUEDUCT)
Paraventricular nucleus?
Posterior commissure
Preoptic migration
Hypothalamic migration
DIENCEPHALIC SUPERVENTRICLE (FUTURE THIRD VENTRICLE)
Damaged area in pretectum
Hypothalamic NEP
Subthalamic NEP
Preoptic NEP
GEP (posterior commissure)
EPI-THALAMUS
Pretectal NEP
PREOPTIC AREA
HYPOTHALAMUS
Ventral/central thalamic NEP
Epithalamic NEP
PRETECTUM
SUB-THALAMUS
MESENCEPHALON
Subthalamic nucleus?
Incipient cerebral peduncle?
THALAMUS
DIENCEPHALON
Lateral geniculate migration
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Arrows indicate the presumed direction of axon growth in brain fiber tracts.

PLATE 91A

GW9 Horizontal
CR 43 mm, C886
Level 9: Section 81



See the brain core enlarged in parts C and D of this plate on the following pages.

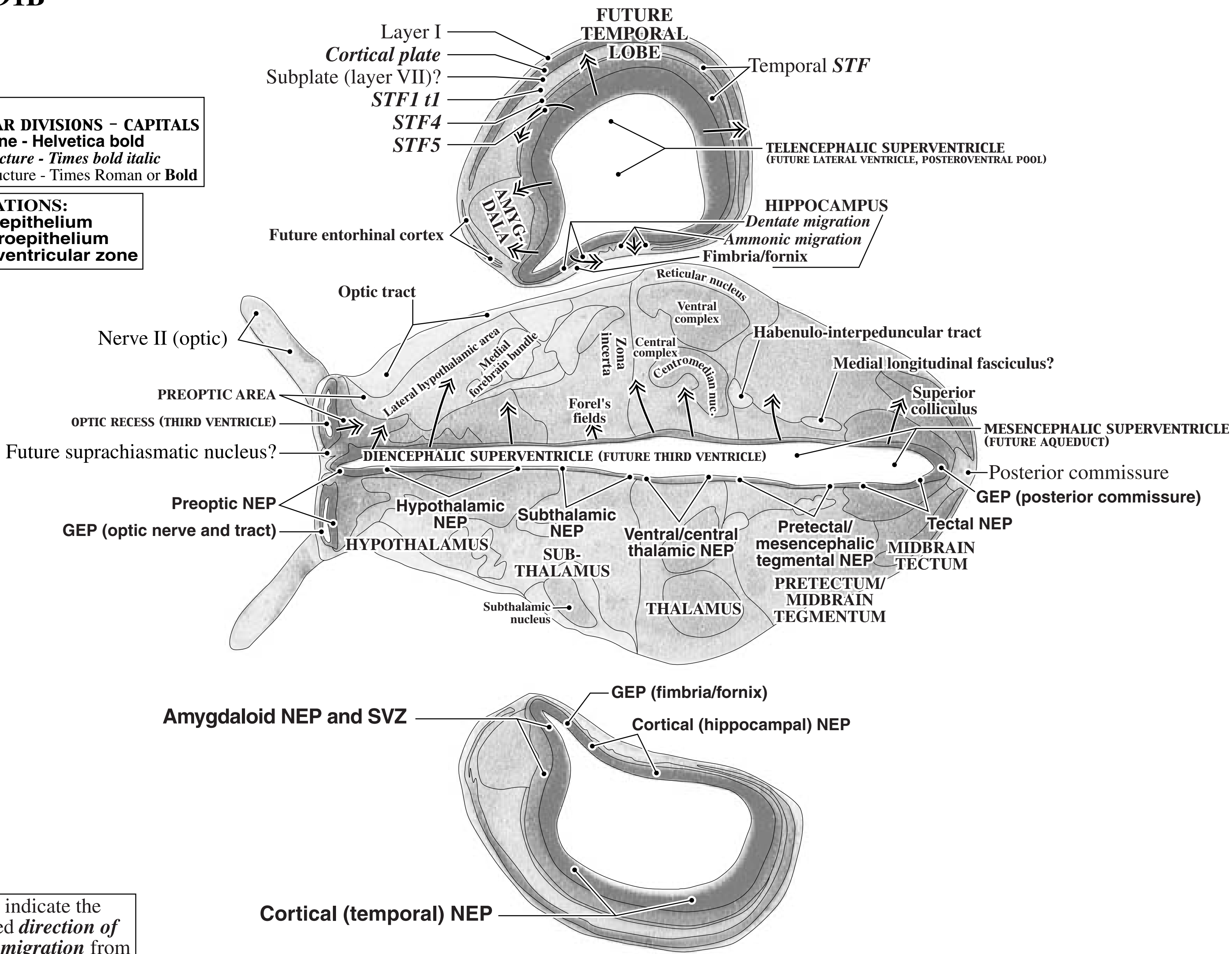
LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 91B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

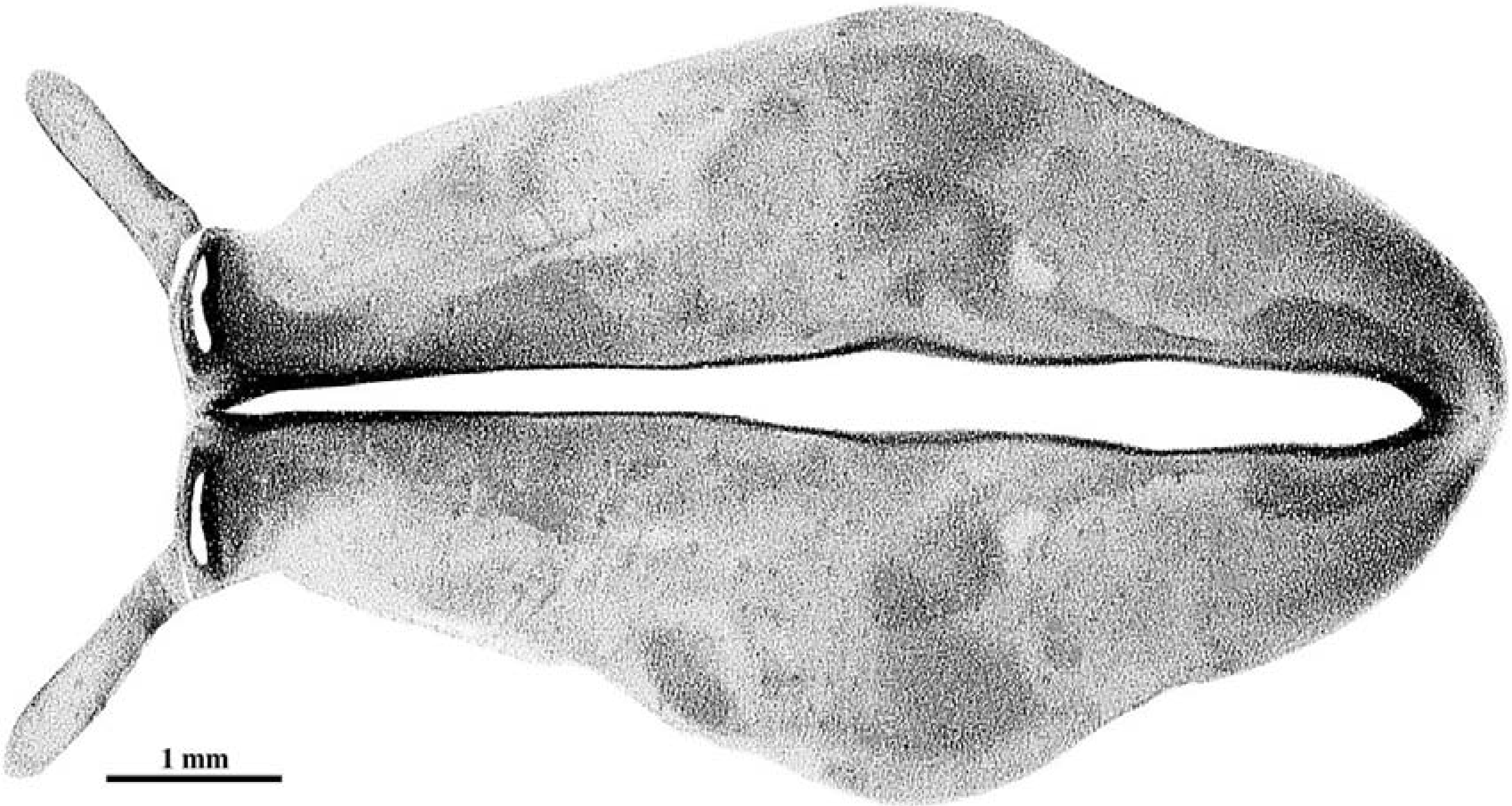
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 91C

GW9 Horizontal
CR 43 mm, C886
Level 9: Section 81



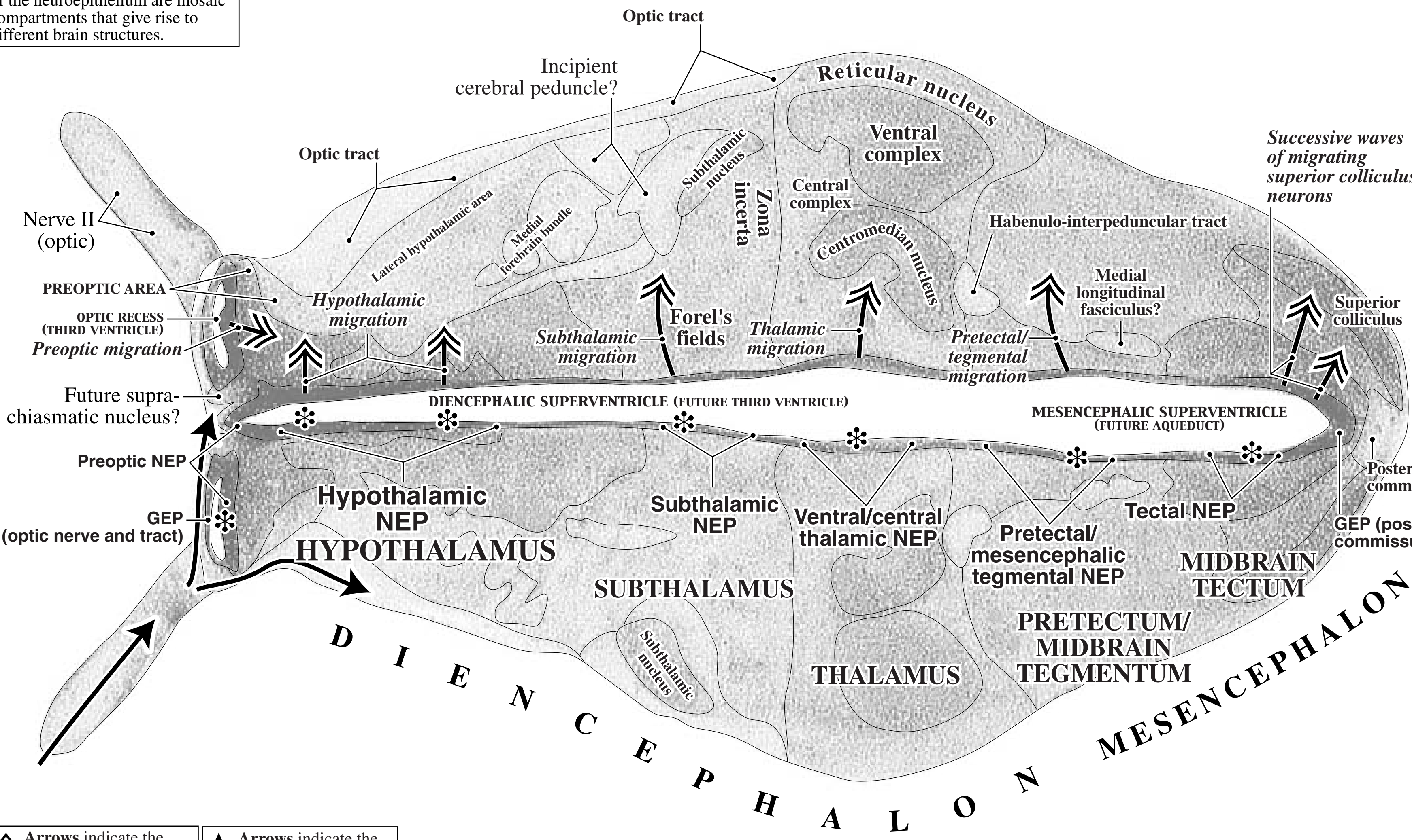
See the entire section in parts A and B of this plate on the preceding pages.

PLATE 91D

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

❋ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**



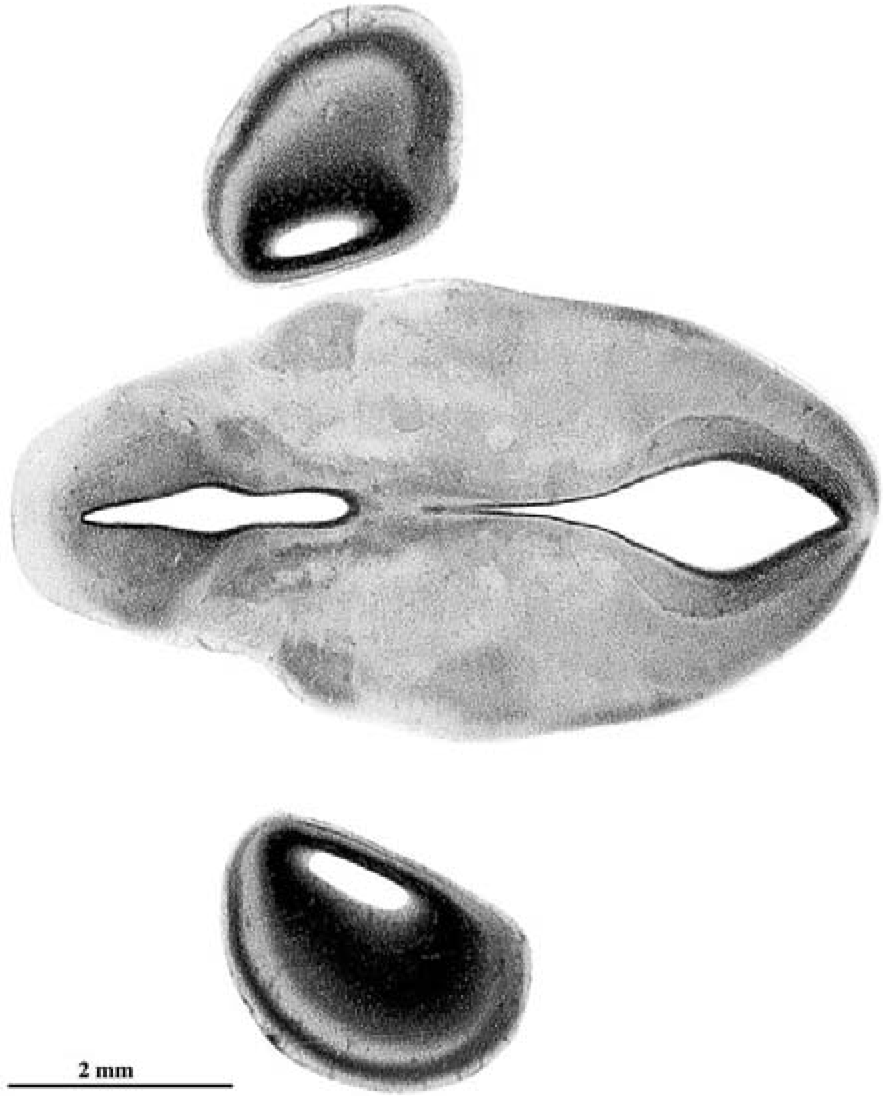
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

PLATE 92A

GW9 Horizontal
CR 43 mm, C886
Level 10: Section 86

See the brain core enlarged in parts C and D of this plate on the following pages.



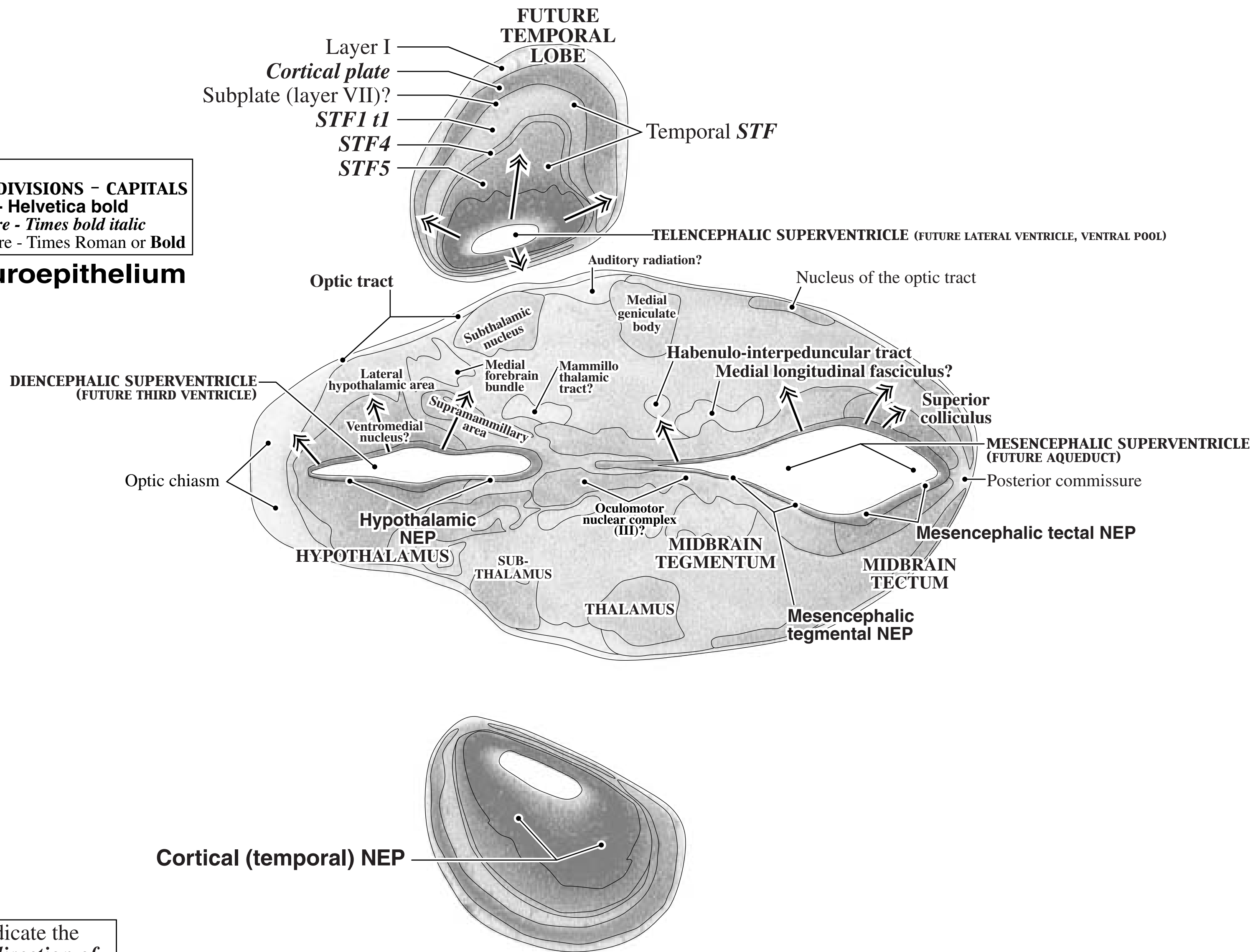
LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 92B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

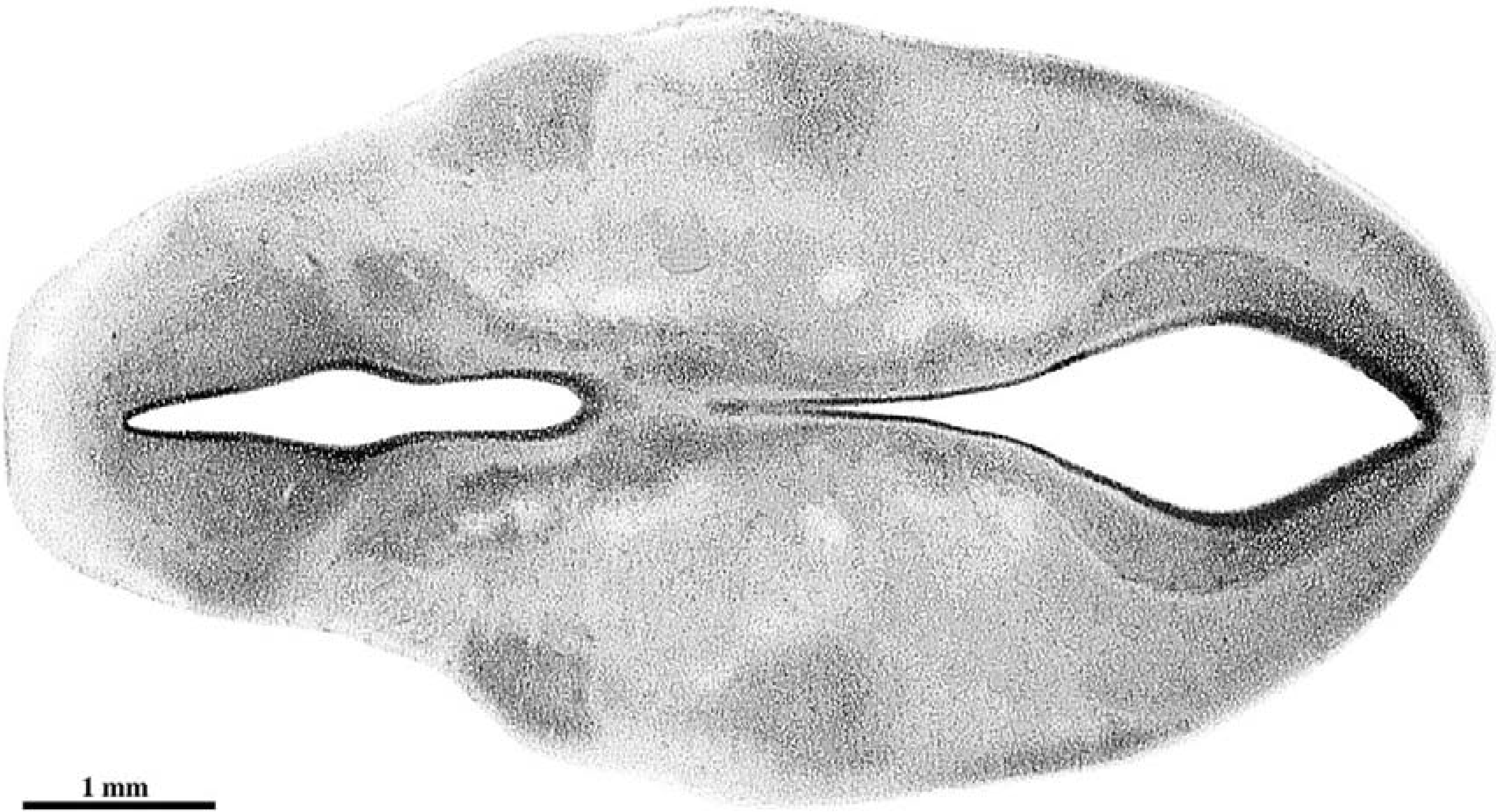
NEP - Neuroepithelium



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 92C

GW9 Horizontal
CR 43 mm, C886
Level 10: Section 86



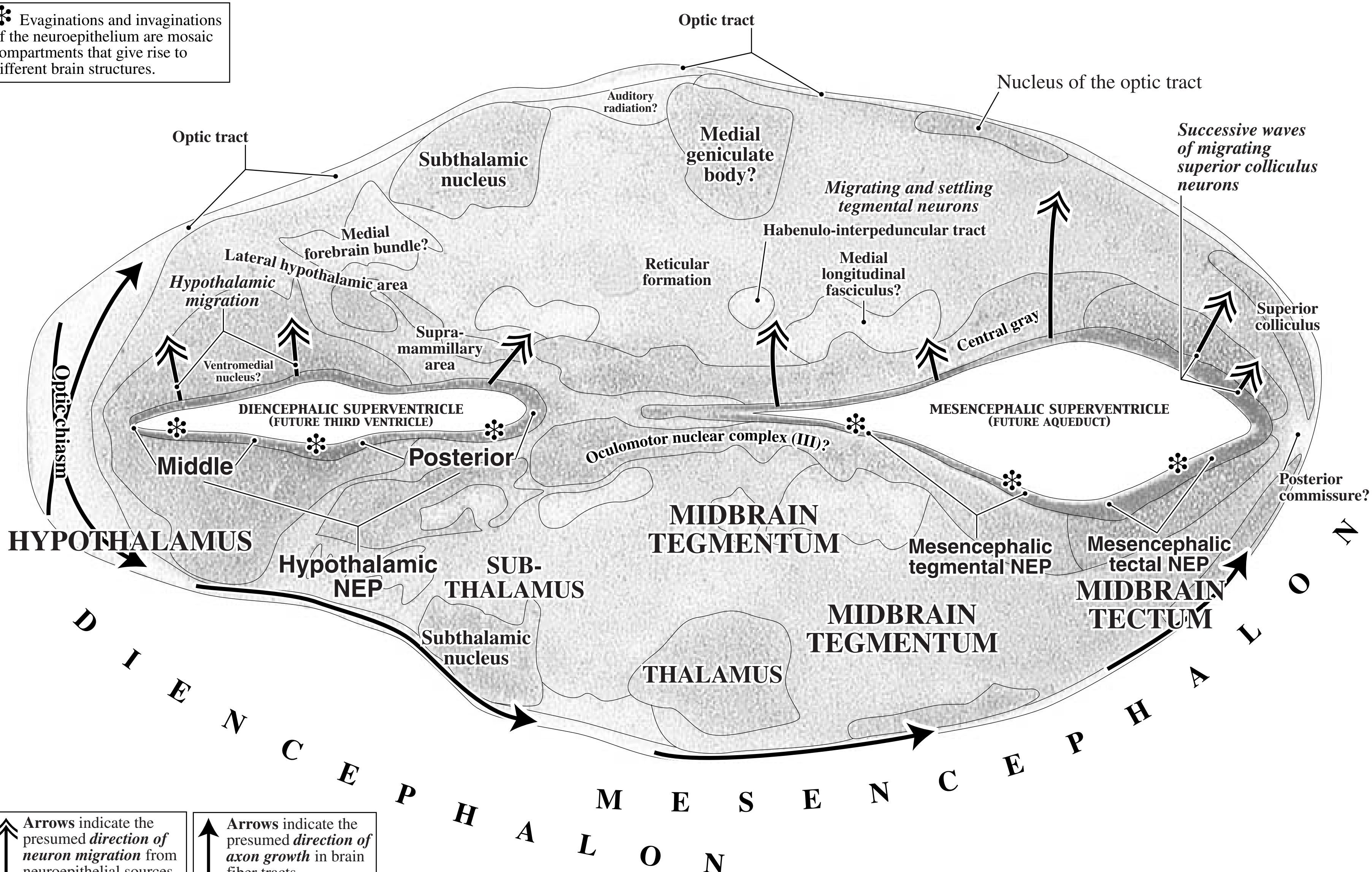
See the entire section in parts A and B of this plate on the preceding pages.

PLATE 92D

NEP - Neuroepithelium

❋ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

PLATE 93A

GW9 Horizontal
CR 43 mm, C886
Level 11: Section 90

See the brain core enlarged in parts C and D of this plate on the following pages.

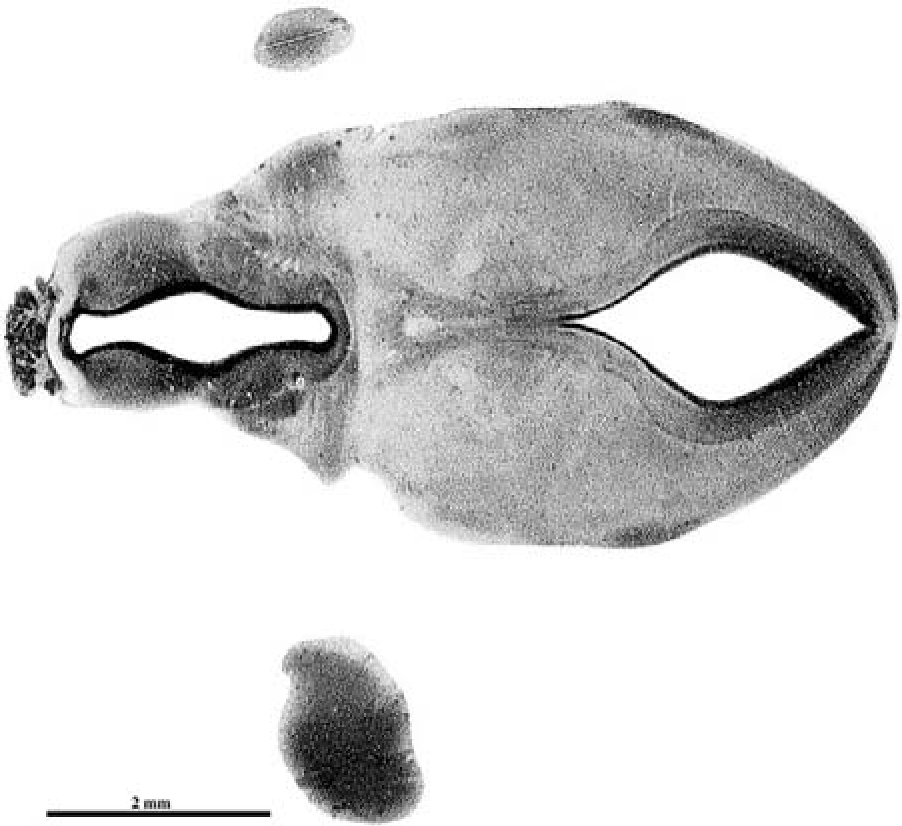
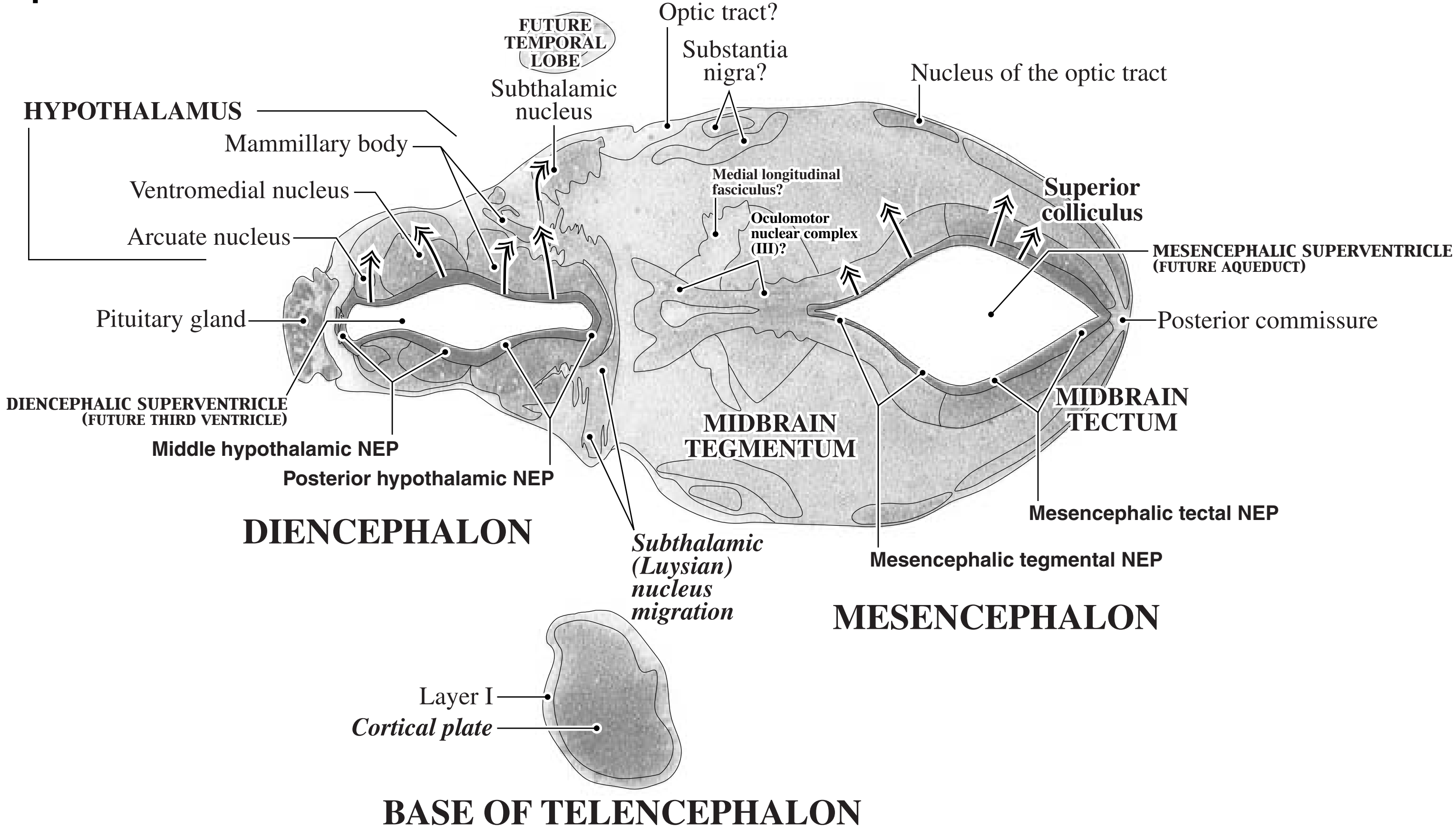


PLATE 93B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

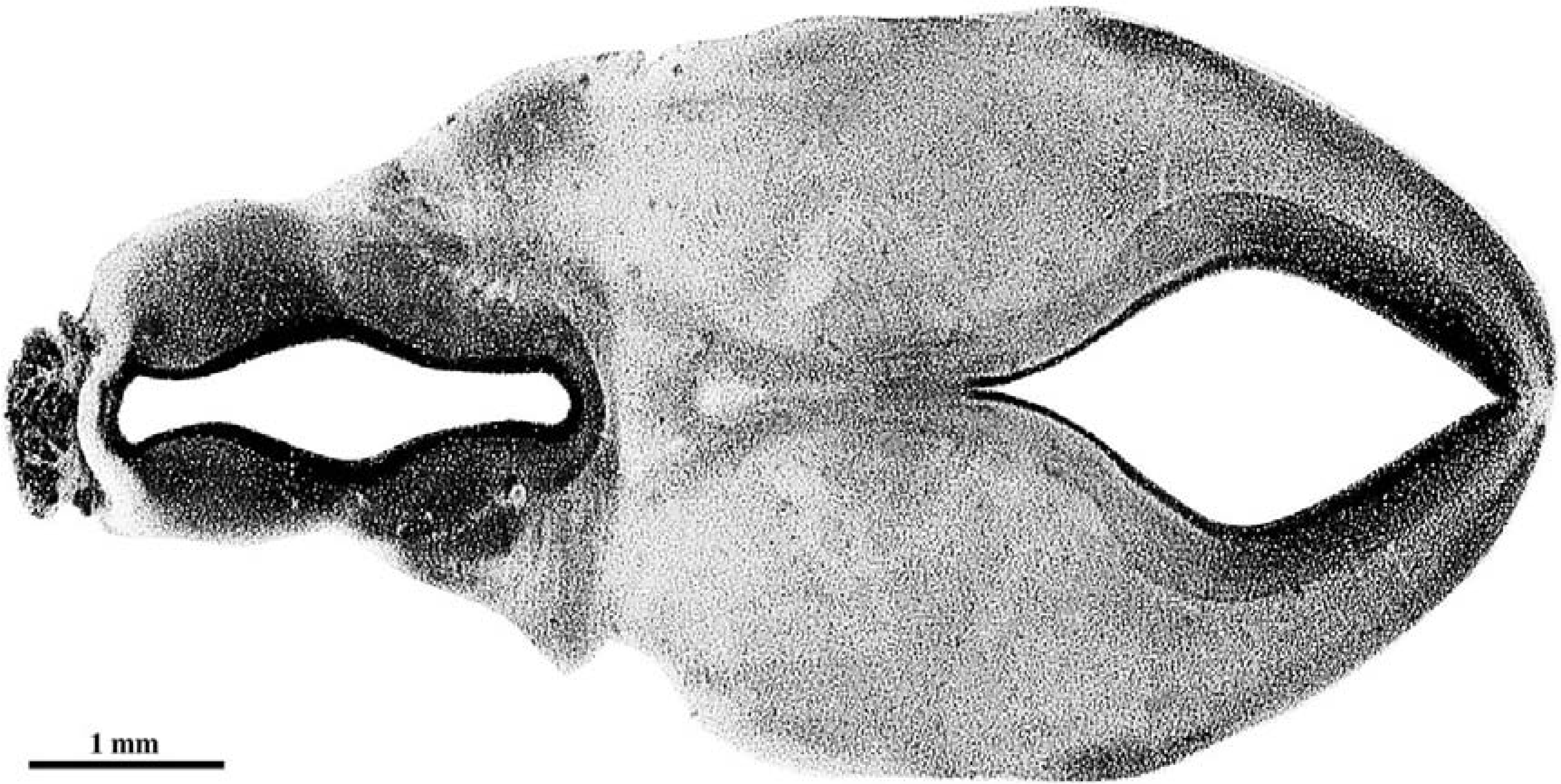
NEP - Neuroepithelium



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 93C

GW9 Horizontal
CR 43 mm, C886
Level 11: Section 90



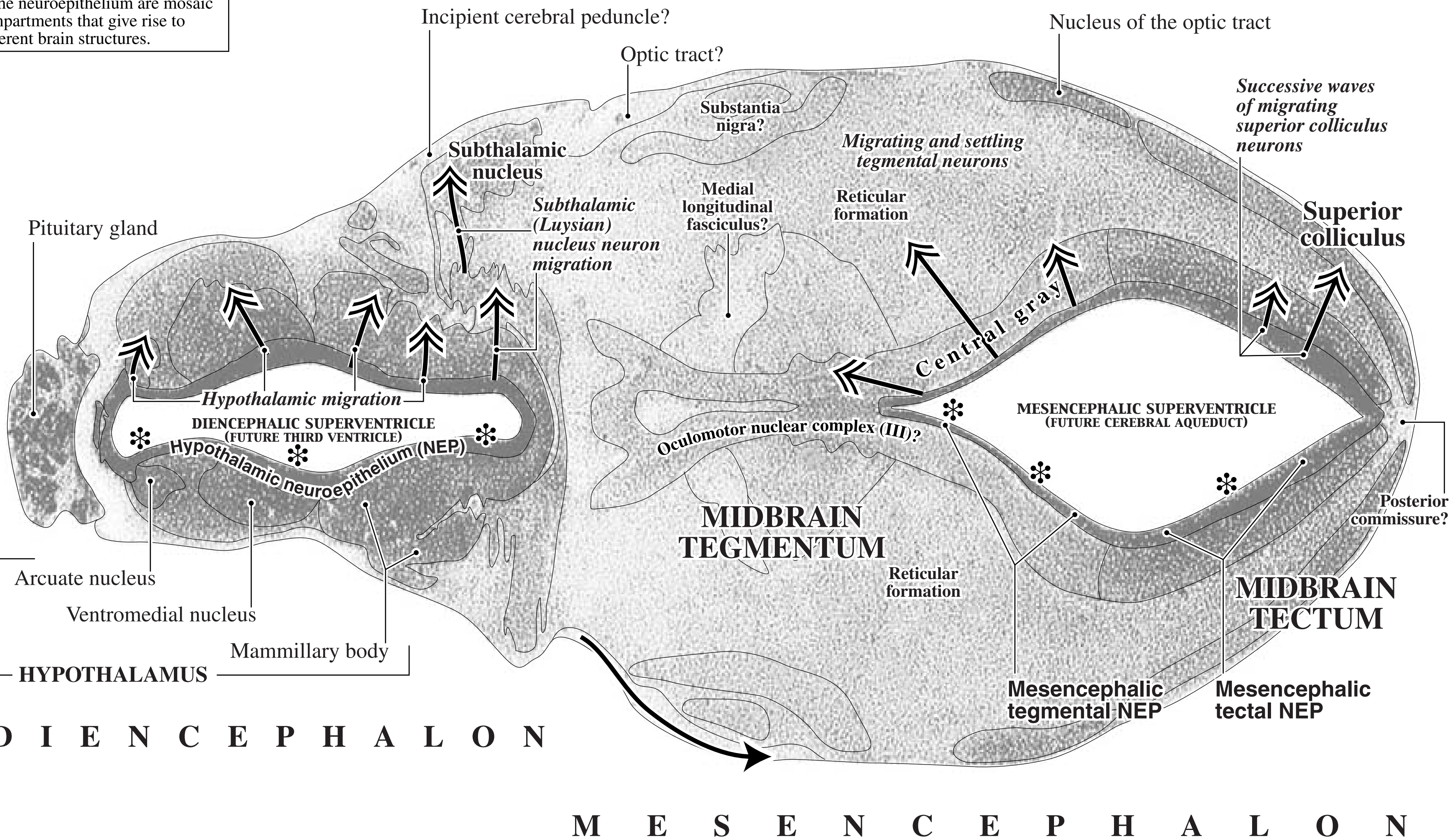
See the entire section in parts A and B of this plate on the preceding pages.

PLATE 93D

NEP - Neuroepithelium

❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

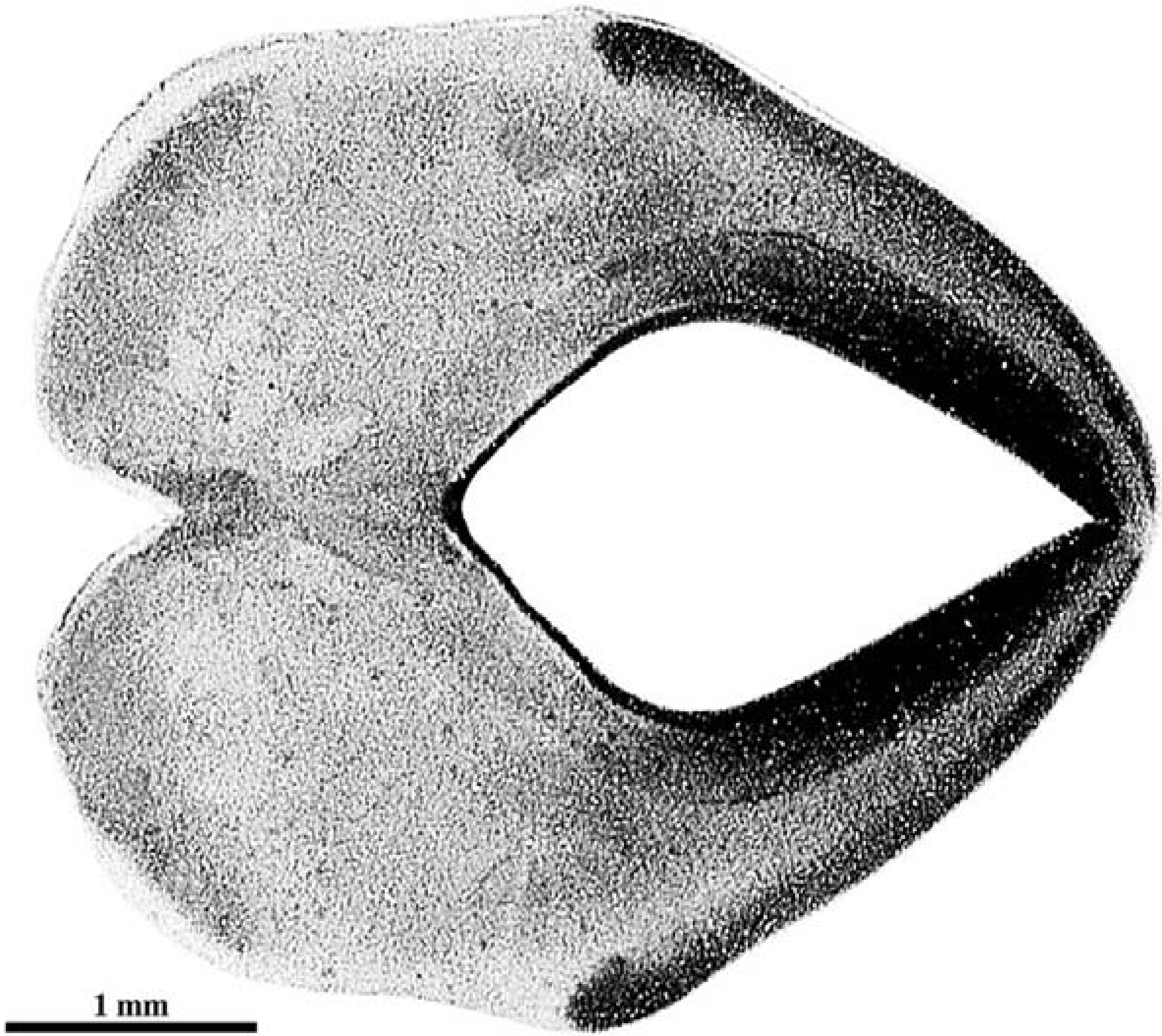


Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

PLATE 94A

GW9 Horizontal
CR 43 mm, C886
Level 12: Section 100



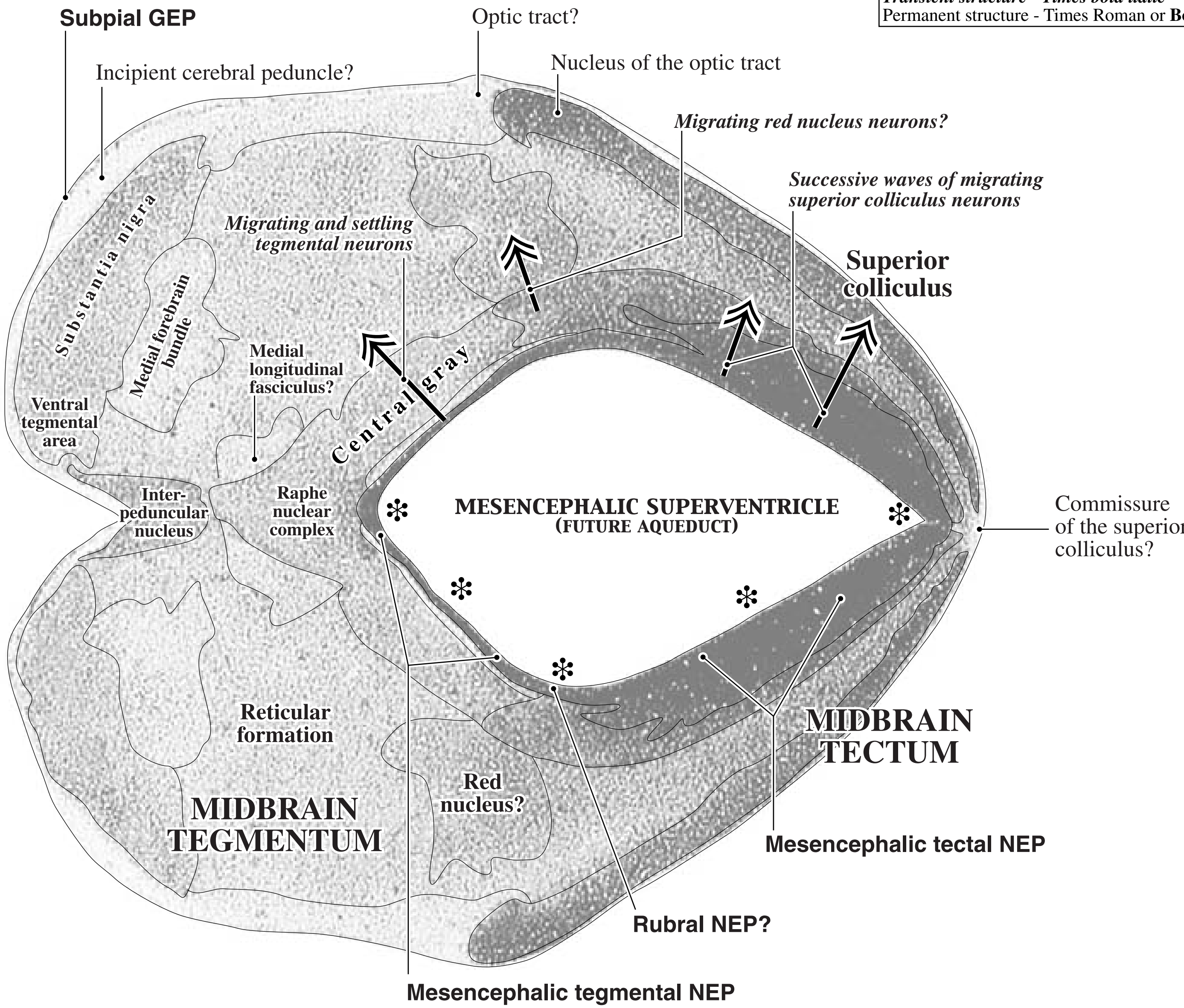
Levels 12 to 19 are shown only at higher magnification.

PLATE 94B

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 95A

GW9 Horizontal
CR 43 mm, C886
Level 13: Section 105

Levels 12 to 19 are shown only at higher magnification.

PLATE 95B

❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.	**ABBREVIATIONS:** **GEP - Glioepithelium** **NEP - Neuroepithelium**	**FONT KEY:** **VENTRICULAR DIVISIONS - CAPITALS** **Germinal zone - Helvetica bold** ***Transient structure - Times bold italic*** Permanent structure - Times Roman or **Bold**

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

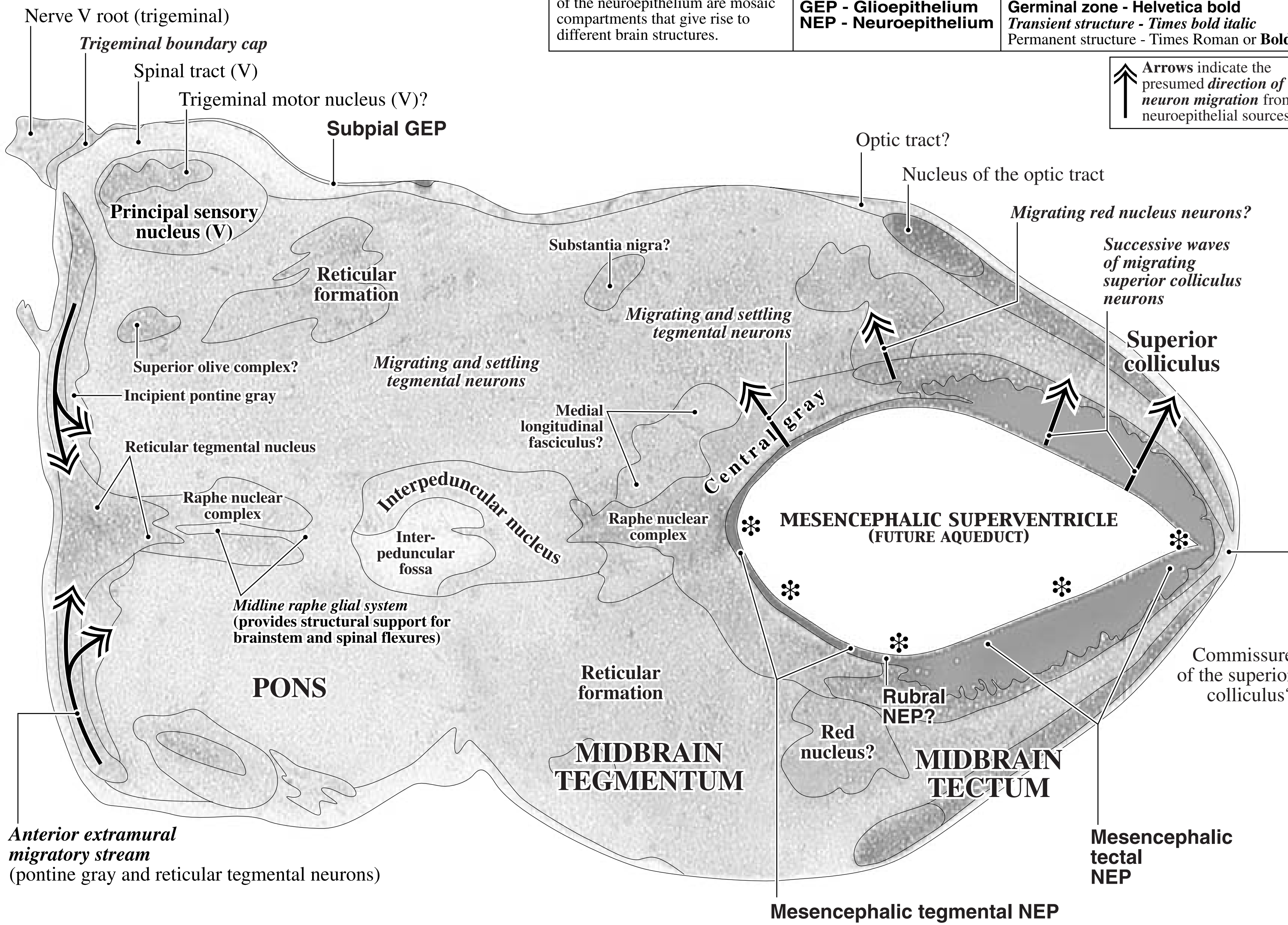
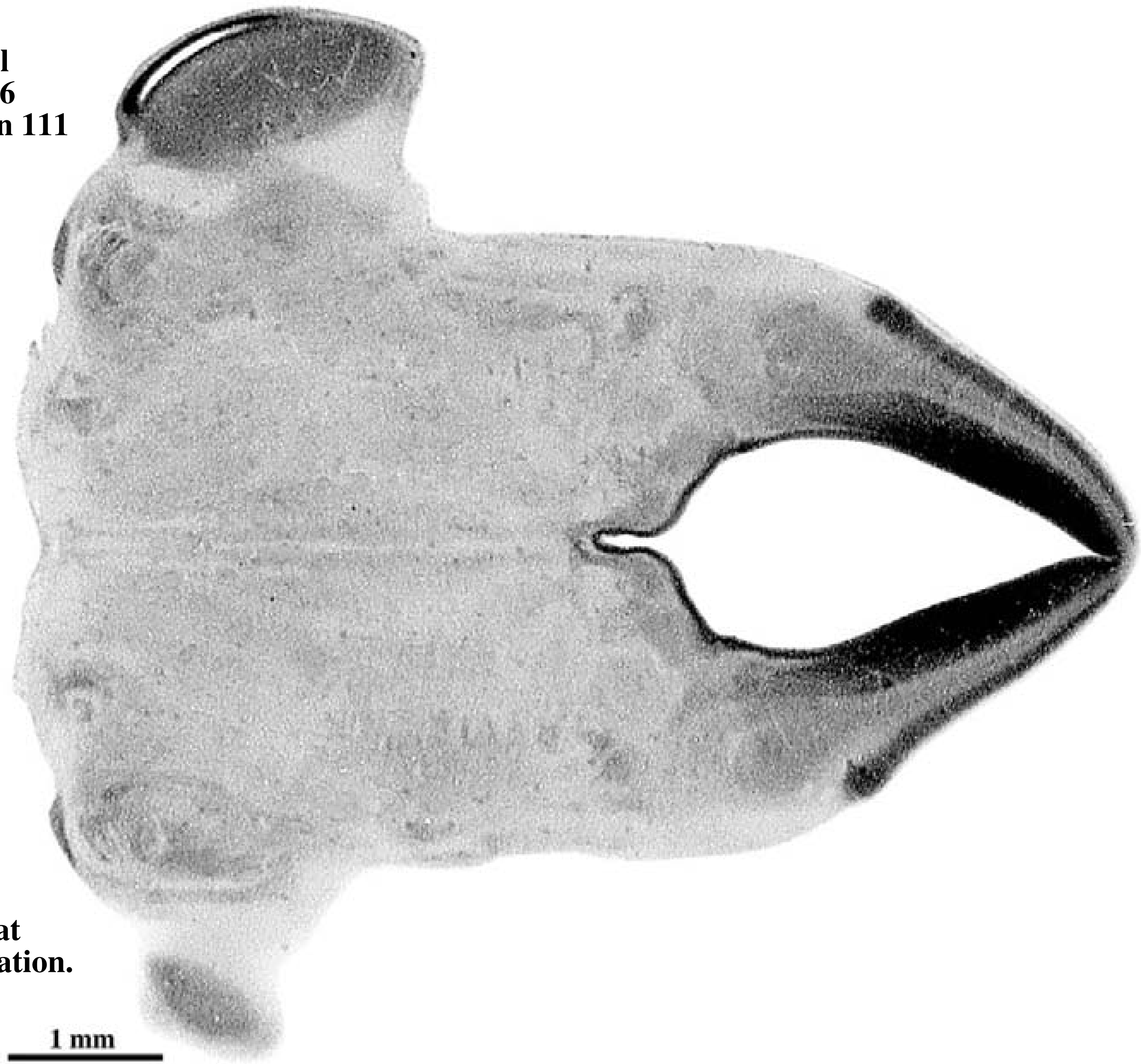


PLATE 96A

GW9 Horizontal
CR 43 mm, C886
Level 14: Section 111



Levels 12 to 19
are shown only at
higher magnification.

PLATE 96B

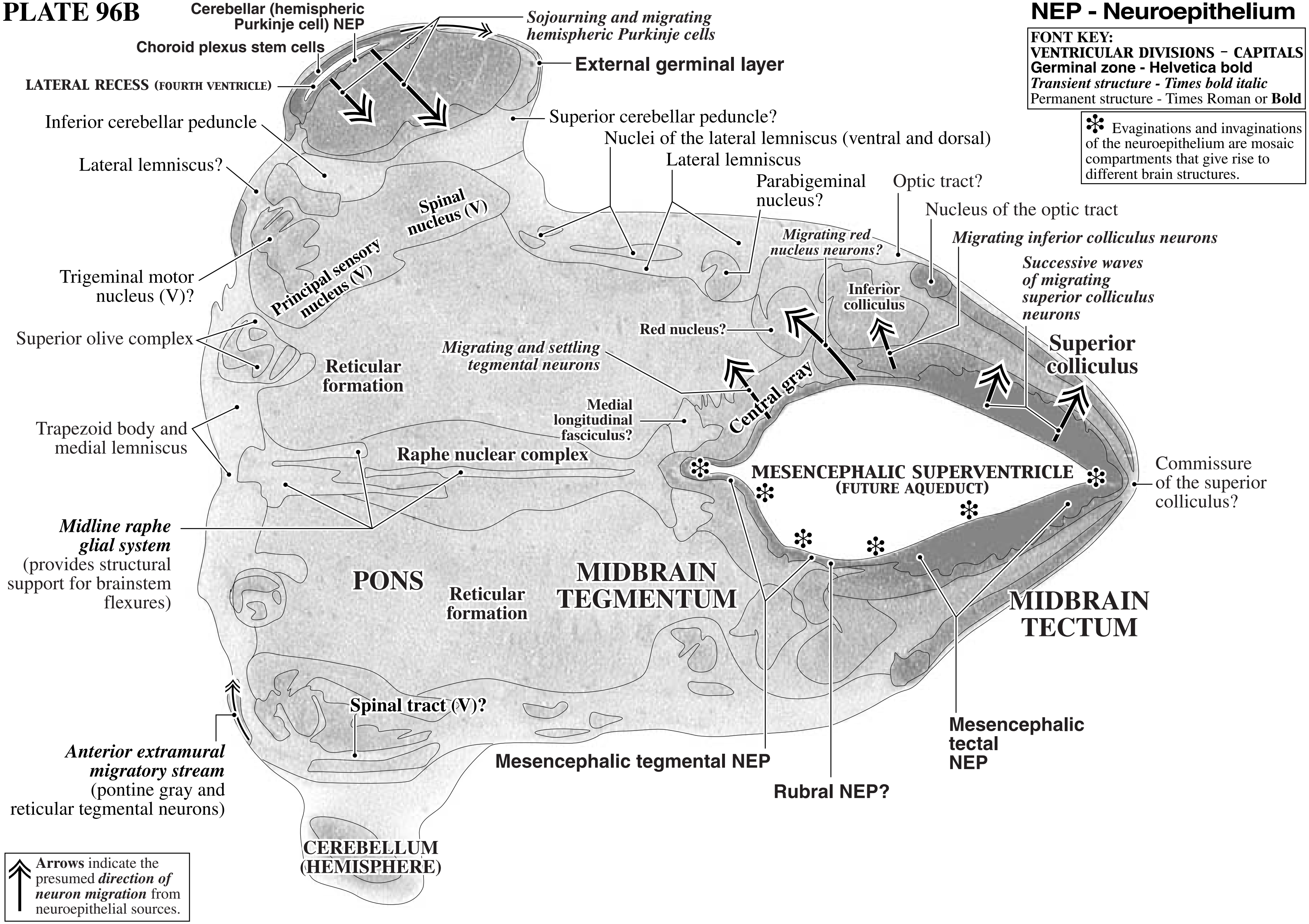
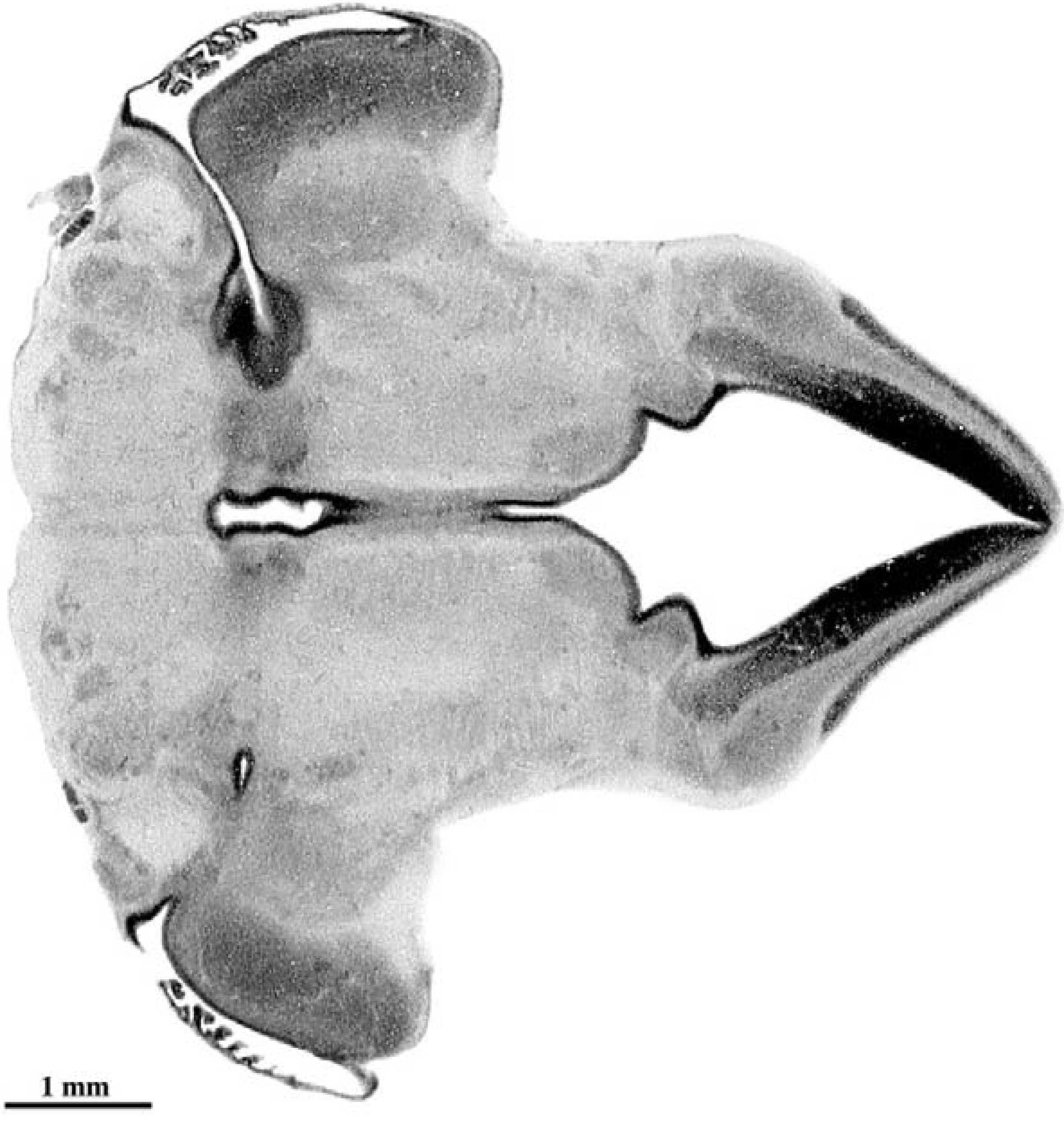

NEP - Neuroepithelium
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
❋ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.
Cerebellar (hemispheric Purkinje cell) NEP
Choroid plexus stem cells
LATERAL RECESS (FOURTH VENTRICLE)
Sojourning and migrating hemispheric Purkinje cells
External germinal layer
Inferior cerebellar peduncle
Superior cerebellar peduncle?
Nuclei of the lateral lemniscus (ventral and dorsal)
Lateral lemniscus
Lateral lemniscus?
Parabigeminal nucleus?
Optic tract?
Nucleus of the optic tract
Spinal nucleus (V)
Principal sensory nucleus (V)
Trigeminal motor nucleus (V)?
Migrating red nucleus neurons?
Migrating inferior colliculus neurons
Successive waves of migrating superior colliculus neurons
Inferior colliculus
Red nucleus?
Superior olive complex
Reticular formation
Migrating and settling tegmental neurons
Superior colliculus
Central gray
Medial longitudinal fasciculus?
Trapezoid body and medial lemniscus
Raphe nuclear complex
MESENCEPHALIC SUPERVENTRICLE
(FUTURE AQUEDUCT)
Commissure of the superior colliculus?
Midline raphe glial system
(provides structural support for brainstem flexures)
PONS
Reticular formation
MIDBRAIN TEGMENTUM
MIDBRAIN TECTUM
Spinal tract (V)?
Anterior extramural migratory stream
(pontine gray and reticular tegmental neurons)
Mesencephalic tegmental NEP
Rubral NEP?
Mesencephalic tectal NEP
CEREBELLUM (HEMISPHERE)
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.

PLATE 97A

GW9 Horizontal
CR 43 mm, C886
Level 15: Section 117



Levels 12 to 19
are shown only at
higher magnification.

PLATE 97B

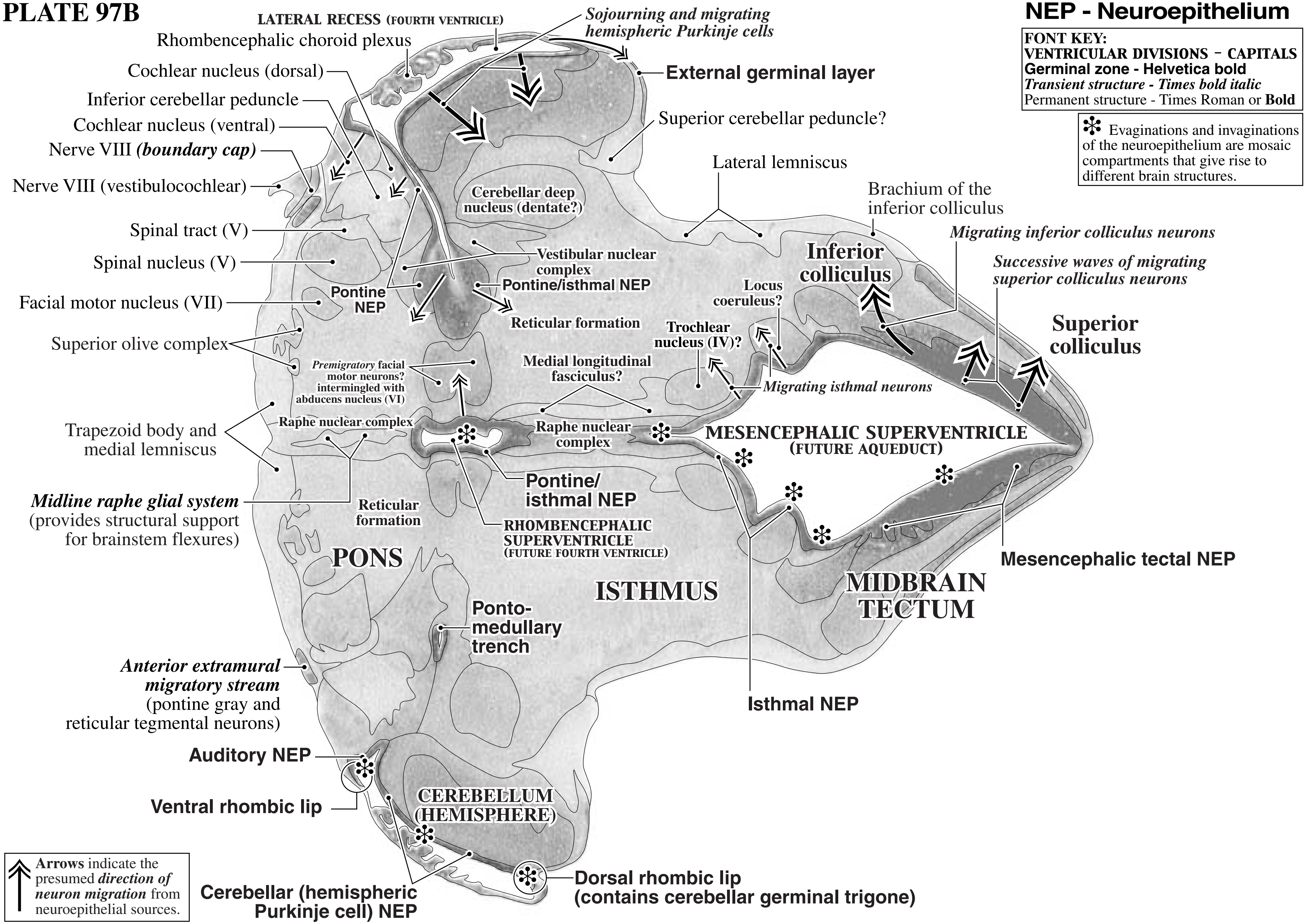
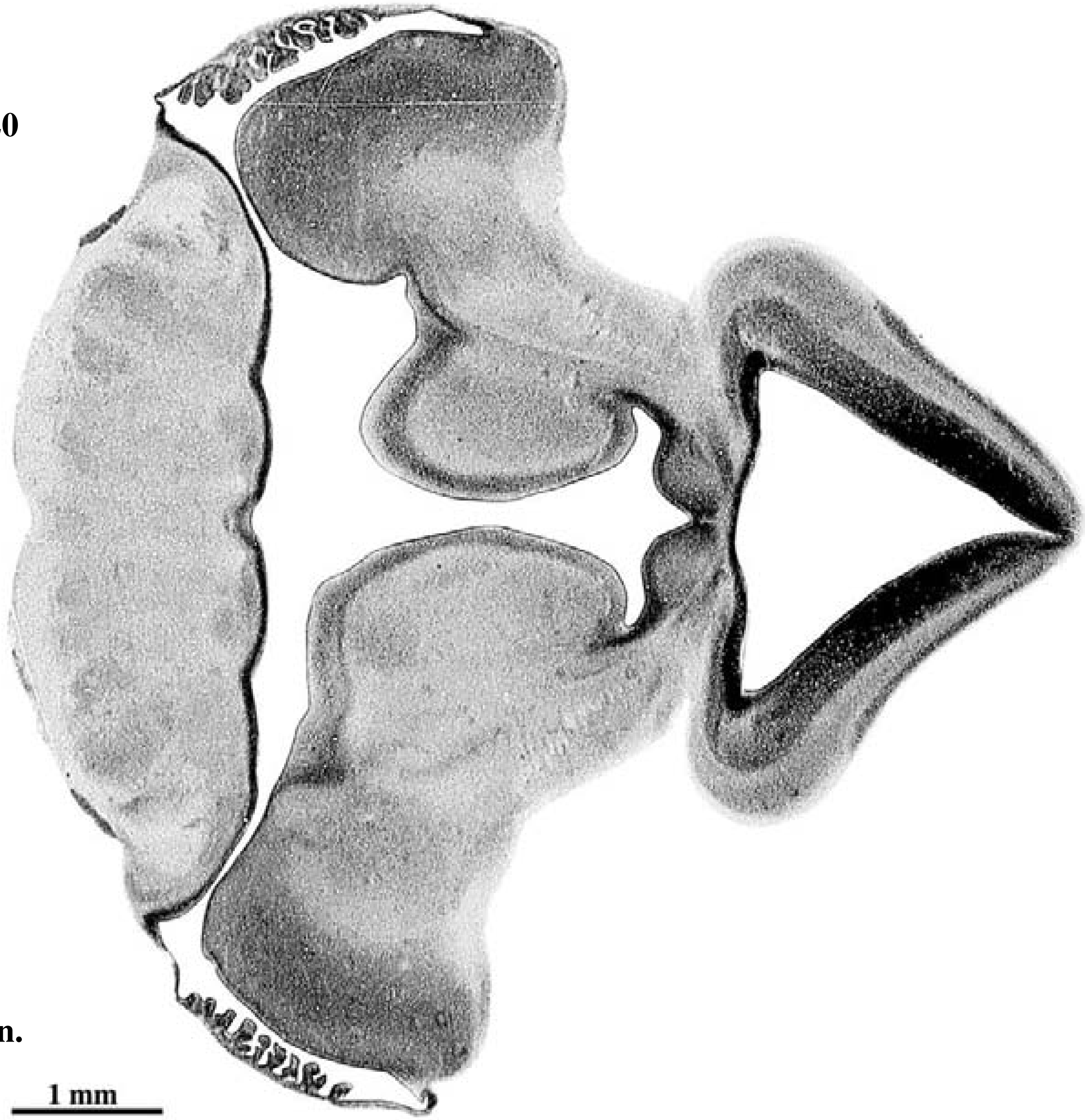

NEP - Neuroepithelium
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.
LATERAL RECESS (FOURTH VENTRICLE)
Rhombencephalic choroid plexus
Sojourning and migrating hemispheric Purkinje cells
External germinal layer
Cochlear nucleus (dorsal)
Inferior cerebellar peduncle
Cochlear nucleus (ventral)
Superior cerebellar peduncle?
Nerve VIII (boundary cap)
Nerve VIII (vestibulocochlear)
Lateral lemniscus
Cerebellar deep nucleus (dentate?)
Brachium of the inferior colliculus
Spinal tract (V)
Migrating inferior colliculus neurons
Vestibular nuclear complex
Spinal nucleus (V)
Inferior colliculus
Successive waves of migrating superior colliculus neurons
Pontine NEP
Pontine/isthmal NEP
Locus coeruleus?
Facial motor nucleus (VII)
Reticular formation
Trochlear nucleus (IV)?
Superior colliculus
Superior olive complex
Medial longitudinal fasciculus?
Premigratory facial motor neurons? intermingled with abducens nucleus (VI)
Migrating isthmal neurons
Raphe nuclear complex
Raphe nuclear complex
MESENCEPHALIC SUPERVENTRICLE (FUTURE AQUEDUCT)
Trapezoid body and medial lemniscus
Pontine/ isthmal NEP
Midline raphe glial system (provides structural support for brainstem flexures)
Reticular formation
RHOMBENCEPHALIC SUPERVENTRICLE (FUTURE FOURTH VENTRICLE)
PONS
Mesencephalic tectal NEP
ISTHMUS
MIDBRAIN TECTUM
Ponto- medullary trench
Anterior extramural migratory stream (pontine gray and reticular tegmental neurons)
Isthmal NEP
Auditory NEP
Ventral rhombic lip
CEREBELLUM (HEMISPHERE)
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Cerebellar (hemispheric Purkinje cell) NEP
Dorsal rhombic lip (contains cerebellar germinal trigone)

PLATE 98A

GW9 Horizontal
CR 43 mm, C886
Level 16: Section 120



Levels 12 to 19
are shown only at
higher magnification.

PLATE 98B

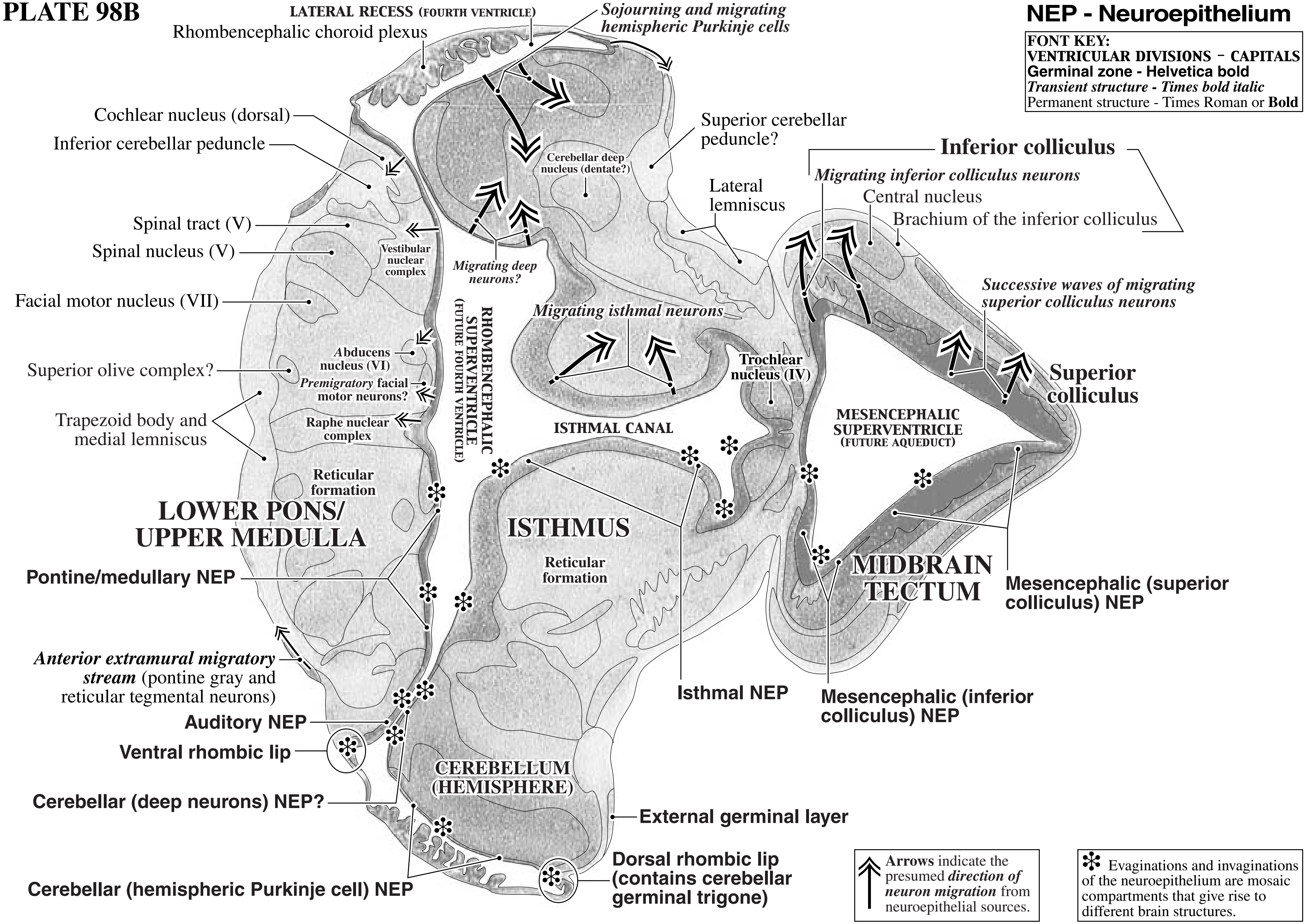
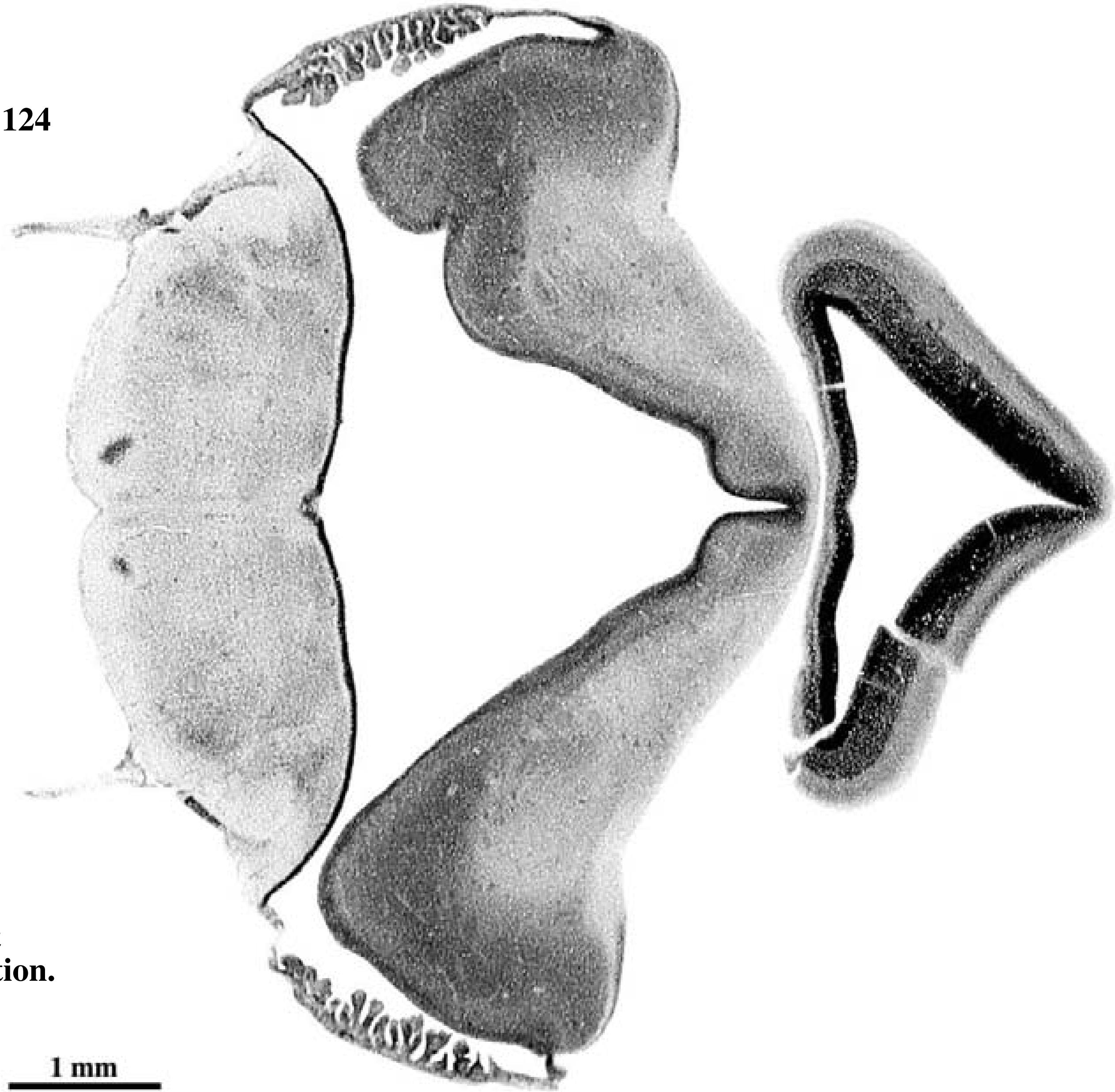

NEP - Neuroepithelium
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
LATERAL RECESS (FOURTH VENTRICLE)
Rhombencephalic choroid plexus
Sojourning and migrating hemispheric Purkinje cells
Cochlear nucleus (dorsal)
Inferior cerebellar peduncle
Cerebellar deep nucleus (dentate?)
Superior cerebellar peduncle?
Inferior colliculus
Migrating inferior colliculus neurons
Central nucleus
Brachium of the inferior colliculus
Lateral lemniscus
Spinal tract (V)
Spinal nucleus (V)
Vestibular nuclear complex
Migrating deep neurons?
Facial motor nucleus (VII)
RHOMBENCEPHALIC SUPERVENTRICLE (FUTURE FOURTH VENTRICLE)
Migrating isthmal neurons
Successive waves of migrating superior colliculus neurons
Abducens nucleus (VI)
Superior olive complex?
Premigratory facial motor neurons?
Trochlear nucleus (IV)
Superior colliculus
Trapezoid body and medial lemniscus
Raphe nuclear complex
ISTHMAL CANAL
MESENCEPHALIC SUPERVENTRICLE (FUTURE AQUEDUCT)
Reticular formation
LOWER PONS/ UPPER MEDULLA
ISTHMUS
Pontine/medullary NEP
Reticular formation
MIDBRAIN TECTUM
Mesencephalic (superior colliculus) NEP
Anterior extramural migratory stream (pontine gray and reticular tegmental neurons)
Isthmal NEP
Mesencephalic (inferior colliculus) NEP
Auditory NEP
Ventral rhombic lip
CEREBELLUM (HEMISPHERE)
Cerebellar (deep neurons) NEP?
External germinal layer
Dorsal rhombic lip (contains cerebellar germinal trigone)
Cerebellar (hemispheric Purkinje cell) NEP
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

PLATE 99A

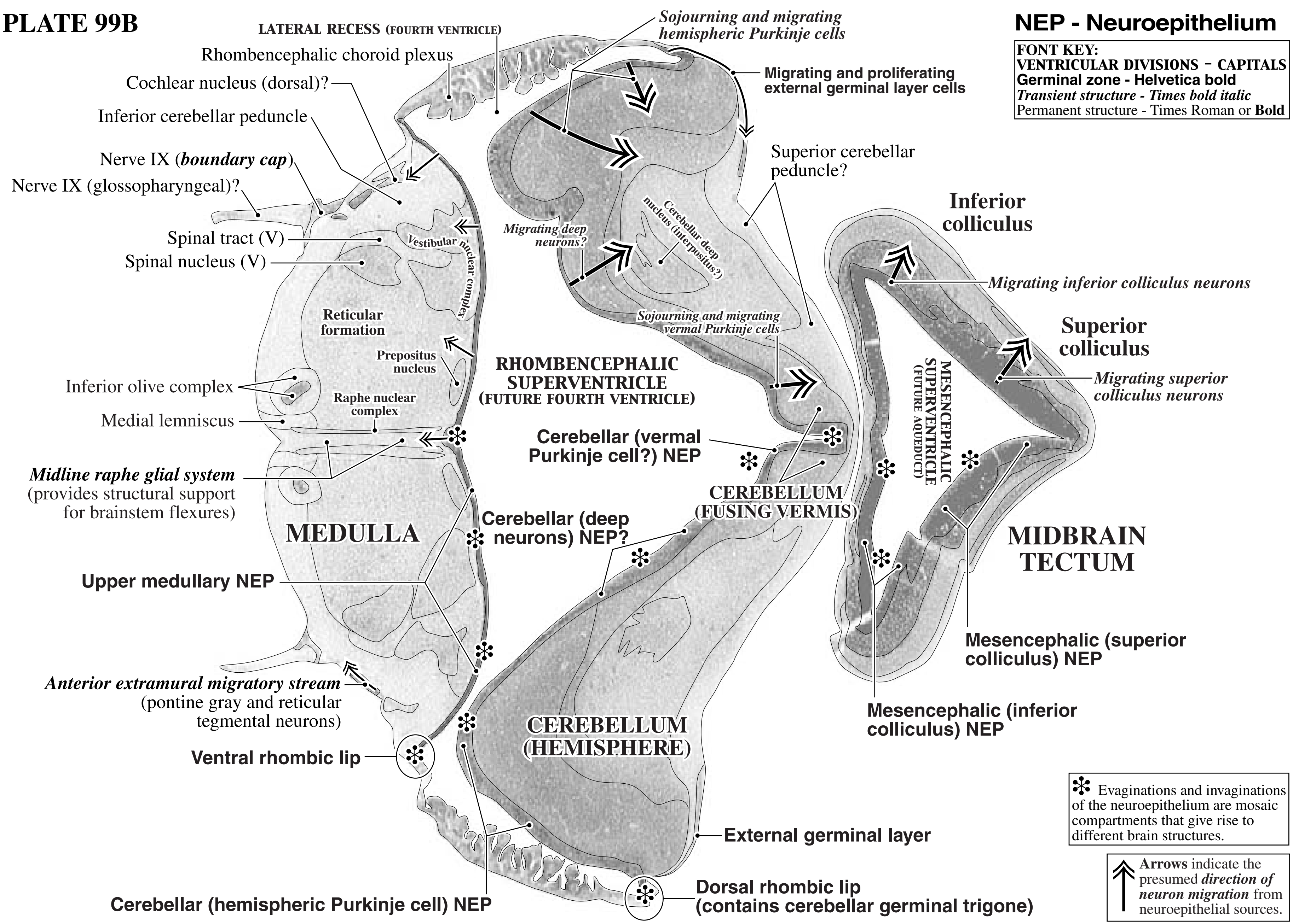
GW9 Horizontal
CR 43 mm, C886
Level 17: Section 124



Levels 12 to 19
are shown only at
higher magnification.

1 mm

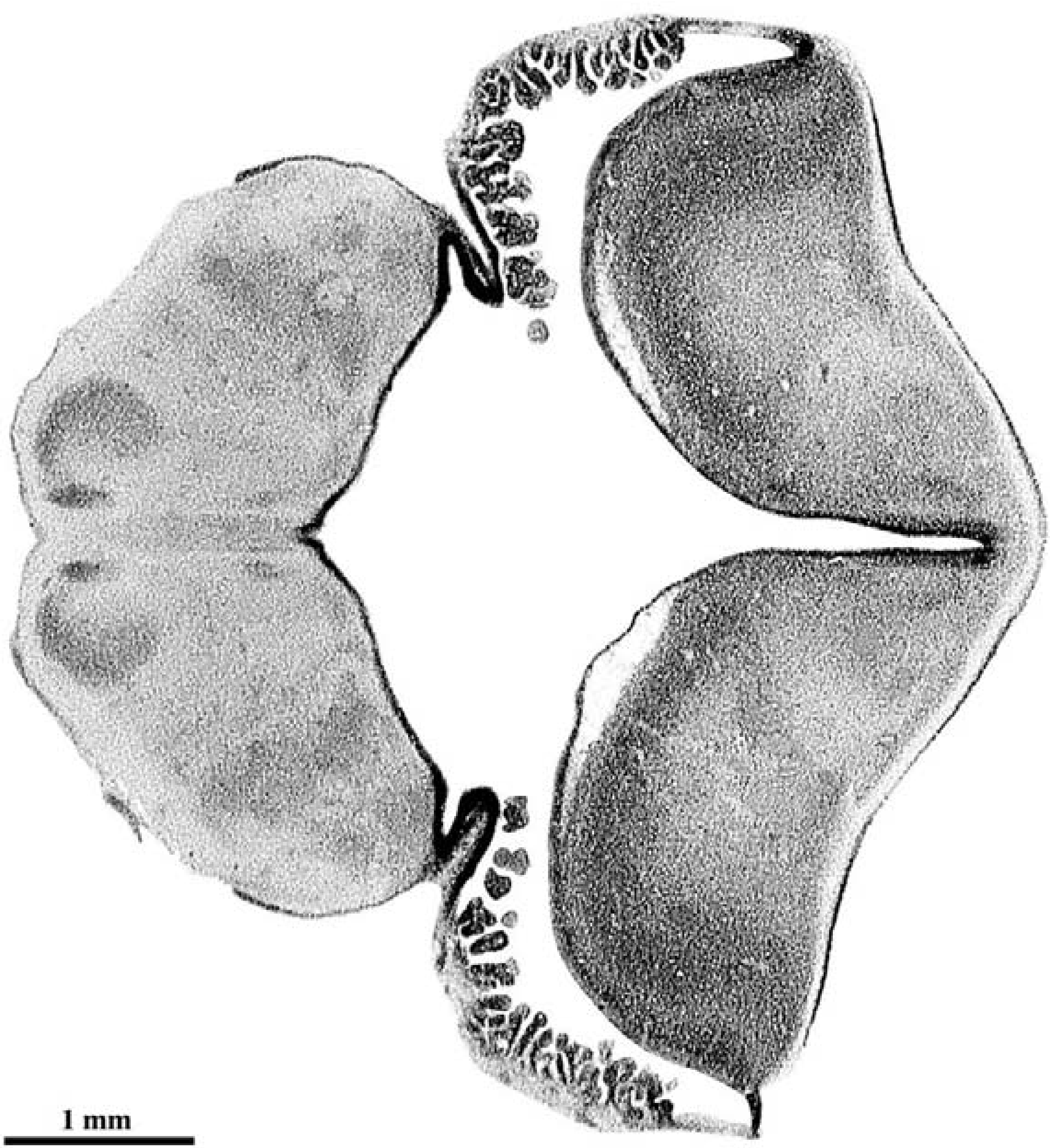
PLATE 99B



NEP - Neuroepithelium
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
LATERAL RECESS (FOURTH VENTRICLE)
Rhombencephalic choroid plexus
Cochlear nucleus (dorsal)?
Inferior cerebellar peduncle
Nerve IX (boundary cap)
Nerve IX (glossopharyngeal)?
Spinal tract (V)
Spinal nucleus (V)
Vestibular nuclear complex
Reticular formation
Prepositus nucleus
Raphe nuclear complex
Inferior olive complex
Medial lemniscus
Midline raphe glial system
(provides structural support for brainstem flexures)
MEDULLA
Upper medullary NEP
Anterior extramural migratory stream
(pontine gray and reticular tegmental neurons)
Ventral rhombic lip
Cerebellar (hemispheric Purkinje cell) NEP
Sojourning and migrating hemispheric Purkinje cells
Migrating and proliferating external germinal layer cells
Superior cerebellar peduncle?
Migrating deep neurons?
Cerebellar deep nucleus (interpositus?)
Sojourning and migrating vermal Purkinje cells
RHOMBENCEPHALIC SUPERVENTRICLE (FUTURE FOURTH VENTRICLE)
Cerebellar (vermal Purkinje cell?) NEP
Cerebellar (deep neurons) NEP?
CEREBELLUM (FUSING VERMIS)
CEREBELLUM (HEMISPHERE)
External germinal layer
Dorsal rhombic lip (contains cerebellar germinal trigone)
Inferior colliculus
Migrating inferior colliculus neurons
Superior colliculus
Migrating superior colliculus neurons
MESENCEPHALIC SUPERVENTRICLE (FUTURE AQUEDUCT)
MIDBRAIN TECTUM
Mesencephalic (superior colliculus) NEP
Mesencephalic (inferior colliculus) NEP
Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.

PLATE 100A

GW9 Horizontal
CR 43 mm, C886
Level 18: Section 134



Levels 12 to 19
are shown only at
higher magnification.

PLATE 100B

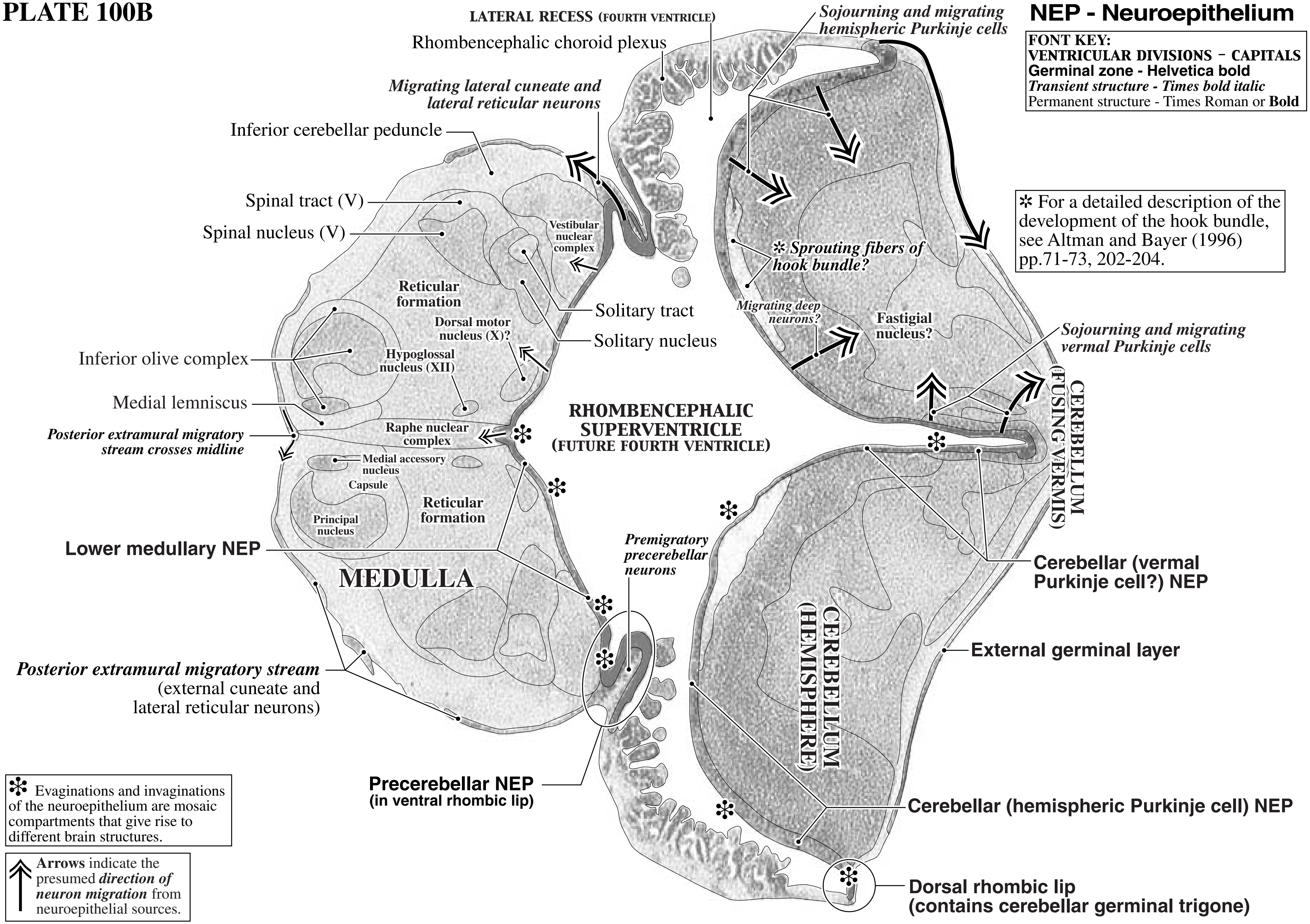
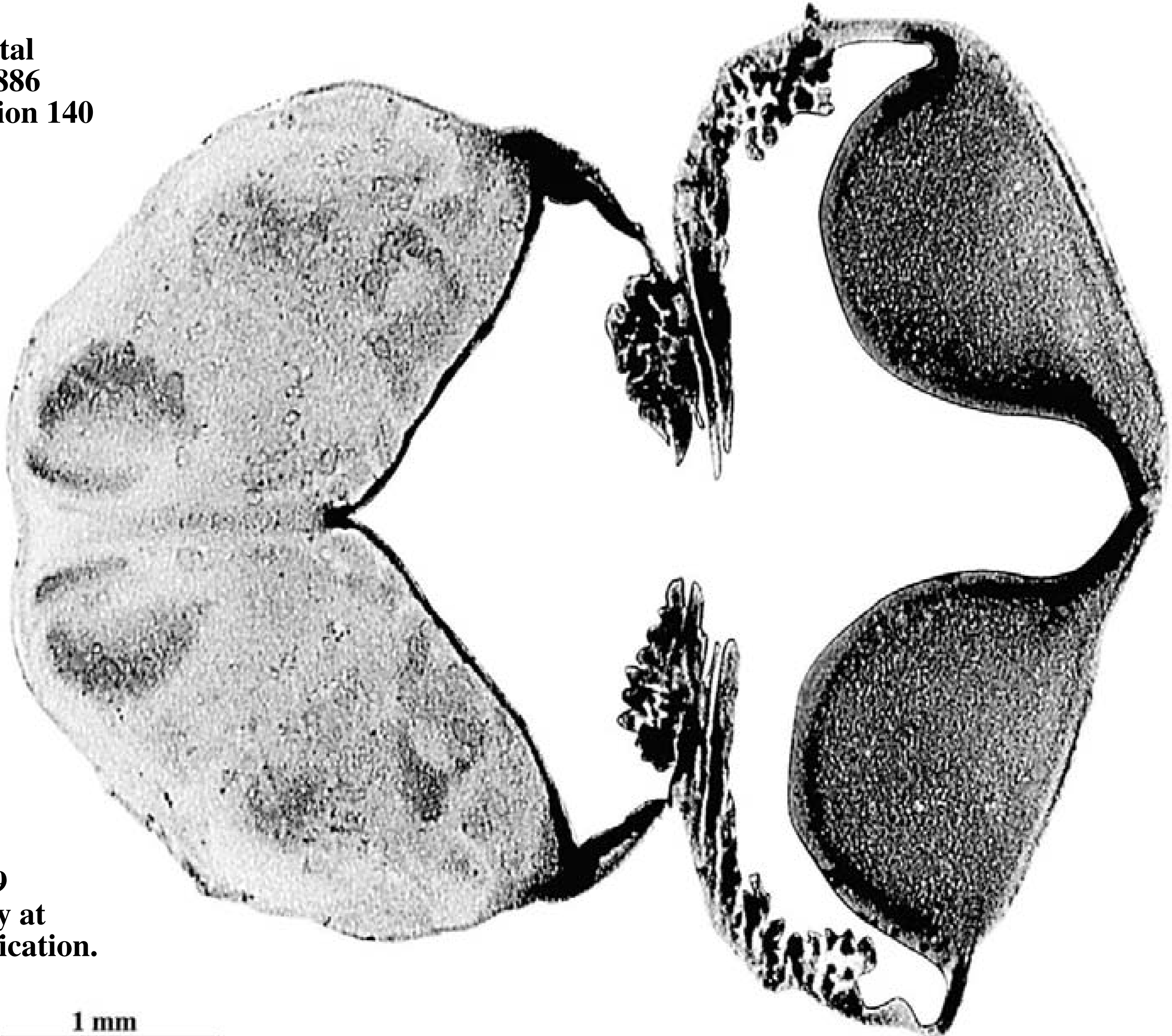

NEP - Neuroepithelium
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
LATERAL RECESS (FOURTH VENTRICLE)
Rhombencephalic choroid plexus
Sojourning and migrating hemispheric Purkinje cells
Migrating lateral cuneate and lateral reticular neurons
Inferior cerebellar peduncle
Spinal tract (V)
Spinal nucleus (V)
Vestibular nuclear complex
✻ For a detailed description of the development of the hook bundle, see Altman and Bayer (1996) pp.71-73, 202-204.
✻ Sprouting fibers of hook bundle?
Reticular formation
Solitary tract
Solitary nucleus
Migrating deep neurons?
Fastigial nucleus?
Dorsal motor nucleus (X)?
Hypoglossal nucleus (XII)
Inferior olive complex
Sojourning and migrating vermal Purkinje cells
CEREBELLUM (FUSING VERMIS)
Medial lemniscus
RHOMBENCEPHALIC SUPERVENTRICLE (FUTURE FOURTH VENTRICLE)
Raphe nuclear complex
Posterior extramural migratory stream crosses midline
Medial accessory nucleus
Capsule
Principal nucleus
Reticular formation
Lower medullary NEP
MEDULLA
Premigratory precerebellar neurons
Cerebellar (vermal Purkinje cell?) NEP
CEREBELLUM (HEMISPHERE)
External germinal layer
Posterior extramural migratory stream (external cuneate and lateral reticular neurons)
✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.
Precerebellar NEP (in ventral rhombic lip)
Cerebellar (hemispheric Purkinje cell) NEP
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Dorsal rhombic lip (contains cerebellar germinal trigone)

PLATE 101A

GW9 Horizontal
CR 43 mm, C886
Level 19: Section 140



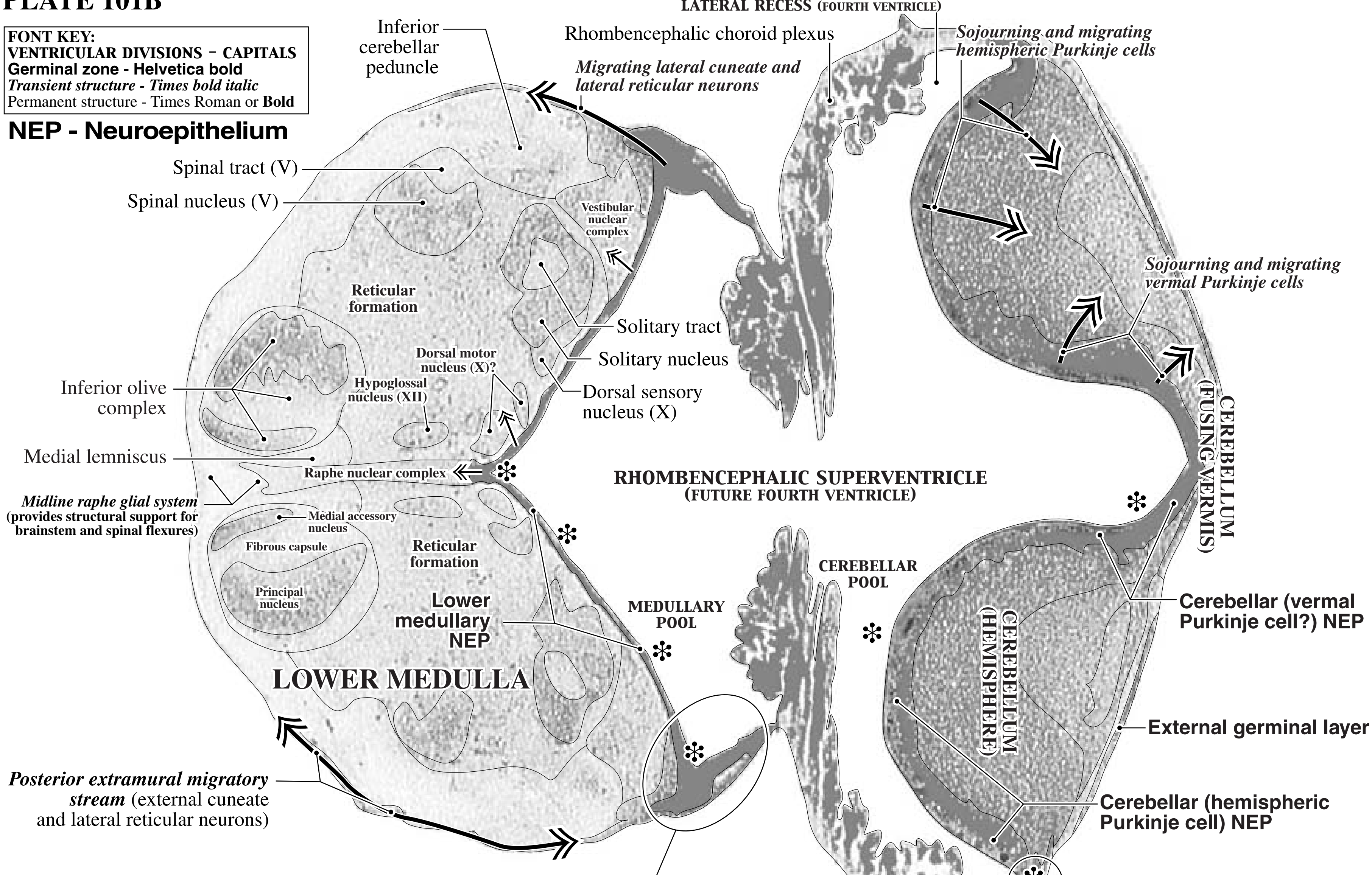
Levels 12 to 19
are shown only at
higher magnification.

1 mm

PLATE 101B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

NEP - Neuroepithelium



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

PART VI: GW9 CORONAL

PART VI: GW9 CORONAL

This specimen is human fetus number 282 with a crown-rump length (CR) of 42 mm estimated to be at gestational week (GW) 9 (Minot Collection histological record number 841, referred to here as M841). The fetus was embedded in paraffin, cut in 10-µm thick sections, and stained with borax carmine and Lyon's blue. No information is available on date of collection (sometime between 1900 and 1910) and the kind of fixative. Since there is no photograph of this brain before it was embedded and cut, a specimen from Hochstetter (1919) that is comparable to M841 has been modified to show the approximate section plane and external features of the brain at GW9 (inset, **Figure 5**). Like most of the specimens in this Volume, the sections are not cut exactly in one plane; M841 is midway between coronal and horizontal. Since the cerebral cortex is in every section and the brainstem is cut in a more horizontal orientation, the brain more closely resembles a coronally sectioned brain. Photographs of 22 sections (**Levels 1-22**) are illustrated at low magnification in **Plates 102-121**. Excellent tissue detail is preserved at low magnification, but there is a fine granular precipitate visible at high magnification.

M841 is similar to the other GW9 specimens in the level of brain maturation. The chief reason for including this specimen is to provide a third perspective for viewing brain structure at GW9. In the cerebral cortex, the ***neuroepithelium*** is prominent as the sole germinal matrix; the ***stratified transitional field (STF)*** consists of ***STF1***, ***STF5***, and ***STF4*** only in lateral areas. The anterolateral (thicker) to dorsomedial (thinner) maturation gradient in the cortical plate and ***STF*** layers are evident. In this specimen, the olfactory evagination is most evident coming from the basal telencephalic rather than from the cerebral cortical neuroepithelium. In anterolateral parts of the cerebral cortex, streams of neurons and glia appear to leave ***STF4*** and enter the ***lateral migratory stream***. A massive ***neuroepithelium/subventricular zone*** overlies the amygdala, nucleus accumbens, and striatum (caudate and putamen) where neurons (and glia) are being generated.

The cerebellum has a definite ***neuroepithelium*** at the ventricular surface. Most of the Purkinje cells are sojourning in a thick dense layer outside the neuroepithelium, and others are migrating upward. Many of the deep neurons are superificial in the cerebellum, but some are migrating downward to intermingle with upwardly migrating Purkinje cells. The cortical surface is partially covered by an ***external germinal layer (egl)*** that is actively producing neuronal stem cells, as it grows over the surface of the cerebellar cortex.

The third ventricle, aqueduct, and fourth ventricle are lined by thin ***neuroepithelia***. The midbrain tegmentum, pons, and medulla have the thinnest neuroepithelia indicating that only the latest generated neurons are being produced at this time. The thick precerebellar neuroepithelium is an exception in the medulla. Thicker neuroepithelia are in the cerebellum (see above) and midbrain tectum, indicating many neurons are still being generated, although the majority of the neurons in these sites are already postmitotic. The neuroepithelium is still thicker in the hypothalamus and thalamus, in accordance with the later maturation of the diencephalon compared to the rest of the brainstem.

Neurons throughout the diencephalon, midbrain tegmentum, pons, and medulla are migrating and settling. Nuclear divisions are very indistinct throughout the diencephalon because more neurons are migrating and have not yet settled permanently. More definition is seen in the midbrain tegmentum, pons, and medulla where cell migration is waning. As with the other GW9 speciments, the ***anterior extramural*** and ***posterior extramural migratory streams*** are dense subpial accumulations in the medulla and pons.

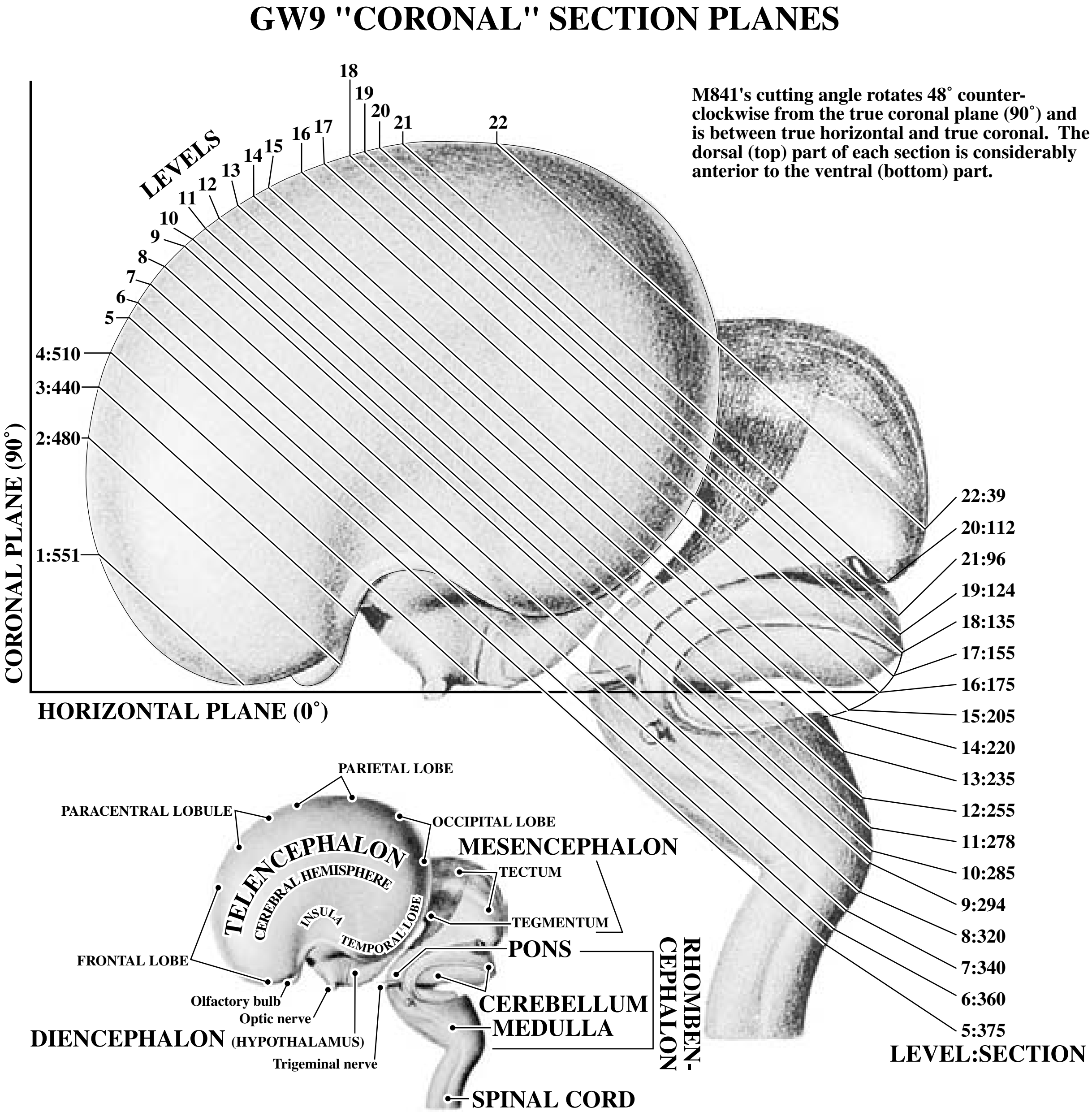


Figure 5. The lateral view of the brain and upper cervical spinal cord from a specimen with a crown-rump length of 38 mm (modified from Figure 43, Table VII, Hochstetter, 1919) serves to show the approximate locations and cutting angles of the illustrated sections of M841 in the following pages. The small inset identifies the major structural features. The line in the cerebellum and dorsal edges of the pons and medulla is the cut edge of the medullary velum.

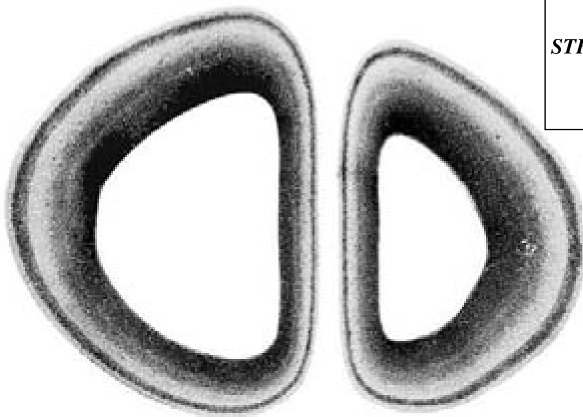
PLATE 102A

GW9 Coronal
CR 42 mm
M841

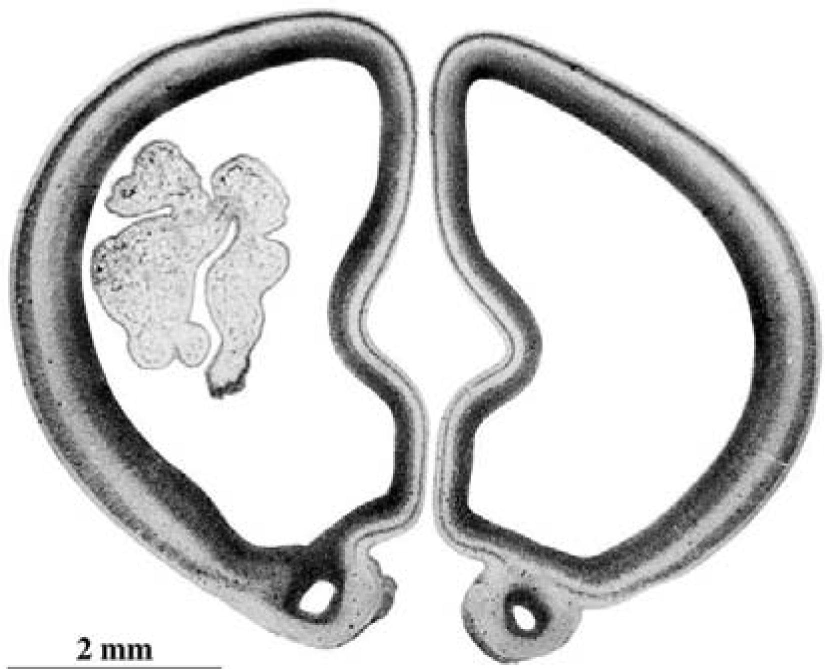
LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

Level 1: Section 551



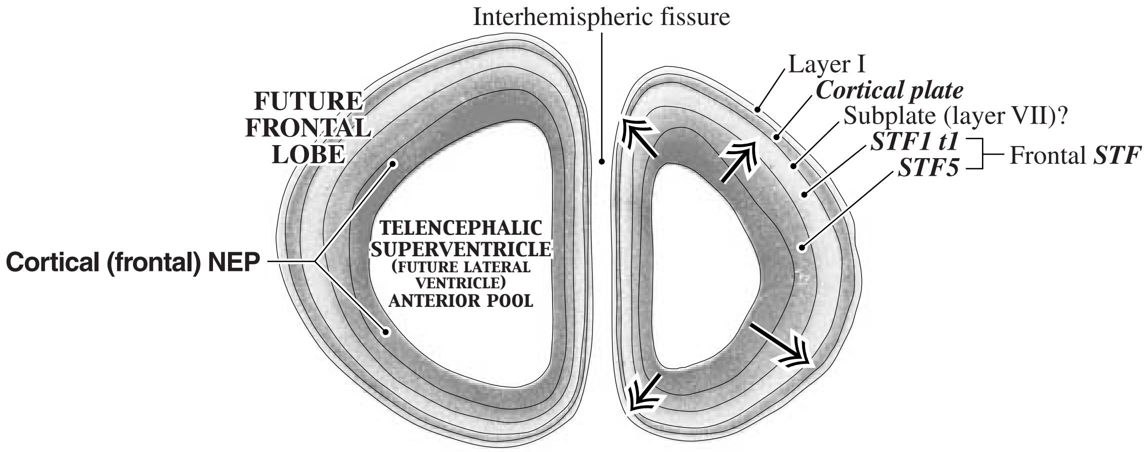
Level 2: Section 480



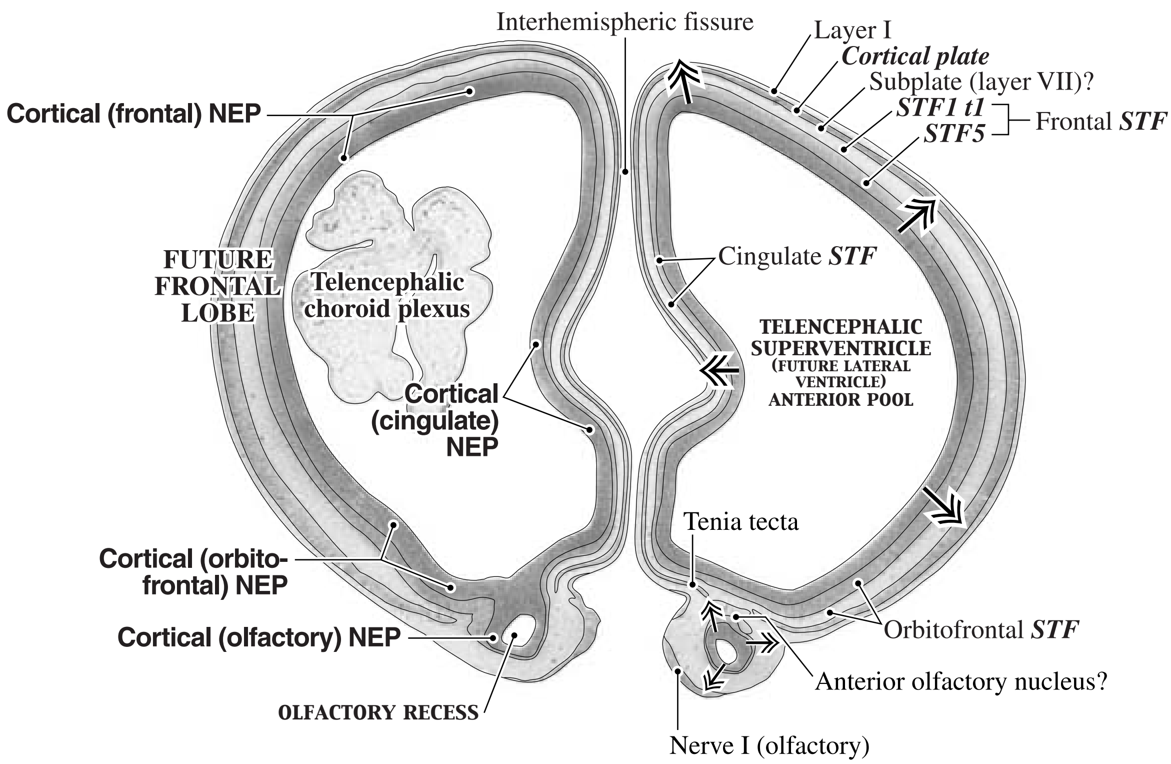
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 102B

Level 1: Section 551



Level 2: Section 480



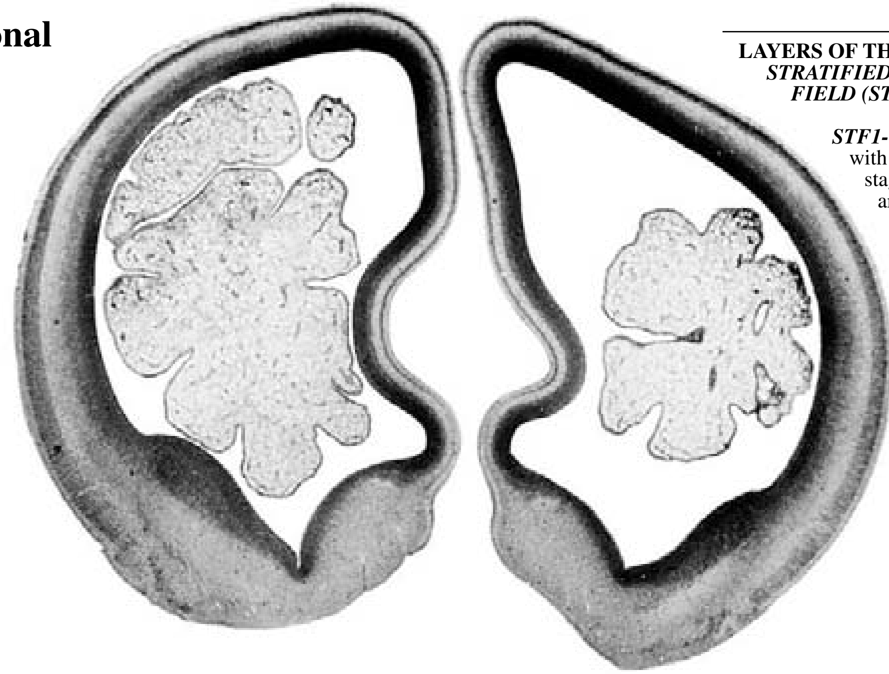
Cortical folding in the midline is a shrinkage artifact.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 103A

GW9 Coronal
CR 42 mm
M841

Level 3: Section 440

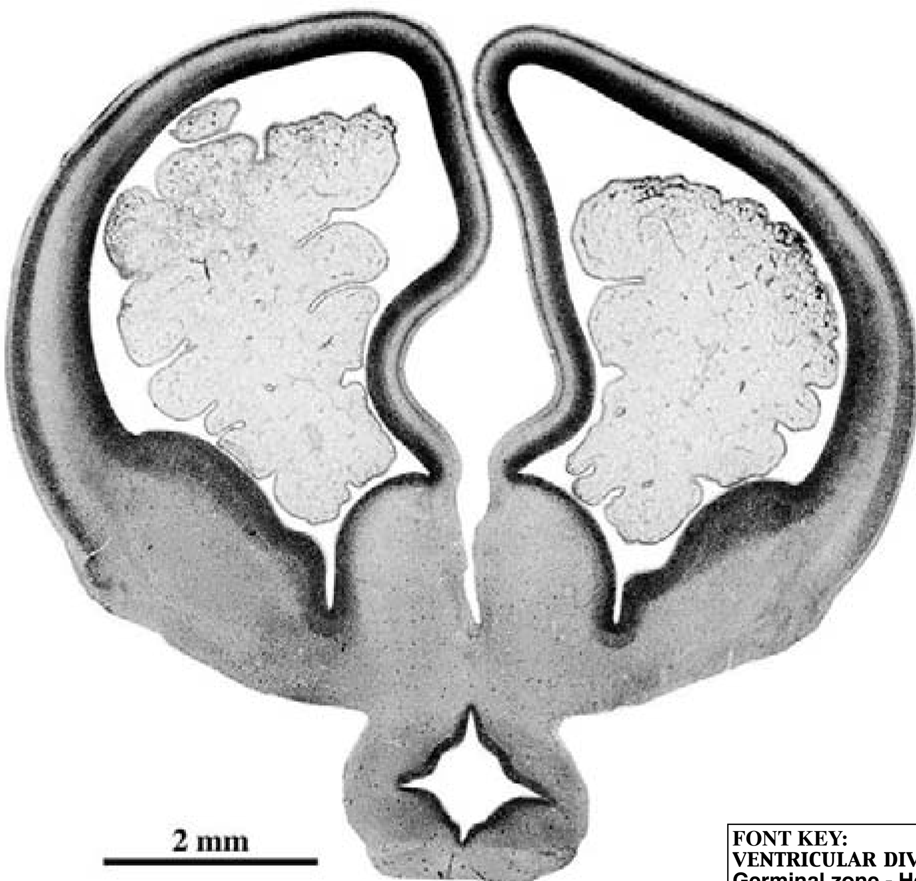


LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1*-**Superficial fibrous layer with an early developmental stage ***(t1) when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.

***STF5*-**Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal

Level 4: Section 410

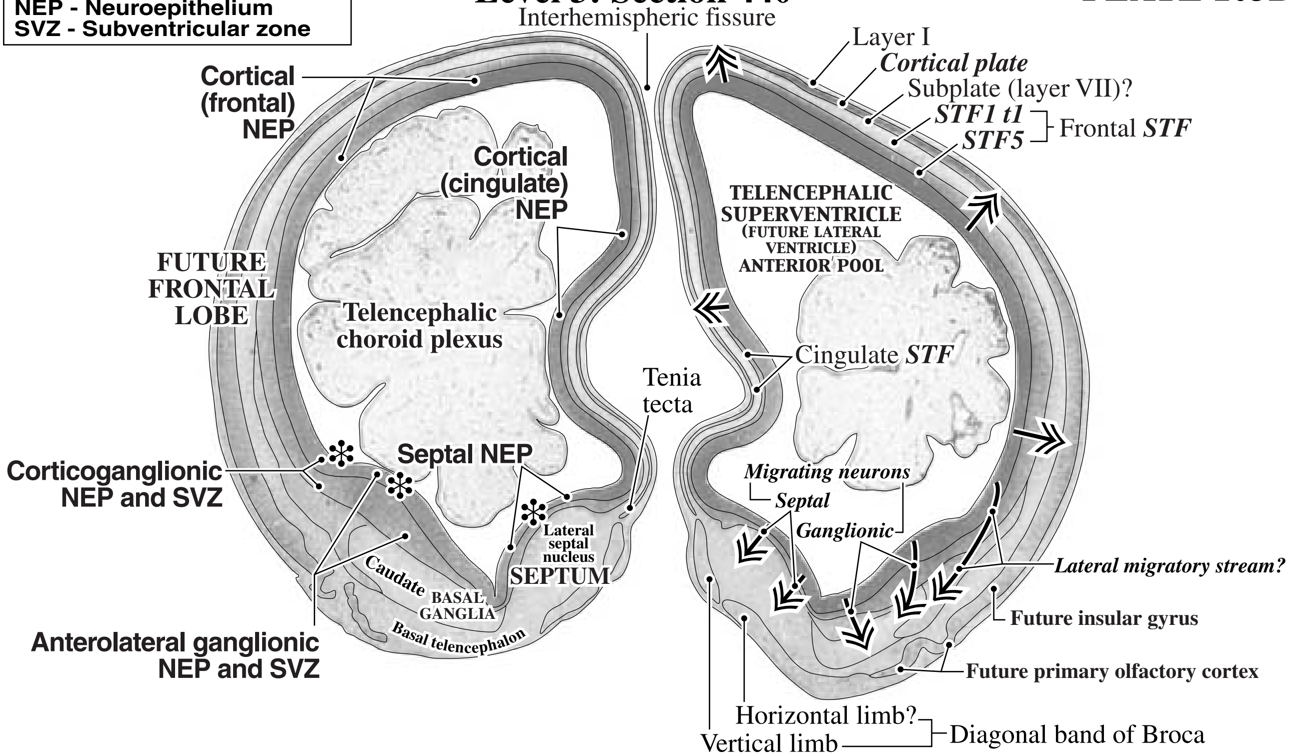


FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 103B

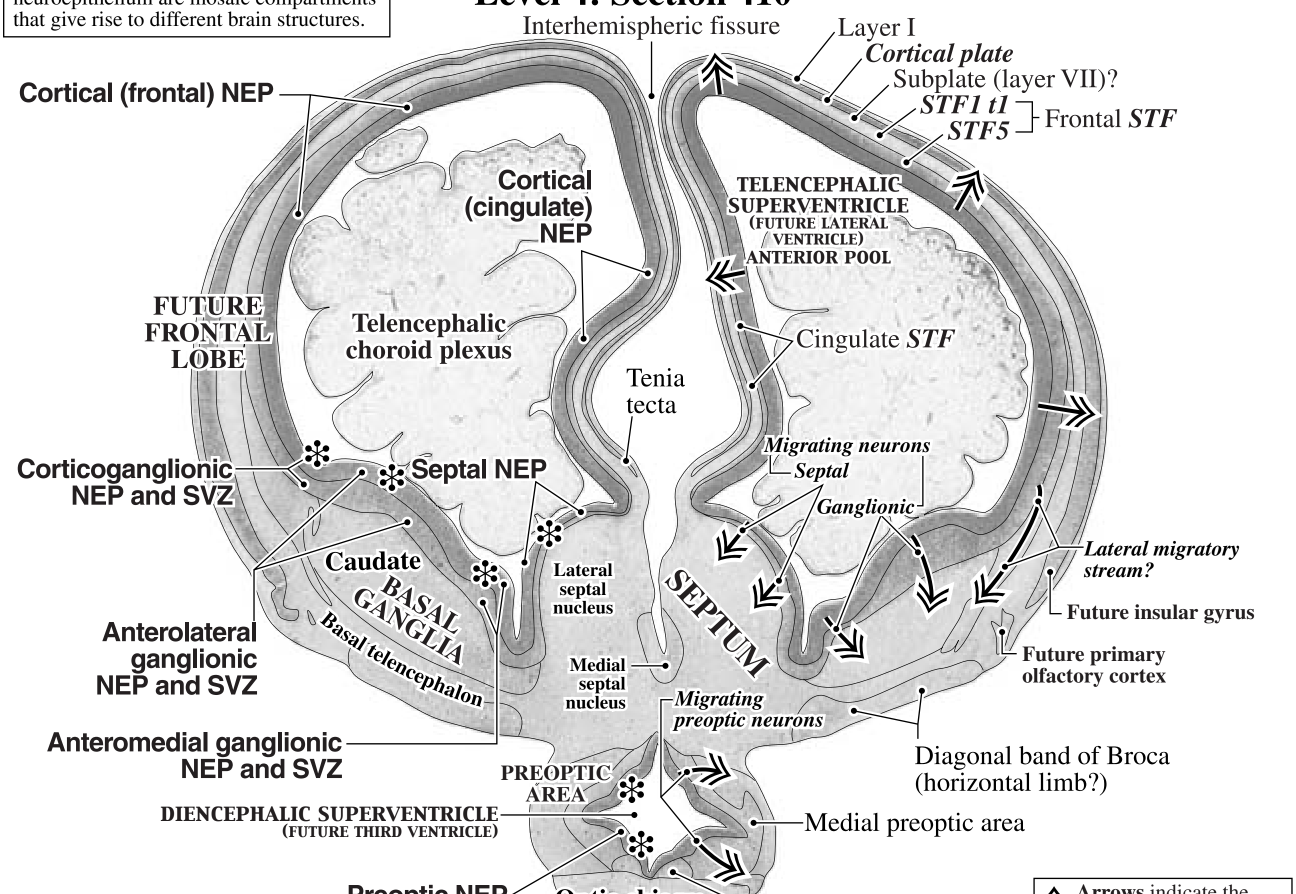
ABBREVIATIONS:
NEP - Neuroepithelium
SVZ - Subventricular zone

Level 3: Section 440



✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

Level 4: Section 410

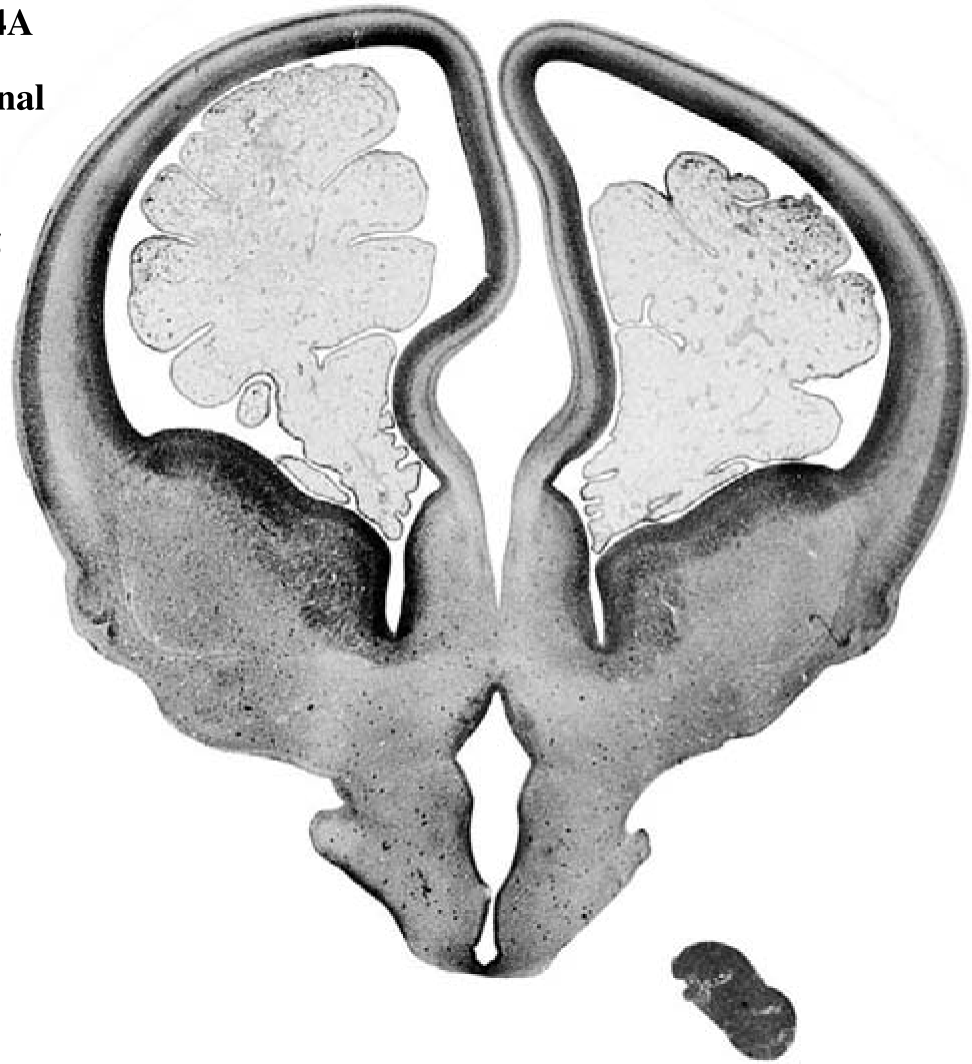


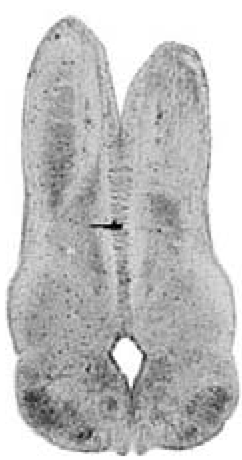
Cortical folding in the midline is a shrinkage artifact.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 104A

GW9 Coronal
CR 42 mm
M841
Level 5:
Section 375





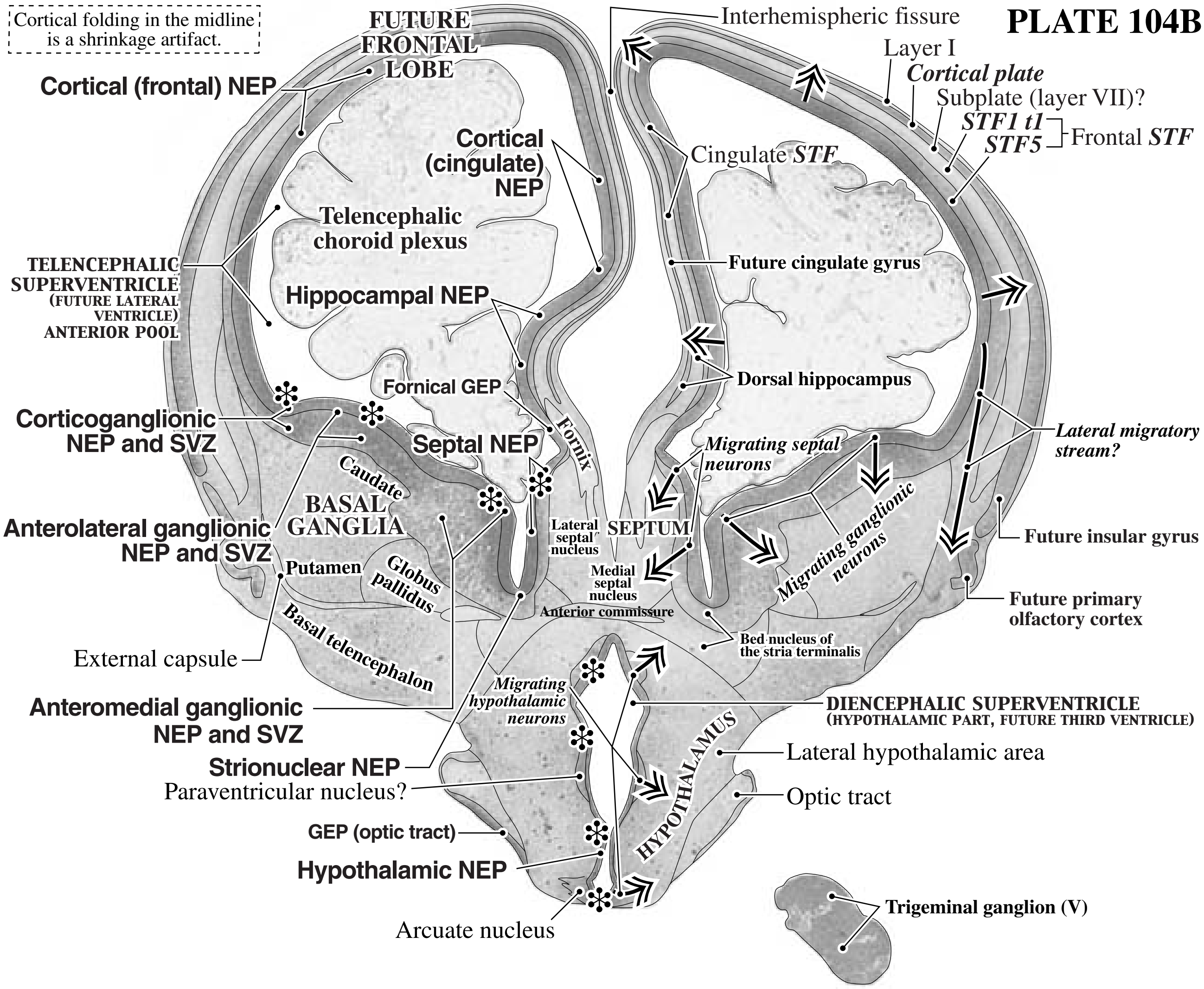
2 mm

LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 104B



❃ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

SPINAL CORD

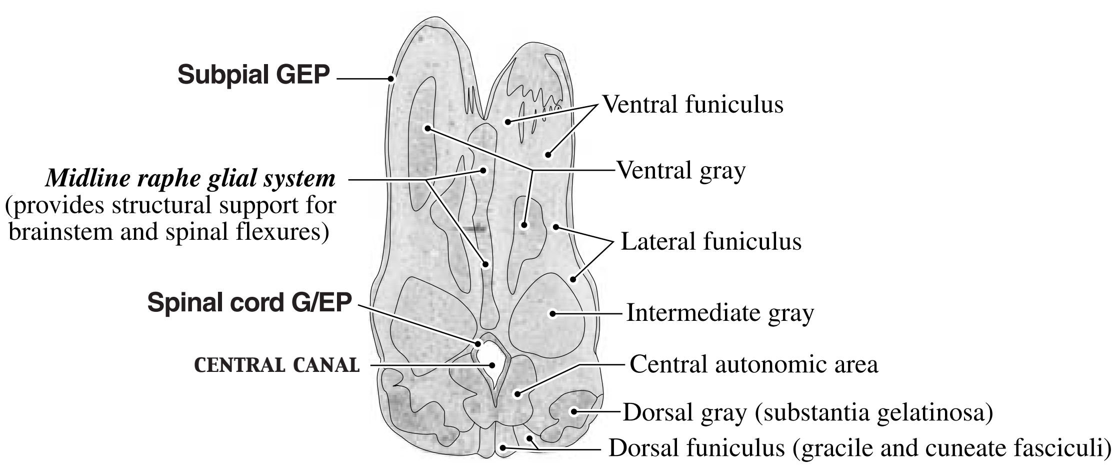
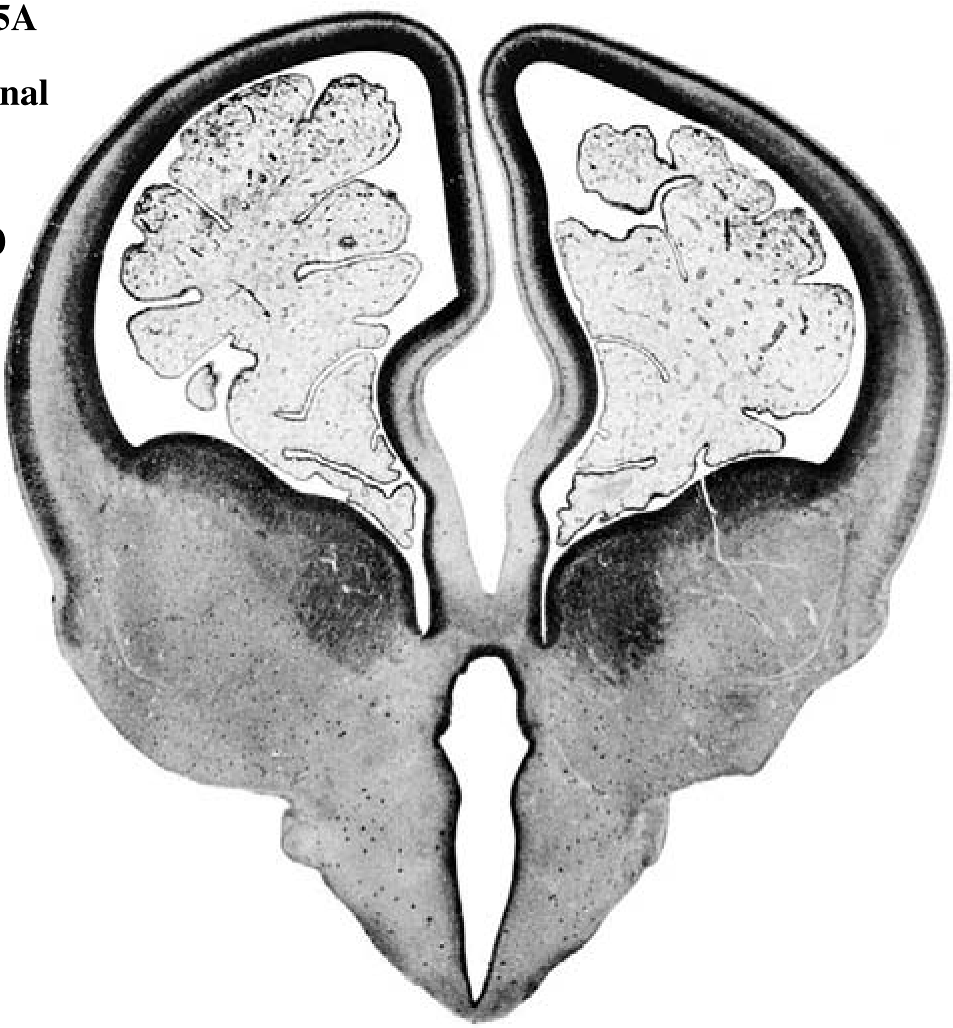


PLATE 105A

GW9 Coronal
CR 42 mm
M841
Level 6:
Section 360



LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

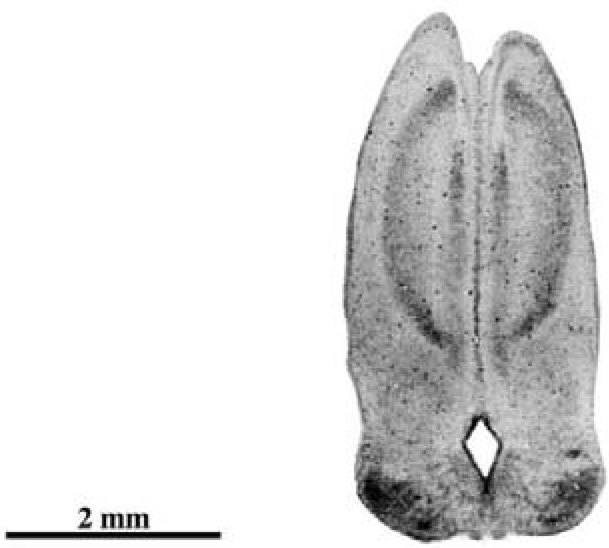
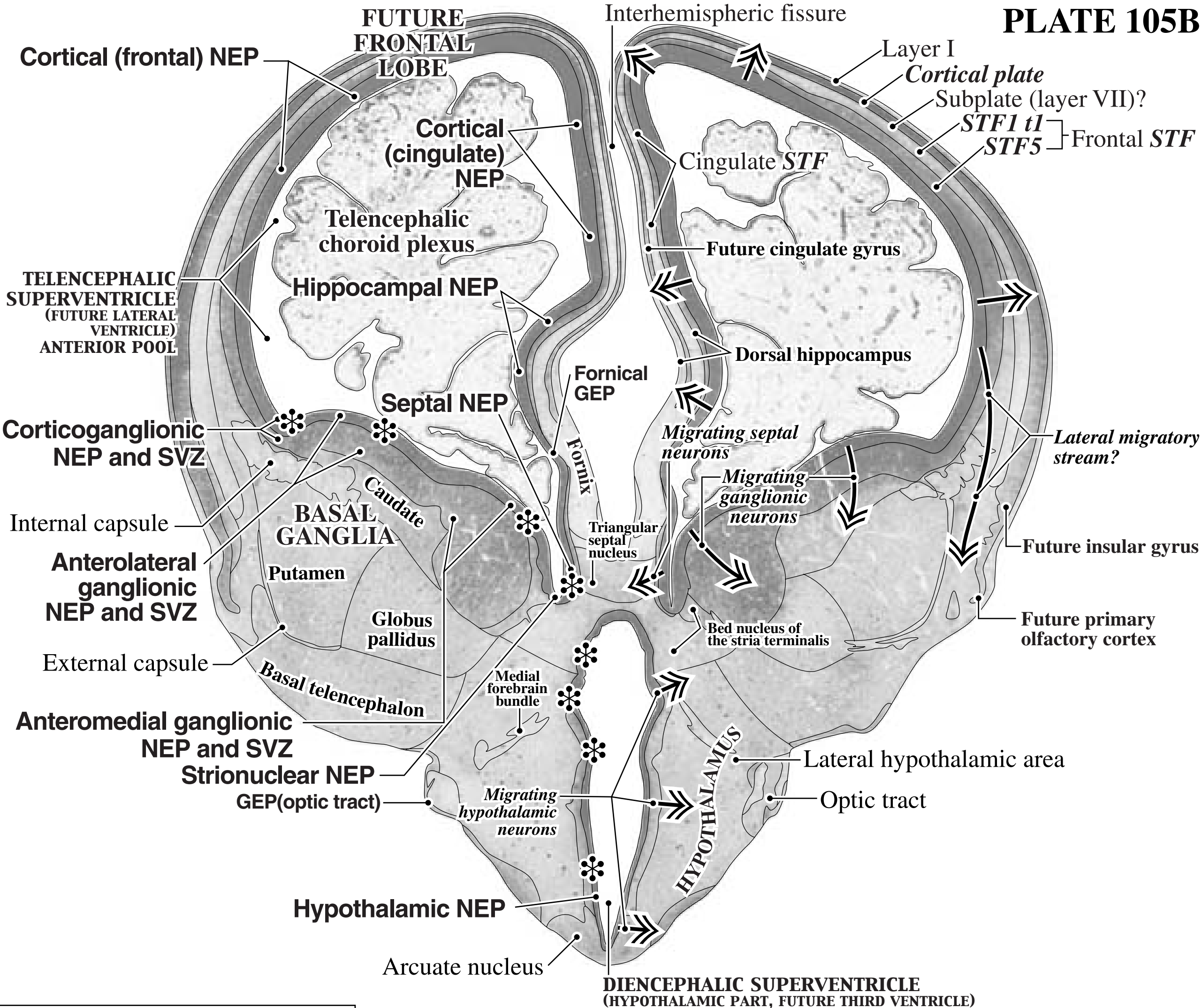


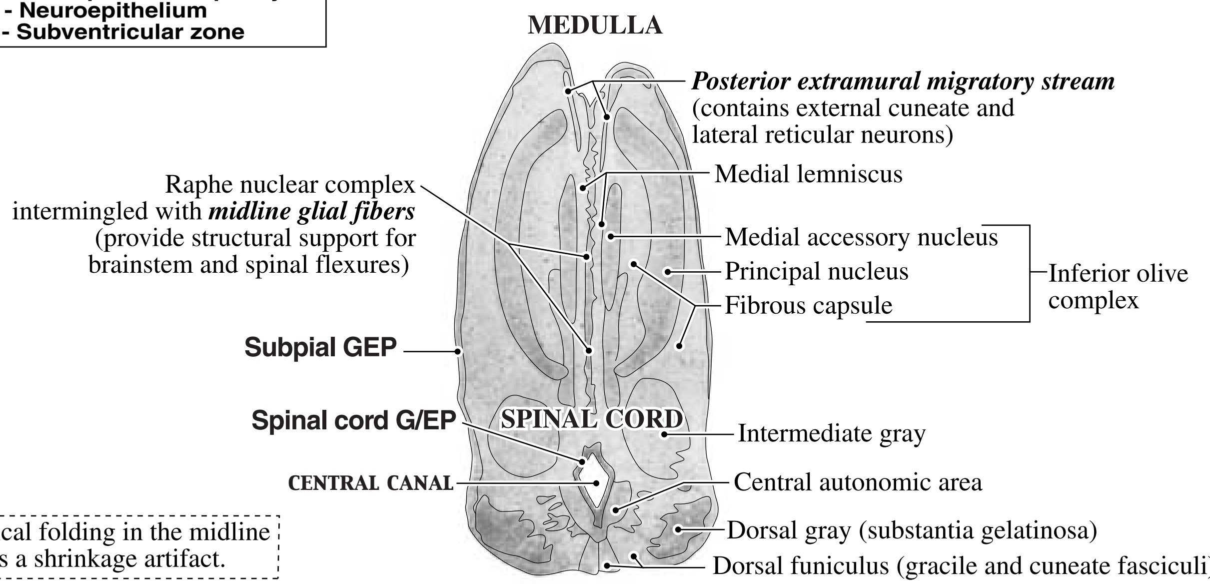
PLATE 105B



✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

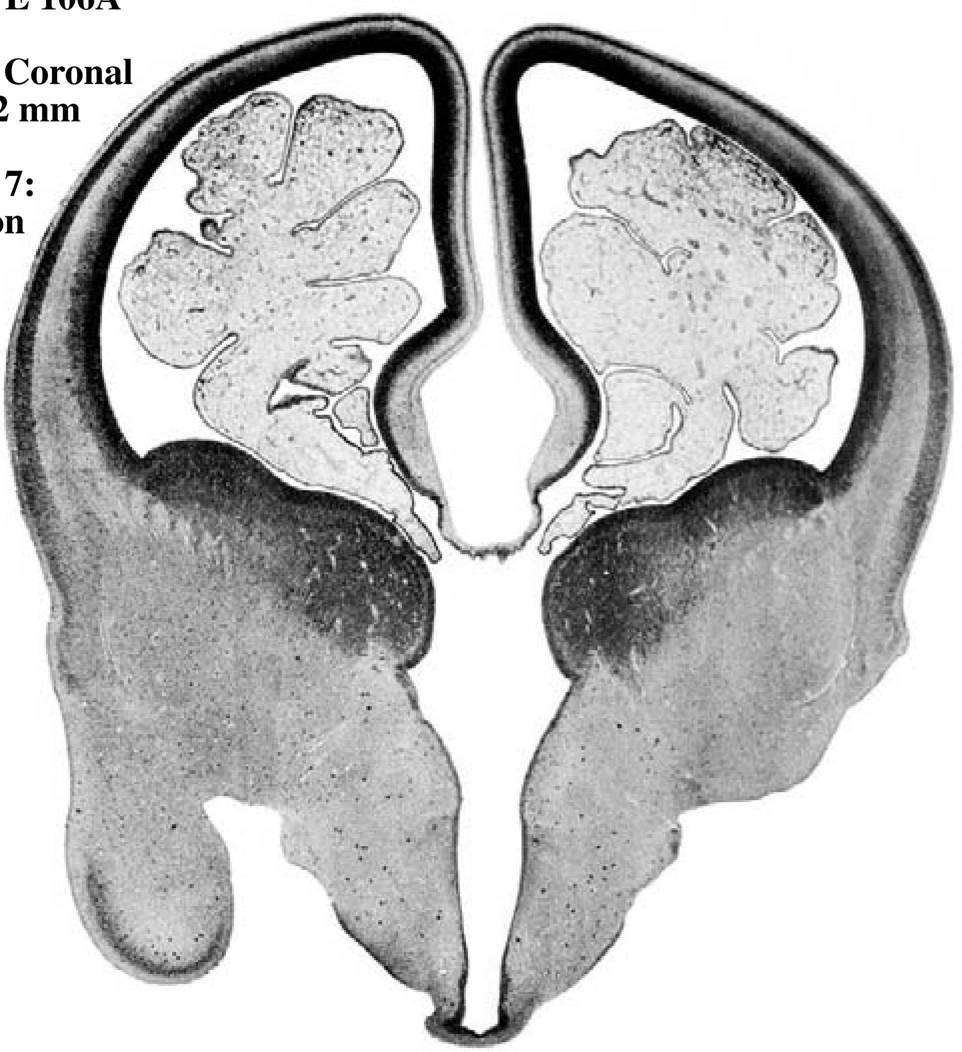
ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone

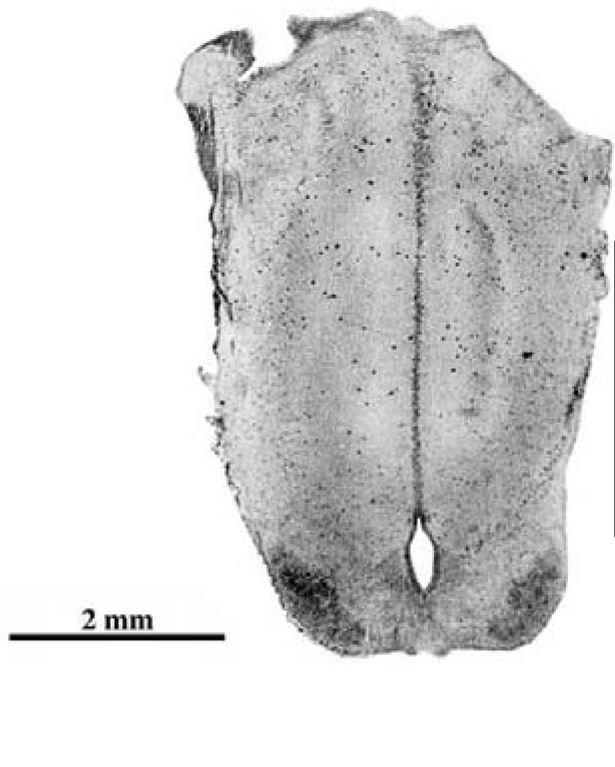


Cortical folding in the midline is a shrinkage artifact.

PLATE 106A

GW9 Coronal
CR 42 mm
M841
Level 7:
Section
340



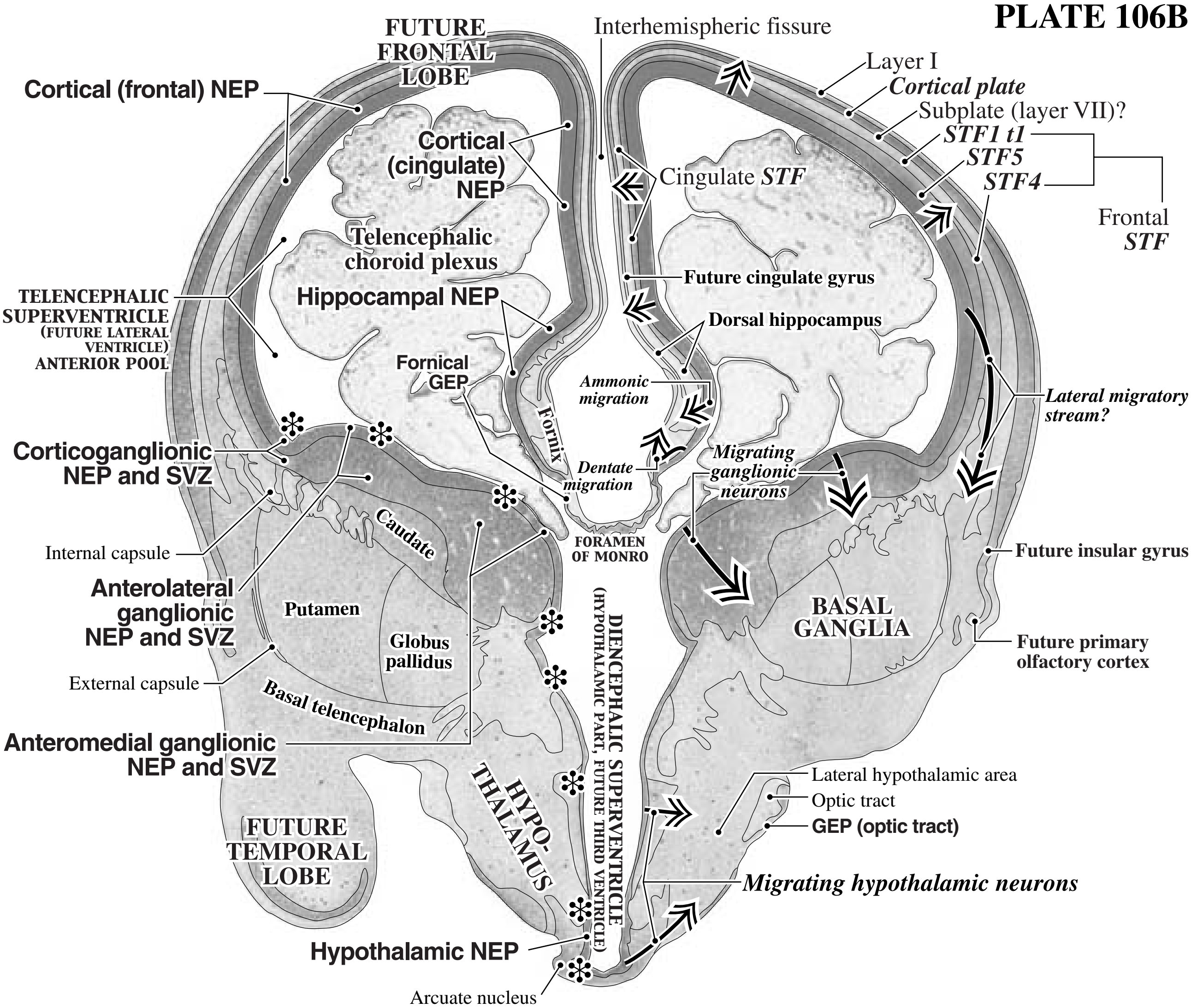


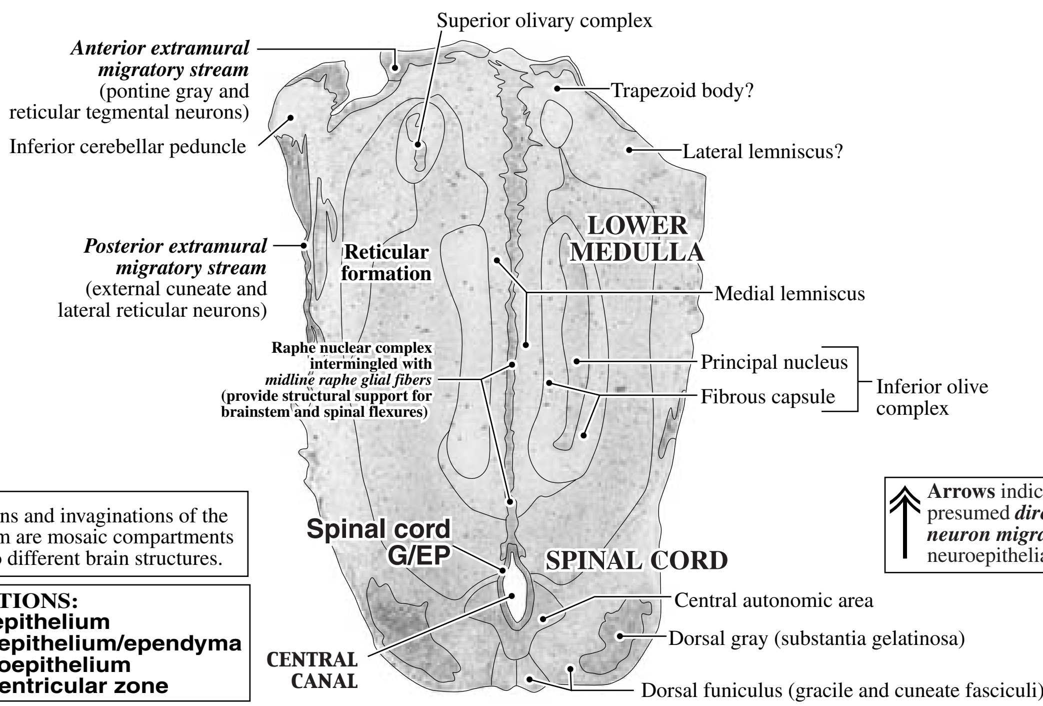
LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 106B





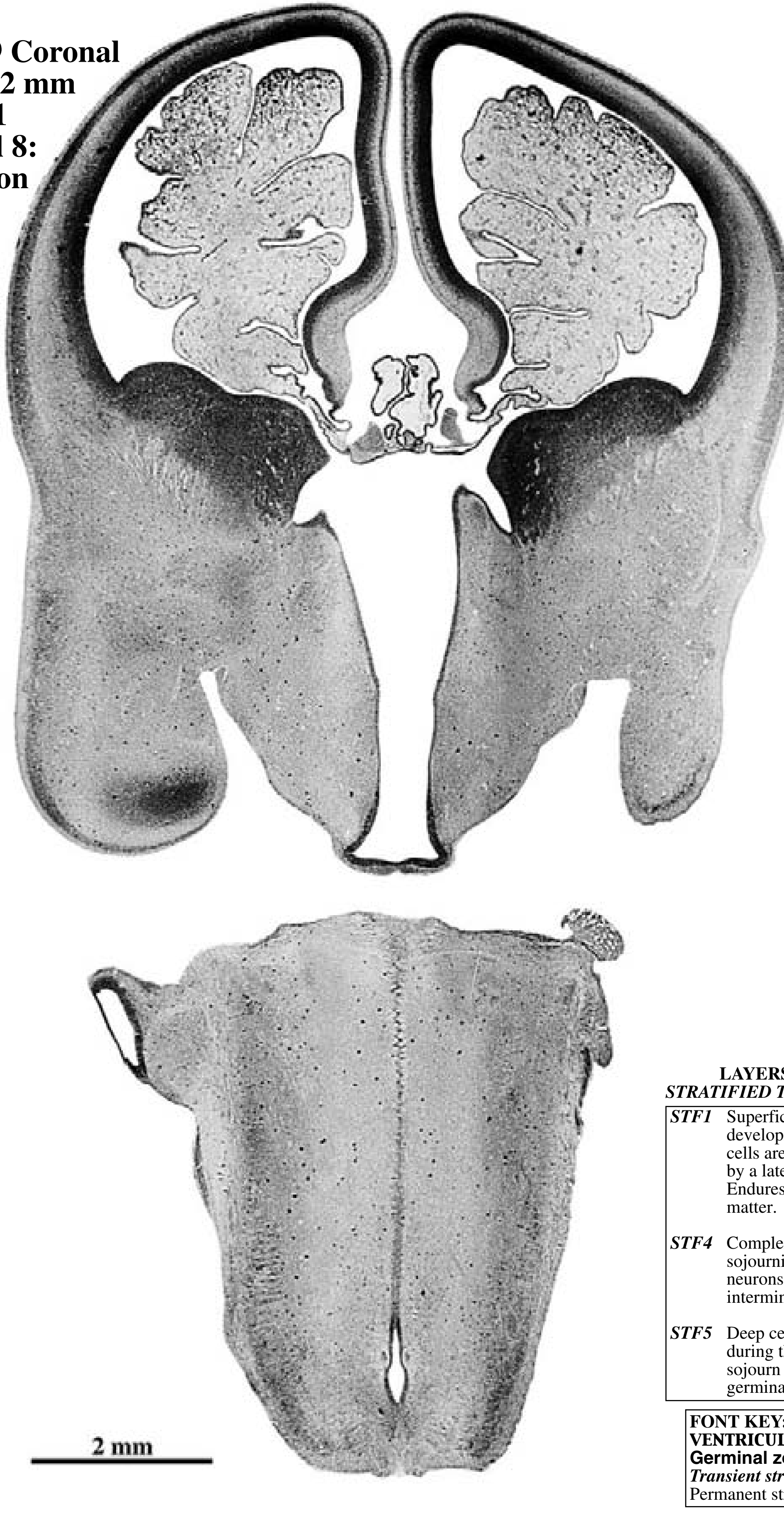
❋ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 107A

GW9 Coronal
CR 42 mm
M841
Level 8:
Section
320



LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 107B

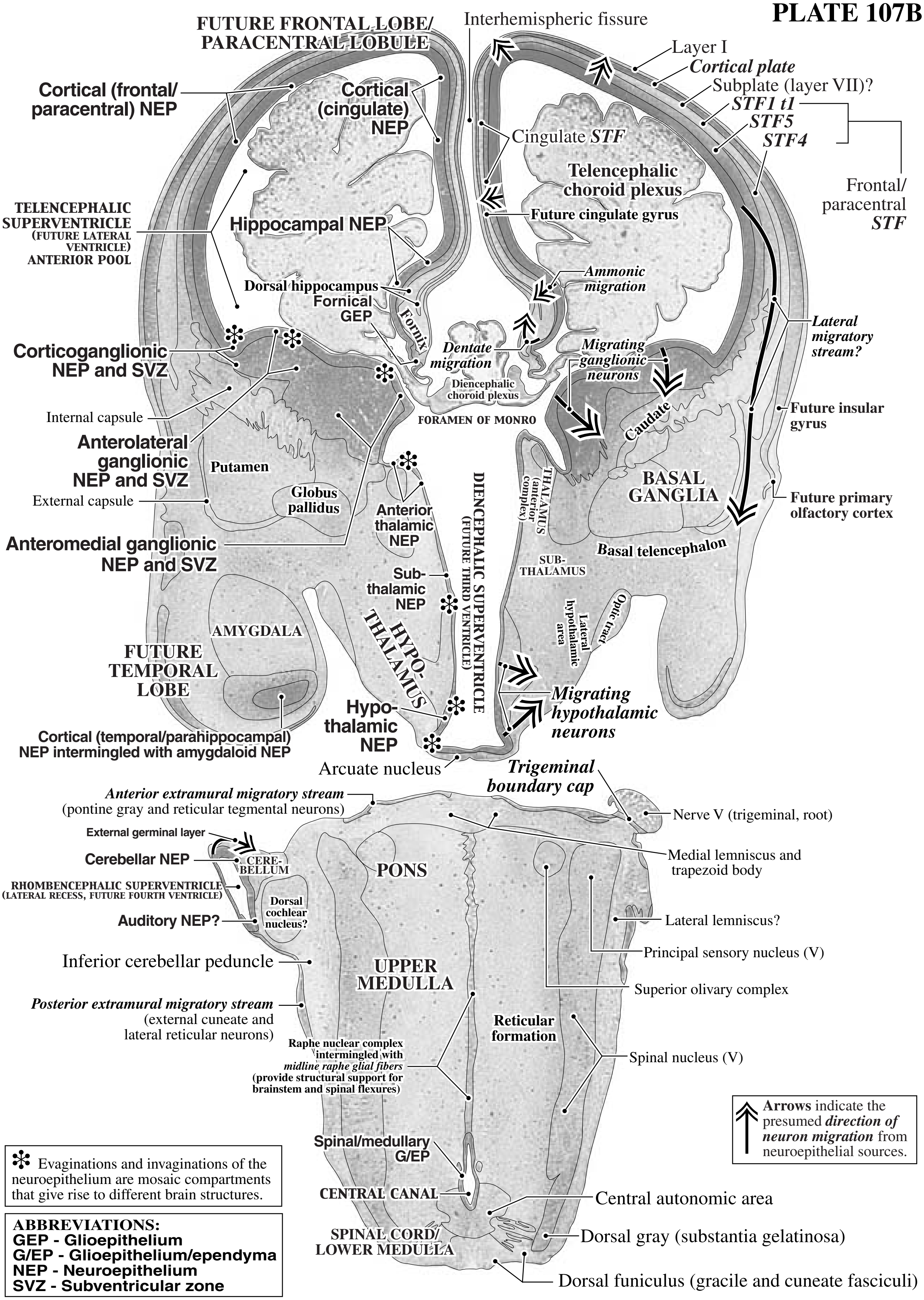
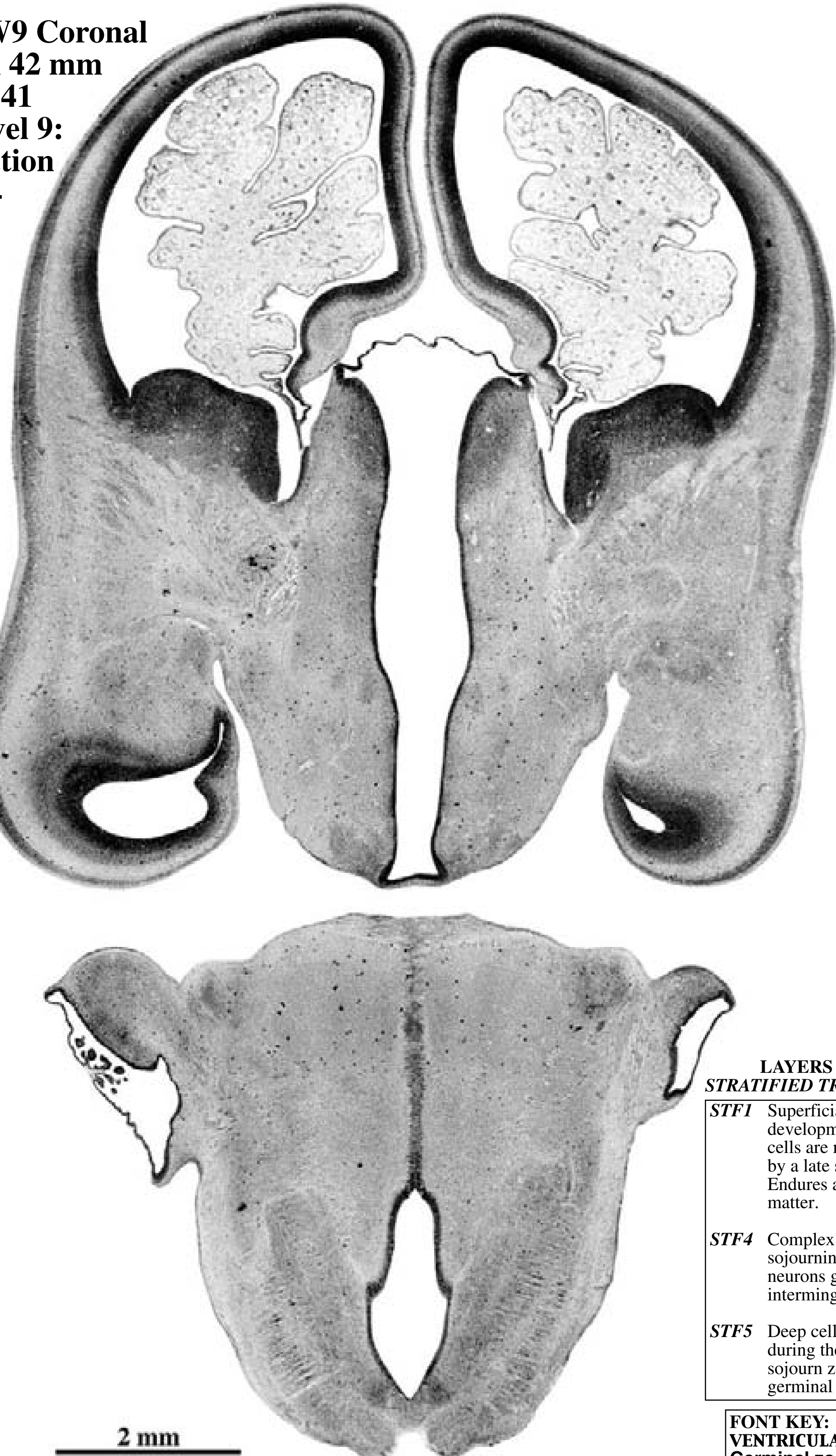

FUTURE FRONTAL LOBE/
PARACENTRAL LOBULE
Interhemispheric fissure
Layer I
Cortical plate
Subplate (layer VII)?
STF1 t1
STF5
STF4
Frontal/
paracentral
STF
Cortical (frontal/
paracentral) NEP
Cortical
(cingulate)
NEP
Cingulate STF
Telencephalic
choroid plexus
Future cingulate gyrus
TELENCEPHALIC
SUPERVENTRICLE
(FUTURE LATERAL
VENTRICLE)
ANTERIOR POOL
Hippocampal NEP
Dorsal hippocampus
Fornical
GEP
Fornix
Ammonic
migration
Lateral
migratory
stream?
Corticoganglionic
NEP and SVZ
Dentate
migration
Migrating
ganglionic
neurons
Diencephalic
choroid plexus
FORAMEN OF MONRO
Caudate
Future insular
gyrus
Internal capsule
Anterolateral
ganglionic
NEP and SVZ
Putamen
Globus
pallidus
THALAMUS
(anterior
complex)
BASAL
GANGLIA
Future primary
olfactory cortex
External capsule
Anterior
thalamic
NEP
DIENCEPHALIC SUPERVENTRICLE
(FUTURE THIRD VENTRICLE)
Anteromedial ganglionic
NEP and SVZ
Basal telencephalon
Sub-
thalamic
NEP
SUB-
THALAMUS
Lateral
hypothalamic
area
Optic tract
AMYGDALA
HYPO-
THALAMUS
FUTURE
TEMPORAL
LOBE
Migrating
hypothalamic
neurons
Hypo-
thalamic
NEP
Cortical (temporal/parahippocampal)
NEP intermingled with amygdaloid NEP
Arcuate nucleus
Trigeminal
boundary cap
Anterior extramural migratory stream
(pontine gray and reticular tegmental neurons)
Nerve V (trigeminal, root)
External germinal layer
Cerebellar NEP
CERE-
BELLUM
PONS
Medial lemniscus and
trapezoid body
RHOMBENCEPHALIC SUPERVENTRICLE
(LATERAL RECESS, FUTURE FOURTH VENTRICLE)
Dorsal
cochlear
nucleus?
Auditory NEP?
Lateral lemniscus?
Principal sensory nucleus (V)
Inferior cerebellar peduncle
UPPER
MEDULLA
Superior olivary complex
Posterior extramural migratory stream
(external cuneate and
lateral reticular neurons)
Reticular
formation
Raphe nuclear complex
intermingled with
midline raphe glial fibers
(provide structural support for
brainstem and spinal flexures)
Spinal nucleus (V)
Arrows indicate the
presumed direction of
neuron migration from
neuroepithelial sources.
Spinal/medullary
G/EP
❇ Evaginations and invaginations of the
neuroepithelium are mosaic compartments
that give rise to different brain structures.
CENTRAL CANAL
Central autonomic area
ABBREVIATIONS:
GEP - Glioepithelium
G/EP - Glioepithelium/ependyma
NEP - Neuroepithelium
SVZ - Subventricular zone
SPINAL CORD/
LOWER MEDULLA
Dorsal gray (substantia gelatinosa)
Dorsal funiculus (gracile and cuneate fasciculi)

PLATE 108A

GW9 Coronal
CR 42 mm
M841
Level 9:
Section
294

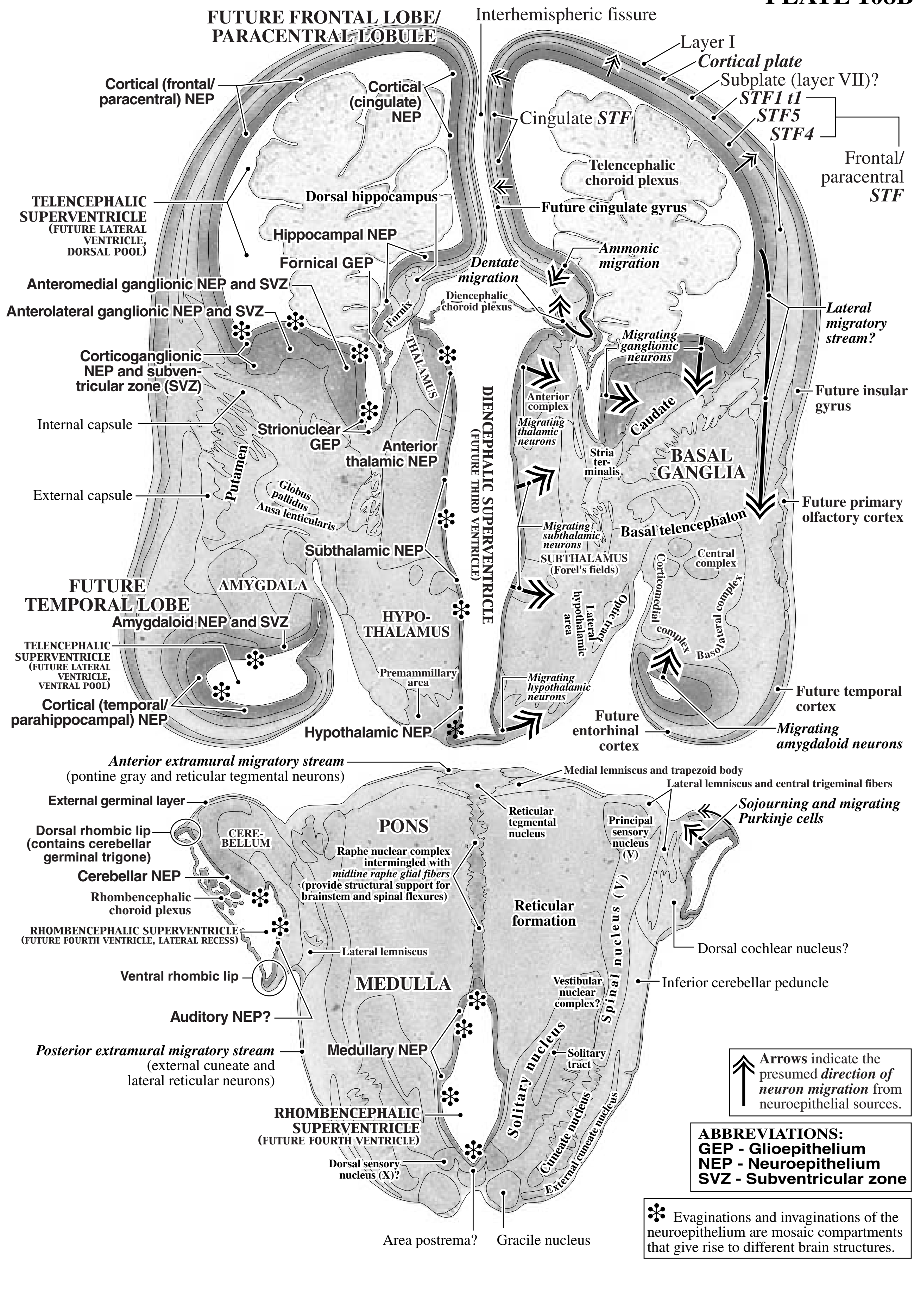


LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 108B



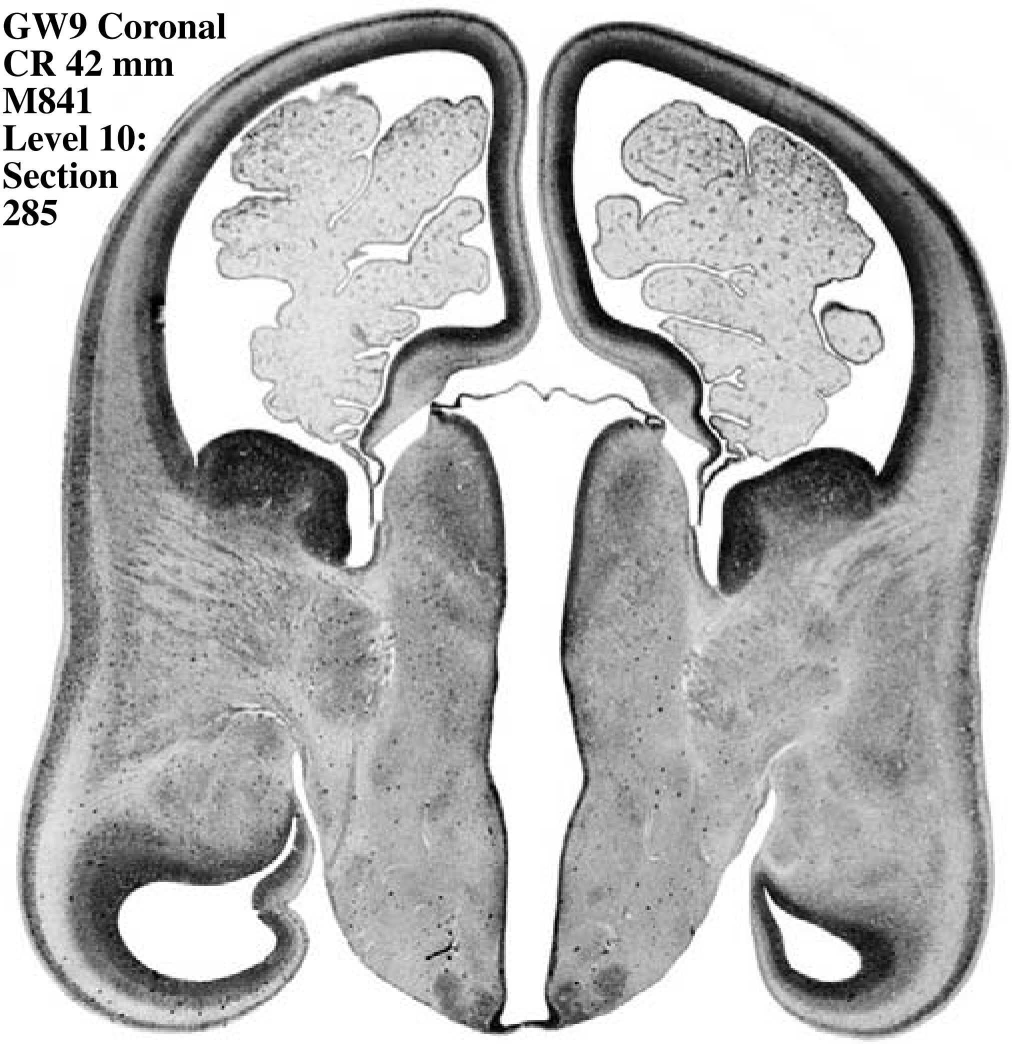
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

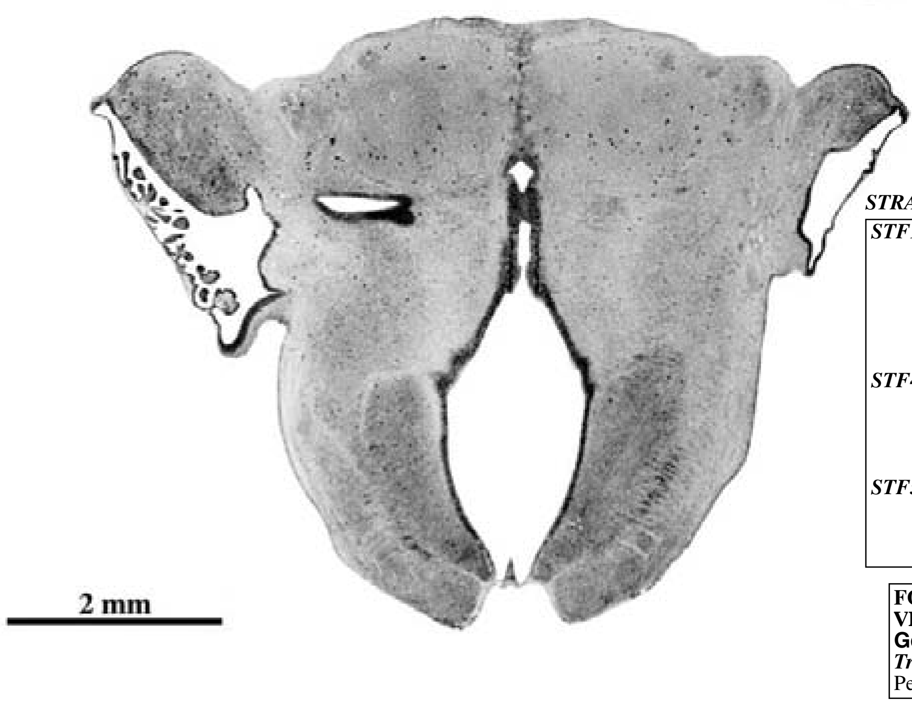
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

PLATE 109A

GW9 Coronal
CR 42 mm
M841
Level 10:
Section
285





LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 109B

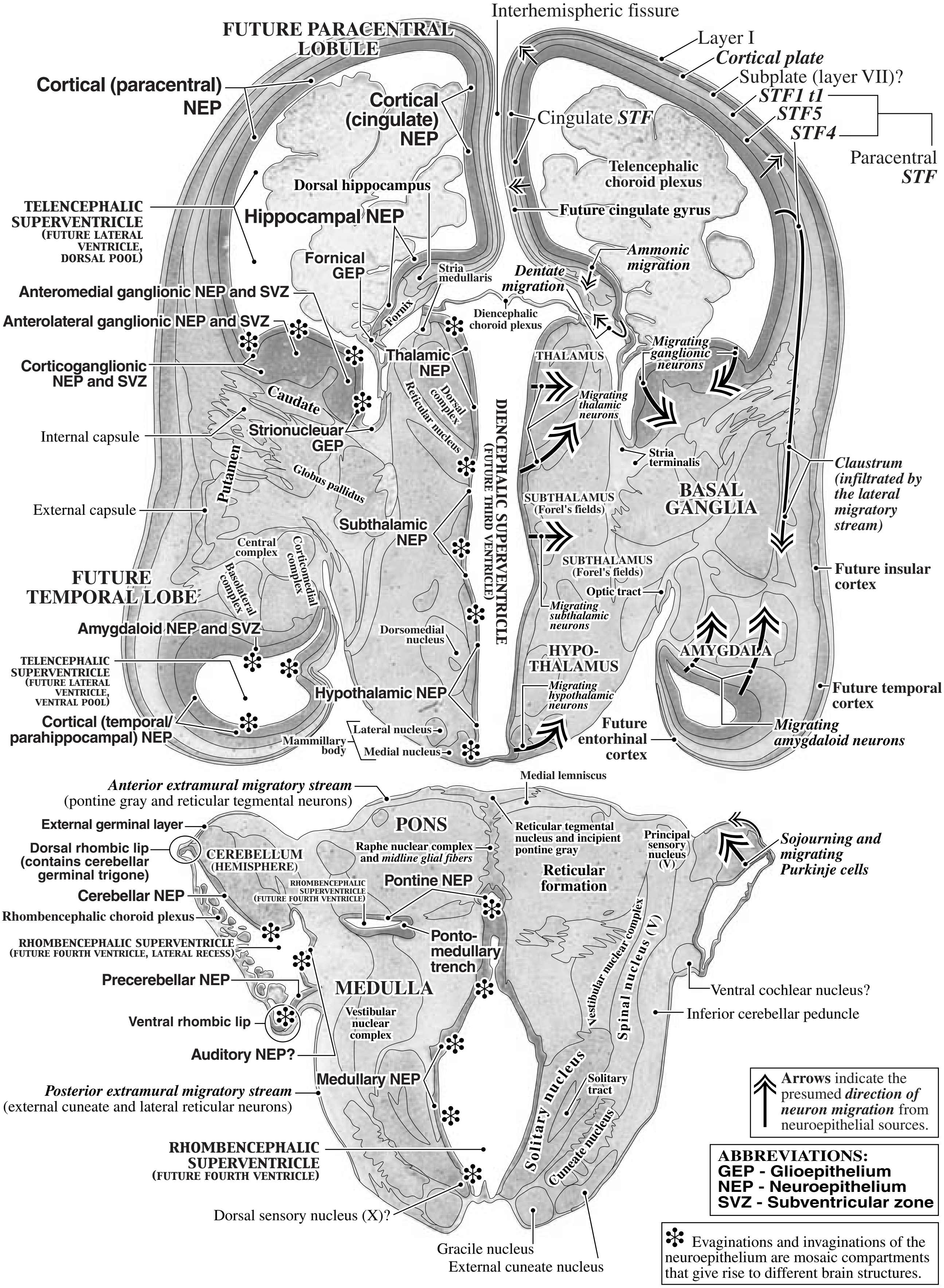
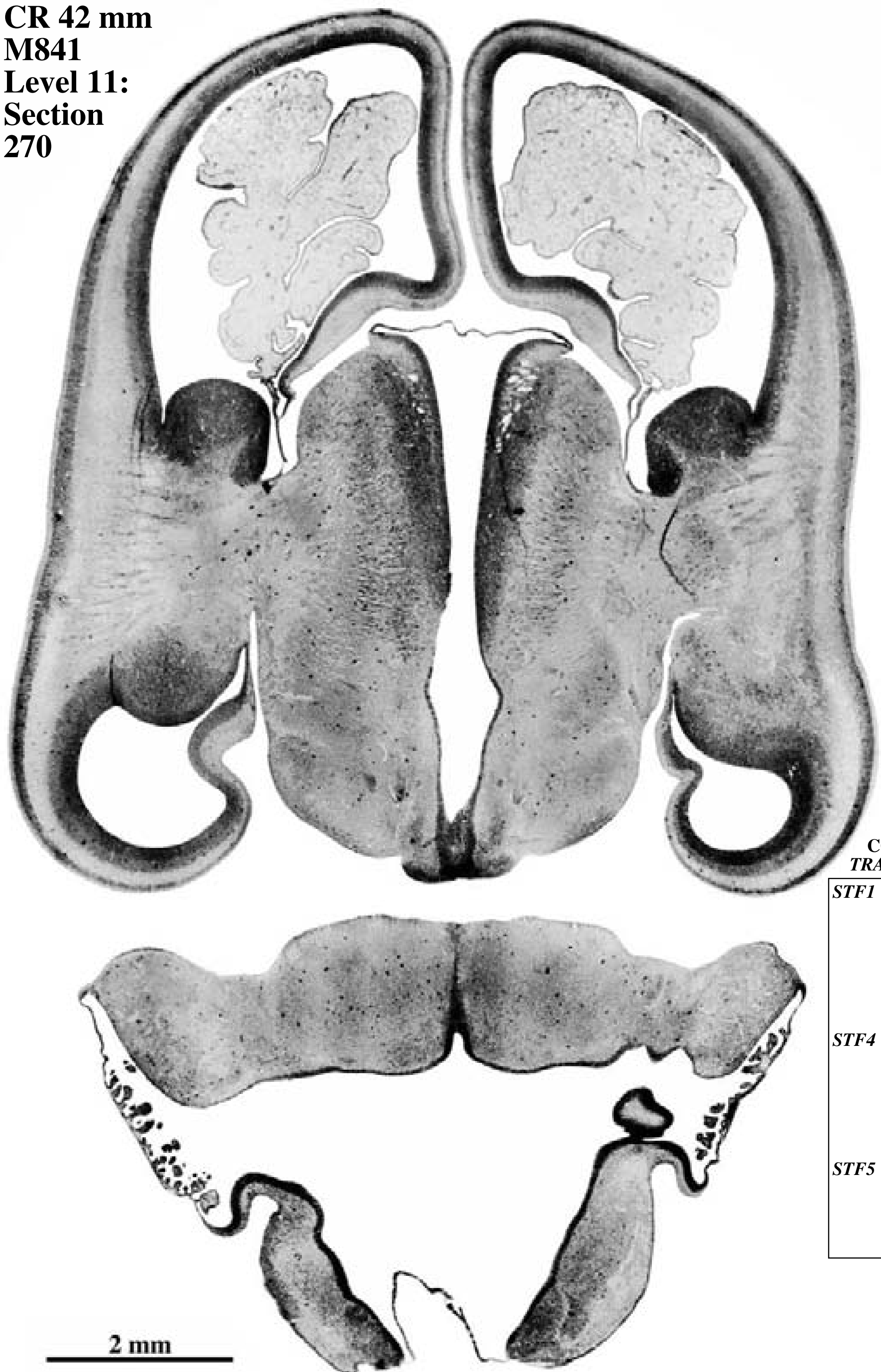

Interhemispheric fissure
FUTURE PARACENTRAL LOBULE
Layer I
Cortical plate
Subplate (layer VII)?
STF1 t1
STF5
STF4
Paracentral STF
Cortical (paracentral) NEP
Cortical (cingulate) NEP
Cingulate STF
Telencephalic choroid plexus
Dorsal hippocampus
TELENCEPHALIC SUPERVENTRICLE (FUTURE LATERAL VENTRICLE, DORSAL POOL)
Hippocampal NEP
Future cingulate gyrus
Ammonic migration
Fornical GEP
Stria medullaris
Dentate migration
Anteromedial ganglionic NEP and SVZ
Fornix
Diencephalic choroid plexus
Anterolateral ganglionic NEP and SVZ
Thalamic NEP
THALAMUS
Migrating ganglionic neurons
Corticoganglionic NEP and SVZ
Caudate
Dorsal complex
Reticular nucleus
Migrating thalamic neurons
Internal capsule
Strionucleuar GEP
DIENCEPHALIC SUPERVENTRICLE (FUTURE THIRD VENTRICLE)
Stria terminalis
Claustrum (infiltrated by the lateral migratory stream)
Putamen
Globus pallidus
SUBTHALAMUS (Forel's fields)
BASAL GANGLIA
External capsule
Subthalamic NEP
Central complex
Corticomedial complex
SUBTHALAMUS (Forel's fields)
Future insular cortex
FUTURE TEMPORAL LOBE
Basolateral complex
Optic tract
Migrating subthalamic neurons
Amygdaloid NEP and SVZ
Dorsomedial nucleus
HYPO-THALAMUS
AMYGDALA
TELENCEPHALIC SUPERVENTRICLE (FUTURE LATERAL VENTRICLE, VENTRAL POOL)
Hypothalamic NEP
Migrating hypothalamic neurons
Future temporal cortex
Cortical (temporal/ parahippocampal) NEP
Lateral nucleus
Mammillary body
Medial nucleus
Future entorhinal cortex
Migrating amygdaloid neurons
Anterior extramural migratory stream (pontine gray and reticular tegmental neurons)
Medial lemniscus
External germinal layer
PONS
Reticular tegmental nucleus and incipient pontine gray
Principal sensory nucleus (V)
Sojourning and migrating Purkinje cells
Dorsal rhombic lip (contains cerebellar germinal trigone)
CEREBELLUM (HEMISPHERE)
Raphe nuclear complex and midline glial fibers
Reticular formation
RHOMBENCEPHALIC SUPERVENTRICLE (FUTURE FOURTH VENTRICLE)
Pontine NEP
Cerebellar NEP
Rhombencephalic choroid plexus
Ponto-medullary trench
Vestibular nuclear complex
Spinal nucleus (V)
RHOMBENCEPHALIC SUPERVENTRICLE (FUTURE FOURTH VENTRICLE, LATERAL RECESS)
Precerebellar NEP
MEDULLA
Ventral cochlear nucleus?
Inferior cerebellar peduncle
Ventral rhombic lip
Vestibular nuclear complex
Auditory NEP?
Medullary NEP
Solitary tract
Posterior extramural migratory stream (external cuneate and lateral reticular neurons)
Solitary nucleus
Cuneate nucleus
RHOMBENCEPHALIC SUPERVENTRICLE (FUTURE FOURTH VENTRICLE)
Dorsal sensory nucleus (X)?
Gracile nucleus
External cuneate nucleus
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone
Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

PLATE 110A

GW9 Coronal
CR 42 mm
M841
Level 11:
Section
270

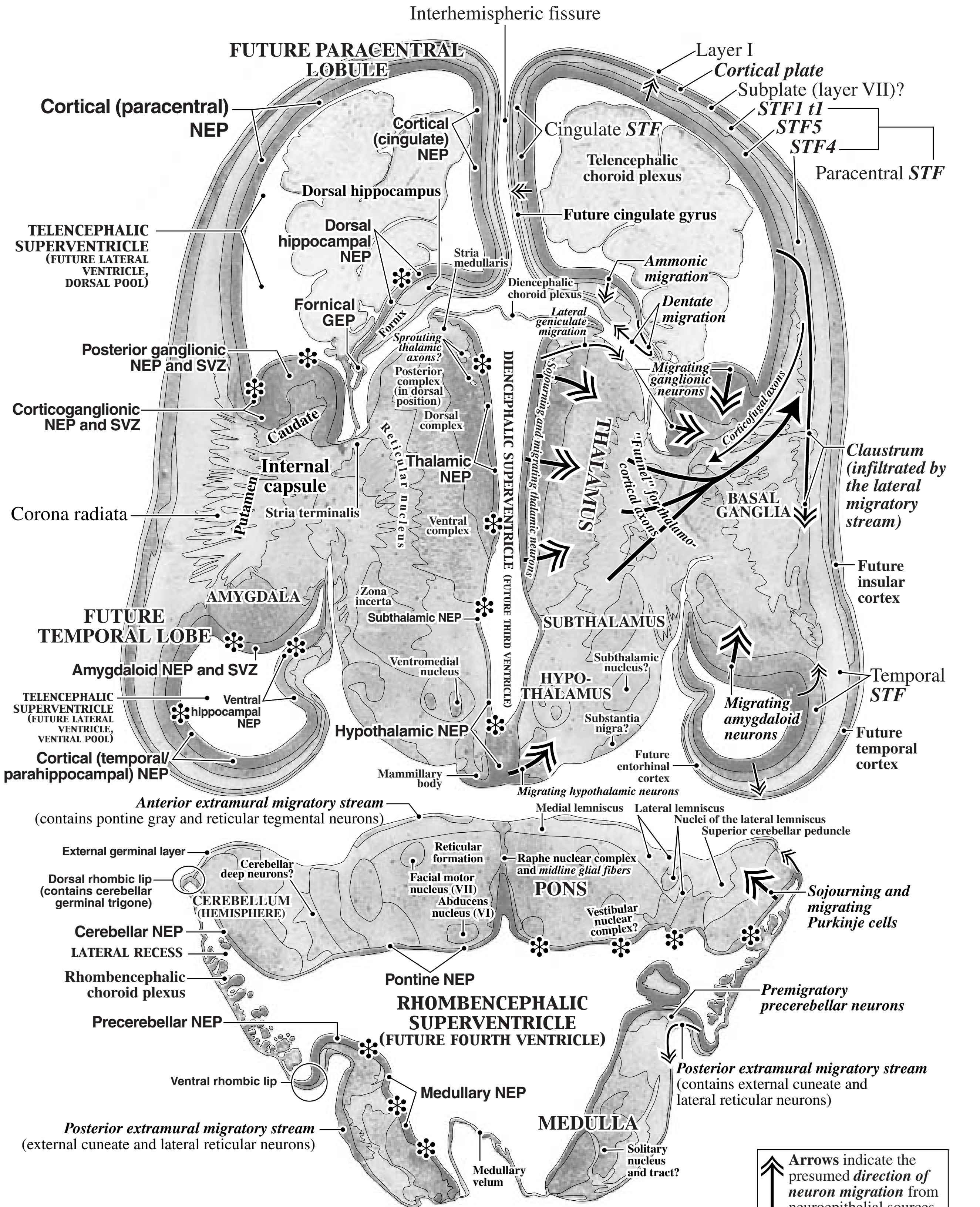


LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF4	Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 110B



Arrows indicate the presumed *direction of neuron migration* from neuroepithelial sources.

Arrows indicate the presumed *direction of axon growth* in brain fiber tracts.

✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

PLATE 111A

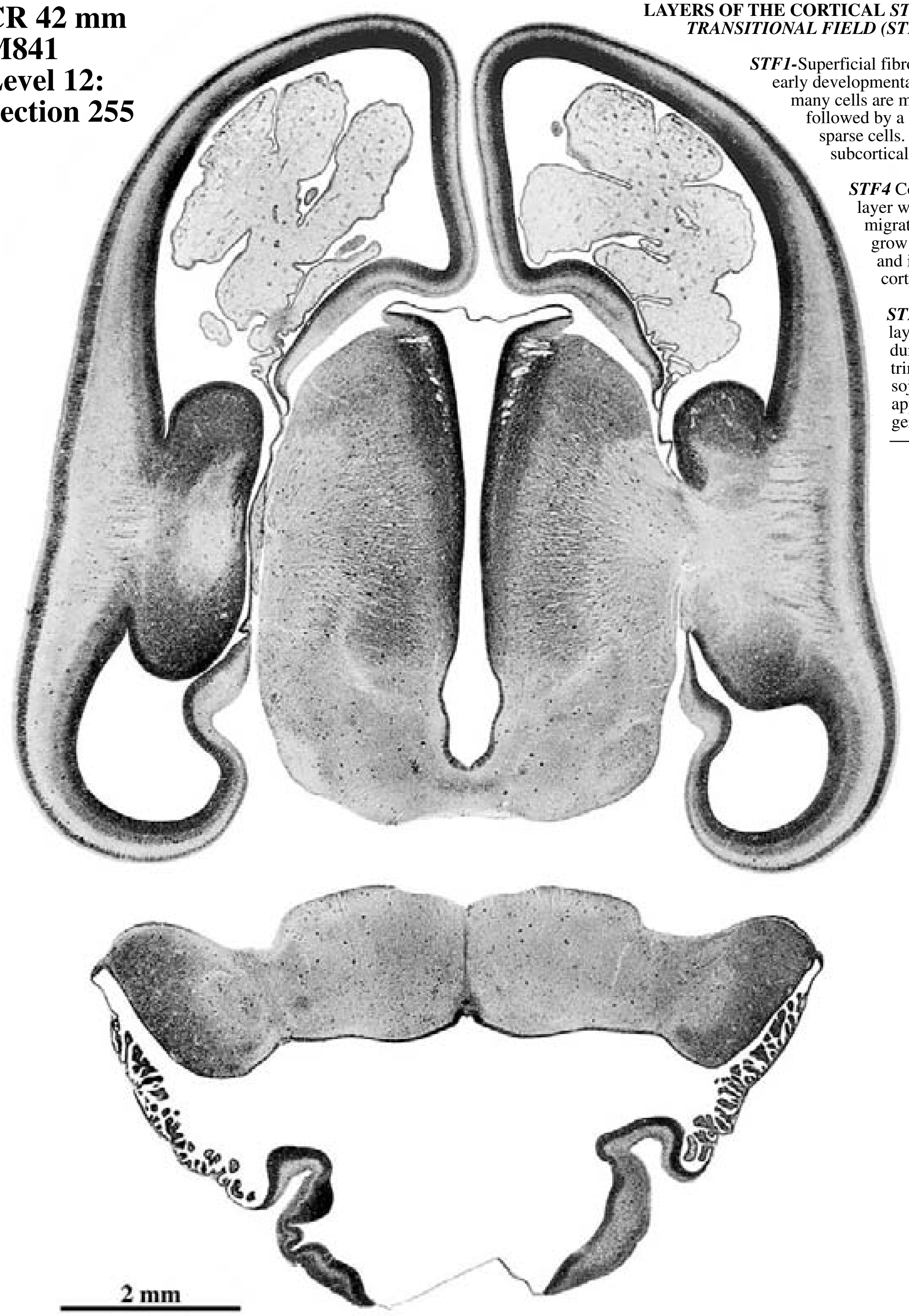
GW9 Coronal
CR 42 mm
M841
Level 12:
Section 255

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1-Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.

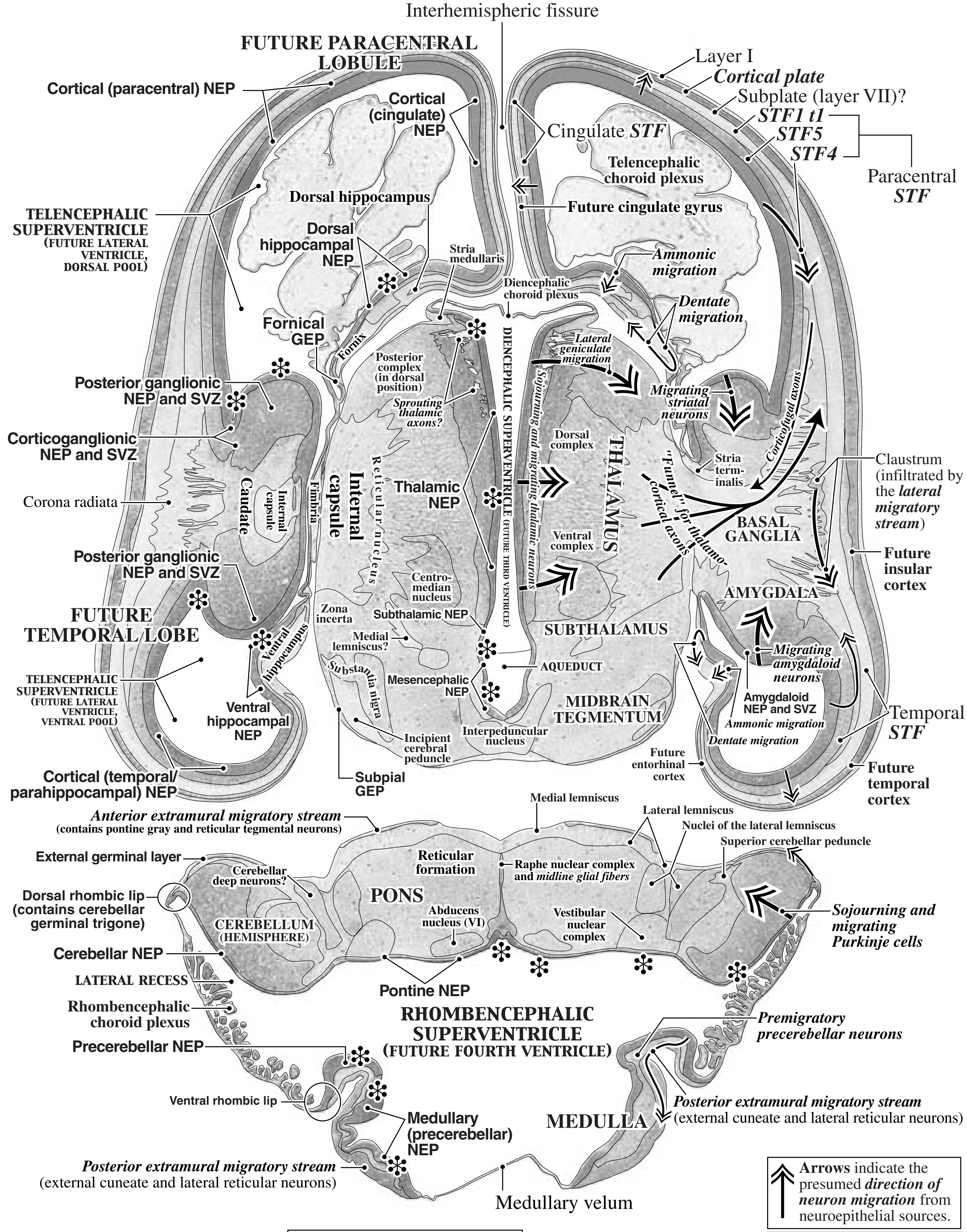
STF4 Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.

STF5-Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 111B



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

PLATE 112A

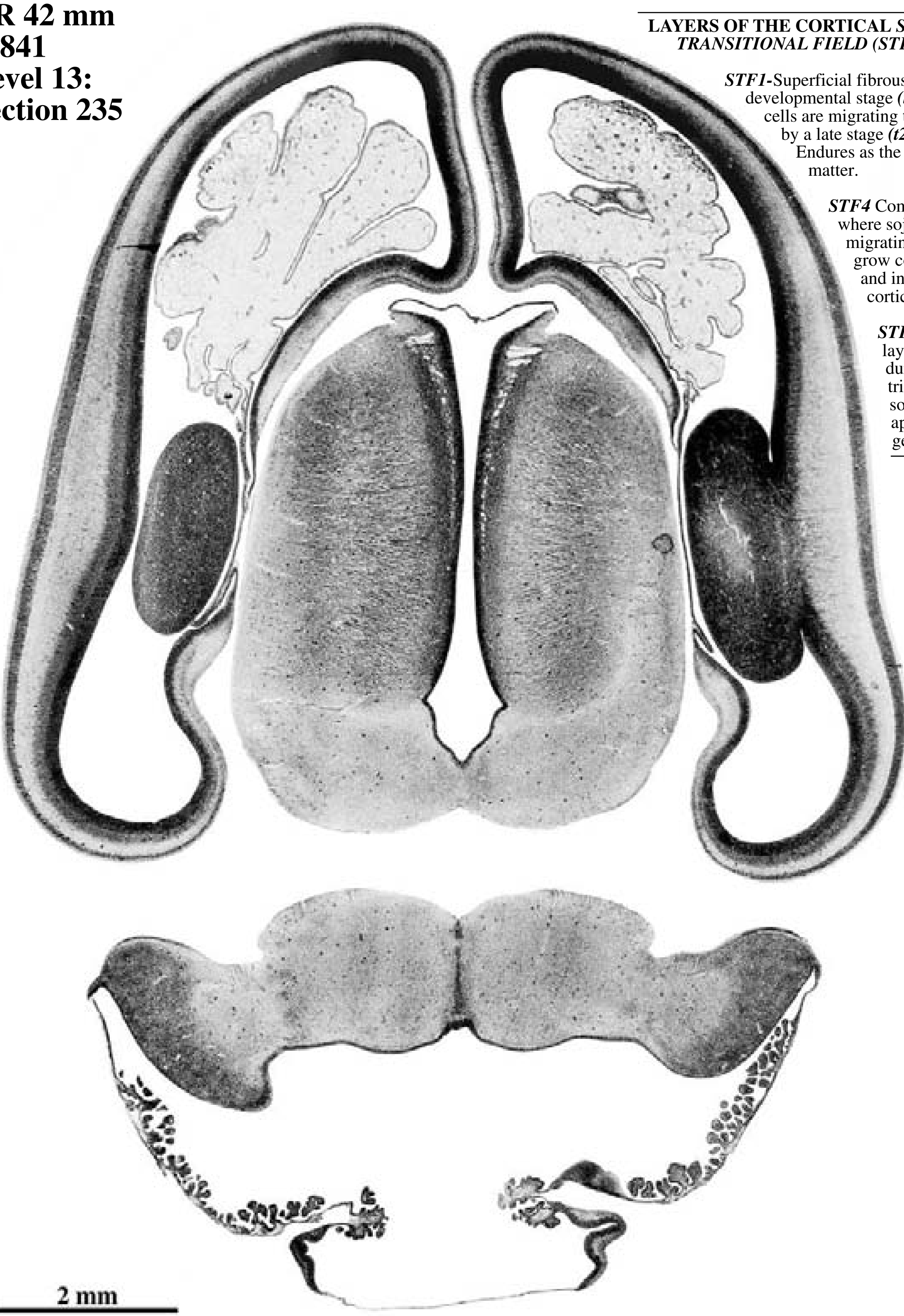
GW9 Coronal
CR 42 mm
M841
Level 13:
Section 235

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1-Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.

STF4 Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.

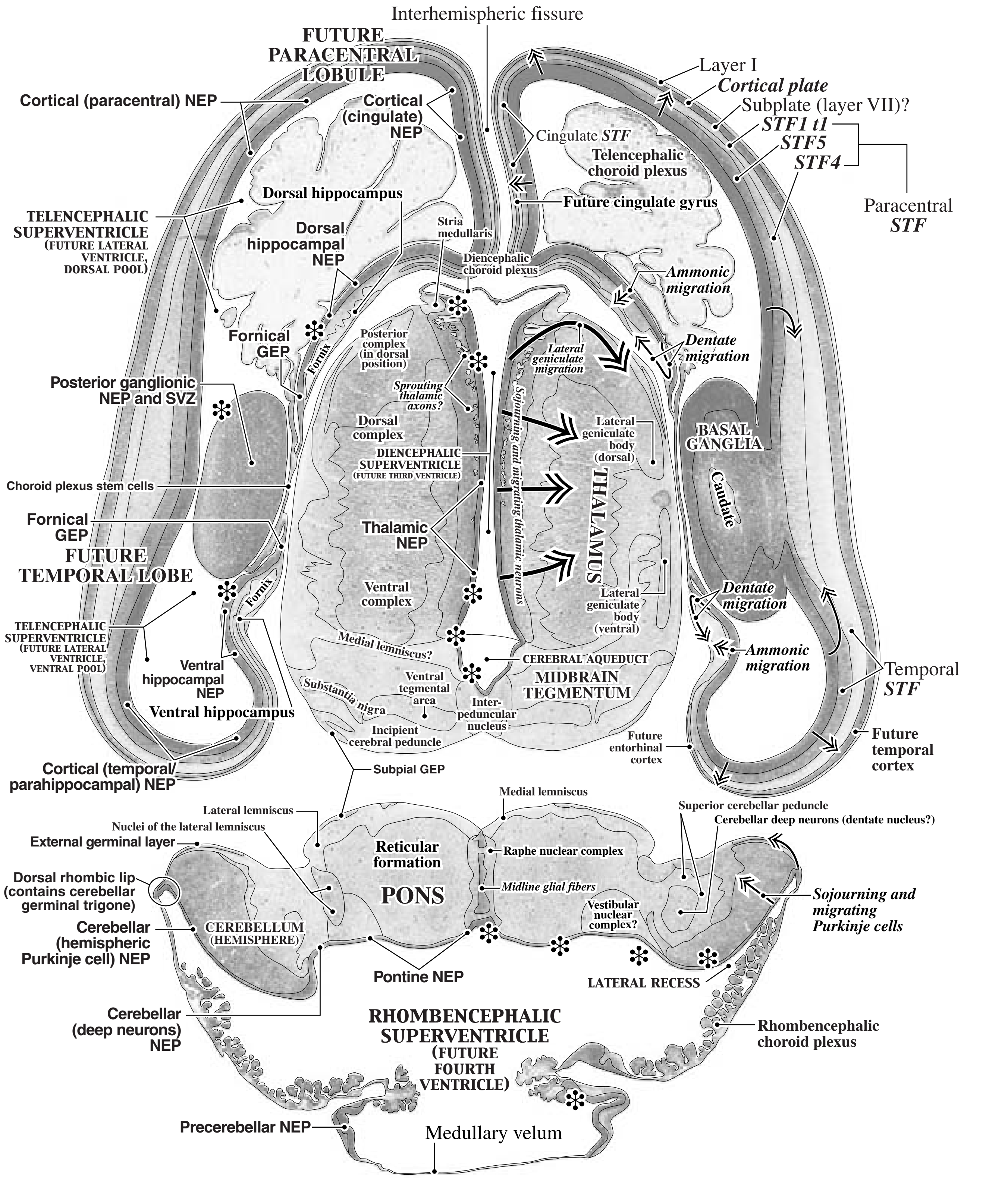
STF5-Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.



2 mm

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 112B



✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 113A

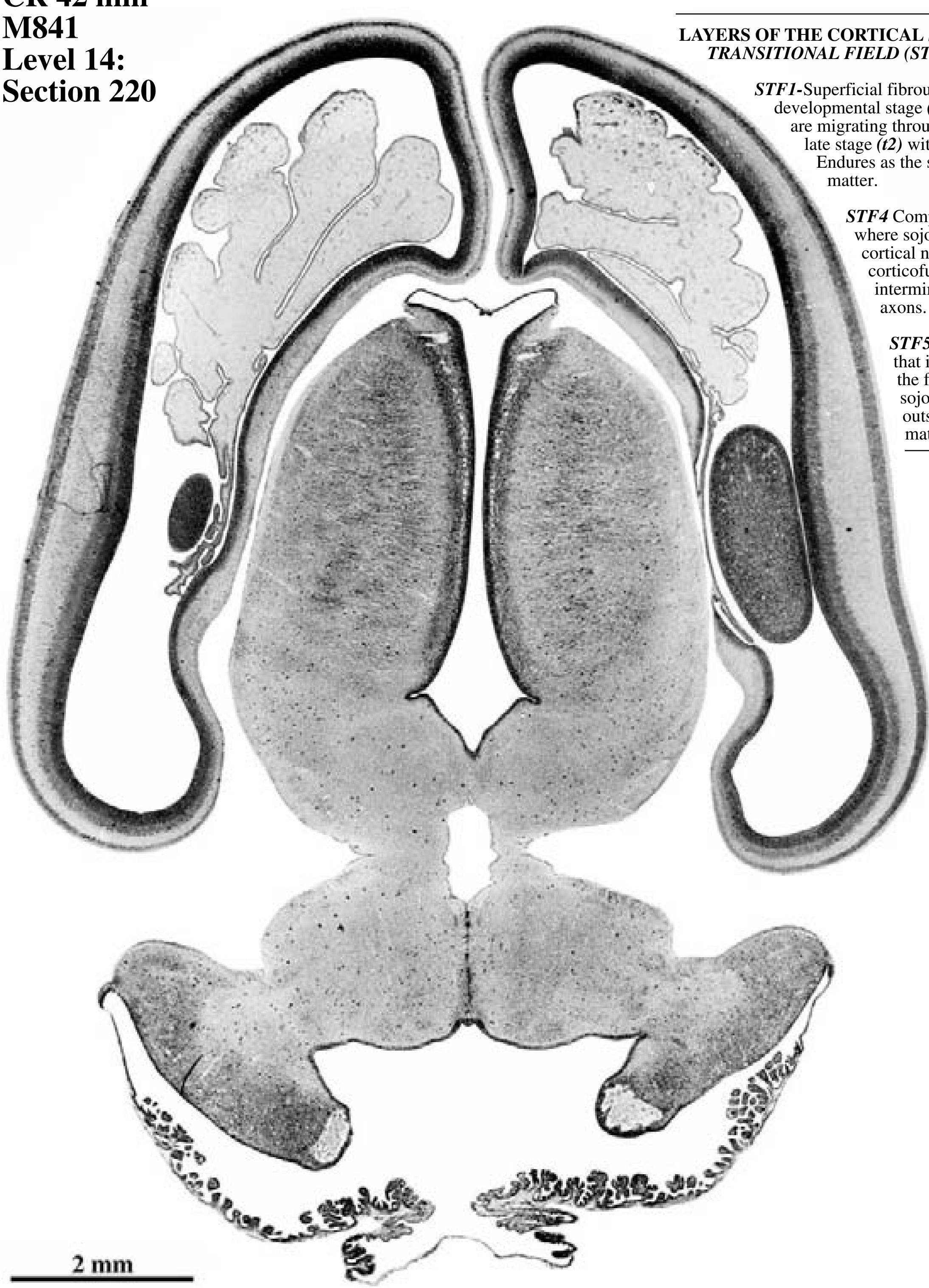
GW9 Coronal
CR 42 mm
M841
Level 14:
Section 220

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1-Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.

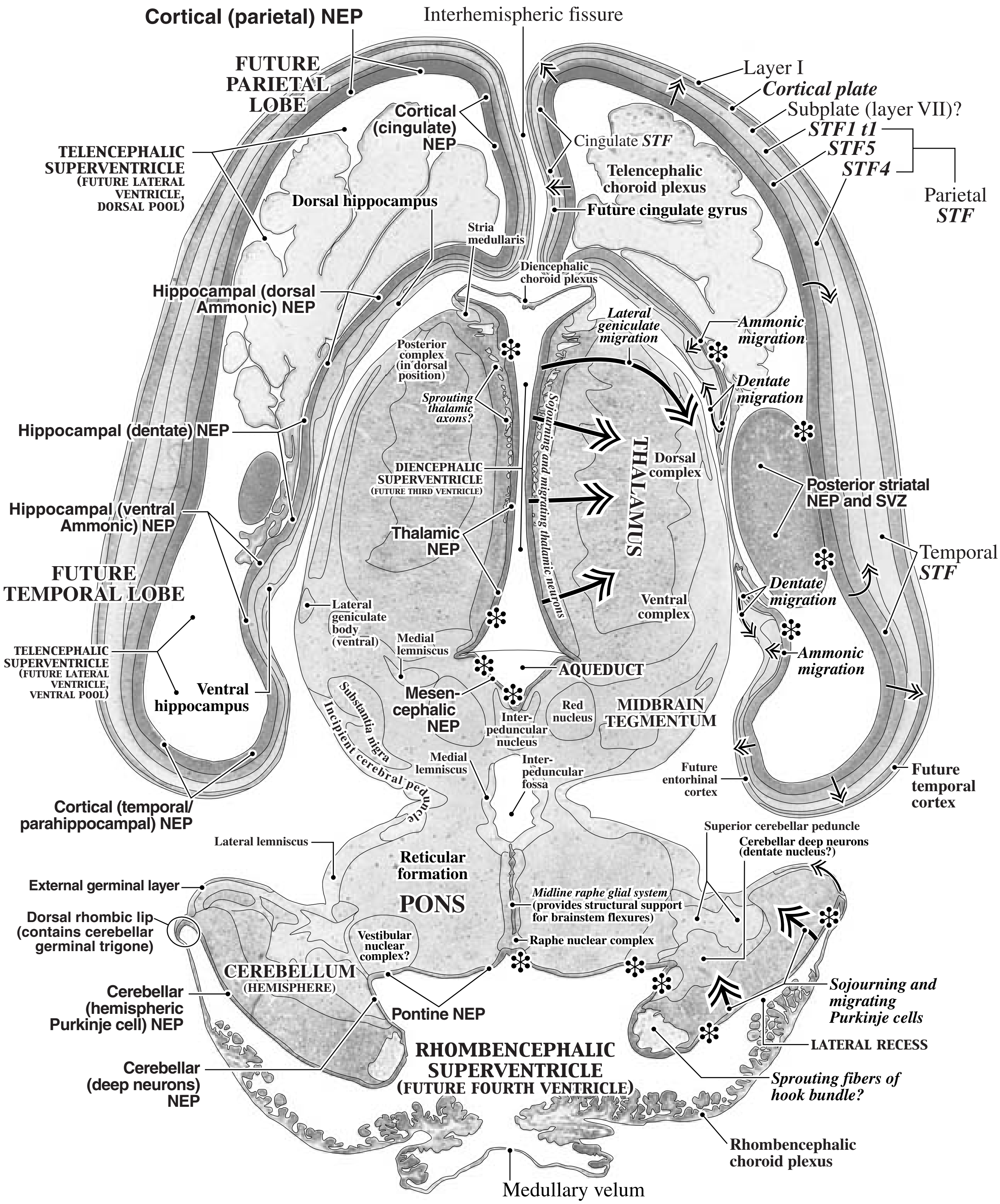
STF4 Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.

STF5-Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 113B



✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
NEP - Neuroepithelium
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 114A

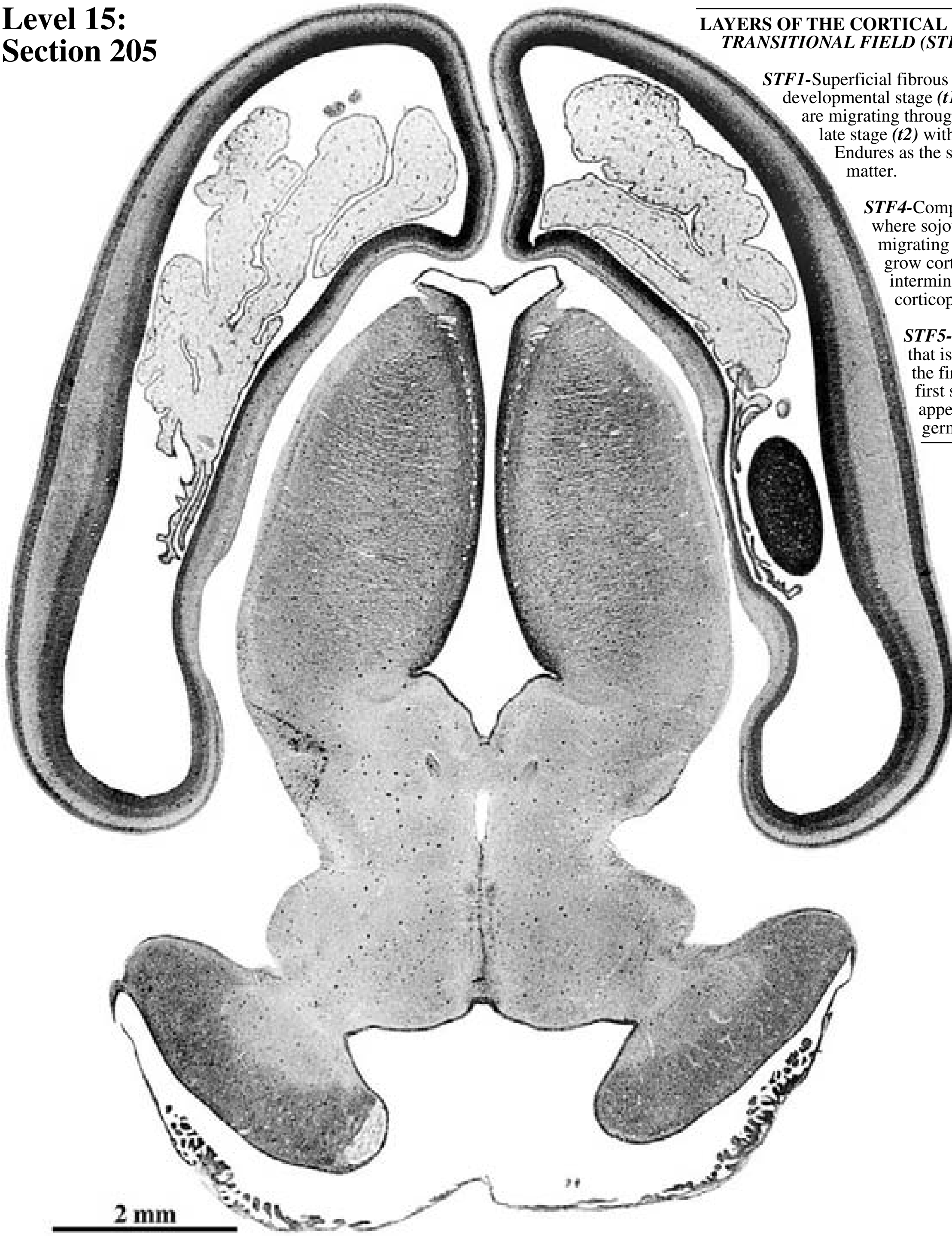
GW9 Coronal
CR 42 mm
M841
Level 15:
Section 205

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1-Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.

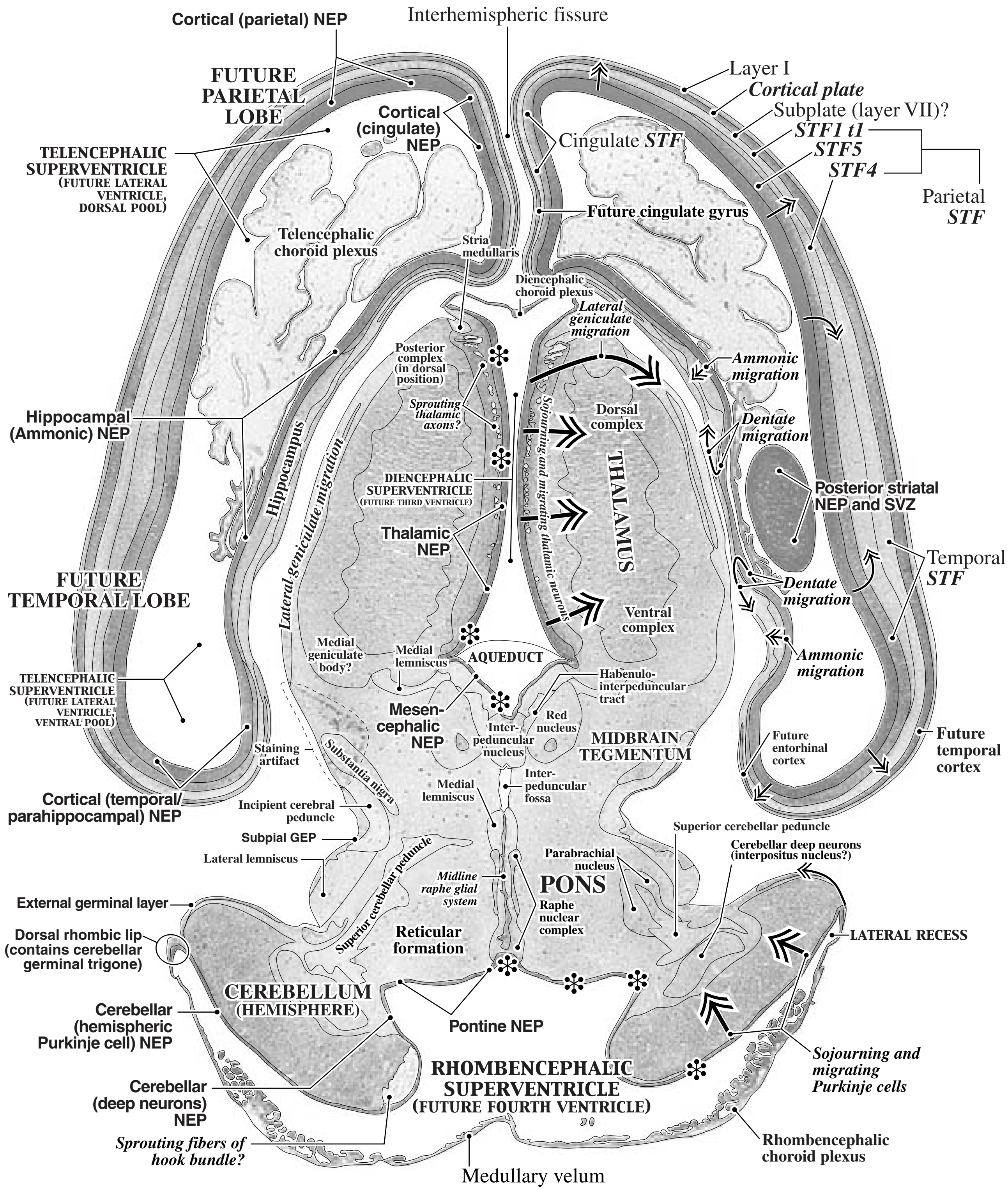
STF4-Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.

STF5-Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.



FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 114B



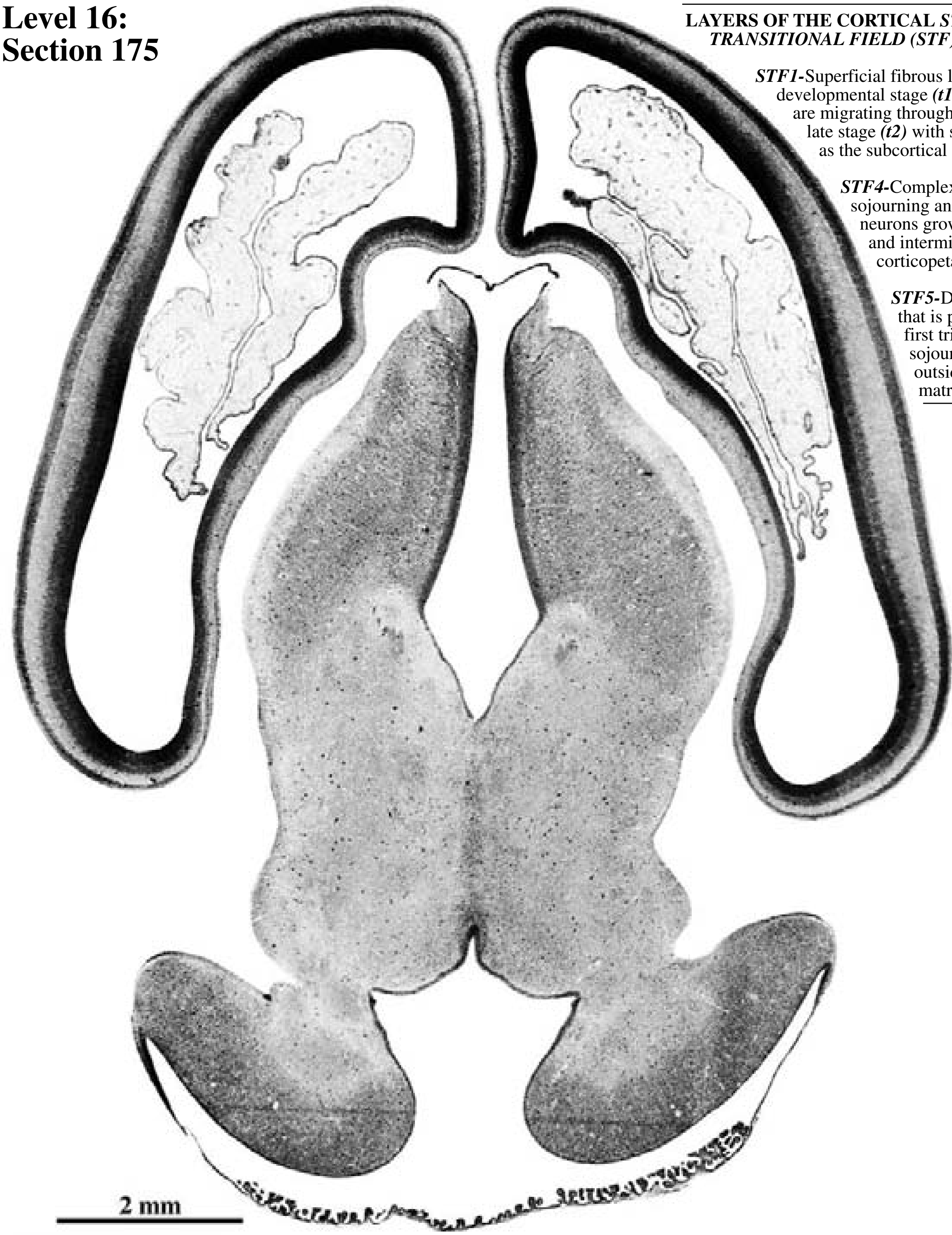
❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 115A

GW9 Coronal
CR 42 mm
M841
Level 16:
Section 175



LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

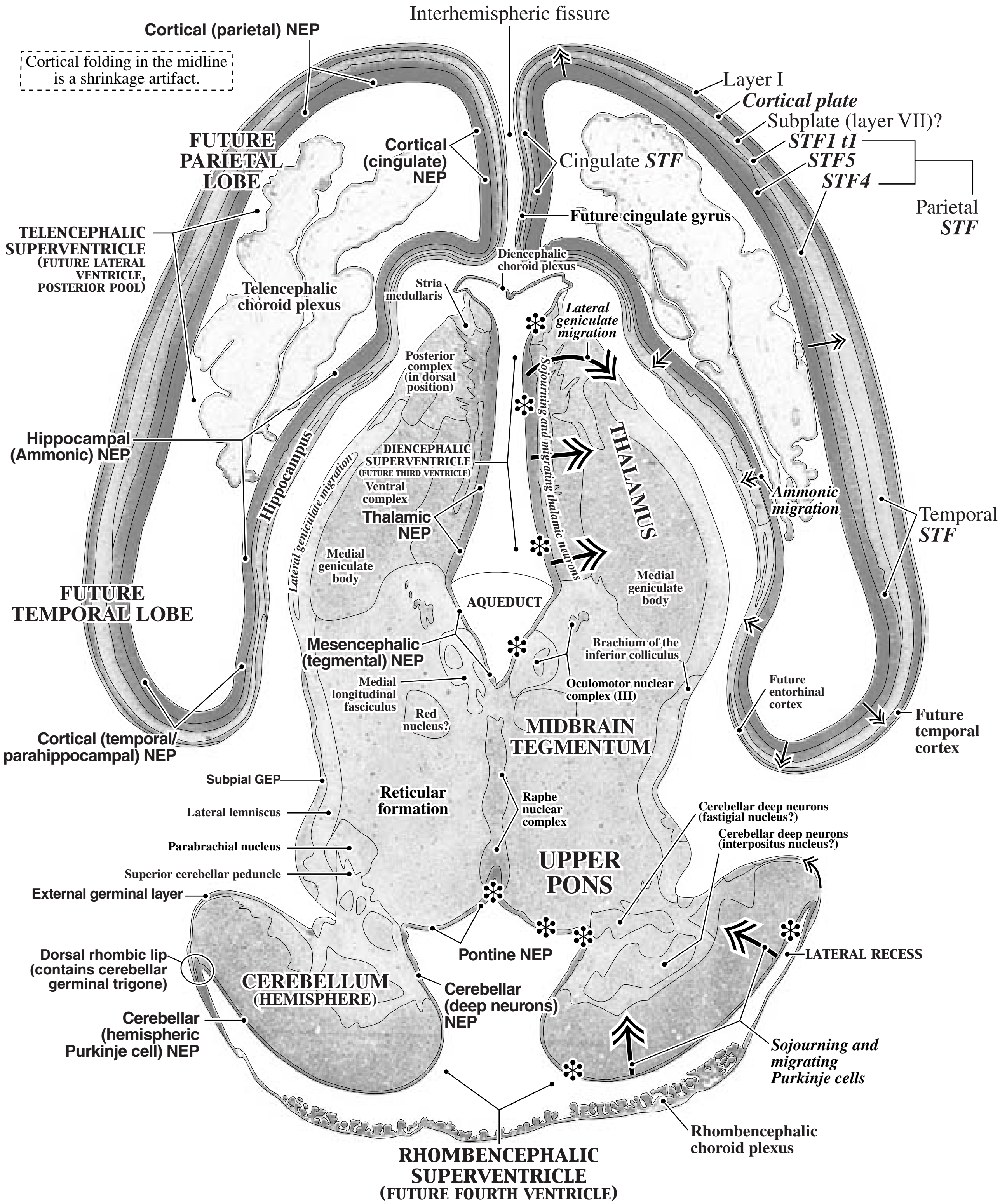
STF1-Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.

STF4-Complex middle layer where sojourning and migrating cortical neurons grow corticofugal axons and intermingle with corticopetal axons.

STF5-Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 115B



✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

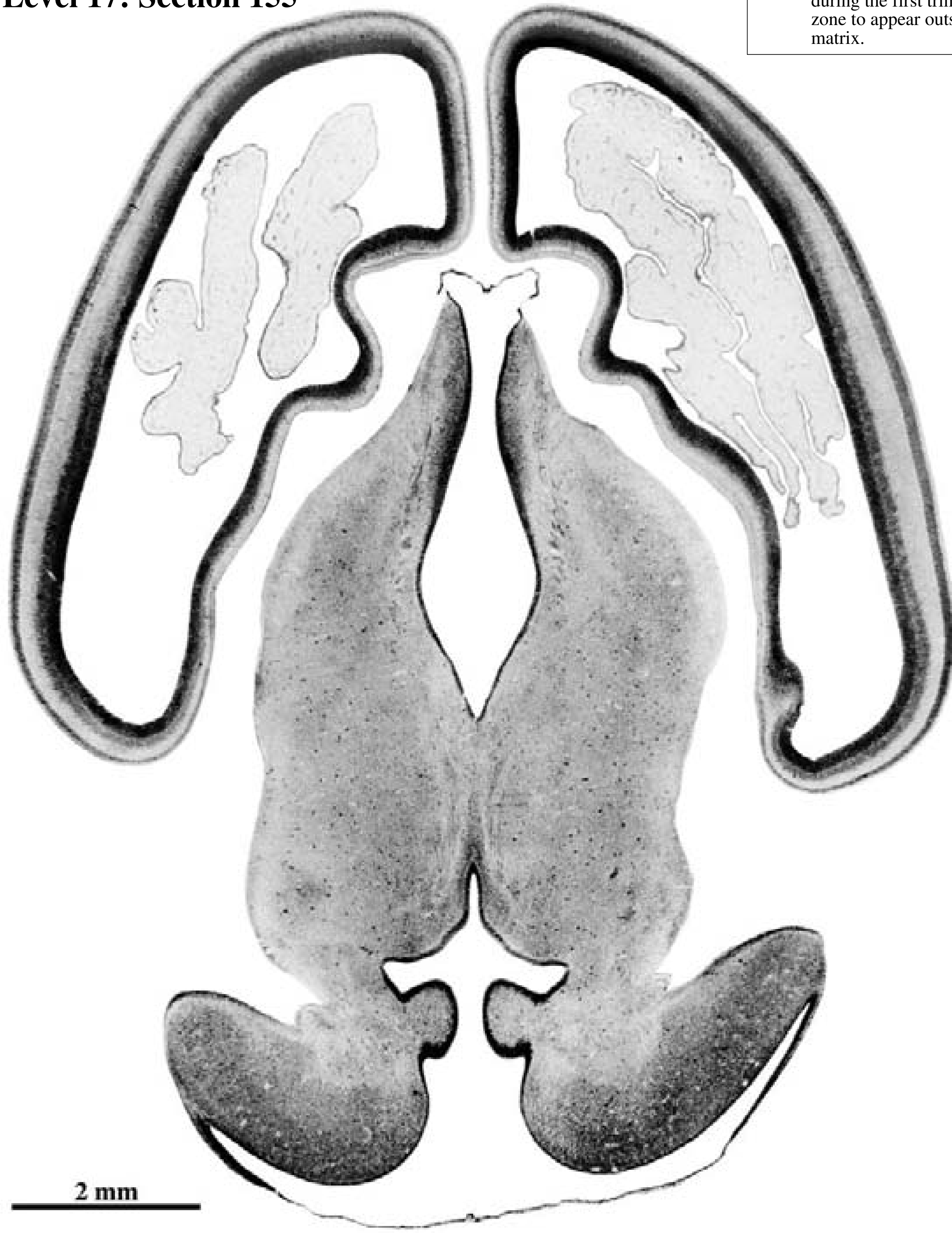
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 116A

GW9 Coronal
CR 42 mm
M841
Level 17: Section 155

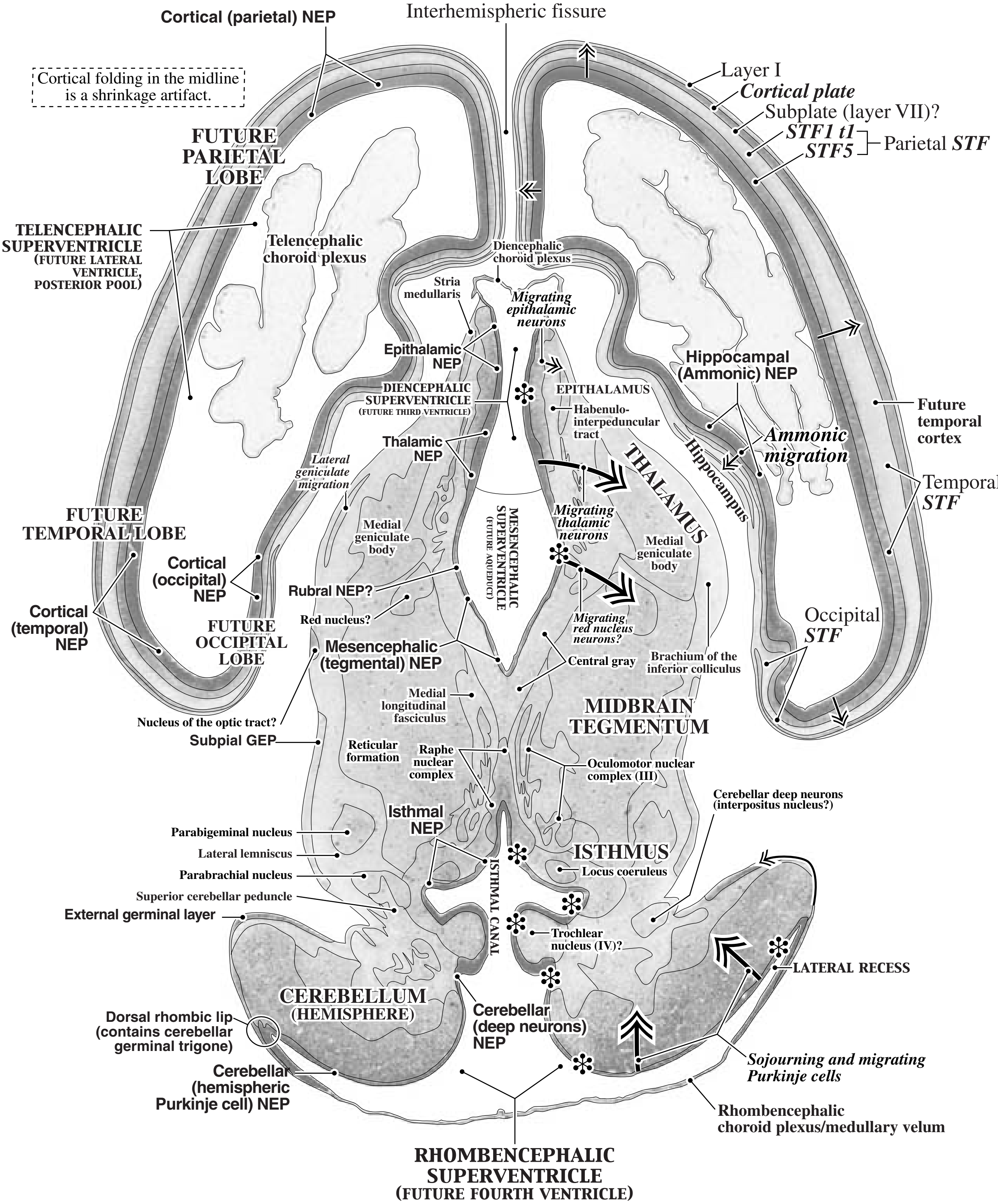
LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 116B



❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 117A

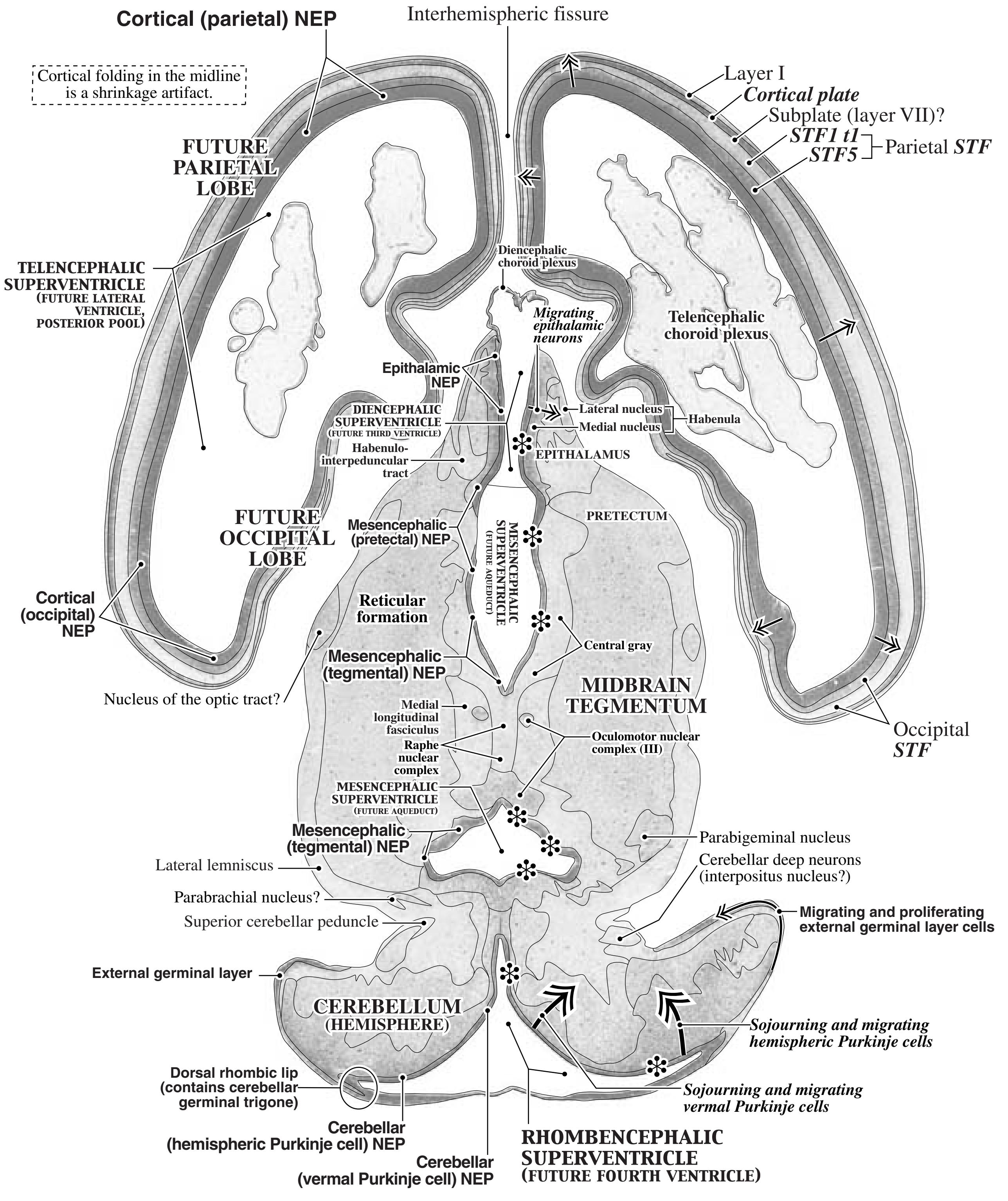
GW9 Coronal
CR 42 mm
M841
Level 18: Section 135

LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 117B



❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

NEP - Neuroepithelium

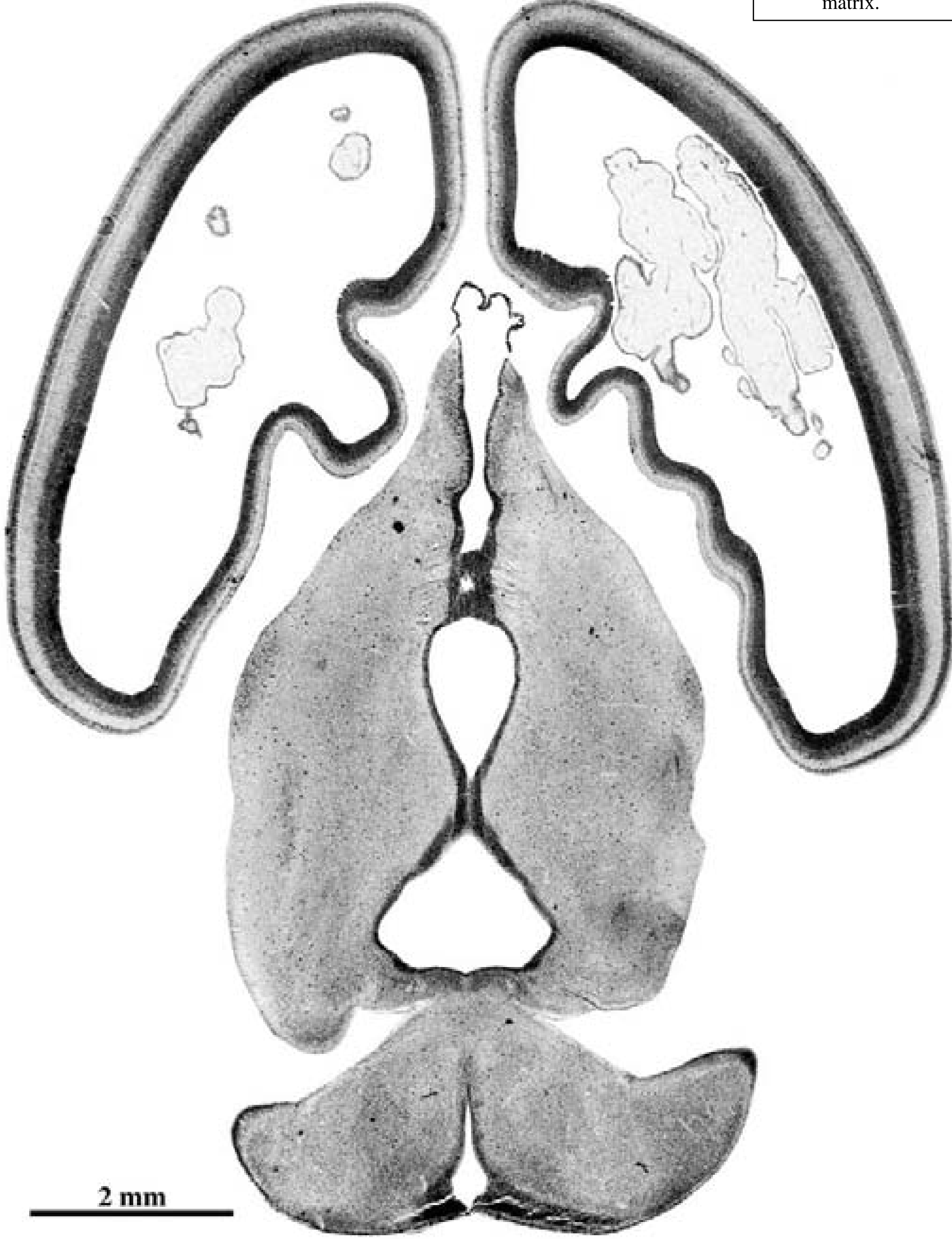
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 118A

GW9 Coronal
CR 42 mm
M841
Level 19: Section 124

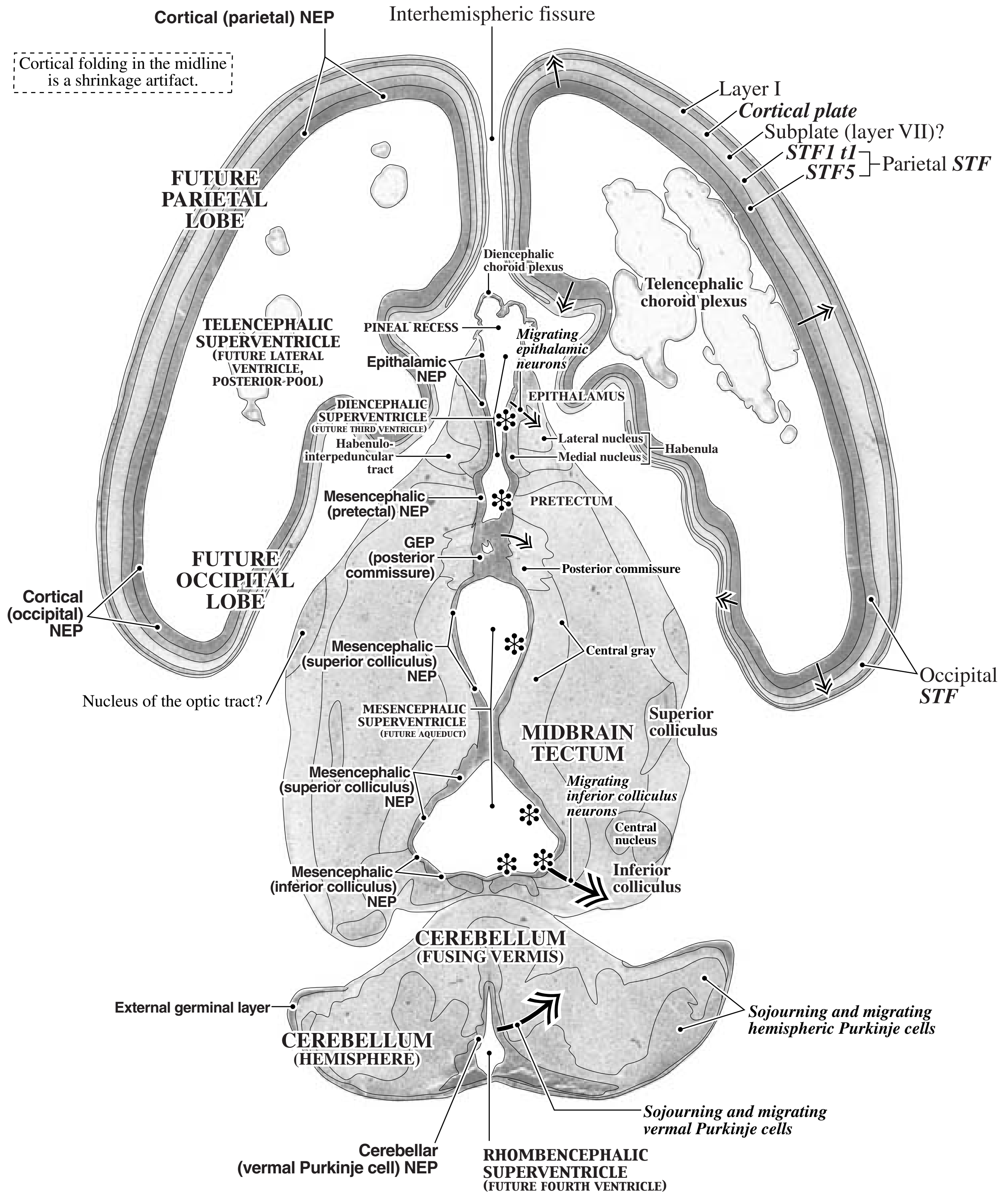
LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 118B



✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

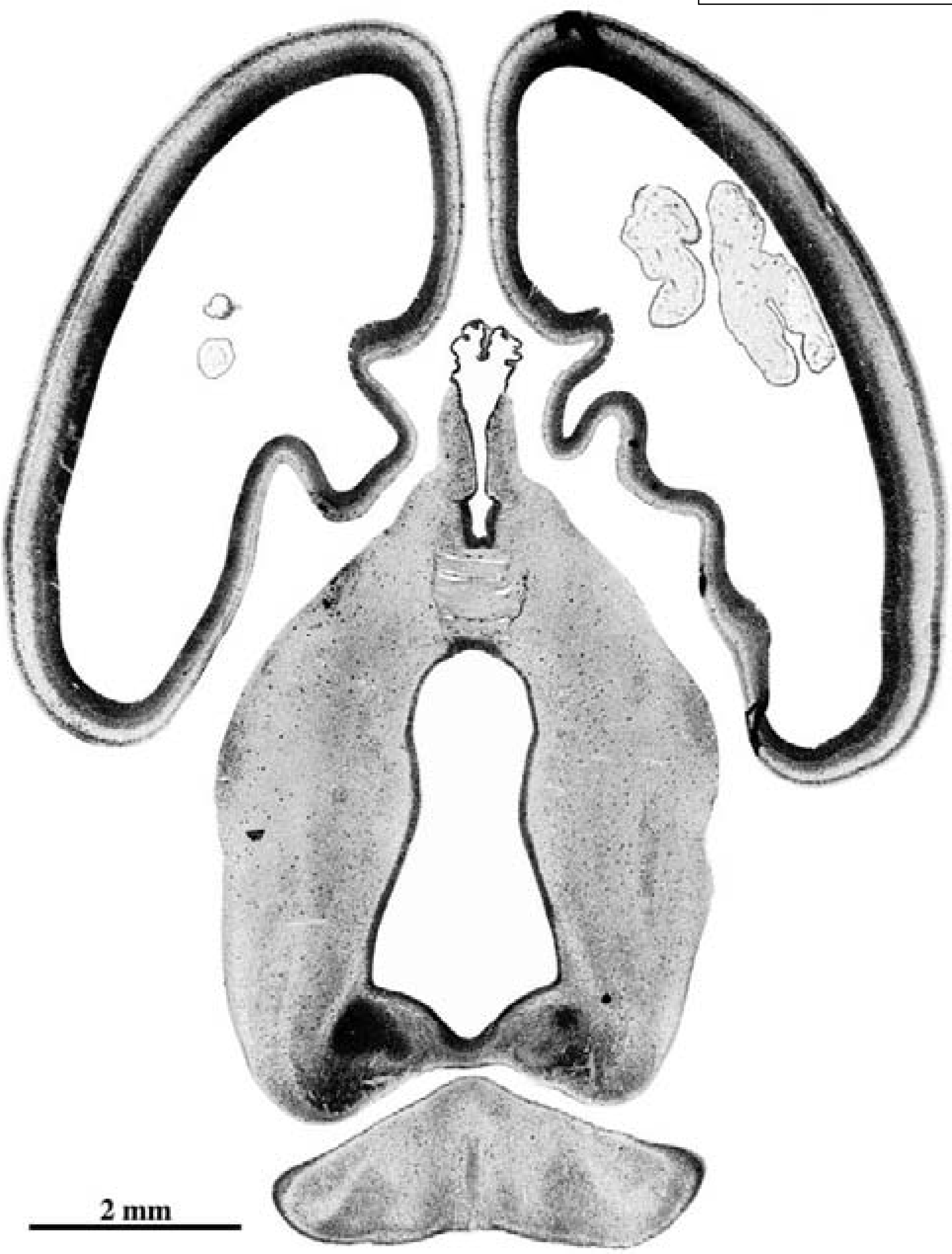
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 119A

GW9 Coronal
CR 42 mm
M841
Level 20: Section 112

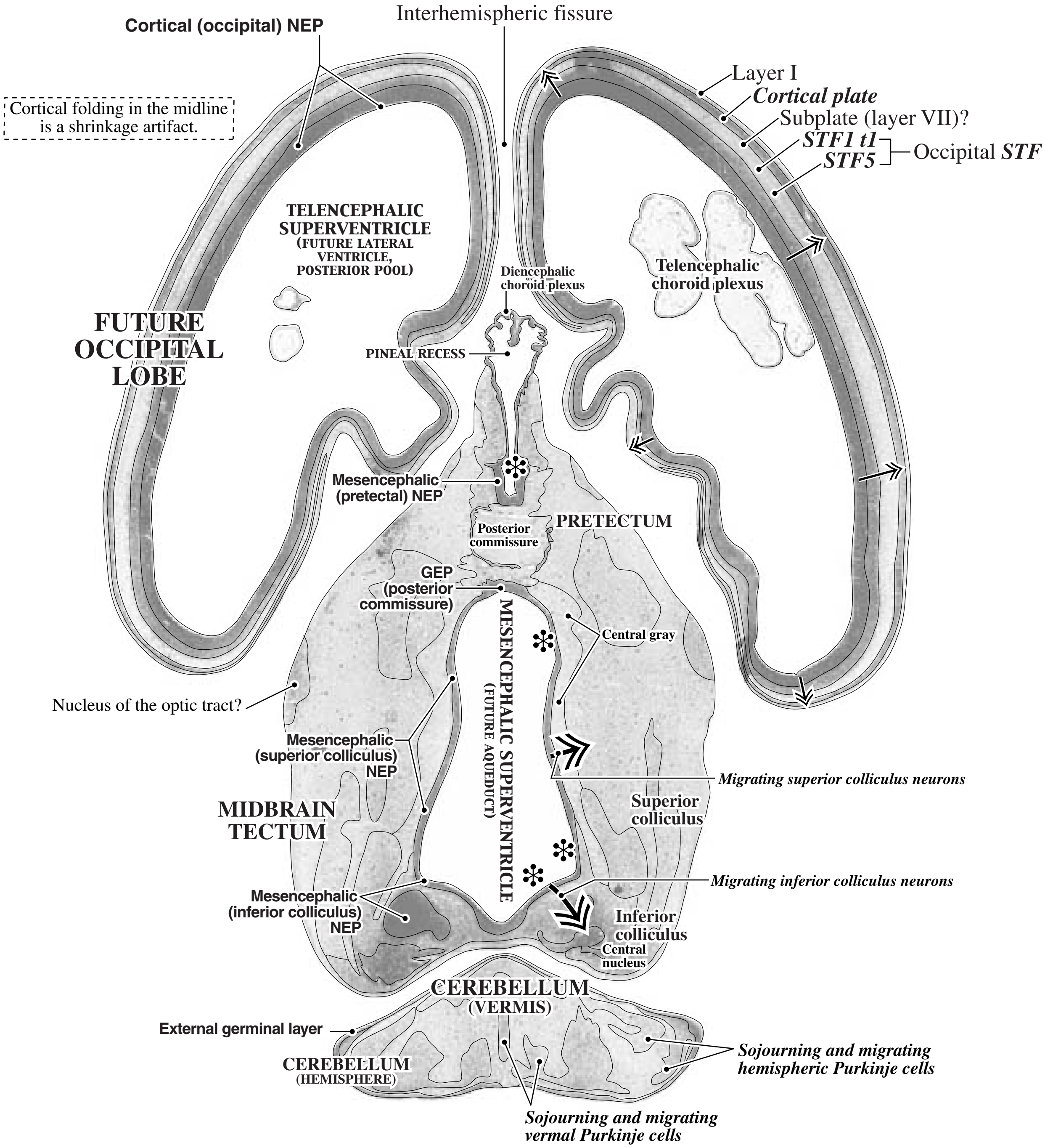
LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 119B



✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

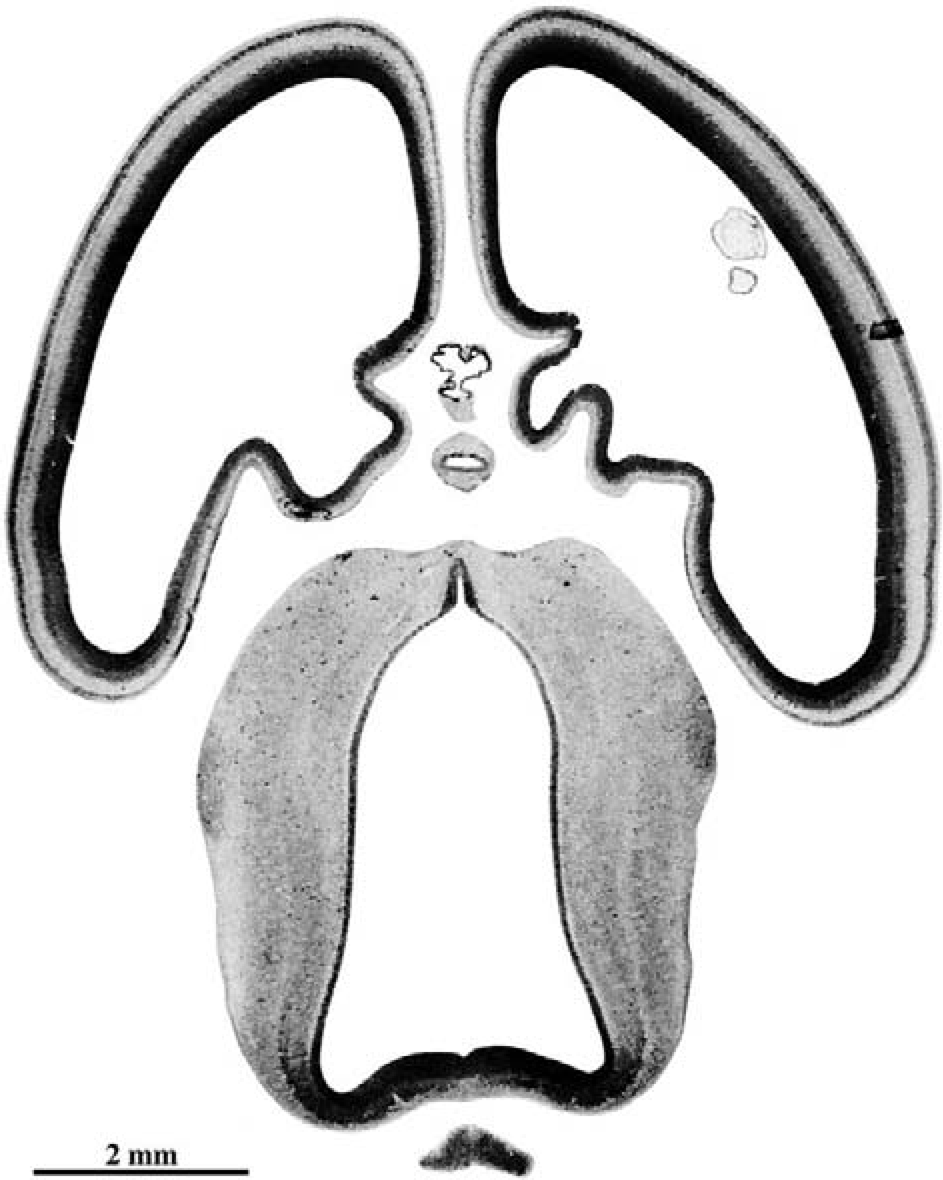
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 120A

GW9 Coronal
CR 42 mm
M841
Level 21: Section 96

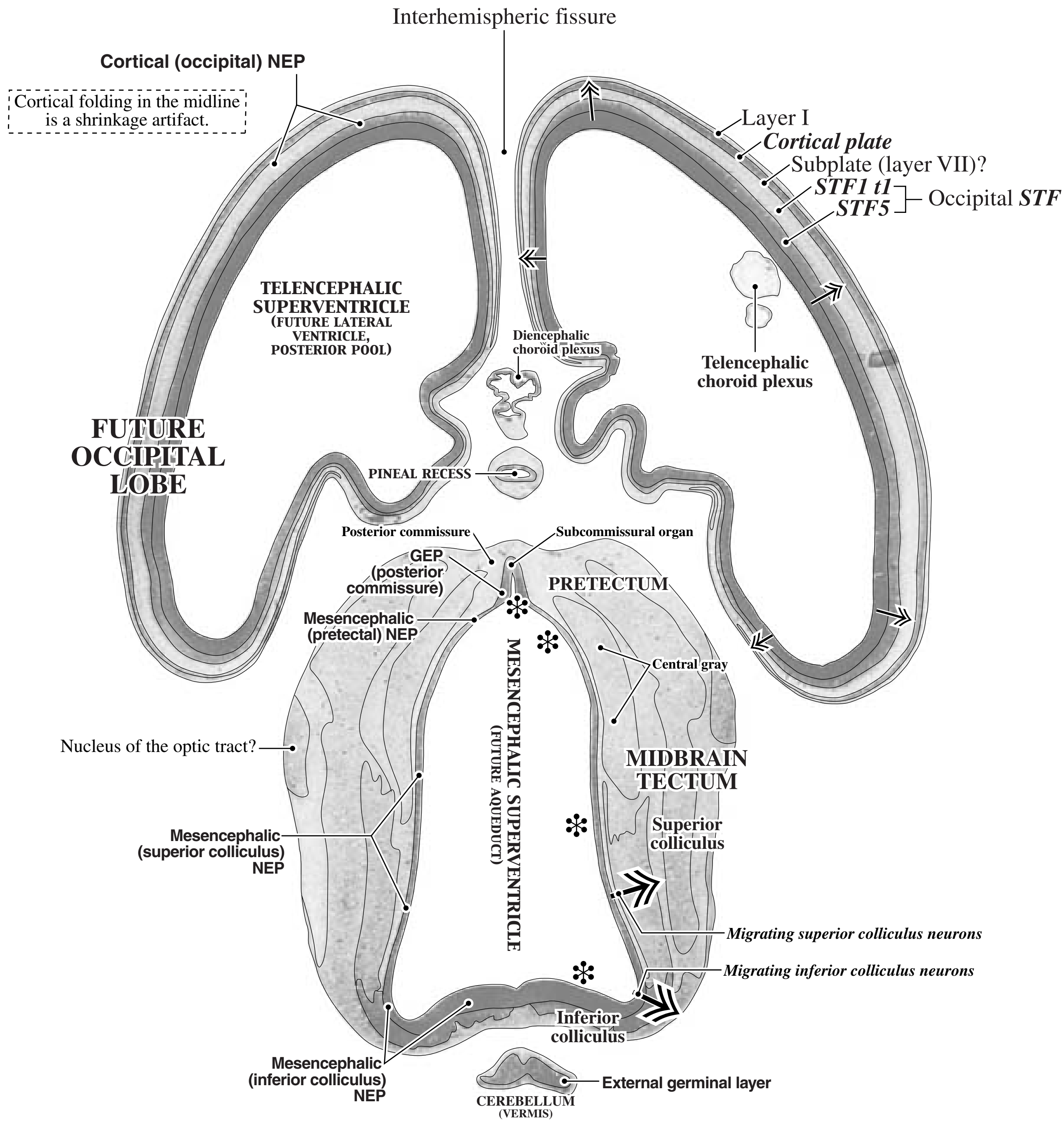
LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 120B



❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

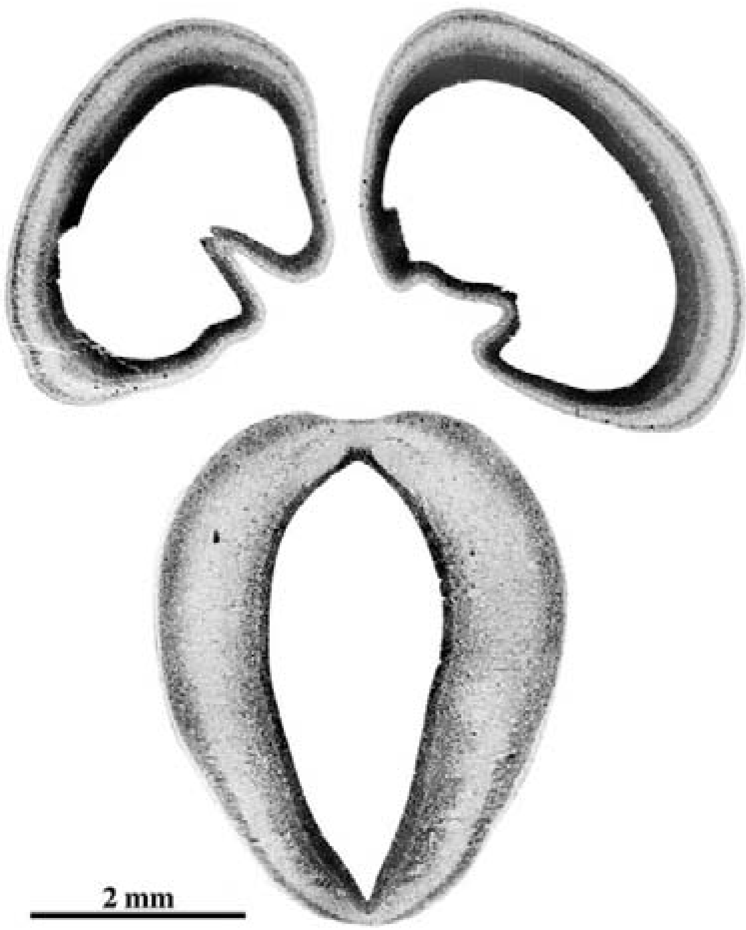
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 121A

GW9 Coronal
CR 42 mm
M841
Level 22: Section 39

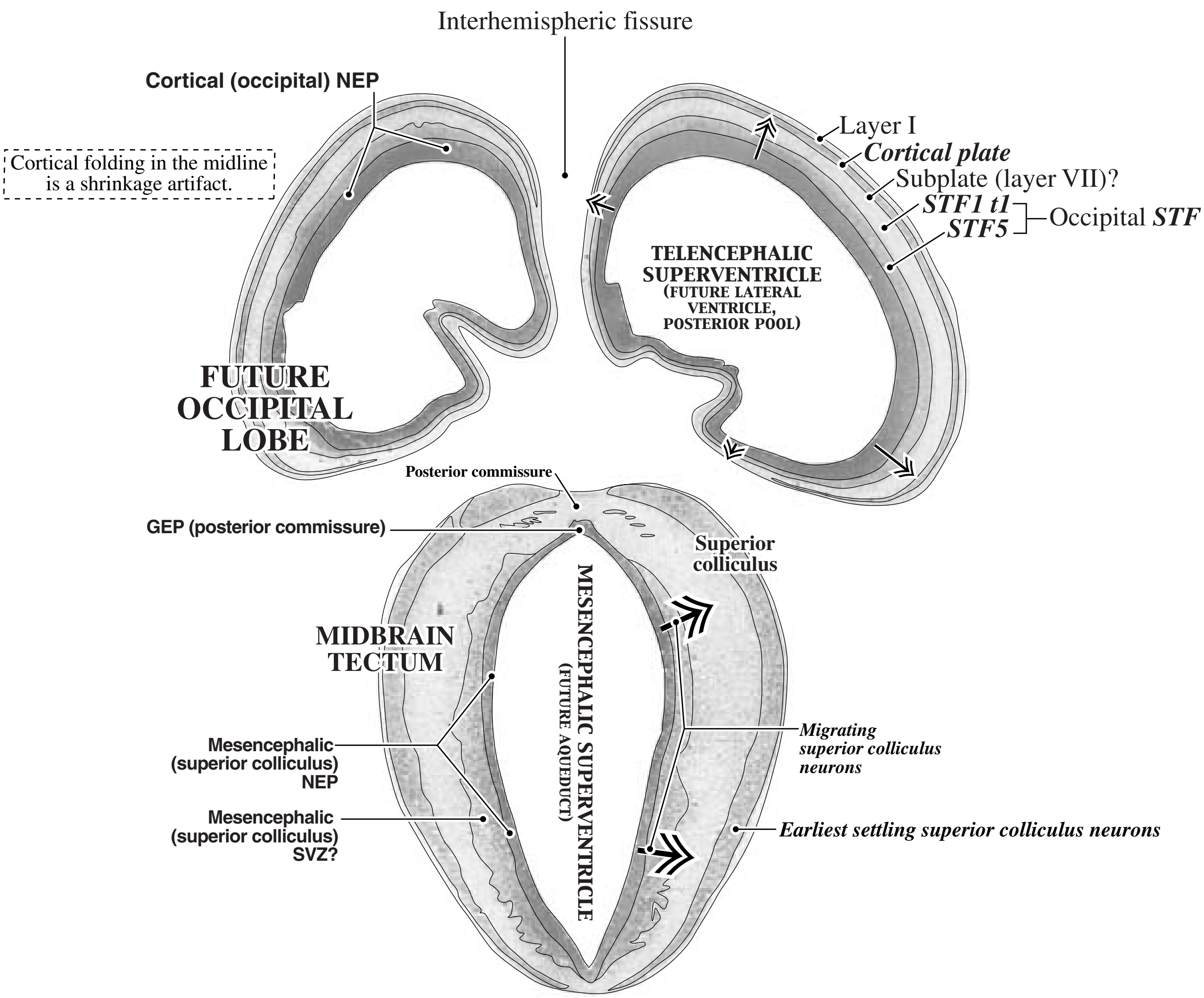
LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 121B



✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PART VII: GW8 SAGITTAL

This is specimen number145 in the Carnegie Collection, designated here as C145, a male with a crown-rump length (CR) of 33 mm estimated to be at gestational week (GW) 8. The entire fetus was cut in the sagittal plane. Information on the date of specimen collection, fixative, section thickness, and embedding medium was not available to us. The sections are thick (probably between 50 to 100 µm) and appear to be embedded in celloidin. Since there is no photograph of C145's brain before histological processing, a specimen from Hochstetter (1919) that is comparable in age to C145 is used to show external brain features at GW8 (**A**, **Figure 6**). C145's brain structures are easier to understand because sections are closely parallel to the midline; **Figure 6** shows the approximate slight rotations in horizontal (**B**) and vertical (**C**) dimensions. Photographs of 10 sections (**Levels 1-10**) are illustrated at low magnification in four parts (**Plates 122A-D** through **131A-D**). The **A/B** parts show the brain in place in the skull; the **C/D** parts show only the brain (and some peripheral ganglia) at slightly higher magnification. **Plates 132-147** show high magnification views of various parts of the brain. All of the high-magnification plates are rotated 90˚ (landscape orientation) to show photographs at higer magnification in the available page space.

C145 is considerably less mature than the GW9 specimens. One of the most notable features of this specimen is the larger volume of the brain ventricles when compared to the brain parenchyma (areas where neurons migrate, settle, and differentiate). The largest structure in each of the brain's major subdivisions is the ***superventricles*** in their cores. For example, the telencephalon is largely occupied by the telencephalic superventricle. The thickness of the parenchyma is a key to the degree of maturation of the various brain structures. It is thickest in the medulla, pons, and midbrain tegmentum where most of the neurons have been generated and thinner in the cerebellum, midbrain tectum, and diencephalon. Within the telencephalon, the cerebral cortex has a very thin parenchyma, while the basal telencephalon and parts of the basal ganglia have thick parenchymal components.

Throughout the cerebral cortex, the ***neuroepithelium*** is prominent as the sole germinal matrix. The ***stratified transitional field (STF)*** contains ***STF1*** and ***STF5*** only in lateral areas. The pronounced anterolateral (thicker) to dorsomedial (thinner) maturation gradient is evident in both the ***cortical plate*** and the ***STF*** layers. The olfactory bulb is just beginning to evaginate in front of the basal telencephalic neuroepithelium. Neurons are just beginning to migrate in the hippocampus. A massive ***neuroepithelium/subventricular zone*** overlies the amygdala, nucleus accumbens, and striatum (caudate and putamen) where neurons (and glia) are being generated.

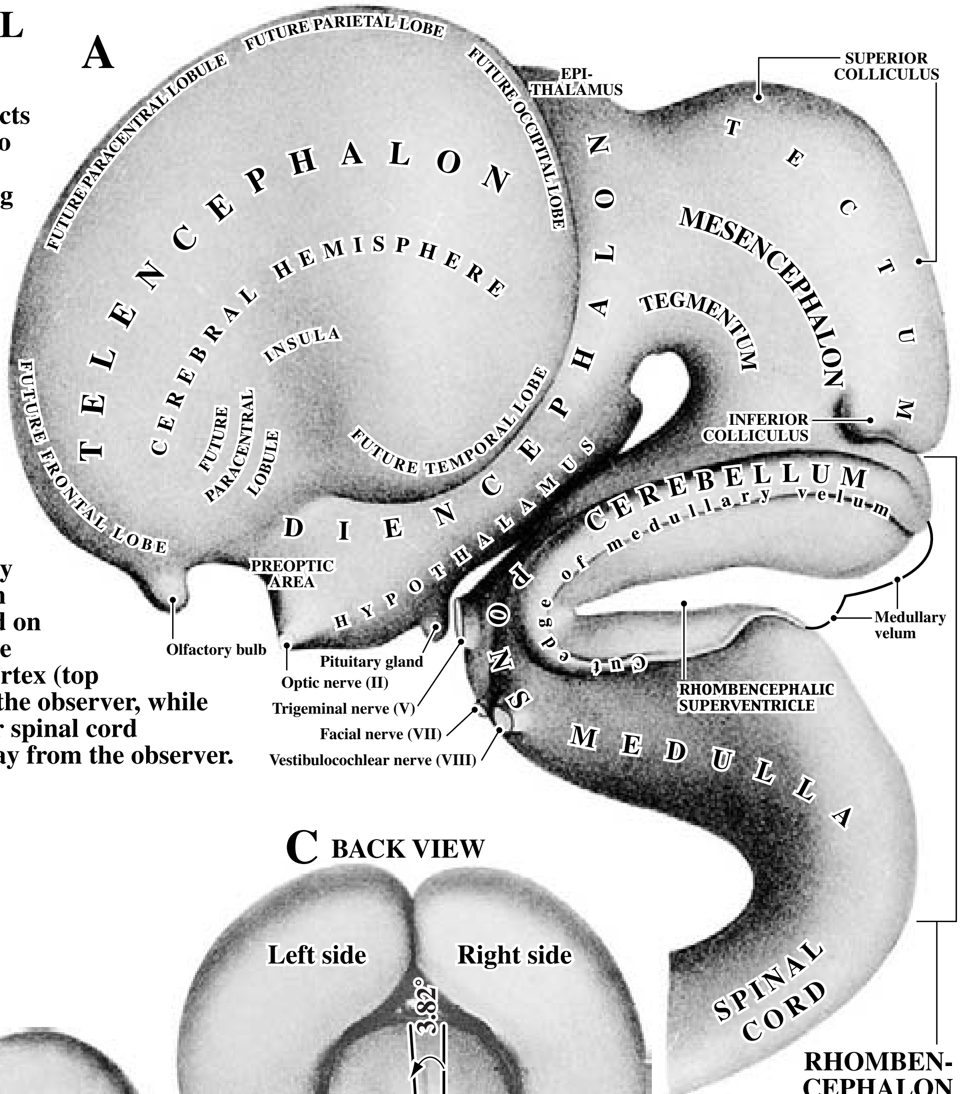
The cerebellum has a thicker ***neuroepithelium***, indicating many Purkinje cells are being generated. Earlier-generated Purkinje cells are sojourning in a dense layer outside the neuroepithelium. Most of the deep neurons are superificial in the cerebellum. The ***external germinal layer (egl)*** is barely visible eminating from the germinal trigone in the dorsal rhombic lip.

In sections near the midline, the brainstem ***neuroepithelium*** varies in thickness. It is thinner in the midbrain tegmentum, pons, and medulla in accordance with an earlier maturation gradient. Most neurons have been generated in these structures and are settling. In the cerebellum (see above), midbrain tectum, and diencephalon, the neuroepithelium is thicker indicating that substantial neurogenesis is happening in these structures, but many neurons have already been produced. However, more lateral sections have a thick ***precerebellar neuroepithelium*** in the medulla. Since the pontine gray is totally absent, nearly all of those neurons have yet to be generated in the precerebellar neuroepithelium; some of the earliest-generated pontine gray neurons are migrating in the ***anterior extramural migratory stream***.

GW8 SAGITTAL

A perfect sagittal cut through the brain bisects the cerebral cortex into two separate hemispheres by passing through the interhemispheric fissure, and does the same in the brainstem by passing through the midline of the ventricles.

Sections of C145's brain are very close to the midline both horizontally (+3.48˚, top view) and vertically (+3.82˚, back view). In each section illustrated on the following pages, the anterior edge of the cortex (top right) is tilted toward the observer, while the medulla and upper spinal cord (bottom) are tilted away from the observer.



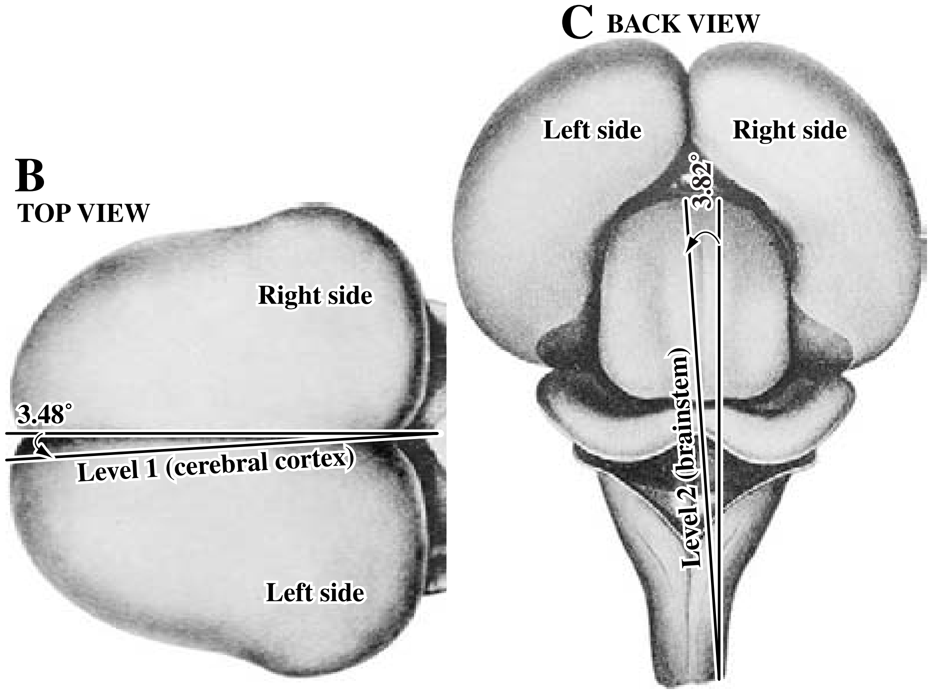


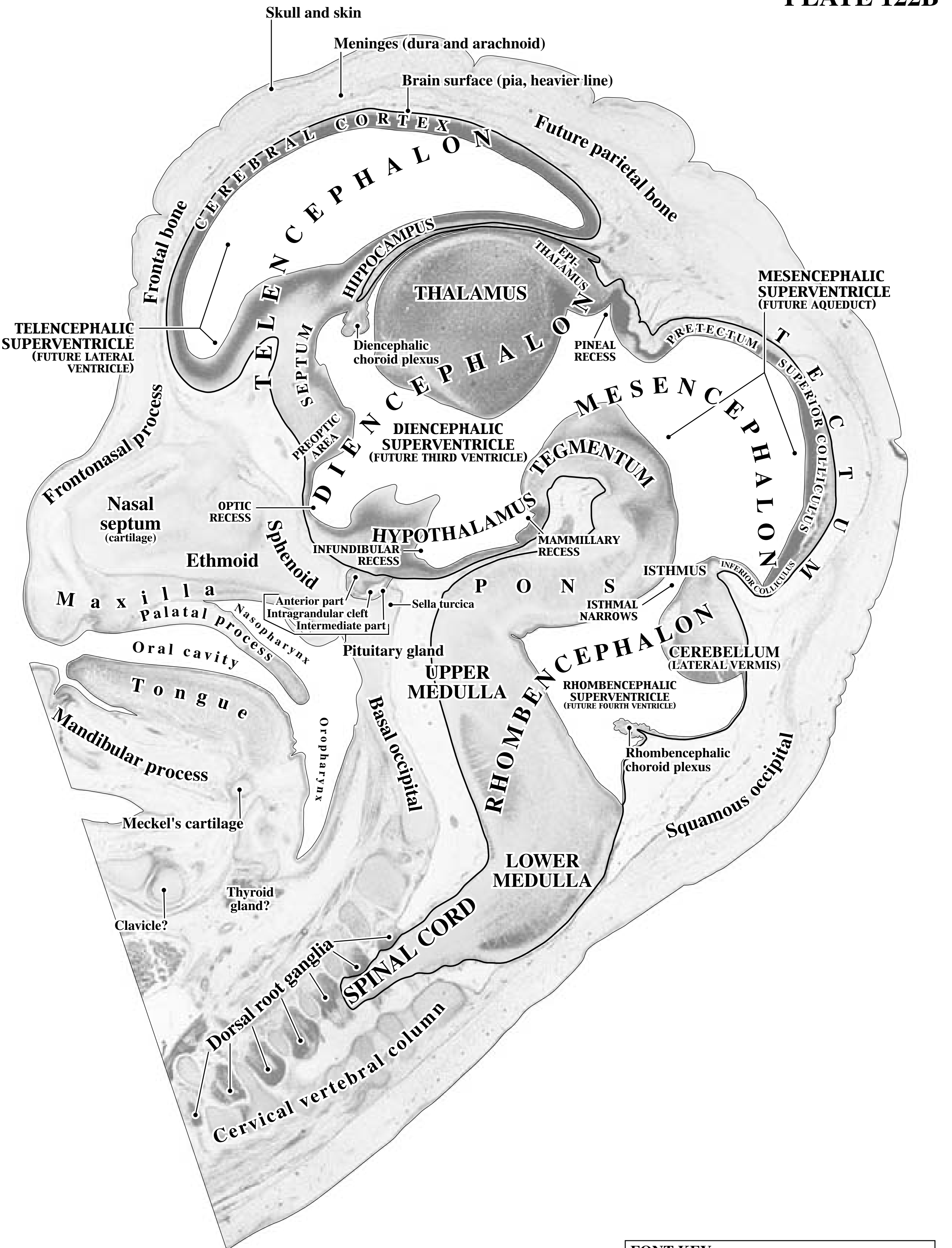
Figure 6. A, The lateral view of the brain and upper cervical spinal cord from a specimen with a crown-rump length of 27 mm (modified from Figure 39, Table VII, Hochstetter, 1919) identifies external features of a brain similar to C145 (CR 33 mm). **B**, Top view of the brain with a crown-rump length of 38 mm (modified from Figure 45, Table VIII, Hochstetter, 1919) shows how C145's sections rotate from a line parallel to the horizontal midline in the interhemispheric fissure. **C**, Back view of the brain in **B** (modified from Figure 44, Table VIII, Hochstetter, 1919) shows how C145's sections rotate from a line parallel to the vertical midline in the brainstem and upper cervical spinal cord.

PLATE 122A

GW8 Sagittal, CR 33 mm, C145
Level 1: Slide 23, Section 2
HEAD STRUCTURES, MAJOR BRAIN REGIONS, AND VENTRICULAR DIVISIONS

Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

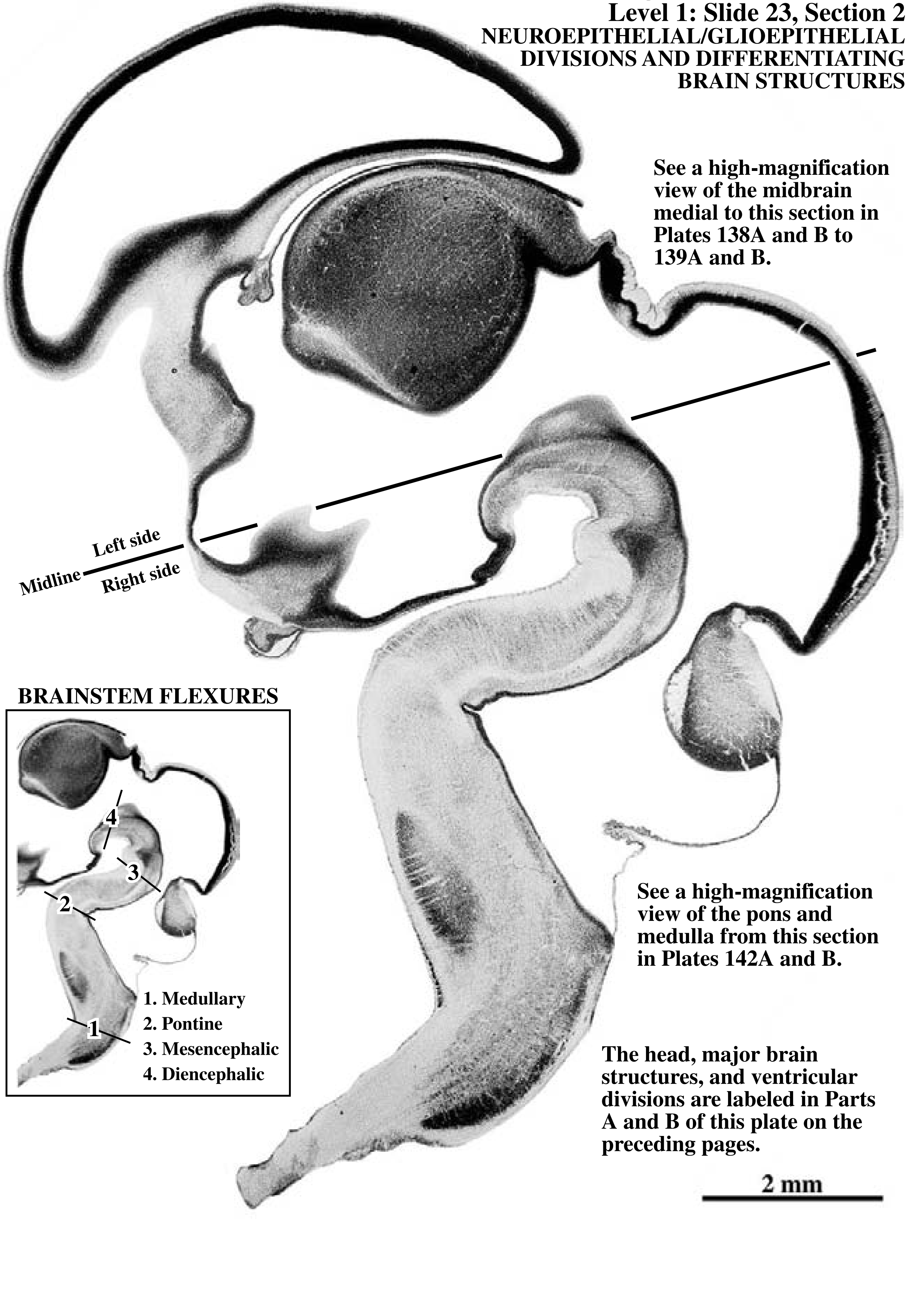
PLATE 122B



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 122C

GW8 Sagittal, CR 33 mm, C145
Level 1: Slide 23, Section 2
NEUROEPITHELIAL/GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES



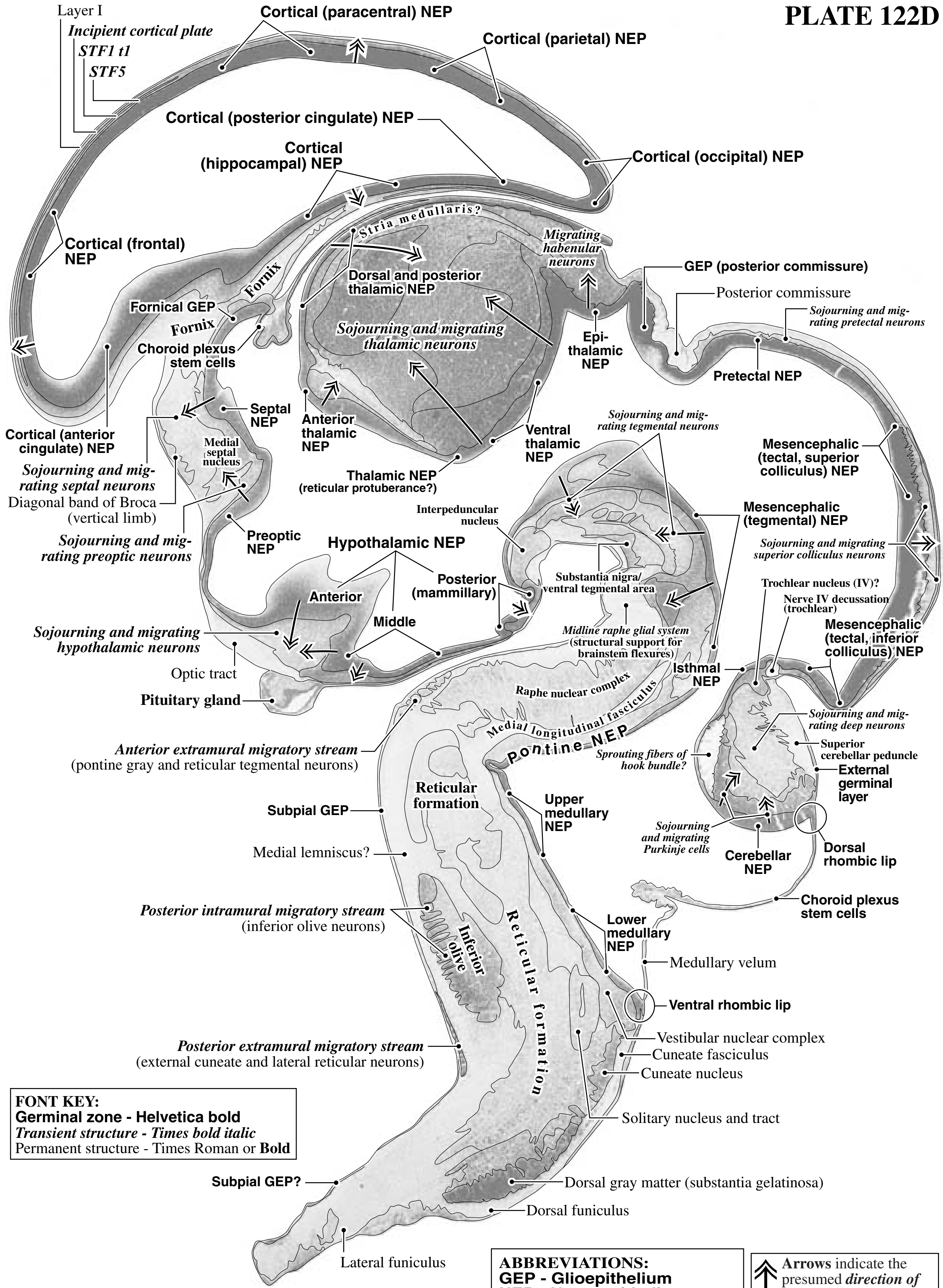
See a high-magnification view of the midbrain medial to this section in Plates 138A and B to 139A and B.

See a high-magnification view of the pons and medulla from this section in Plates 142A and B.

The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

BRAINSTEM FLEXURES

PLATE 122D



FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 123A

GW8 Sagittal, CR 33 mm, C145
Level 2: Slide 22, Section 2
HEAD STRUCTURES, MAJOR BRAIN REGIONS, AND VENTRICULAR DIVISIONS

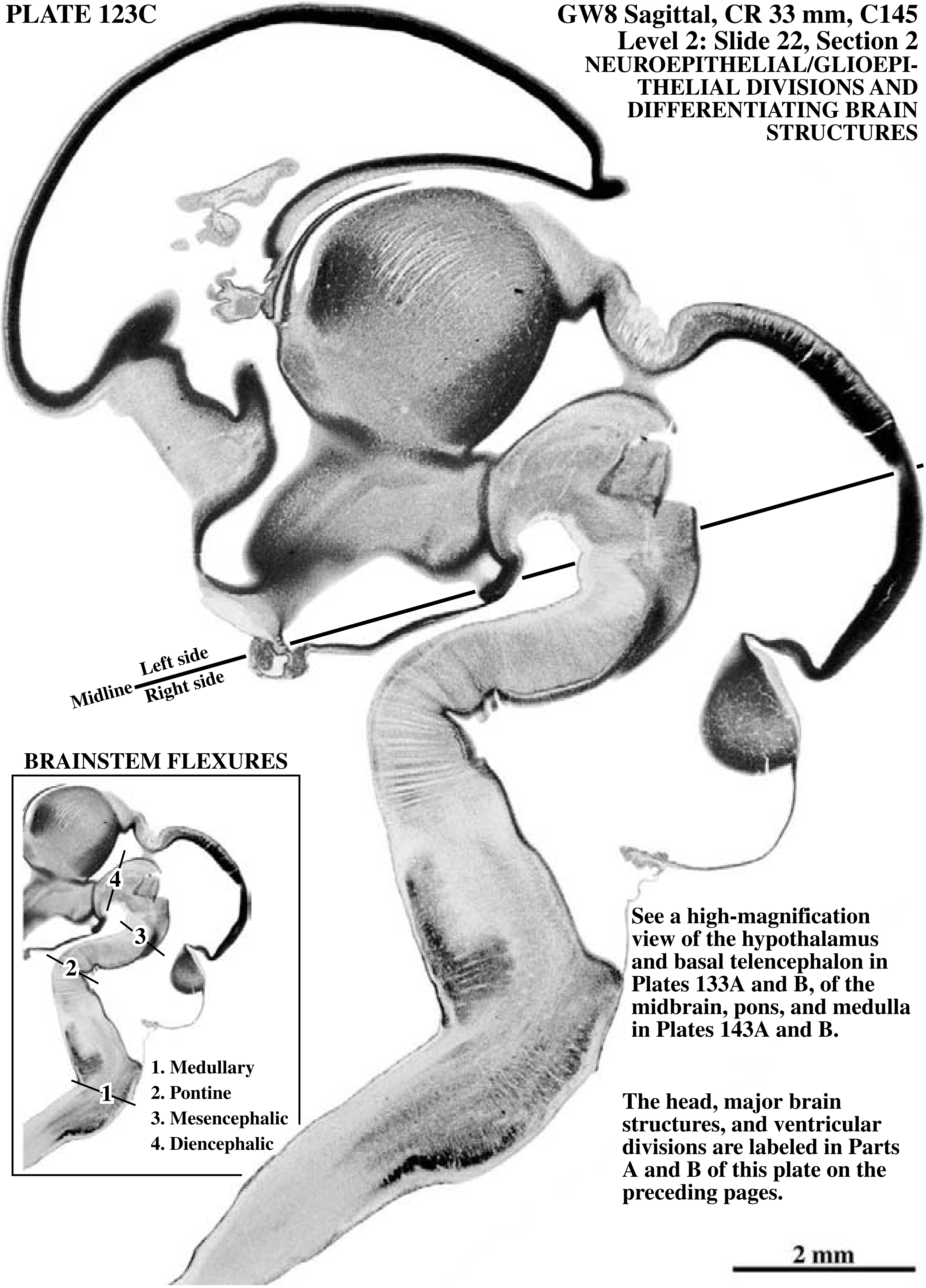
Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

PLATE 123B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 123C

GW8 Sagittal, CR 33 mm, C145
Level 2: Slide 22, Section 2
NEUROEPITHELIAL/GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES



See a high-magnification view of the hypothalamus and basal telencephalon in Plates 133A and B, of the midbrain, pons, and medulla in Plates 143A and B.

The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 123D

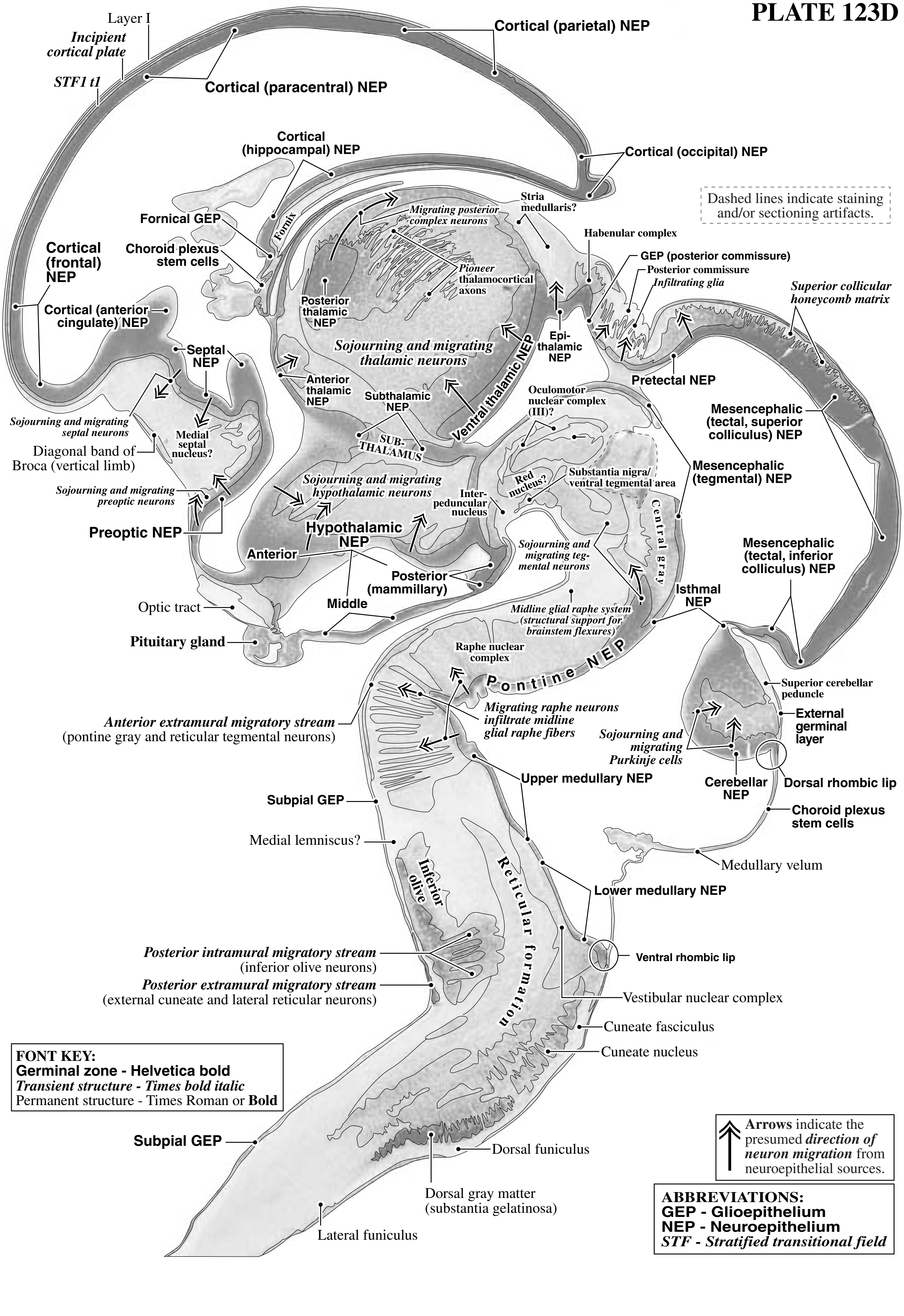

Layer I
Incipient cortical plate
STF1 t1
Cortical (parietal) NEP
Cortical (paracentral) NEP
Cortical (hippocampal) NEP
Cortical (occipital) NEP
Dashed lines indicate staining and/or sectioning artifacts.
Fornix
Migrating posterior complex neurons
Stria medullaris?
Fornical GEP
Habenular complex
Cortical (frontal) NEP
Choroid plexus stem cells
Pioneer thalamocortical axons
GEP (posterior commissure)
Posterior commissure
Infiltrating glia
Posterior thalamic NEP
Superior collicular honeycomb matrix
Cortical (anterior cingulate) NEP
Epi-thalamic NEP
Sojourning and migrating thalamic neurons
Septal NEP
Ventral thalamic NEP
Pretectal NEP
Anterior thalamic NEP
Subthalamic NEP
Oculomotor nuclear complex (III)?
Mesencephalic (tectal, superior colliculus) NEP
Sojourning and migrating septal neurons
Medial septal nucleus?
SUB-THALAMUS
Diagonal band of Broca (vertical limb)
Mesencephalic (tegmental) NEP
Red nucleus?
Substantia nigra/ ventral tegmental area
Sojourning and migrating hypothalamic neurons
Sojourning and migrating preoptic neurons
Inter-peduncular nucleus
Central gray
Hypothalamic NEP
Preoptic NEP
Sojourning and migrating teg-mental neurons
Mesencephalic (tectal, inferior colliculus) NEP
Anterior
Posterior (mammillary)
Isthmal NEP
Middle
Optic tract
Midline glial raphe system (structural support for brainstem flexures)
Pituitary gland
Raphe nuclear complex
Pontine NEP
Superior cerebellar peduncle
Anterior extramural migratory stream
(pontine gray and reticular tegmental neurons)
Migrating raphe neurons infiltrate midline glial raphe fibers
External germinal layer
Sojourning and migrating Purkinje cells
Upper medullary NEP
Cerebellar NEP
Dorsal rhombic lip
Subpial GEP
Choroid plexus stem cells
Medial lemniscus?
Medullary velum
Inferior olive
Reticular formation
Lower medullary NEP
Posterior intramural migratory stream
(inferior olive neurons)
Ventral rhombic lip
Posterior extramural migratory stream
(external cuneate and lateral reticular neurons)
Vestibular nuclear complex
Cuneate fasciculus
Cuneate nucleus
FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Subpial GEP
Dorsal funiculus
Dorsal gray matter (substantia gelatinosa)
Lateral funiculus
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field

PLATE 124A

GW8 Sagittal, CR 33 mm, C145
Level 3: Slide 20, Section 2
HEAD STRUCTURES, MAJOR BRAIN REGIONS, AND VENTRICULAR DIVISIONS

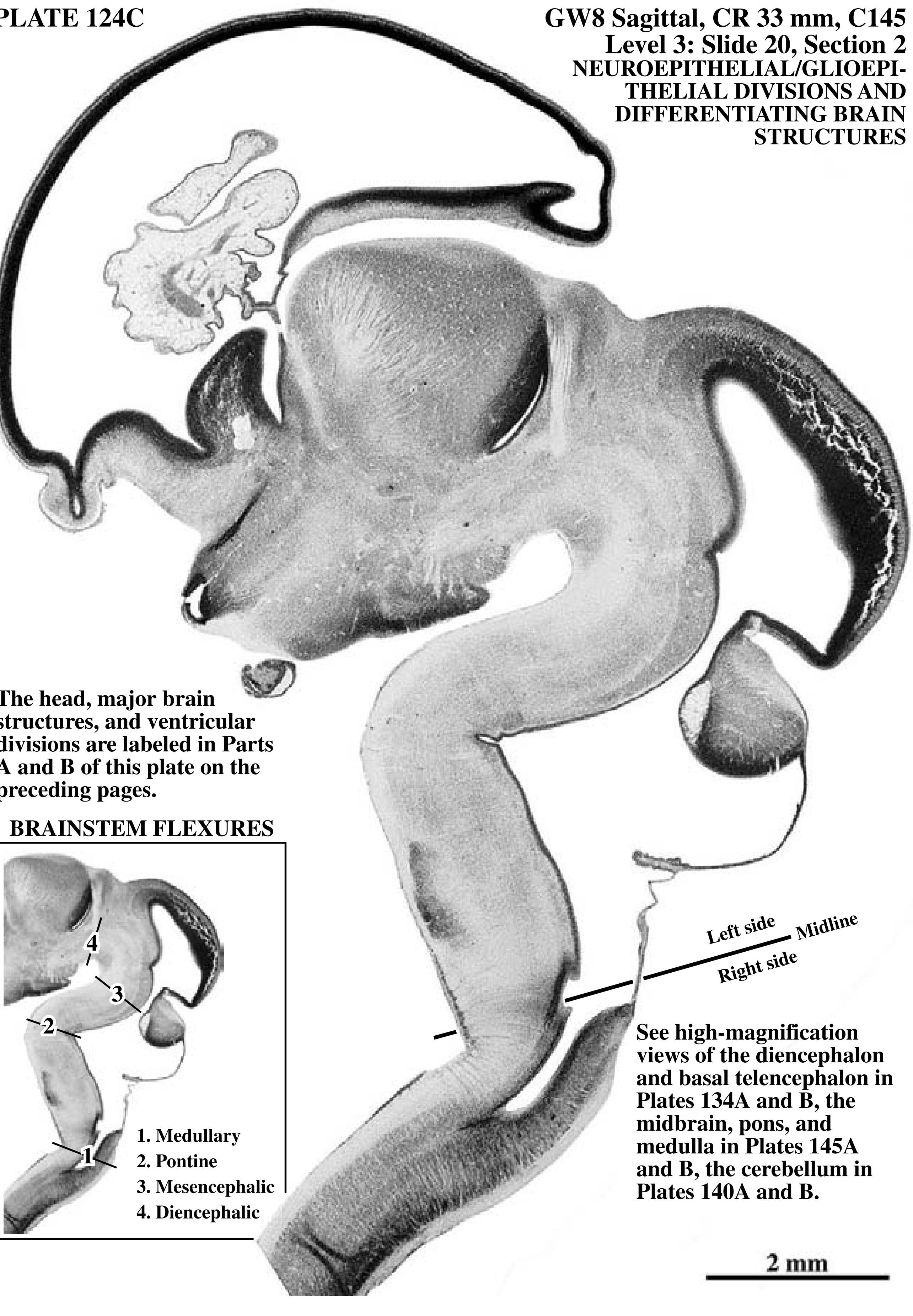
Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

PLATE 124B

FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 124C

GW8 Sagittal, CR 33 mm, C145
Level 3: Slide 20, Section 2
NEUROEPITHELIAL/GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES

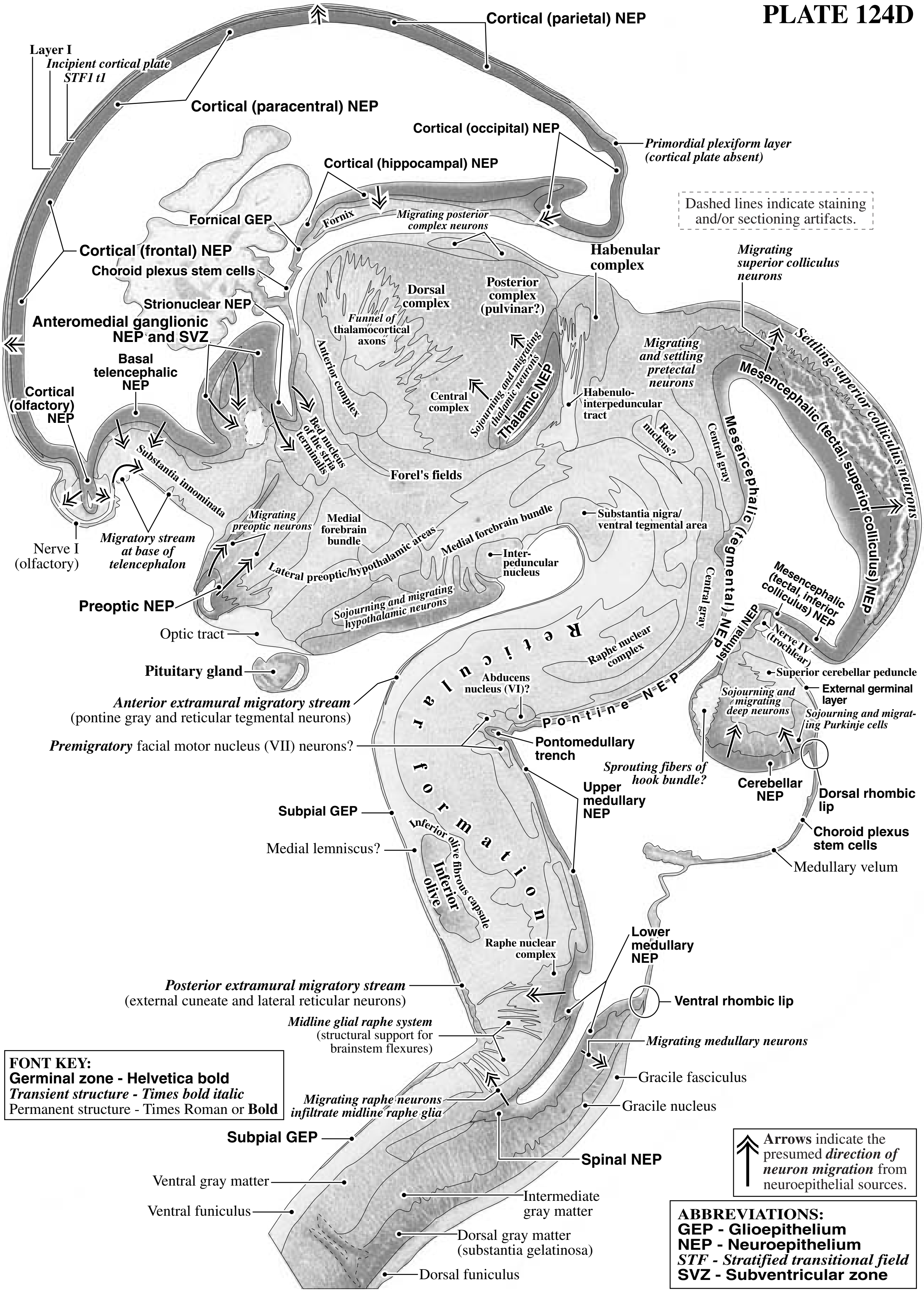


The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

BRAINSTEM FLEXURES

See high-magnification views of the diencephalon and basal telencephalon in Plates 134A and B, the midbrain, pons, and medulla in Plates 145A and B, the cerebellum in Plates 140A and B.

PLATE 124D



Cortical (parietal) NEP
Layer I
Incipient cortical plate
STF1 t1
Cortical (paracentral) NEP
Cortical (occipital) NEP
Primordial plexiform layer
(cortical plate absent)
Cortical (hippocampal) NEP
Dashed lines indicate staining and/or sectioning artifacts.
Fornical GEP
Fornix
Migrating posterior complex neurons
Cortical (frontal) NEP
Choroid plexus stem cells
Habenular complex
Migrating superior colliculus neurons
Dorsal complex
Posterior complex (pulvinar?)
Strionuclear NEP
Anteromedial ganglionic NEP and SVZ
Funnel of thalamocortical axons
Anterior complex
Sojourning and migrating thalamic neurons
Thalamic NEP
Migrating and settling pretectal neurons
Settling superior colliculus neurons
Mesencephalic (tectal, superior colliculus) NEP
Basal telencephalic NEP
Cortical (olfactory) NEP
Central complex
Habenulo-interpeduncular tract
Red nucleus?
Central gray
Bed nucleus of the stria terminalis
Substantia innominata
Forel's fields
Mesencephalic (tegmental) NEP
Substantia nigra/ ventral tegmental area
Nerve I (olfactory)
Migratory stream at base of telencephalon
Migrating preoptic neurons
Medial forebrain bundle
Medial forebrain bundle
Lateral preoptic/hypothalamic areas
Inter-peduncular nucleus
Sojourning and migrating hypothalamic neurons
Preoptic NEP
Mesencephalic (tectal, inferior colliculus) NEP
Isthmal NEP
Nerve IV (trochlear)
Optic tract
Reticular formation
Raphe nuclear complex
Pituitary gland
Superior cerebellar peduncle
External germinal layer
Abducens nucleus (VI)?
Pontine NEP
Sojourning and migrating deep neurons
Sojourning and migrating Purkinje cells
Anterior extramural migratory stream
(pontine gray and reticular tegmental neurons)
Premigratory facial motor nucleus (VII) neurons?
Pontomedullary trench
Sprouting fibers of hook bundle?
Cerebellar NEP
Dorsal rhombic lip
Upper medullary NEP
Subpial GEP
Choroid plexus stem cells
Medial lemniscus?
Inferior olive fibrous capsule
Inferior olive
Medullary velum
Raphe nuclear complex
Lower medullary NEP
Posterior extramural migratory stream
(external cuneate and lateral reticular neurons)
Ventral rhombic lip
Midline glial raphe system
(structural support for brainstem flexures)
Migrating medullary neurons
FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
Gracile fasciculus
Migrating raphe neurons infiltrate midline raphe glia
Gracile nucleus
Subpial GEP
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Spinal NEP
Ventral gray matter
Intermediate gray matter
Ventral funiculus
Dorsal gray matter
(substantia gelatinosa)
Dorsal funiculus
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field
SVZ - Subventricular zone

PLATE 125A

GW8 Sagittal, CR 33 mm, C145
Level 4: Slide 19, Section 2
HEAD STRUCTURES, MAJOR BRAIN REGIONS, AND VENTRICULAR DIVISIONS

Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

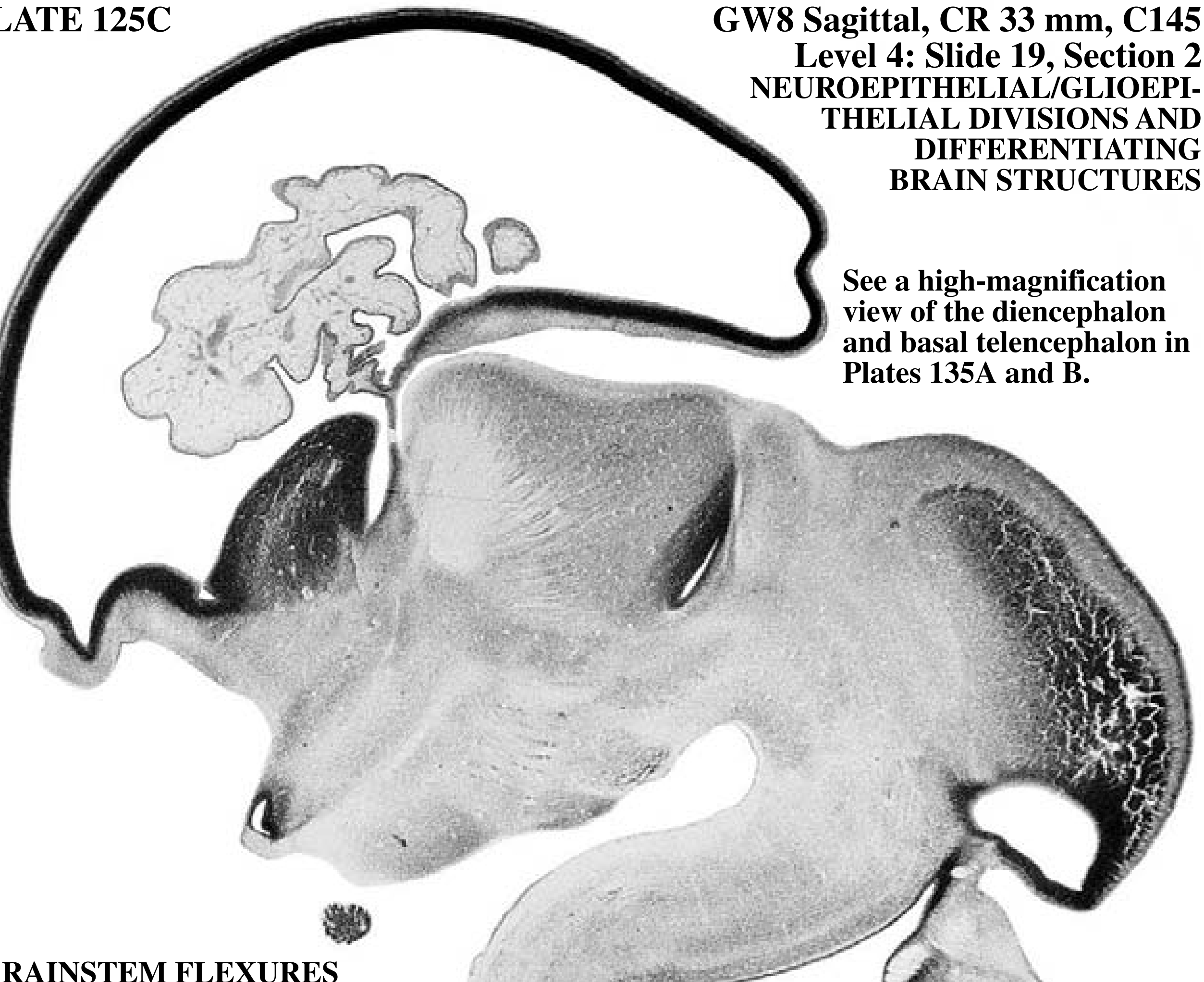
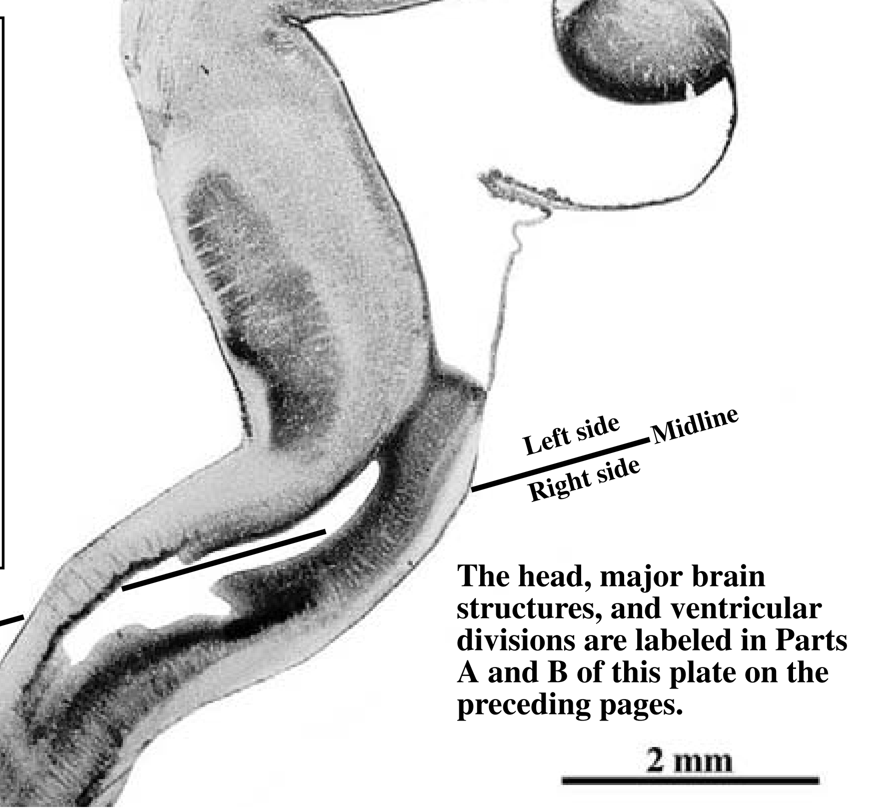
PLATE 125B

FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

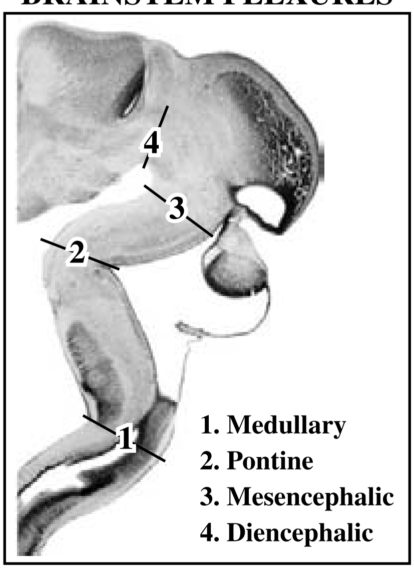
PLATE 125C

GW8 Sagittal, CR 33 mm, C145
Level 4: Slide 19, Section 2
NEUROEPITHELIAL/GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES

See a high-magnification view of the diencephalon and basal telencephalon in Plates 135A and B.

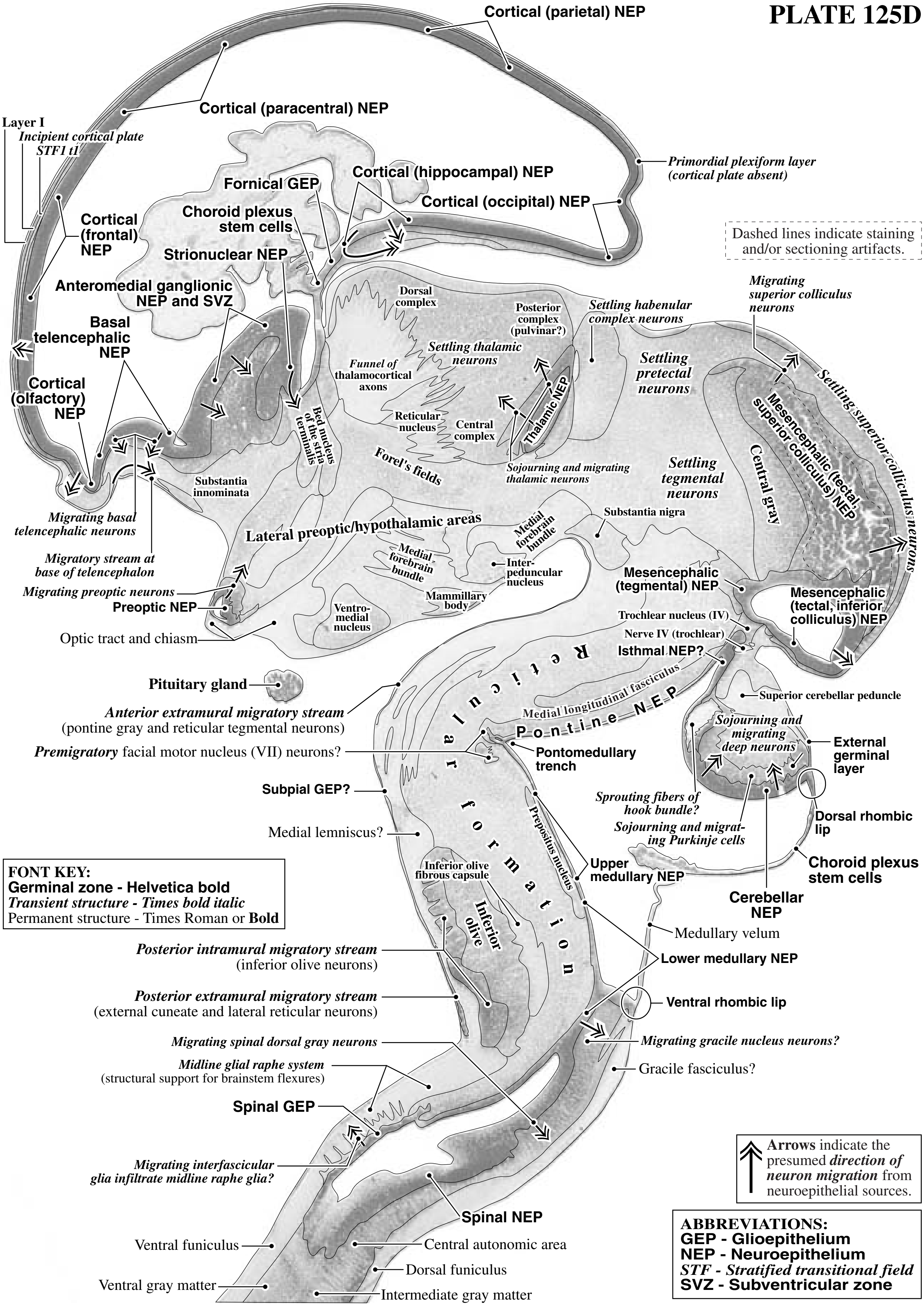



BRAINSTEM FLEXURES



The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 125D



Cortical (parietal) NEP
Cortical (paracentral) NEP
Layer I
Incipient cortical plate
STF1 t1
Primordial plexiform layer
(cortical plate absent)
Cortical (hippocampal) NEP
Fornical GEP
Cortical (occipital) NEP
Choroid plexus
stem cells
Cortical
(frontal)
NEP
Strionuclear NEP
Dashed lines indicate staining
and/or sectioning artifacts.
Anteromedial ganglionic
NEP and SVZ
Dorsal
complex
Posterior
complex
(pulvinar?)
Settling habenular
complex neurons
Migrating
superior colliculus
neurons
Basal
telencephalic
NEP
Settling thalamic
neurons
Funnel of
thalamocortical
axons
Settling
pretectal
neurons
Cortical
(olfactory)
NEP
Bed nucleus
of the stria
terminalis
Thalamic NEP
Settling superior colliculus neurons
Reticular
nucleus
Central
complex
Mesencephalic (tectal,
superior colliculus) NEP
Forel's fields
Sojourning and migrating
thalamic neurons
Settling
tegmental
neurons
Central gray
Substantia
innominata
Migrating basal
telencephalic neurons
Substantia nigra
Lateral preoptic/hypothalamic areas
Medial
forebrain
bundle
Migratory stream at
base of telencephalon
Medial
forebrain
bundle
Inter-
peduncular
nucleus
Mesencephalic
(tegmental) NEP
Migrating preoptic neurons
Mammillary
body
Mesencephalic
(tectal, inferior
colliculus) NEP
Preoptic NEP
Ventro-
medial
nucleus
Trochlear nucleus (IV)
Optic tract and chiasm
Nerve IV (trochlear)
Isthmal NEP?
Pituitary gland
Superior cerebellar peduncle
Anterior extramural migratory stream
(pontine gray and reticular tegmental neurons)
Medial longitudinal fasciculus
Pontine NEP
Sojourning and
migrating
deep neurons
Premigratory facial motor nucleus (VII) neurons?
Pontomedullary
trench
External
germinal
layer
Subpial GEP?
Reticular formation
Sprouting fibers of
hook bundle?
Dorsal rhombic
lip
Medial lemniscus?
Prepositus nucleus
Sojourning and migrat-
ing Purkinje cells
Inferior olive
fibrous capsule
Upper
medullary NEP
Choroid plexus
stem cells
FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
Inferior
olive
Cerebellar
NEP
Medullary velum
Posterior intramural migratory stream
(inferior olive neurons)
Lower medullary NEP
Posterior extramural migratory stream
(external cuneate and lateral reticular neurons)
Ventral rhombic lip
Migrating spinal dorsal gray neurons
Migrating gracile nucleus neurons?
Midline glial raphe system
(structural support for brainstem flexures)
Gracile fasciculus?
Spinal GEP
Arrows indicate the
presumed direction of
neuron migration from
neuroepithelial sources.
Migrating interfascicular
glia infiltrate midline raphe glia?
Spinal NEP
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field
SVZ - Subventricular zone
Ventral funiculus
Central autonomic area
Dorsal funiculus
Ventral gray matter
Intermediate gray matter

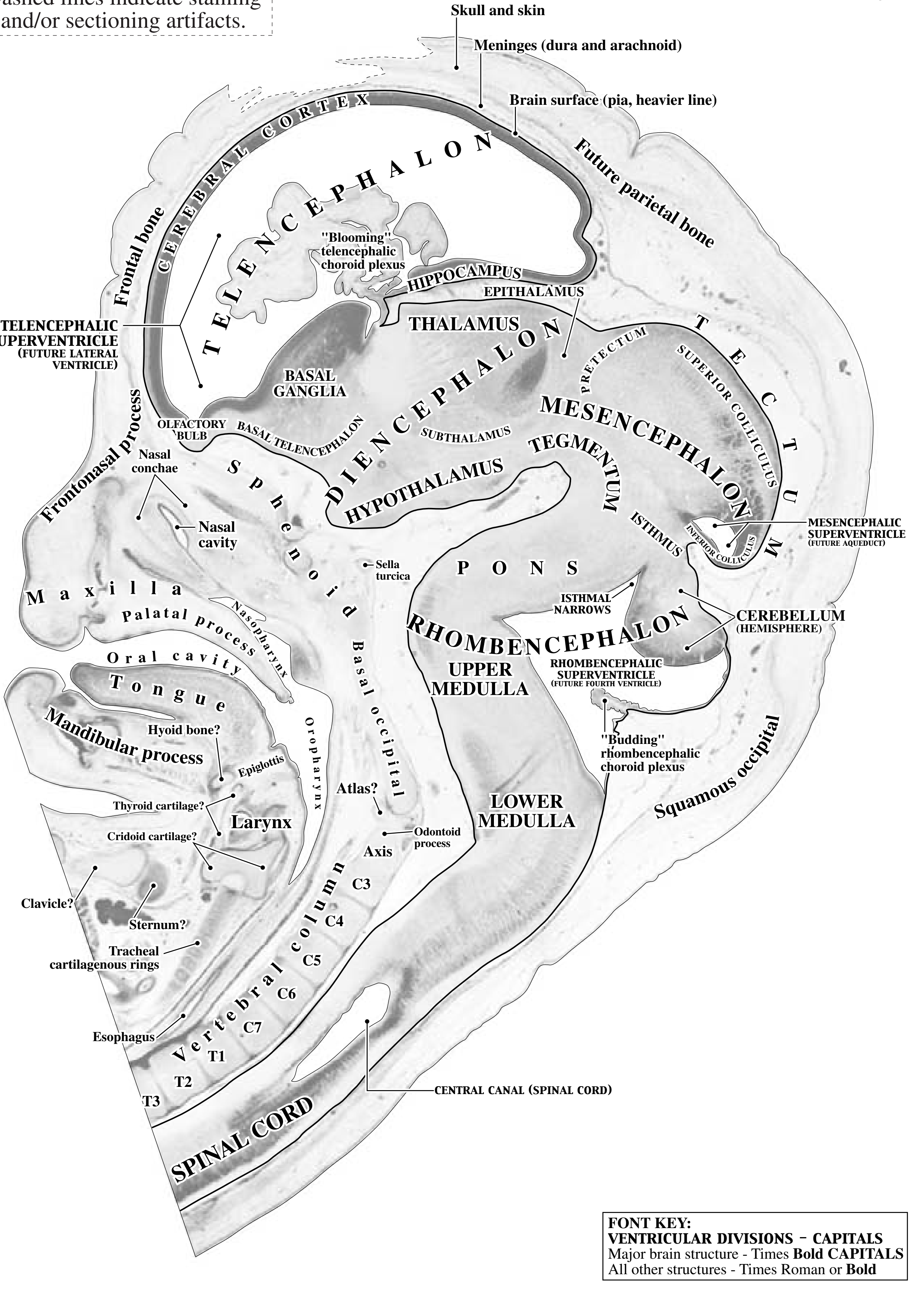
PLATE 126A

GW8 Sagittal, CR 33 mm, C145
Level 5: Slide 18, Section 2
HEAD STRUCTURES, MAJOR BRAIN REGIONS, AND VENTRICULAR DIVISIONS

Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

PLATE 126B

Dashed lines indicate staining and/or sectioning artifacts.

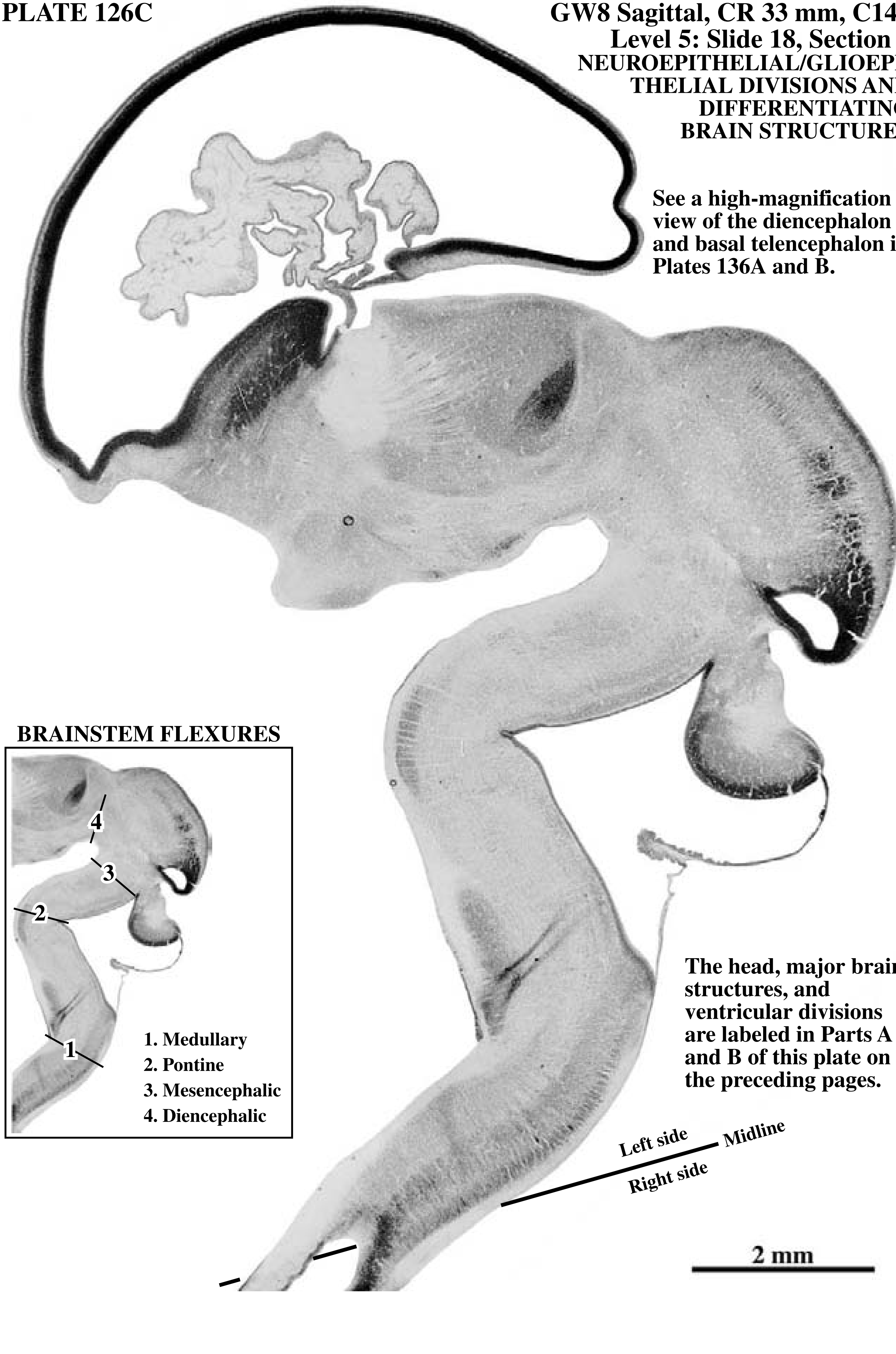


FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 126C

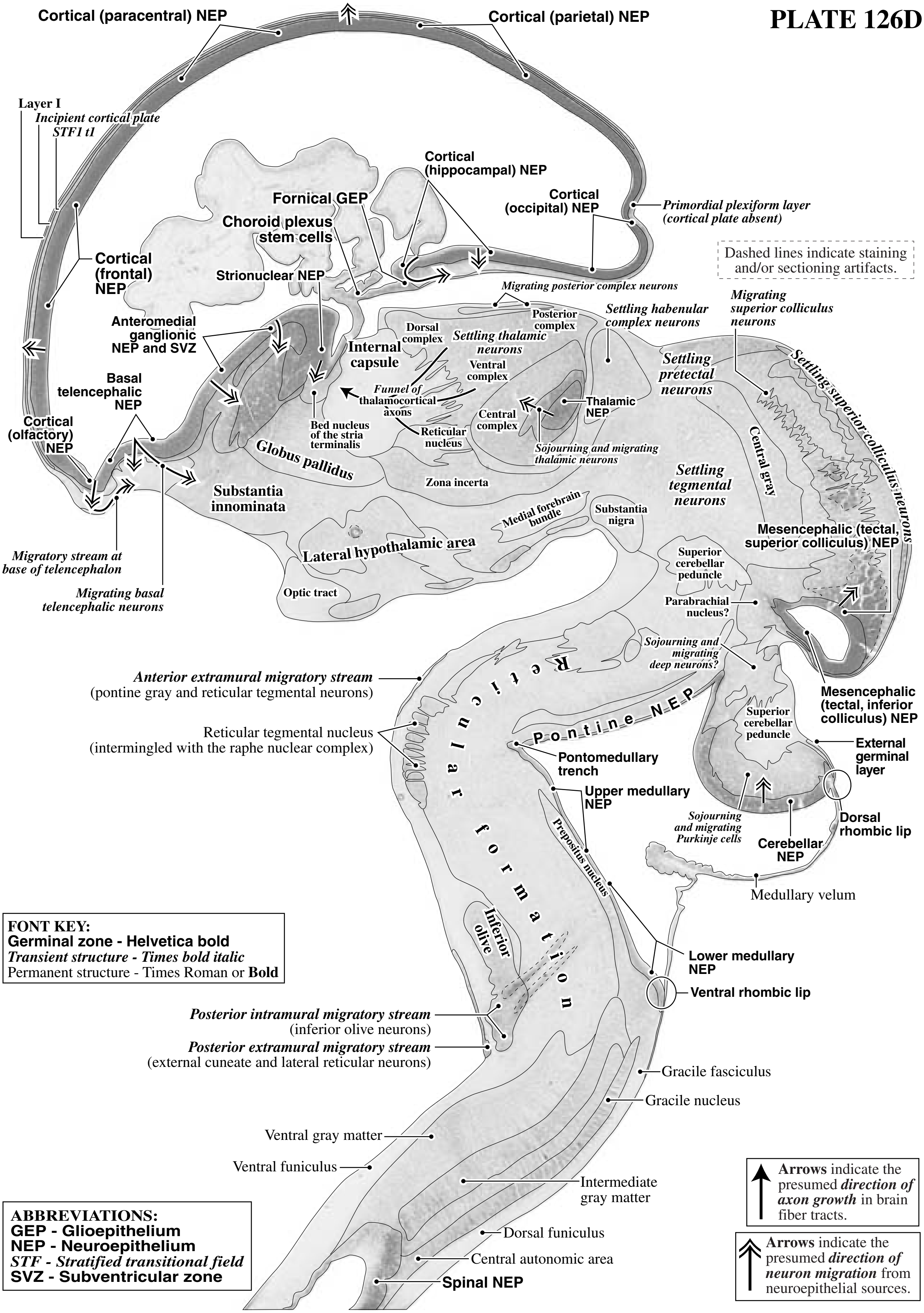
GW8 Sagittal, CR 33 mm, C145
Level 5: Slide 18, Section 2
NEUROEPITHELIAL/GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES

See a high-magnification view of the diencephalon and basal telencephalon in Plates 136A and B.



The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 126D



FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

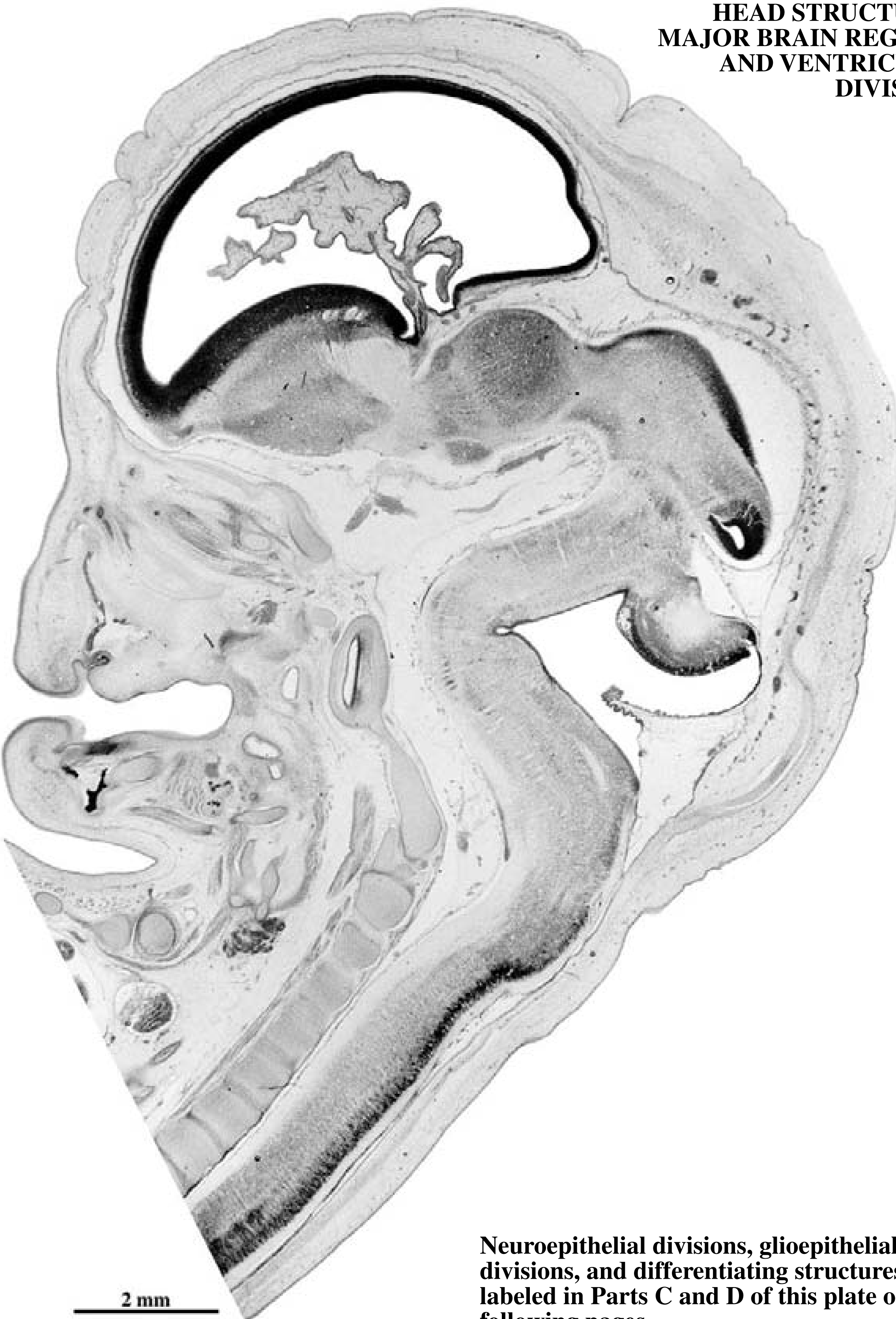
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

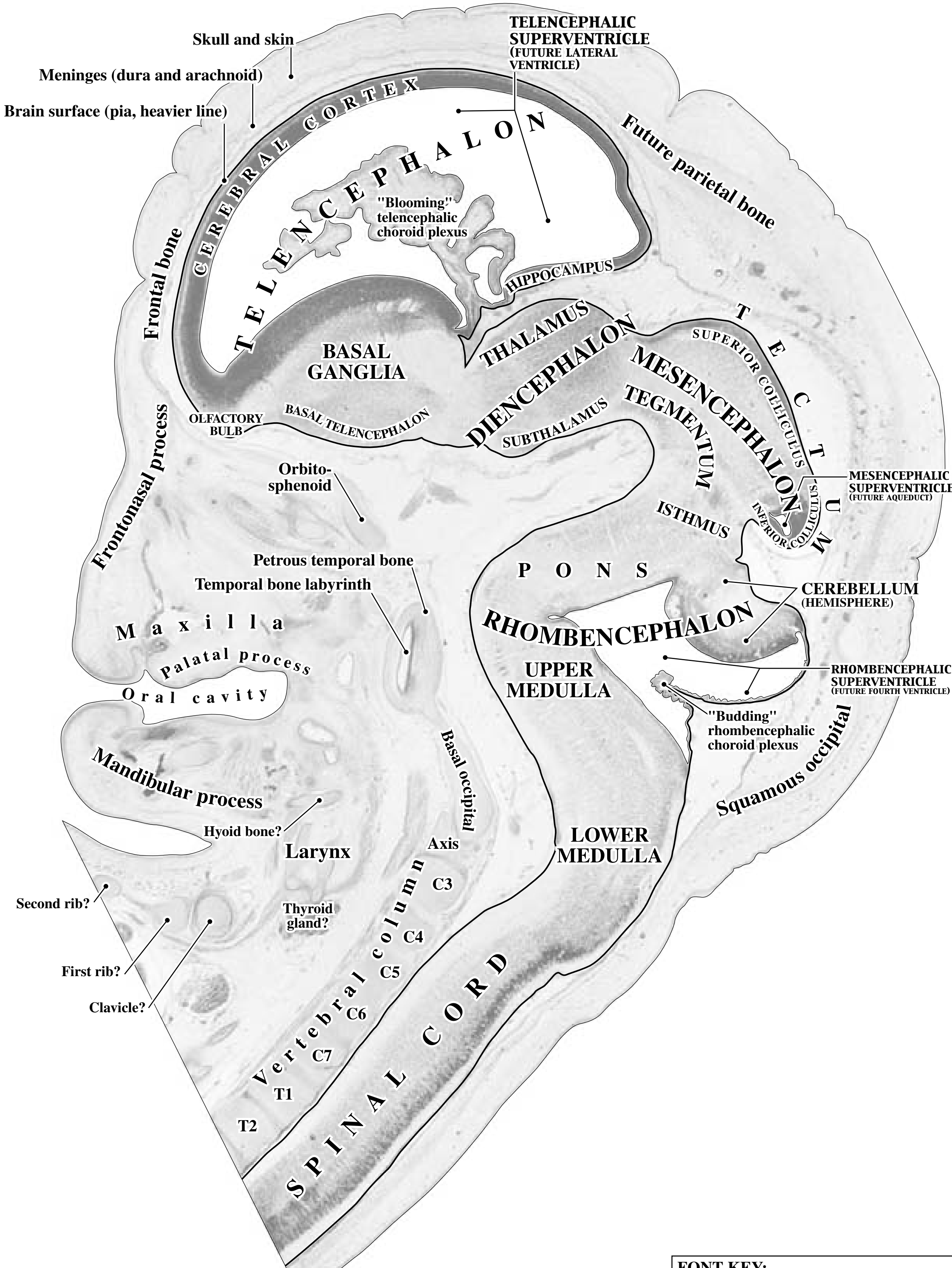
PLATE 127A

GW8 Sagittal, CR 33 mm, C145
Level 6: Slide 16, Section 2
Left side of brain
HEAD STRUCTURES, MAJOR BRAIN REGIONS, AND VENTRICULAR DIVISIONS



Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

PLATE 127B

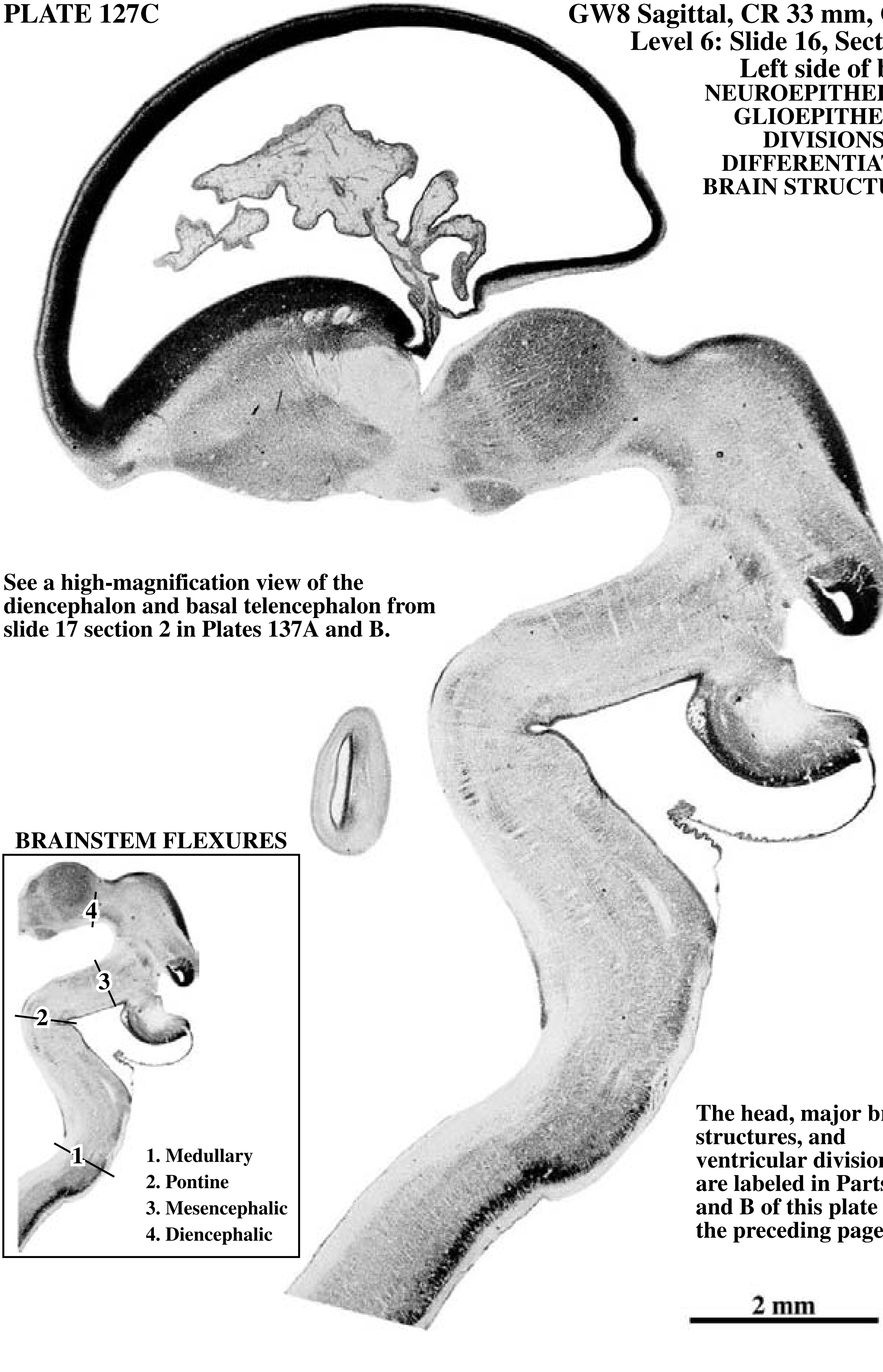


FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 127C

GW8 Sagittal, CR 33 mm, C145
Level 6: Slide 16, Section 2
Left side of brain

NEUROEPITHELIAL/ GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES

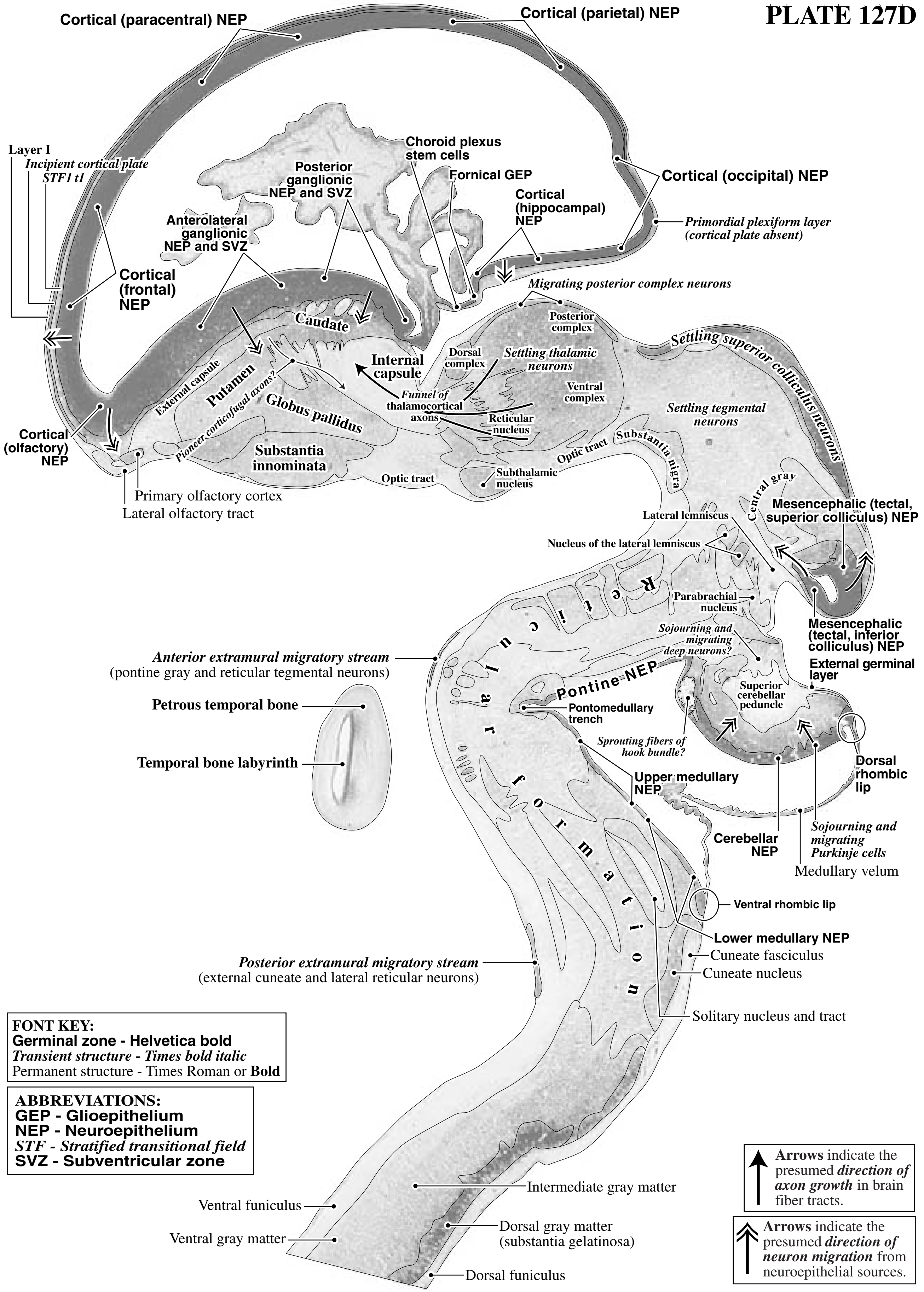


See a high-magnification view of the diencephalon and basal telencephalon from slide 17 section 2 in Plates 137A and B.

BRAINSTEM FLEXURES

The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 127D



FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

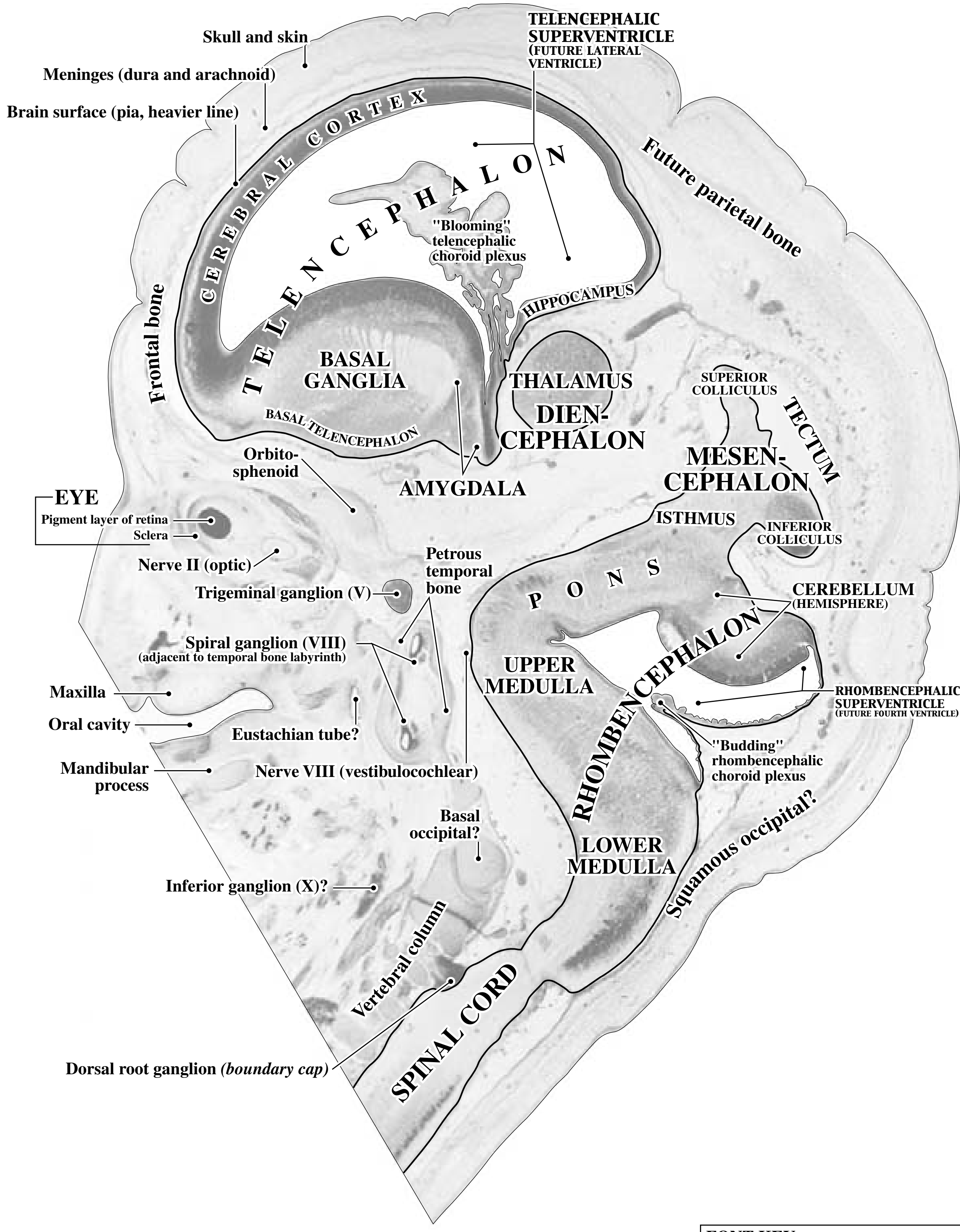
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 128A

GW8 Sagittal, CR 33 mm, C145
Level 7: Slide 15, Section 1
Left side of brain
HEAD STRUCTURES, MAJOR BRAIN REGIONS, AND VENTRICULAR DIVISIONS

Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

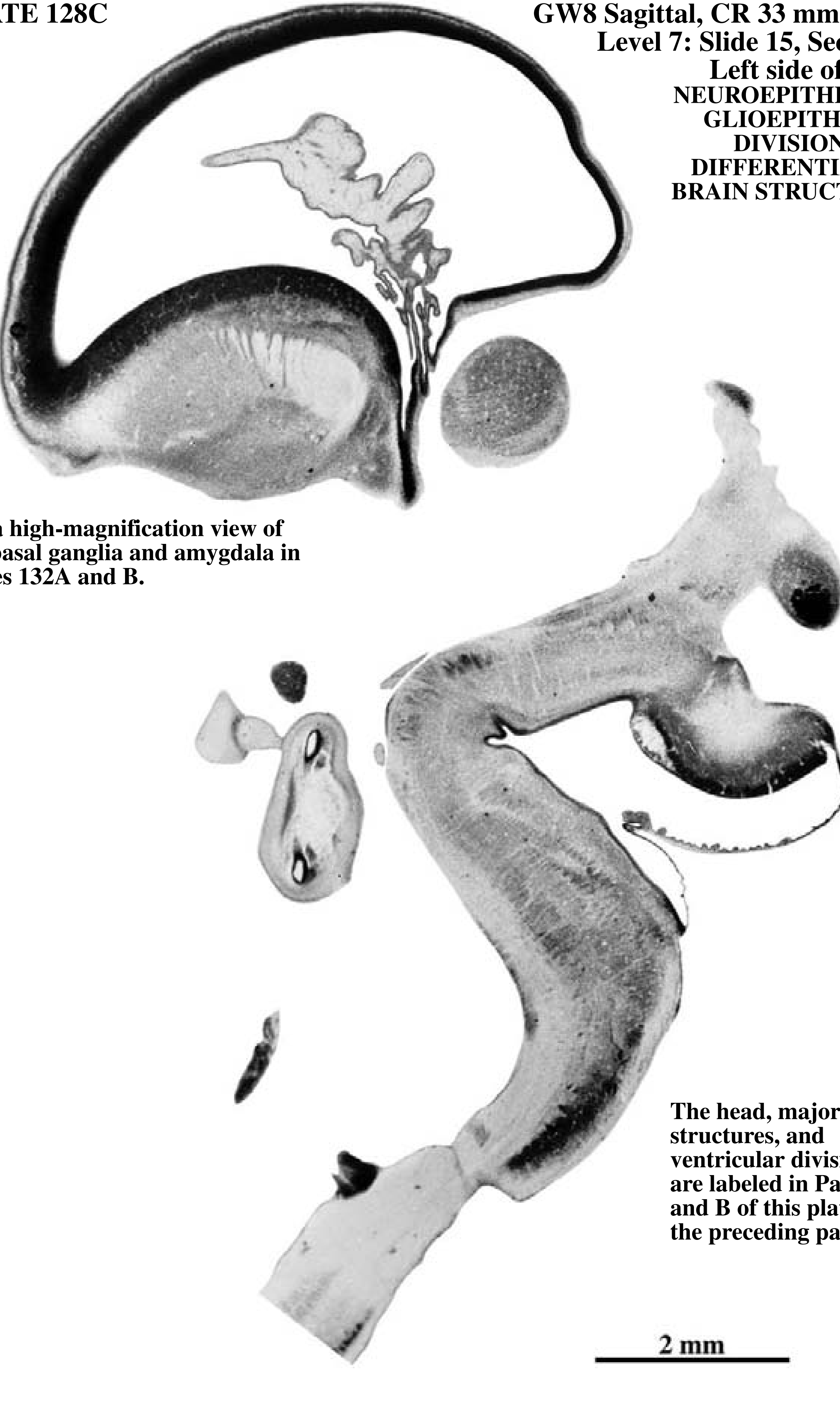
PLATE 128B



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 128C

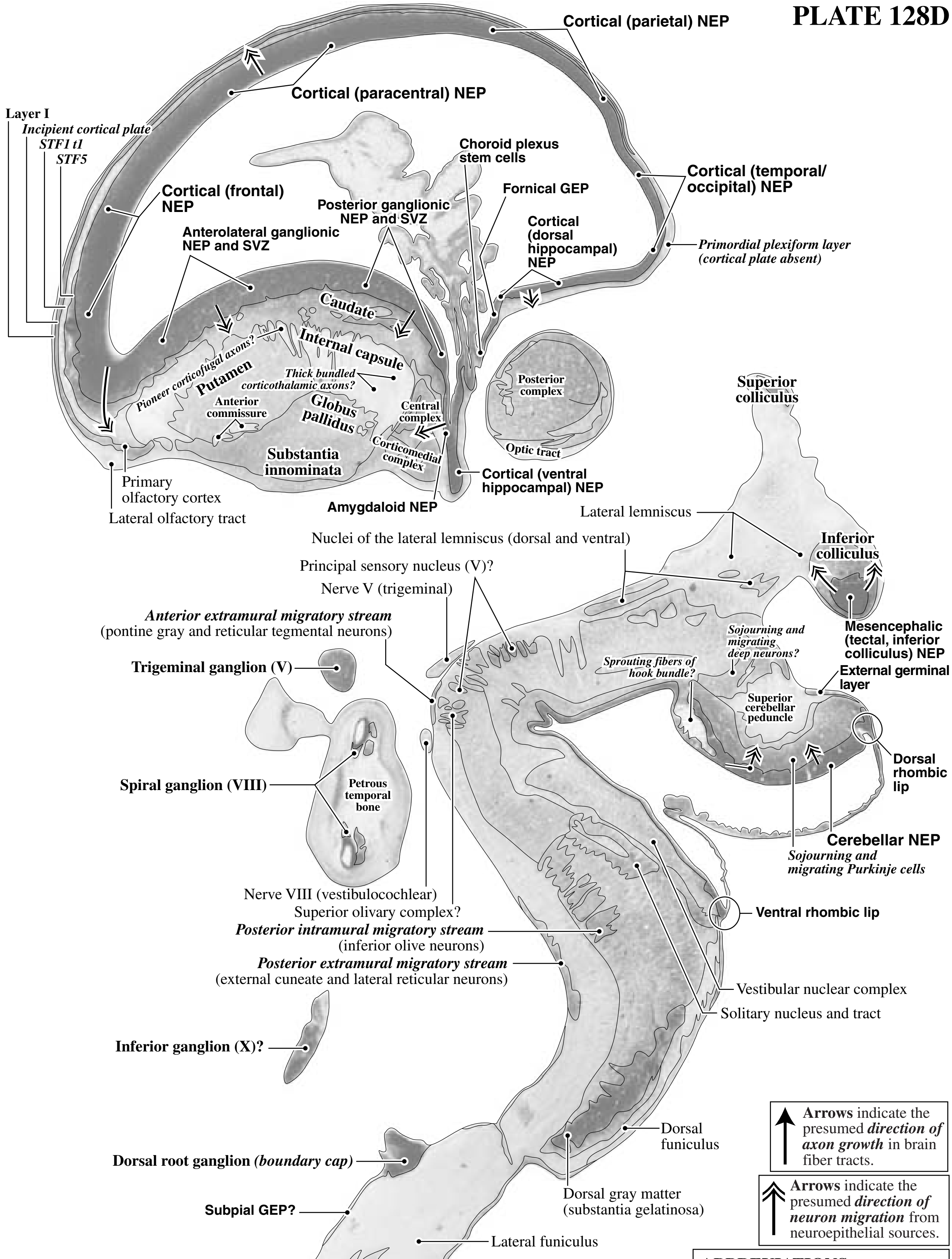
GW8 Sagittal, CR 33 mm, C145
Level 7: Slide 15, Section 1
Left side of brain
NEUROEPITHELIAL/ GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES



See a high-magnification view of the basal ganglia and amygdala in Plates 132A and B.

The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 128D



Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

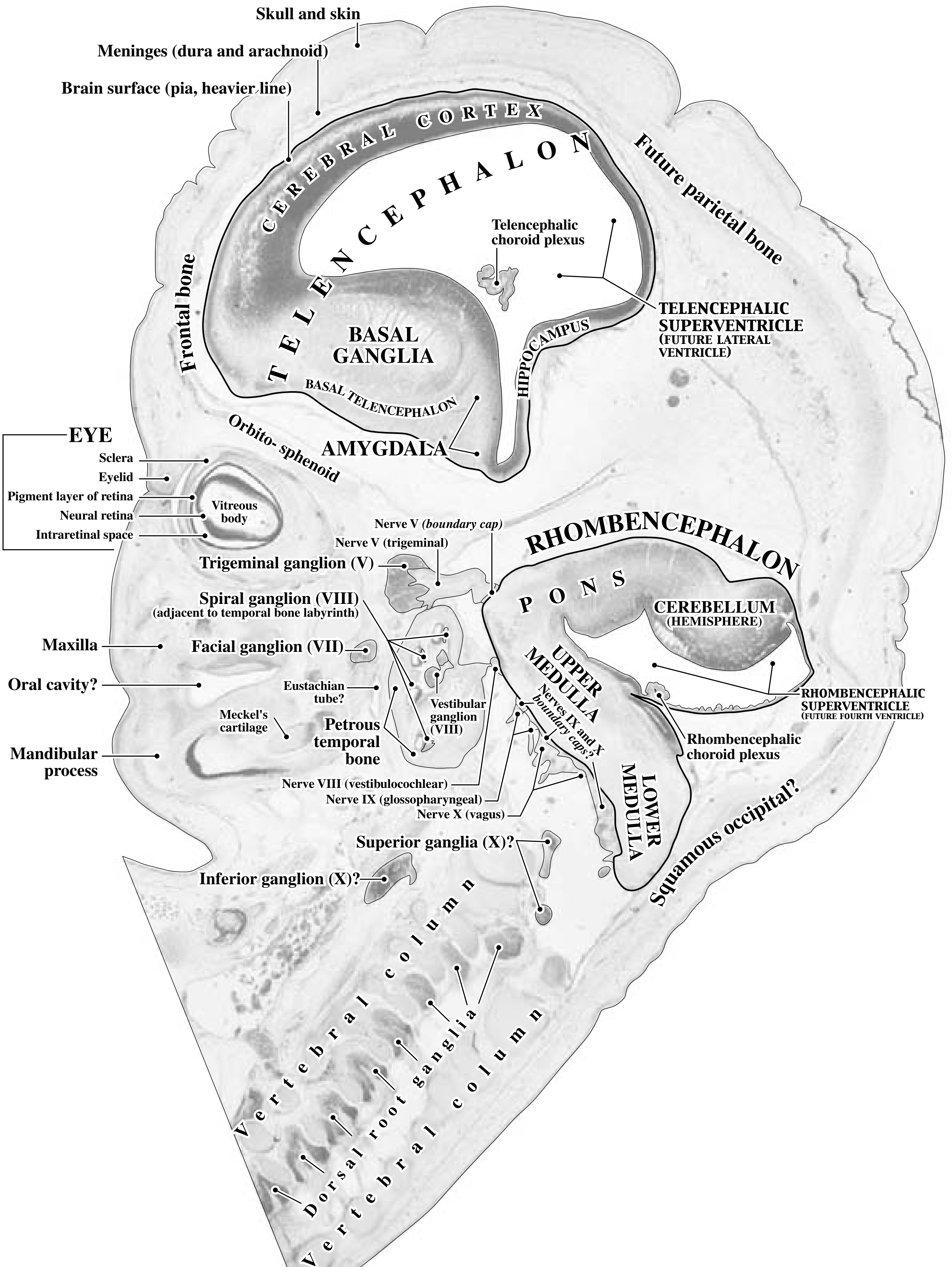
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field
SVZ - Subventricular zone

PLATE 129A

GW8 Sagittal, CR 33 mm, C145
Level 8: Slide 13, Section 2
Left side of brain
HEAD STRUCTURES, MAJOR BRAIN REGIONS, AND VENTRICULAR DIVISIONS

Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

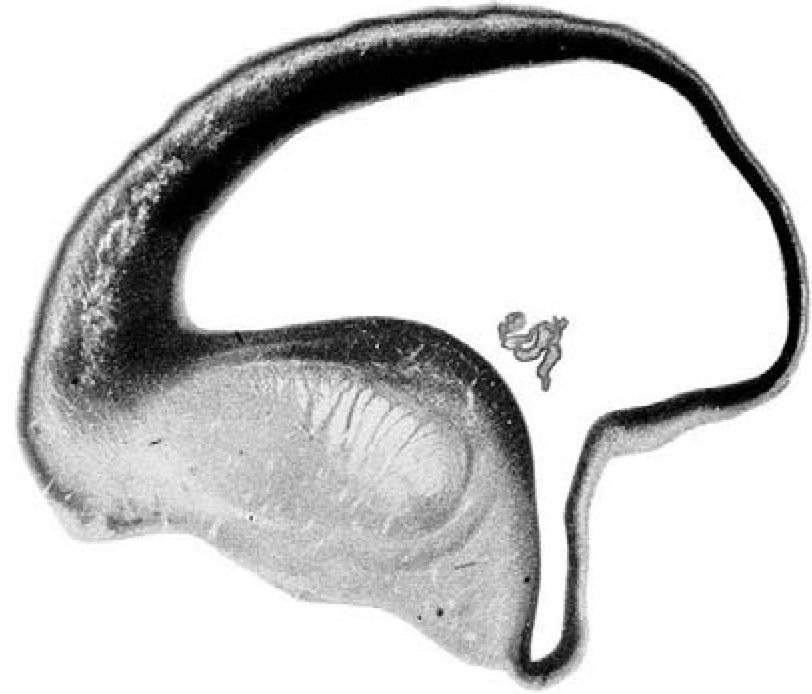
PLATE 129B

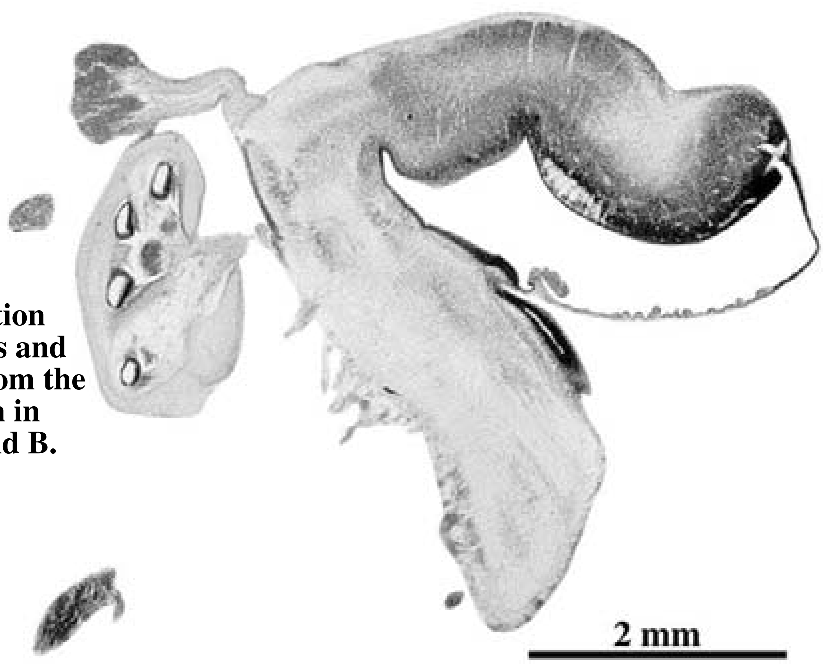


FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 129C

GW8 Sagittal, CR 33 mm, C145
Level 8: Slide 13, Section 2
Left side of brain
NEUROEPITHELIAL/GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES

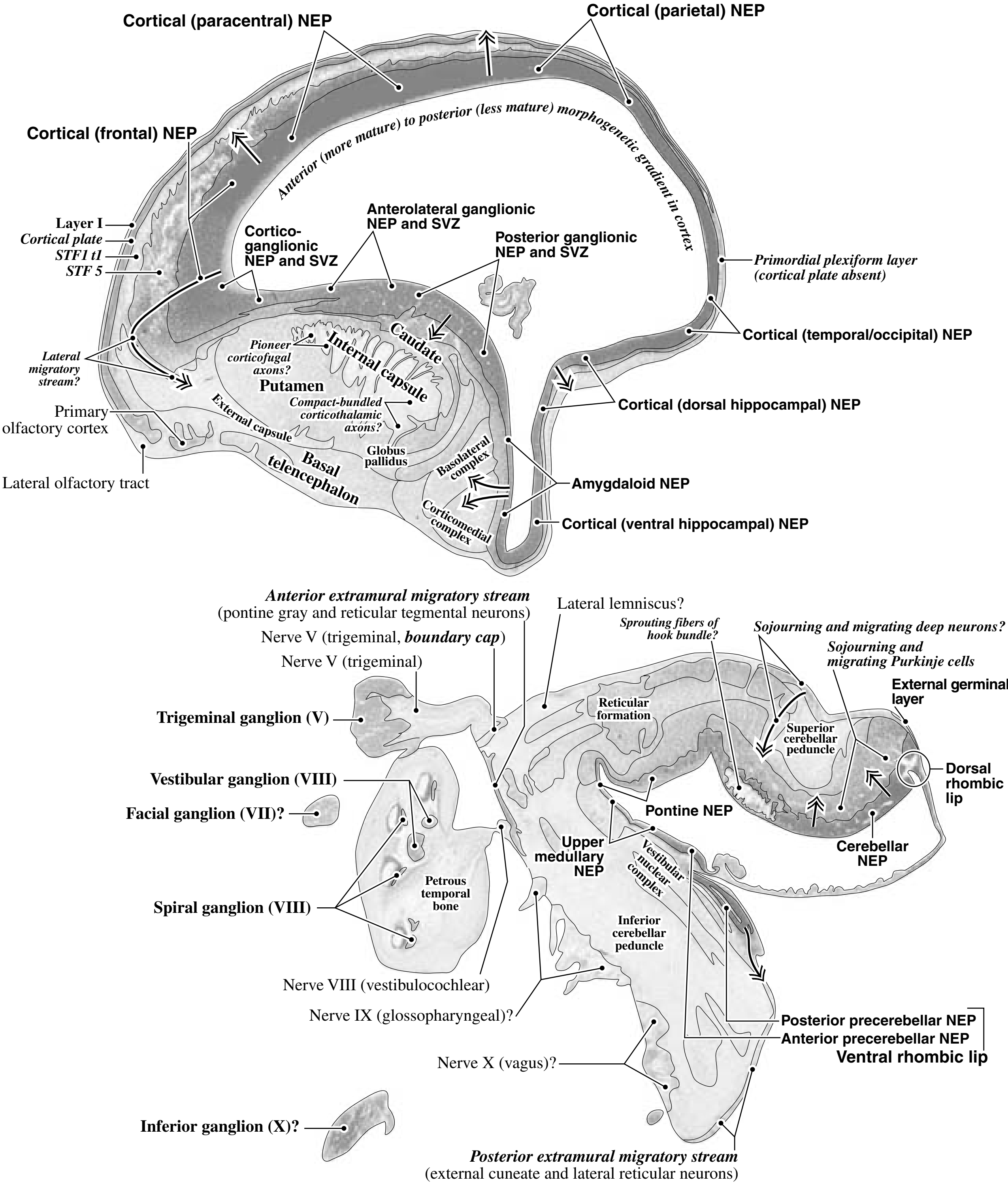




See a high-magnification view of the basal pons and peripheral ganglia from the right side of the brain in Plates 146 to 147A and B.

The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 129D



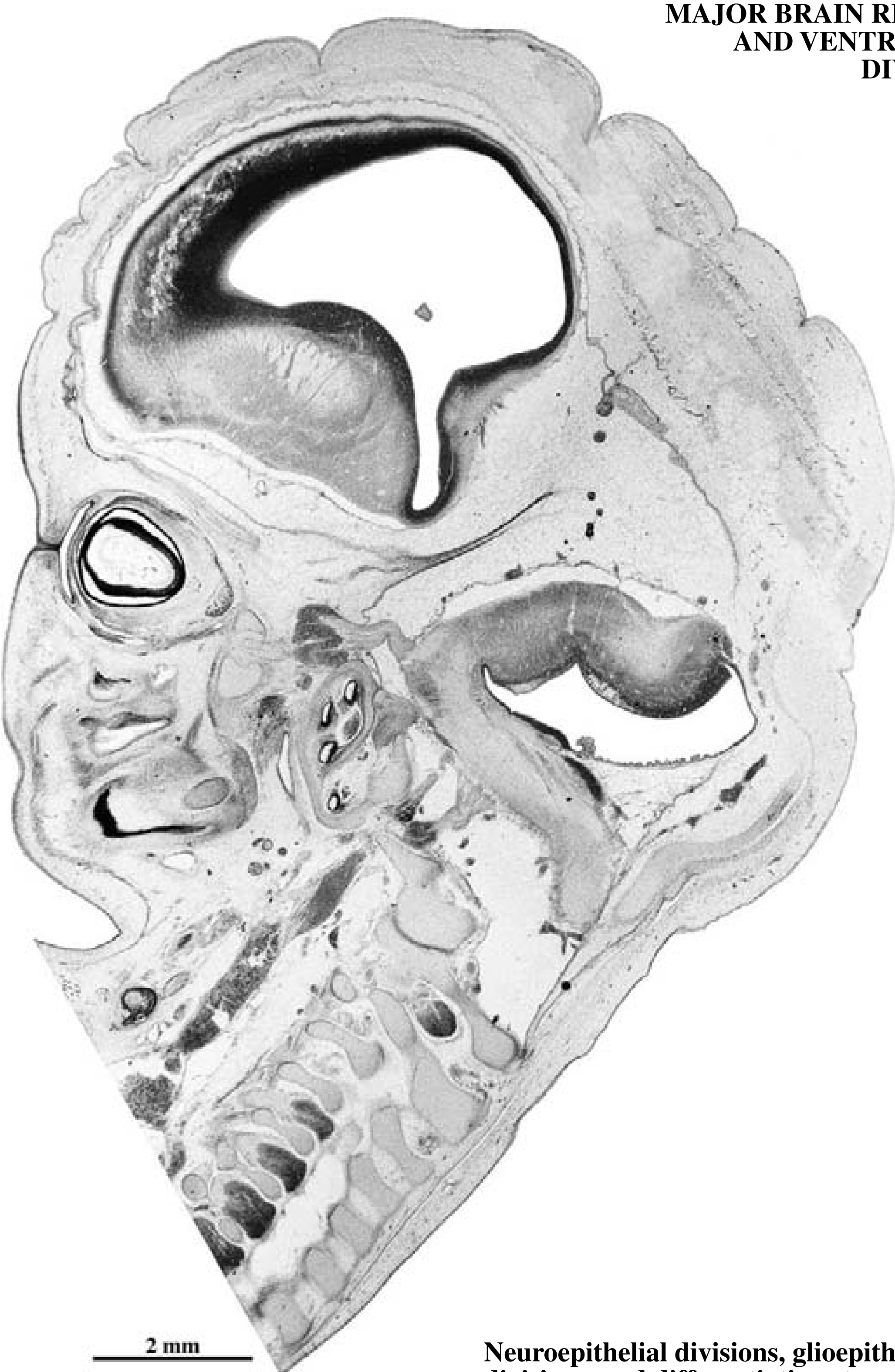
FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
NEP - Neuroepithelium
STF - Stratified transitional field
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

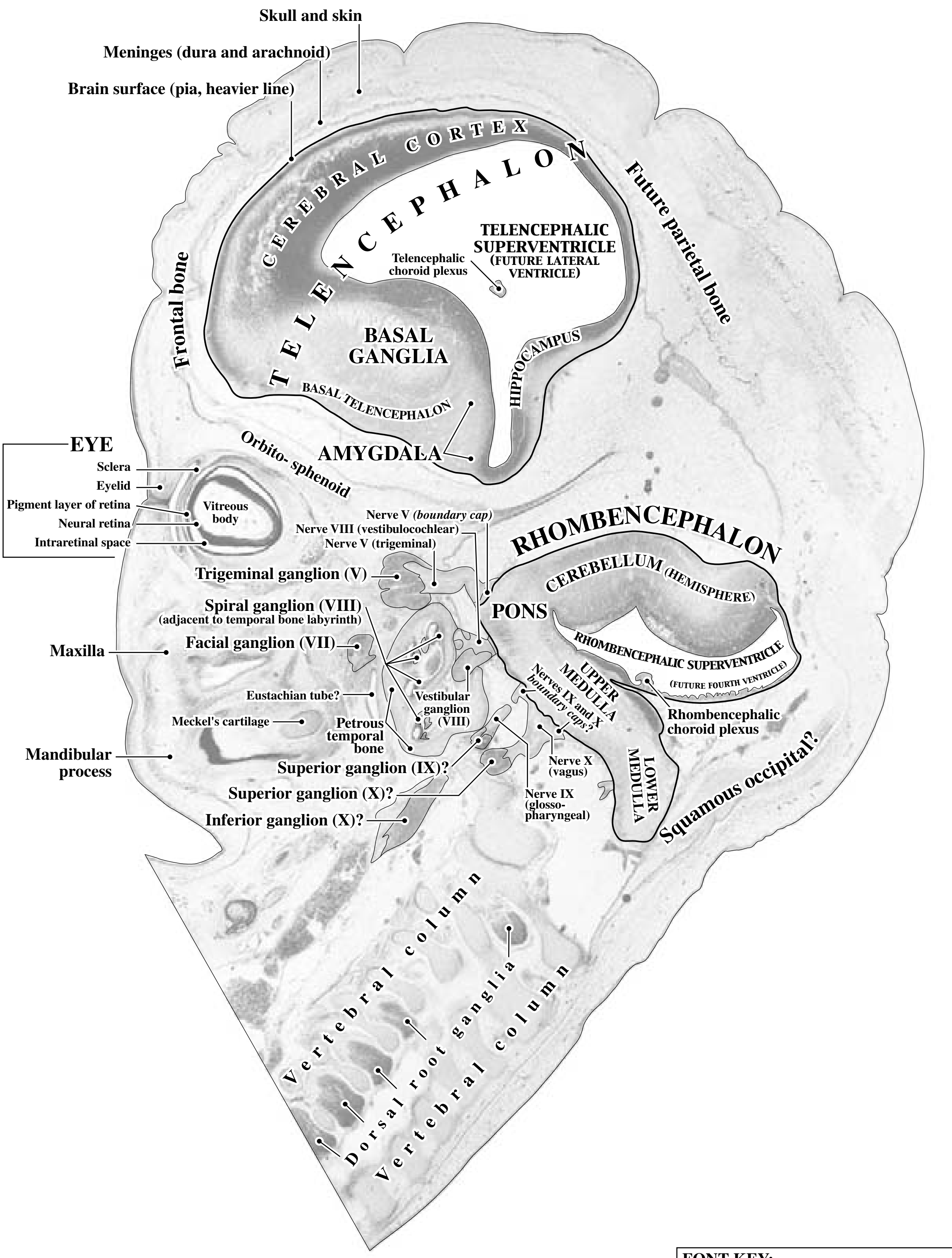
PLATE 130A

GW8 Sagittal, CR 33 mm, C145
Level 9: Slide 12, Section 4
Left side of brain
HEAD STRUCTURES, MAJOR BRAIN REGIONS, AND VENTRICULAR DIVISIONS



Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

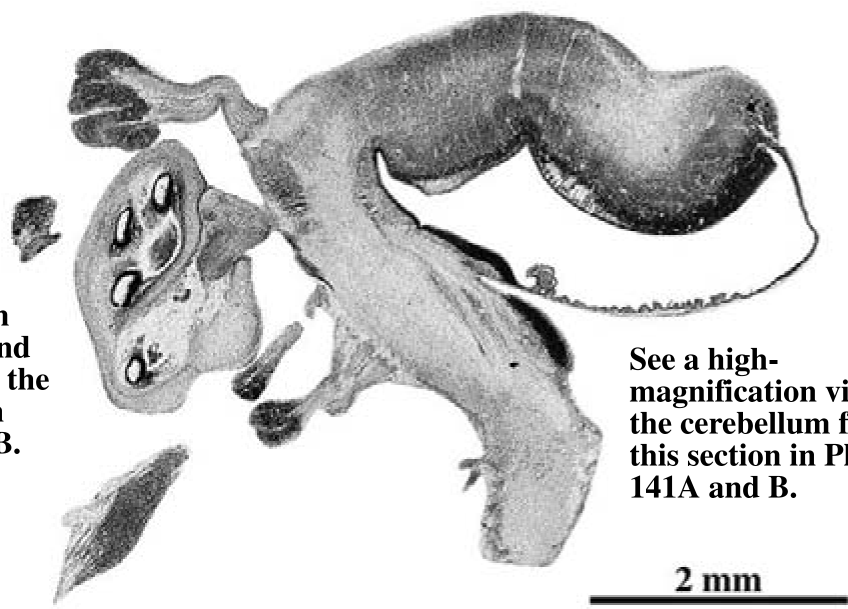
PLATE 130B



FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 130C

GW8 Sagittal, CR 33 mm, C145
Level 9: Slide 12, Section 4
Left side of brain
NEUROEPITHELIAL/GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES

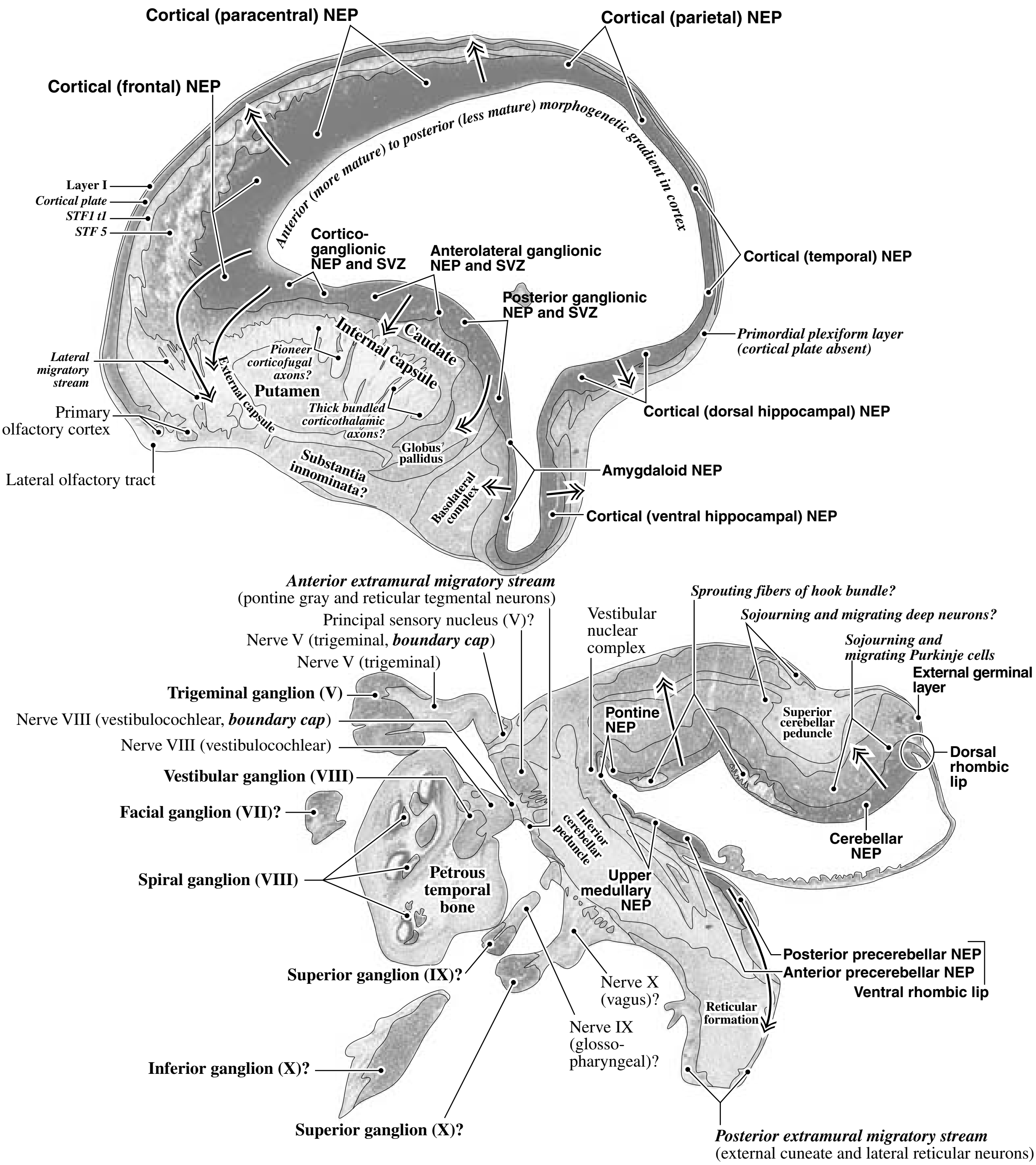


See a high-magnification view of the basal pons and peripheral ganglia from the right side of the brain in Plates 146 to 147A and B.

See a high-magnification view of the cerebellum from this section in Plates 141A and B.

The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 130D



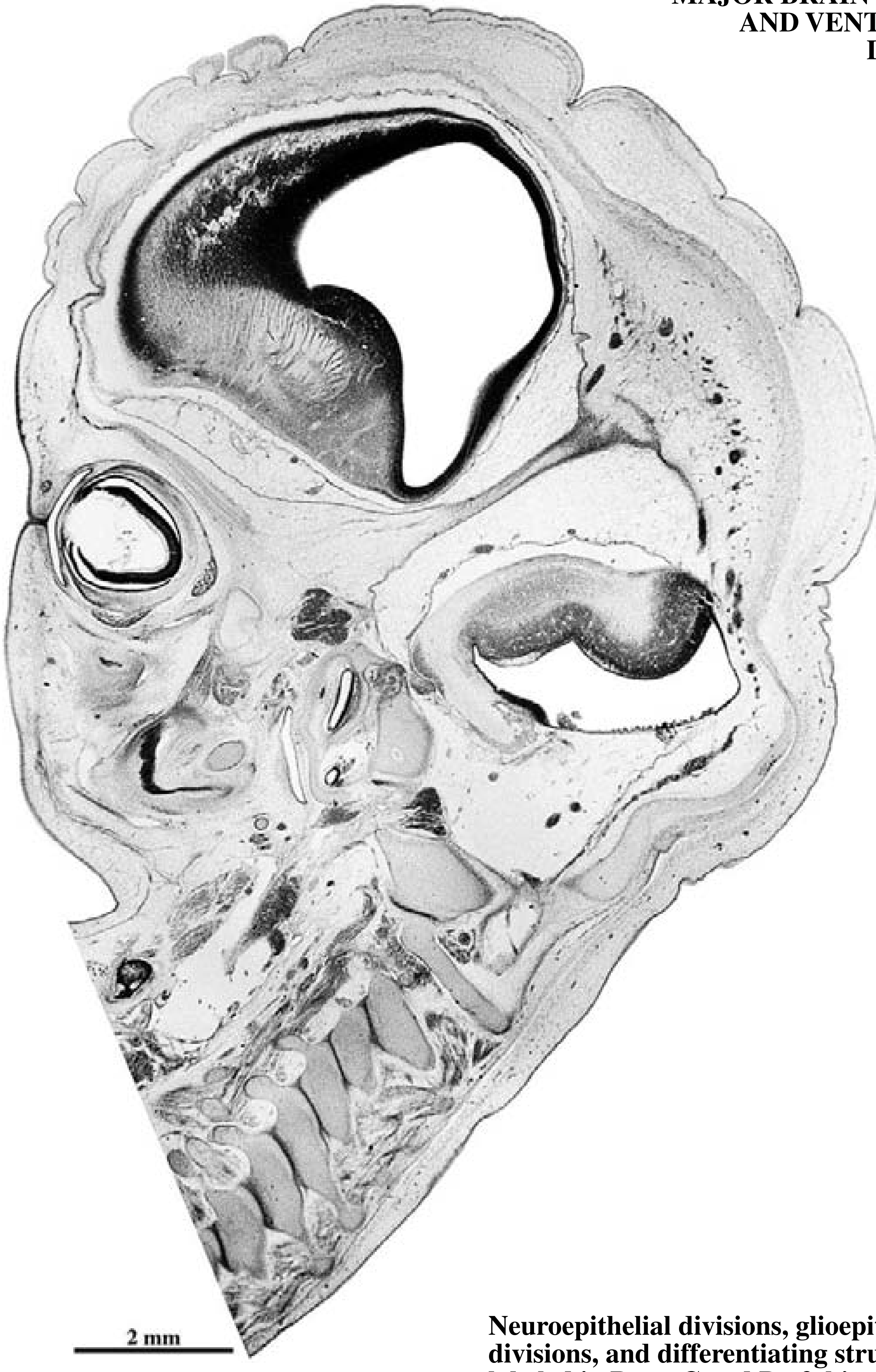
FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
NEP - Neuroepithelium
STF - Stratified transitional field
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

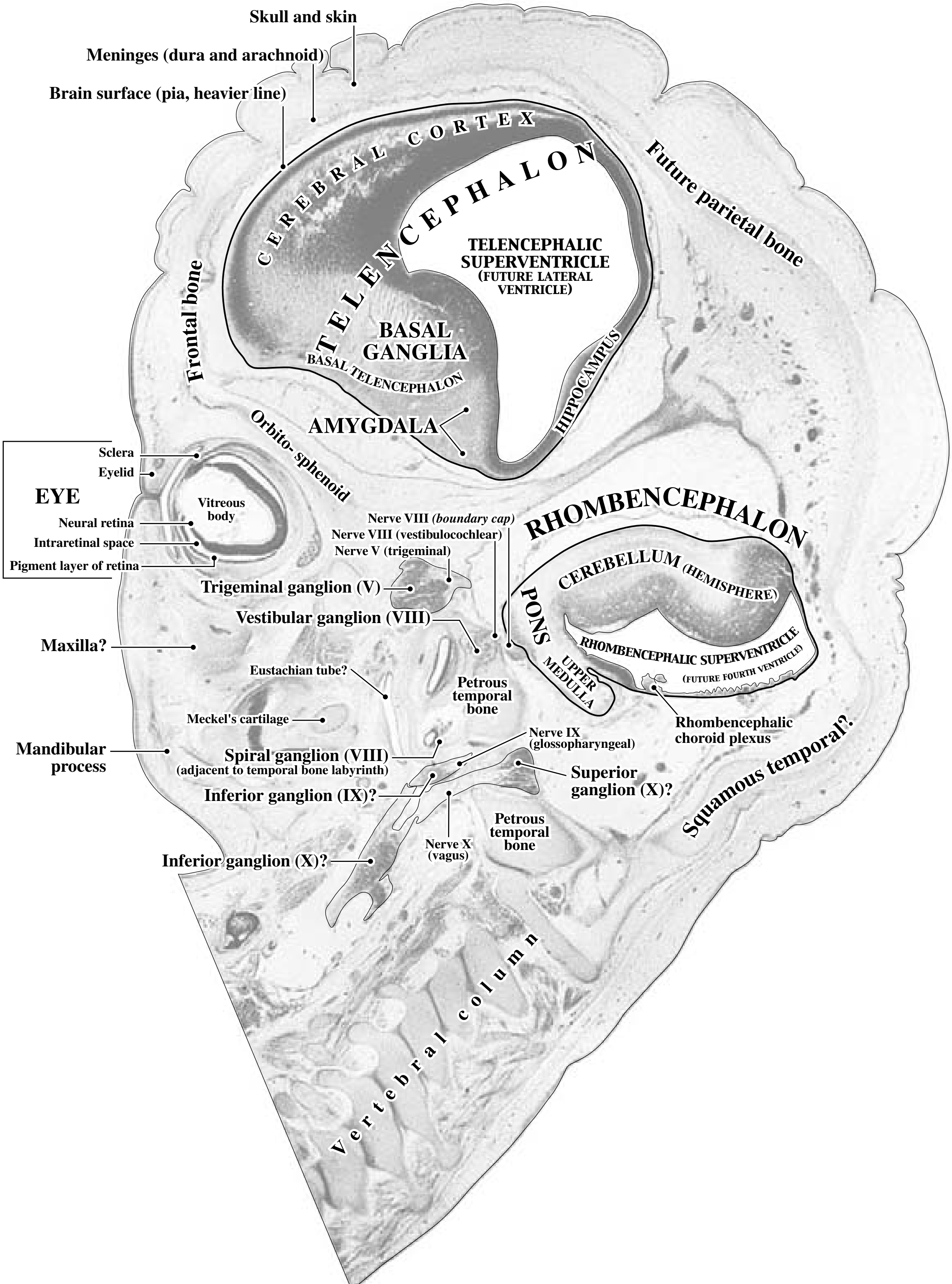
PLATE 131A

GW8 Sagittal, CR 33 mm, C145
Level 10: Slide 11, Section 4
Left side of brain
HEAD STRUCTURES, MAJOR BRAIN REGIONS, AND VENTRICULAR DIVISIONS



Neuroepithelial divisions, glioepithelial divisions, and differentiating structures are labeled in Parts C and D of this plate on the following pages.

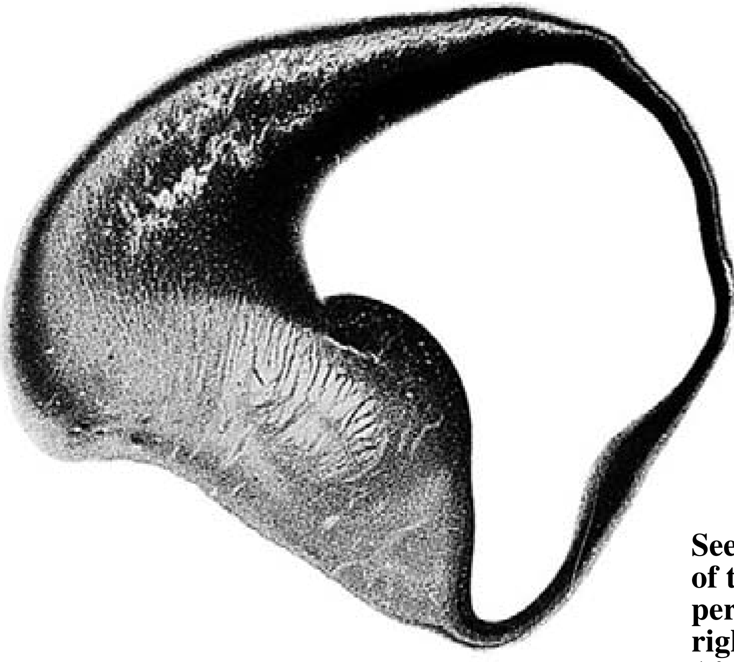
PLATE 131B



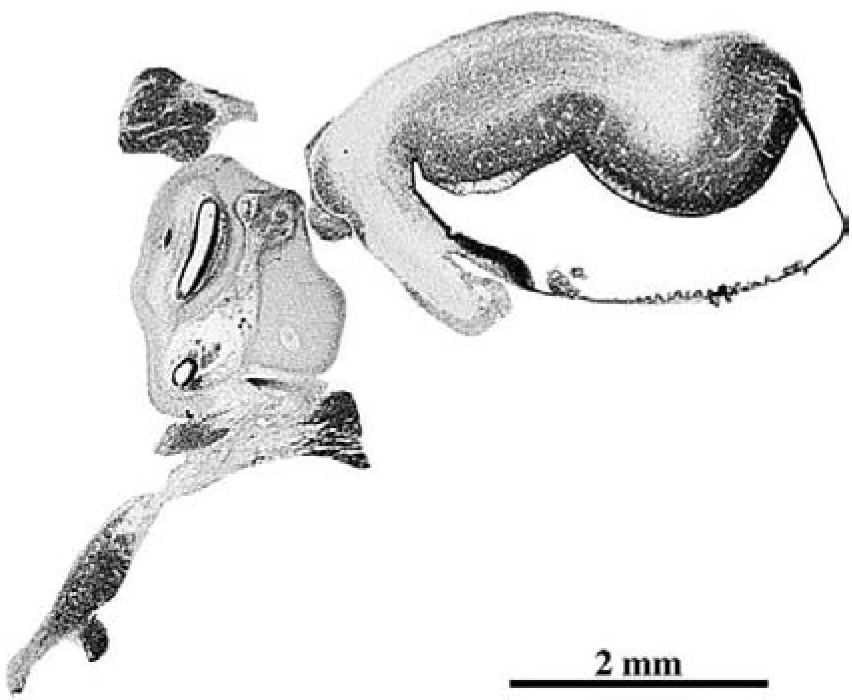
FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 131C

GW8 Sagittal, CR 33 mm, C145
Level 10: Slide 11, Section 4
Left side of brain
NEUROEPITHELIAL/GLIOEPITHELIAL DIVISIONS AND DIFFERENTIATING BRAIN STRUCTURES

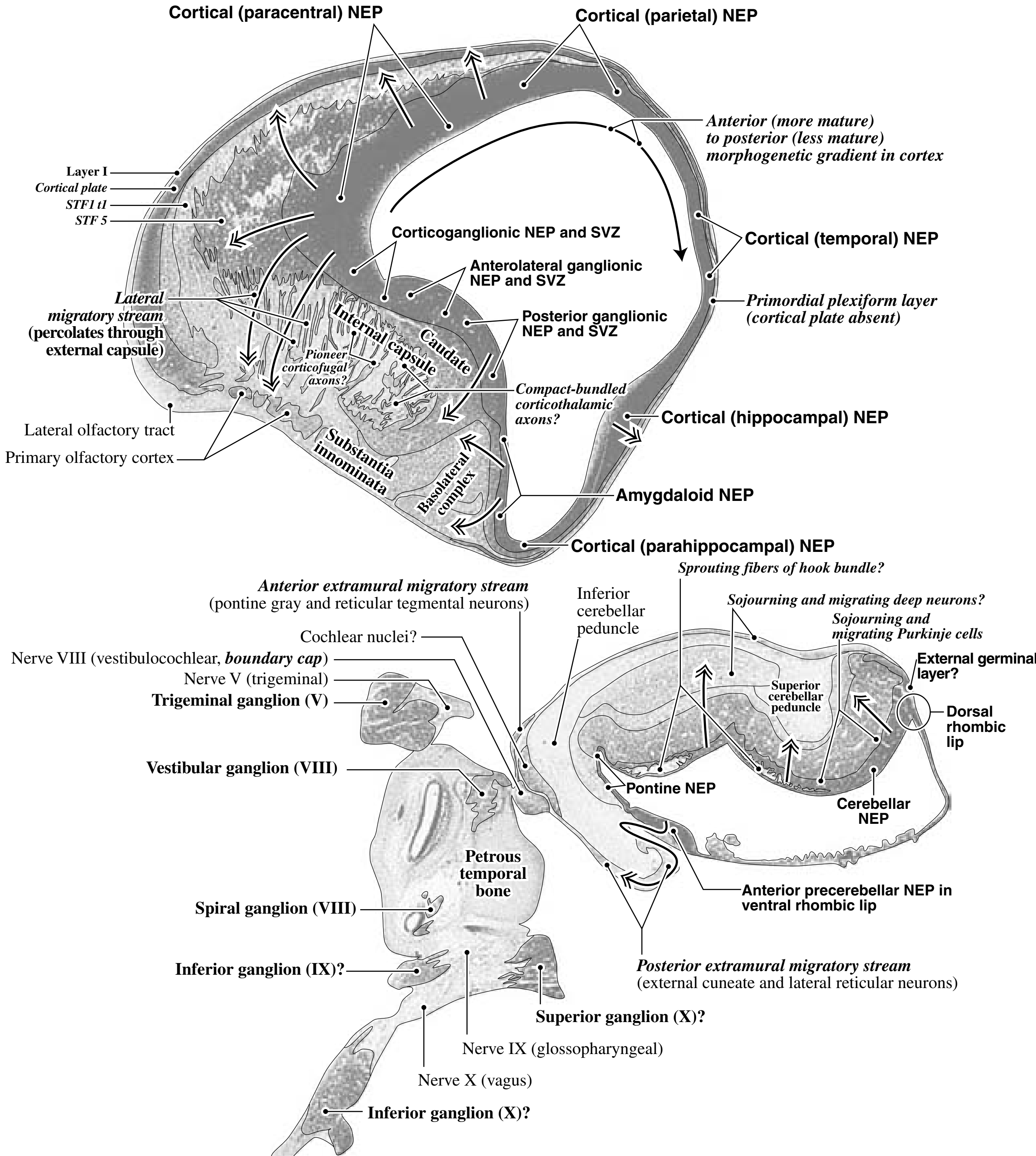


See a high-magnification view of the basal pons and peripheral ganglia from the right side of the brain in Plates 146A and B to 147A and B.



The head, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 131D



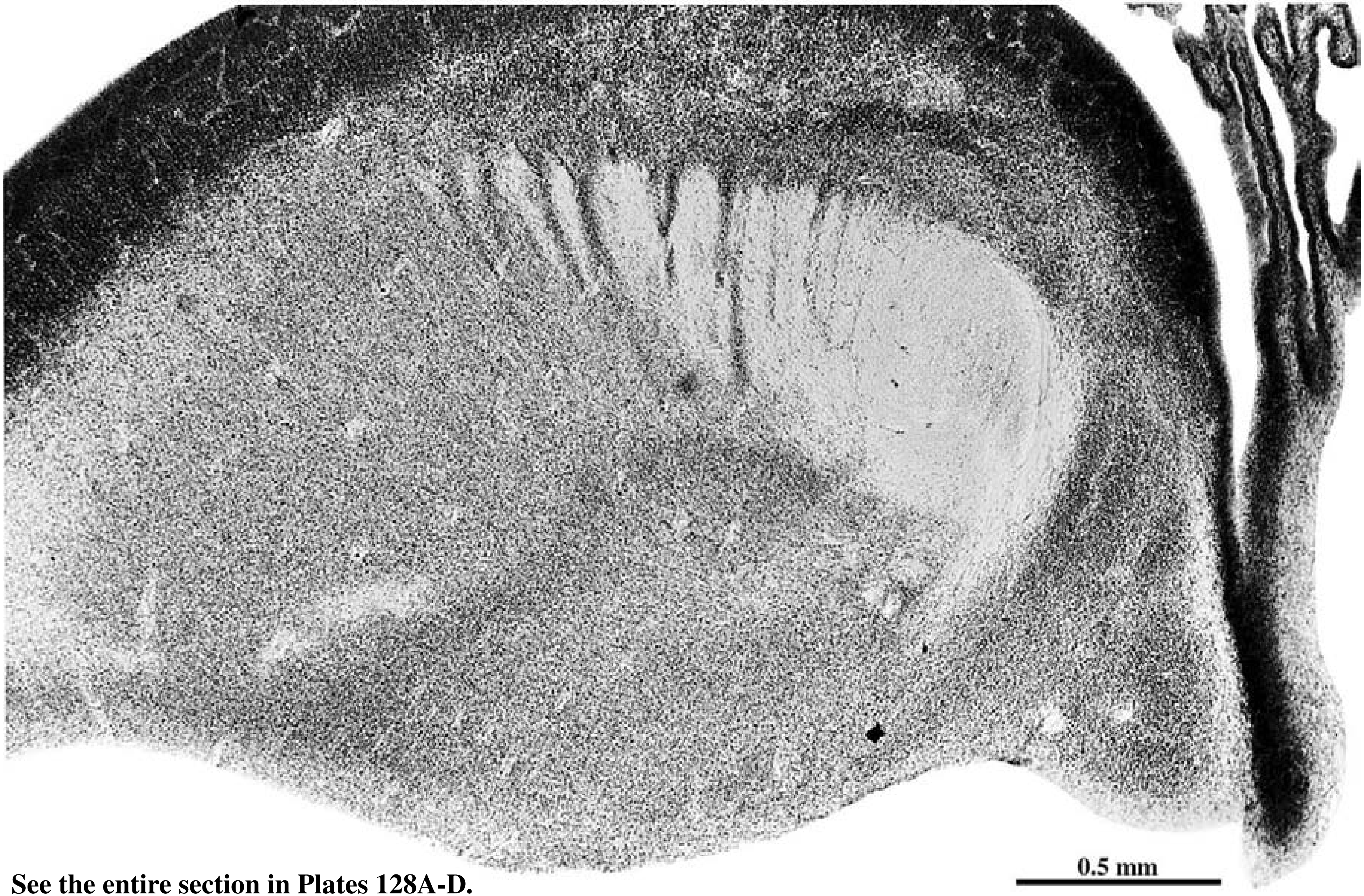
FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
NEP - Neuroepithelium
STF - Stratified transitional field
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 132A **GW8 Sagittal, CR 33 mm, C145**
Level 7: Slide 15, Section 1

BASAL GANGLIA, BASAL TELENCEPHALON, AND AMYGDALA



See the entire section in Plates 128A-D.

PLATE 132B

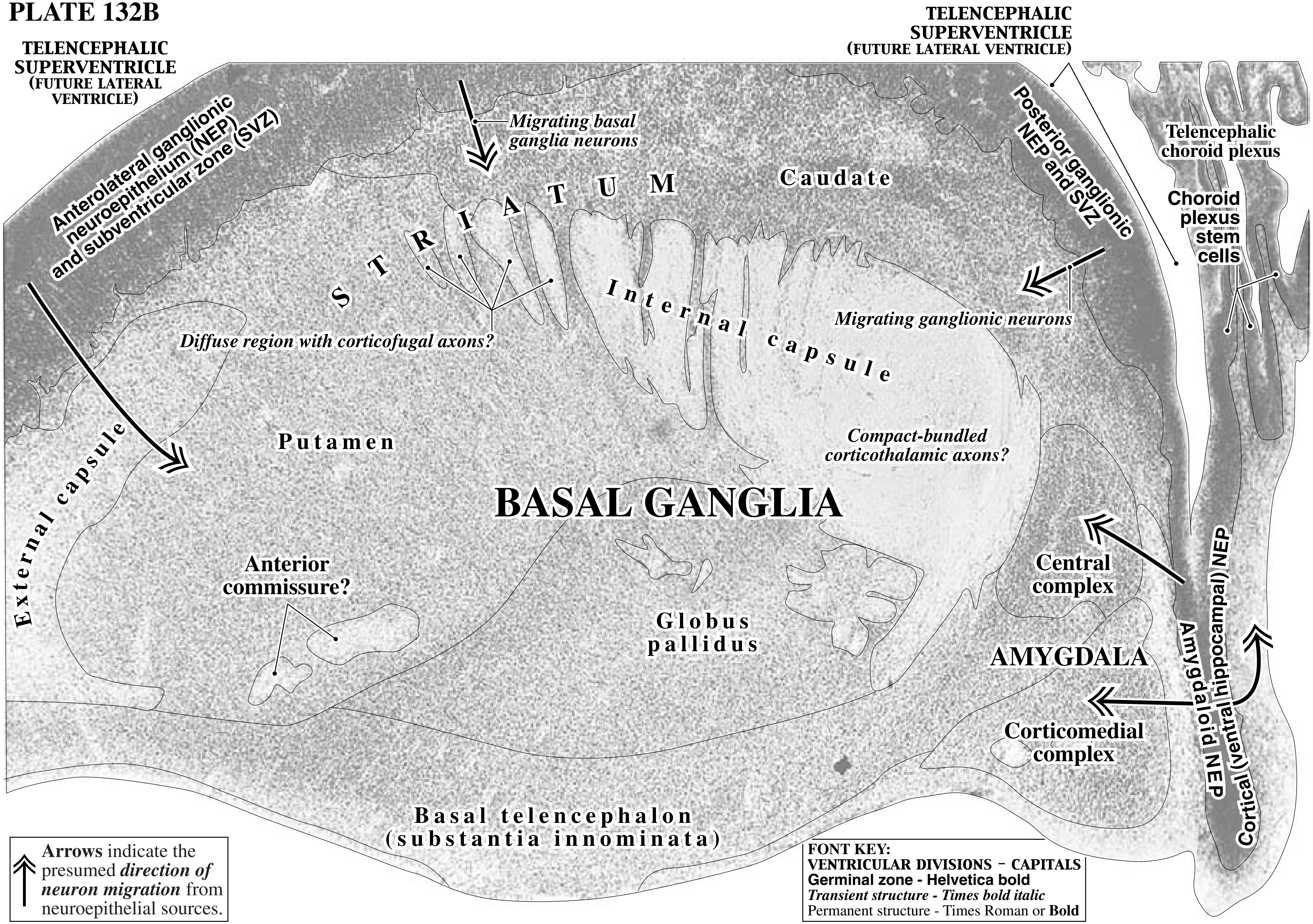
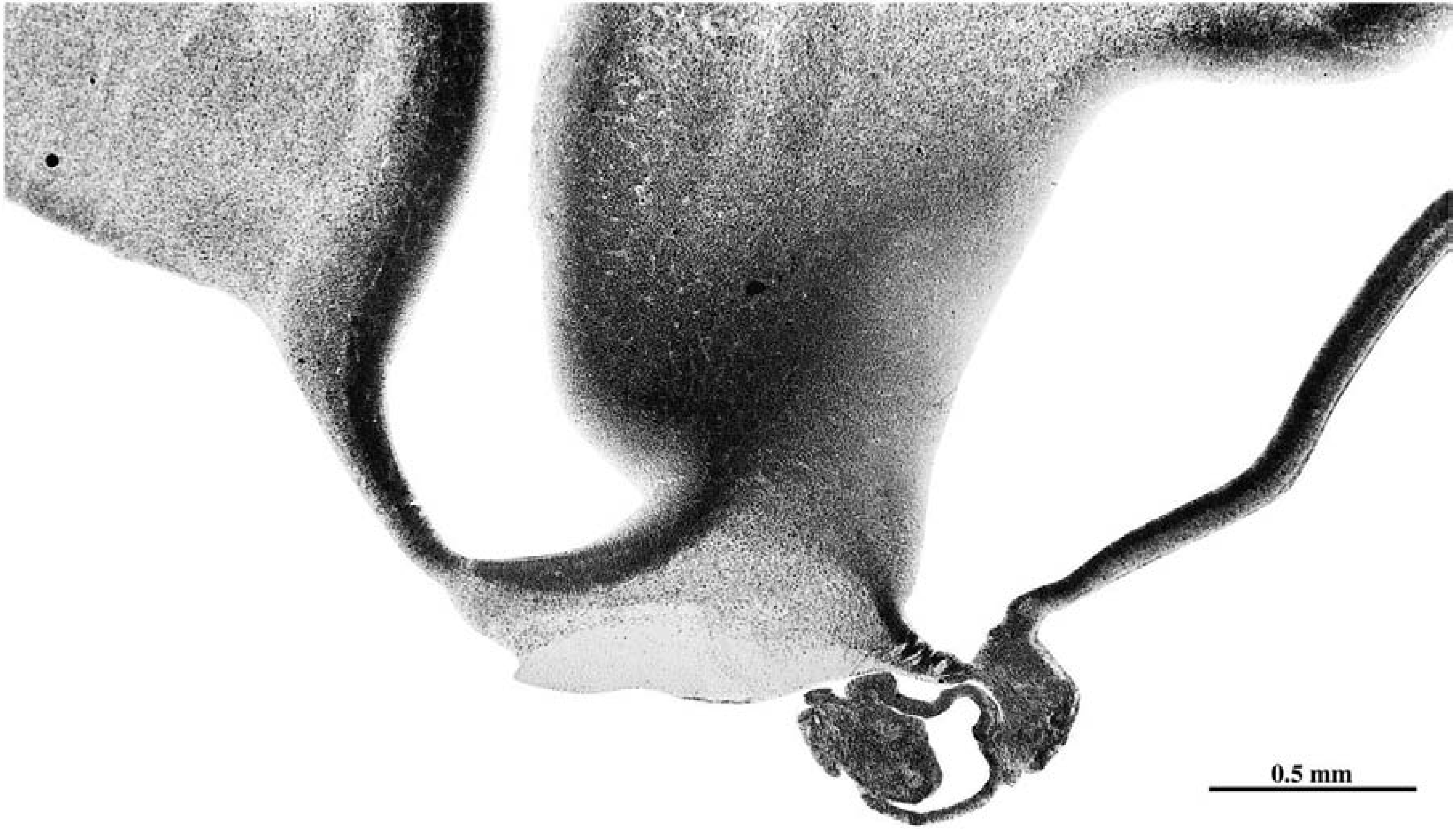
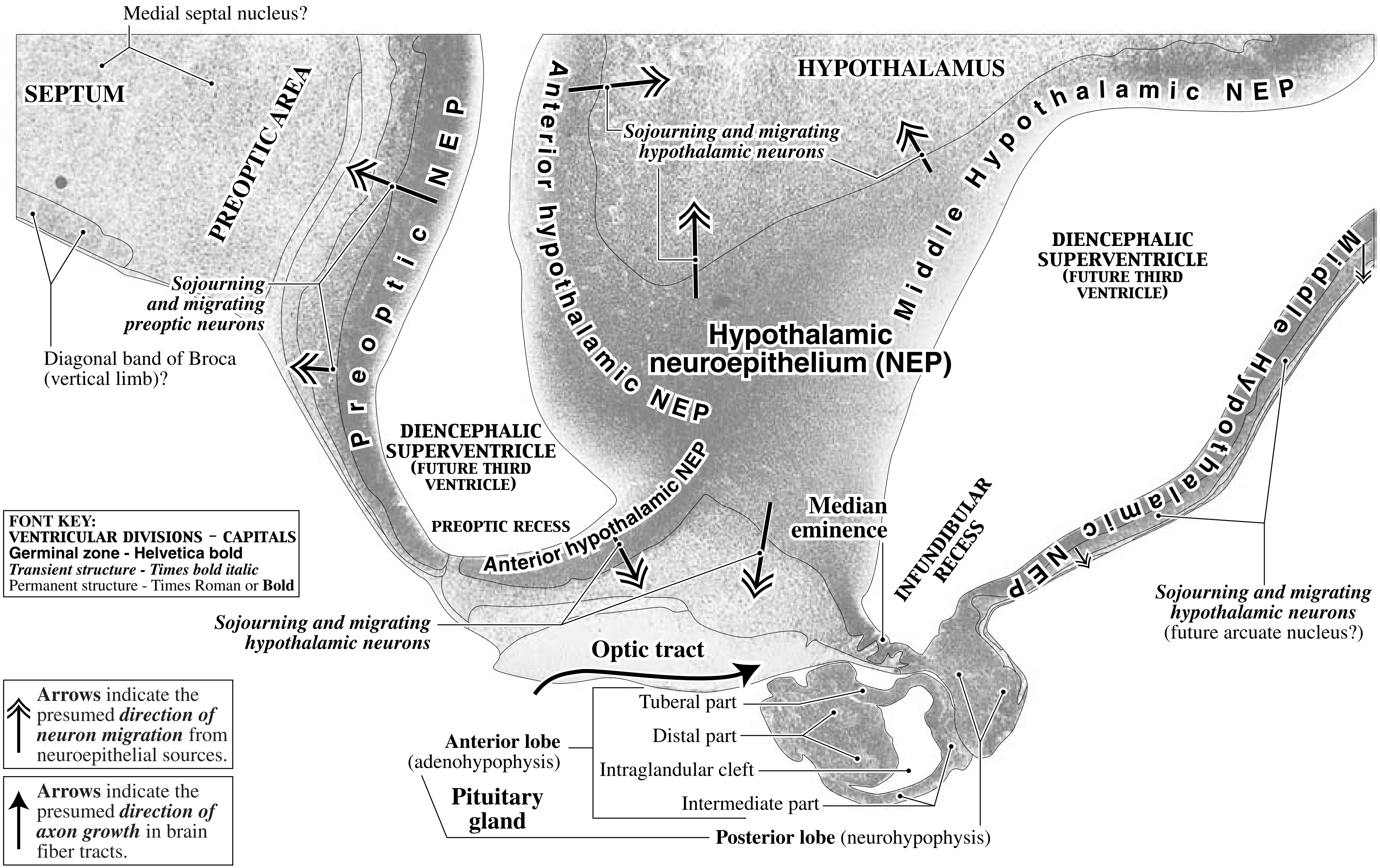

TELENCEPHALIC SUPERVENTRICLE (FUTURE LATERAL VENTRICLE)
TELENCEPHALIC SUPERVENTRICLE (FUTURE LATERAL VENTRICLE)
Anterolateral ganglionic neuroepithelium (NEP) and subventricular zone (SVZ)
Migrating basal ganglia neurons
S T R I A T U M
Caudate
Posterior ganglionic NEP and SVZ
Telencephalic choroid plexus
Choroid plexus stem cells
Internal capsule
Migrating ganglionic neurons
Diffuse region with corticofugal axons?
Putamen
Compact-bundled corticothalamic axons?
External capsule
BASAL GANGLIA
Anterior commissure?
Central complex
Globus pallidus
AMYGDALA
Amygdaloid NEP
Cortical (ventral hippocampal) NEP
Corticomedial complex
Basal telencephalon (substantia innominata)
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold

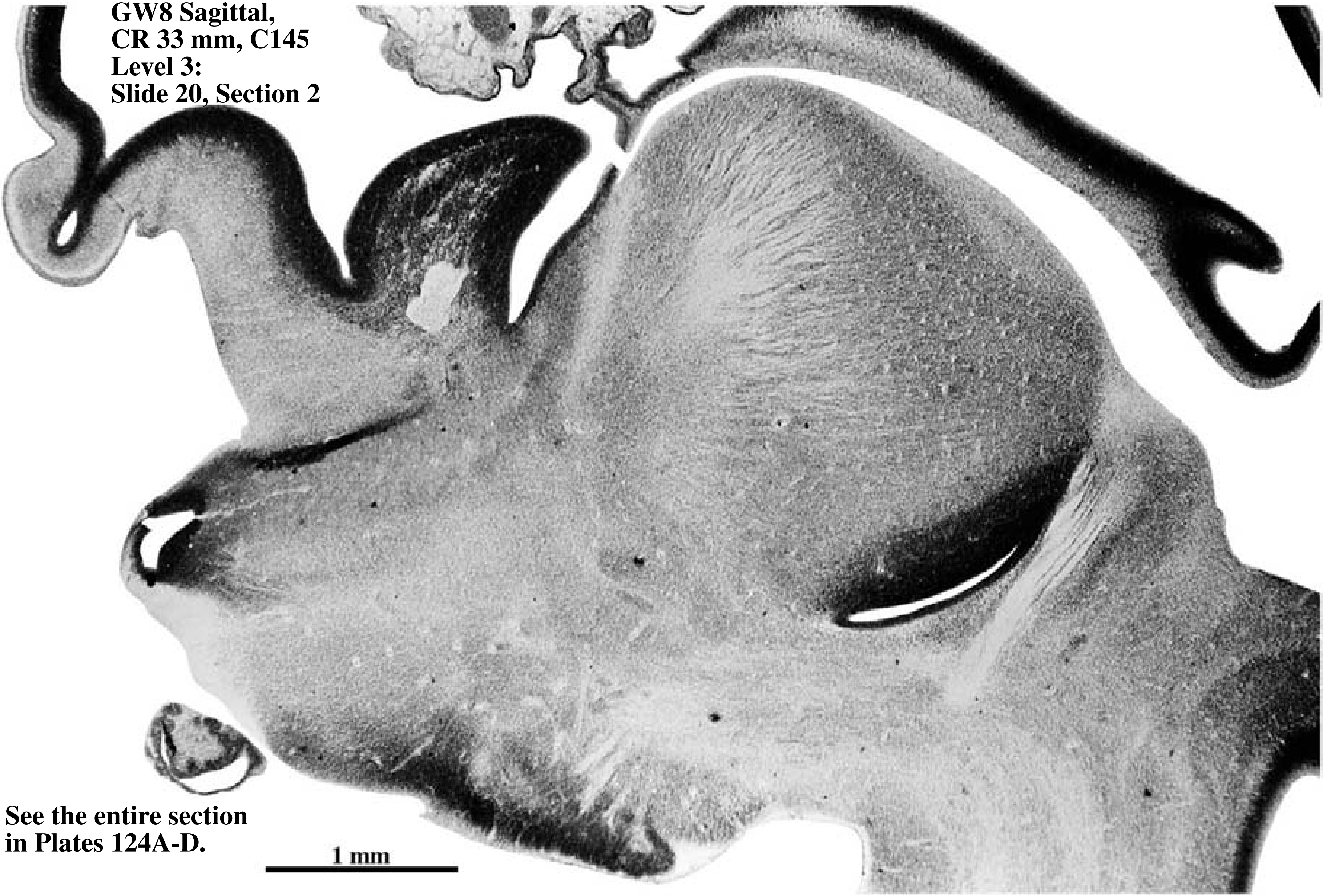
PLATE 133A **GW8 Sagittal, CR 33 mm, C145**
Level 2: Slide 22, Section 2



See the entire section in Plates 123A-D.

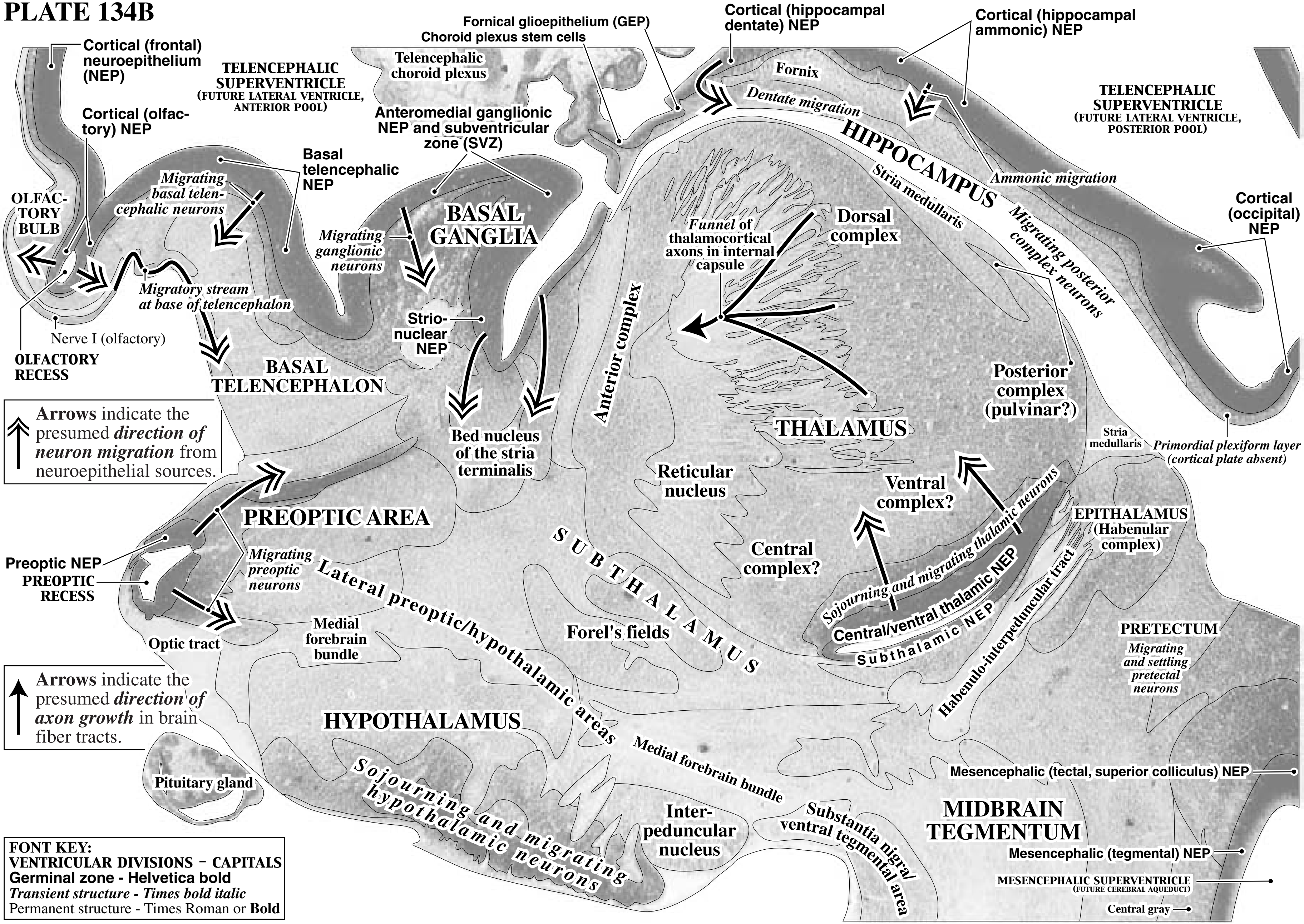
PLATE 133B


Medial septal nucleus?
SEPTUM
PREOPTIC AREA
Preoptic NEP
Sojourning and migrating preoptic neurons
Diagonal band of Broca (vertical limb)?
Anterior hypothalamic NEP
Sojourning and migrating hypothalamic neurons
HYPOTHALAMUS
Middle Hypothalamic NEP
Hypothalamic neuroepithelium (NEP)
DIENCEPHALIC SUPERVENTRICLE (FUTURE THIRD VENTRICLE)
DIENCEPHALIC SUPERVENTRICLE (FUTURE THIRD VENTRICLE)
PREOPTIC RECESS
Anterior hypothalamic NEP
Anterior hypothalamic NEP
Median eminence
INFUNDIBULAR RECESS
Middle Hypothalamic NEP
Sojourning and migrating hypothalamic neurons (future arcuate nucleus?)
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
Sojourning and migrating hypothalamic neurons
Optic tract
Tuberal part
Distal part
Intraglandular cleft
Intermediate part
Anterior lobe (adenohypophysis)
Pituitary gland
Posterior lobe (neurohypophysis)
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Arrows indicate the presumed direction of axon growth in brain fiber tracts.



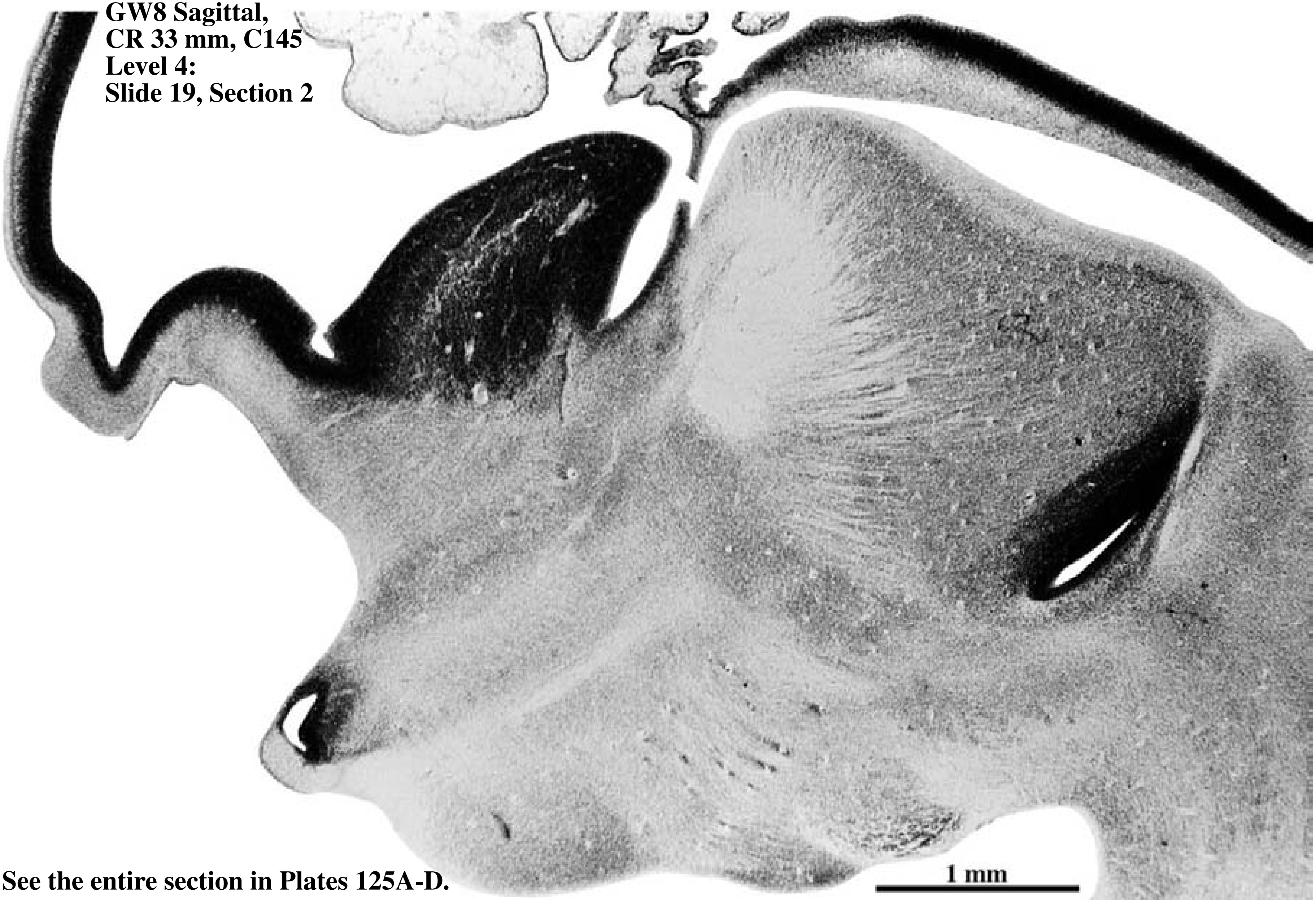
See the entire section in Plates 124A-D.

PLATE 134B



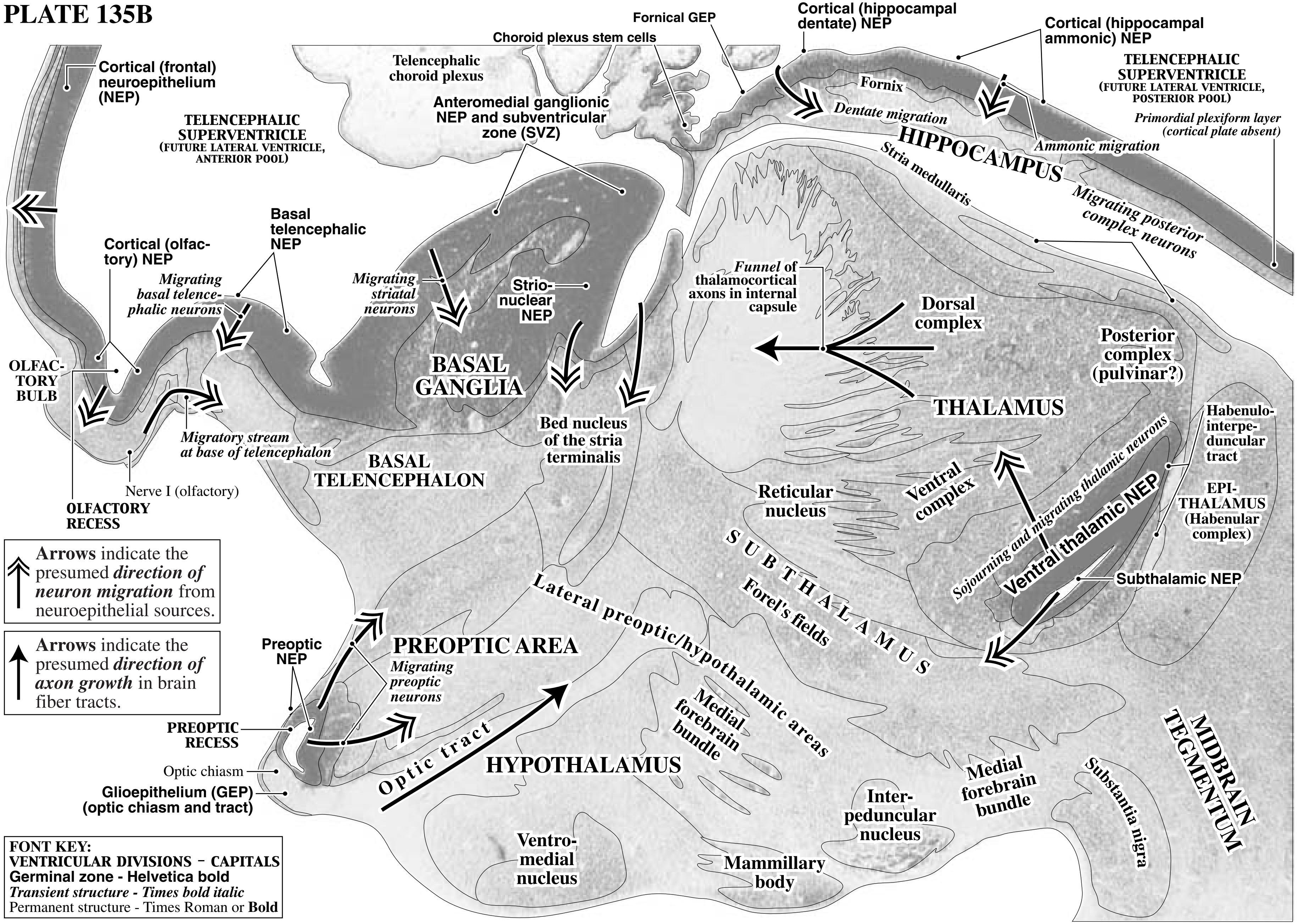
Cortical (frontal) neuroepithelium (NEP)
TELENCEPHALIC SUPERVENTRICLE (FUTURE LATERAL VENTRICLE, ANTERIOR POOL)
Telencephalic choroid plexus
Fornical glioepithelium (GEP)
Choroid plexus stem cells
Cortical (hippocampal dentate) NEP
Cortical (hippocampal ammonic) NEP
Fornix
Dentate migration
TELENCEPHALIC SUPERVENTRICLE (FUTURE LATERAL VENTRICLE, POSTERIOR POOL)
Cortical (olfactory) NEP
Anteromedial ganglionic NEP and subventricular zone (SVZ)
Basal telencephalic NEP
HIPPOCAMPUS
Ammonic migration
Stria medullaris
Migrating basal telencephalic neurons
OLFACTORY BULB
BASAL GANGLIA
Migrating ganglionic neurons
Funnel of thalamocortical axons in internal capsule
Dorsal complex
Cortical (occipital) NEP
Migrating posterior complex neurons
Migratory stream at base of telencephalon
Strionuclear NEP
Nerve I (olfactory)
OLFACTORY RECESS
BASAL TELENCEPHALON
Anterior complex
Posterior complex (pulvinar?)
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Bed nucleus of the stria terminalis
THALAMUS
Stria medullaris
Primordial plexiform layer (cortical plate absent)
Reticular nucleus
Ventral complex?
PREOPTIC AREA
EPITHALAMUS (Habenular complex)
Preoptic NEP
Migrating preoptic neurons
SUBTHALAMUS
Central complex?
Sojourning and migrating thalamic neurons
PREOPTIC RECESS
Lateral preoptic/hypothalamic areas
Central/ventral thalamic NEP
Subthalamic NEP
Habenulo-interpeduncular tract
Medial forebrain bundle
Forel's fields
PRETECTUM
Migrating and settling pretectal neurons
Optic tract
Arrows indicate the presumed direction of axon growth in brain fiber tracts.
HYPOTHALAMUS
Medial forebrain bundle
Mesencephalic (tectal, superior colliculus) NEP
Pituitary gland
Sojourning and migrating hypothalamic neurons
Interpeduncular nucleus
Substantia nigra/ventral tegmental area
MIDBRAIN TEGMENTUM
Mesencephalic (tegmental) NEP
MESENCEPHALIC SUPERVENTRICLE (FUTURE CEREBRAL AQUEDUCT)
Central gray
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold

GW8 Sagittal,
CR 33 mm, C145
Level 4:
Slide 19, Section 2

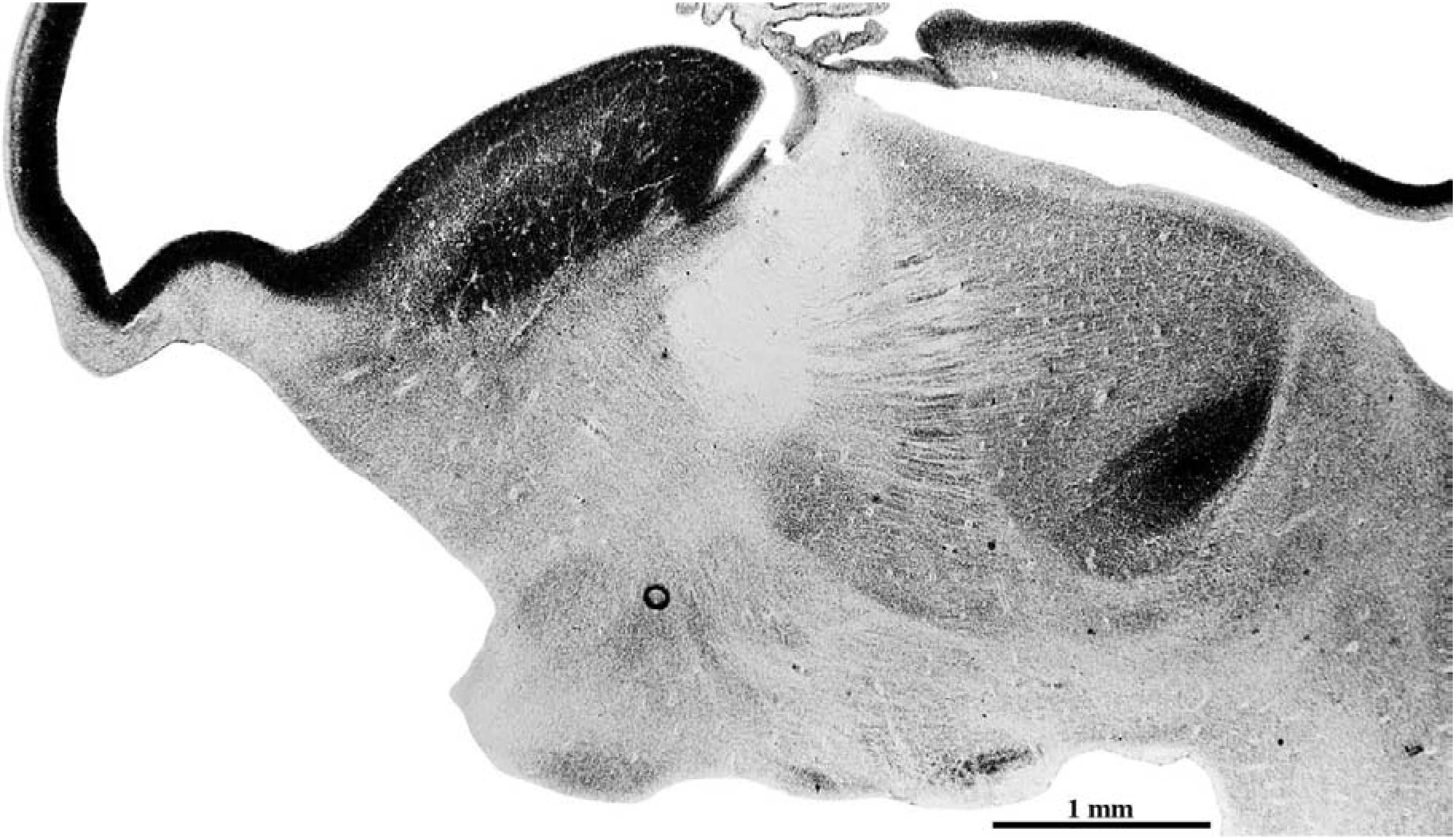


See the entire section in Plates 125A-D.

PLATE 135B

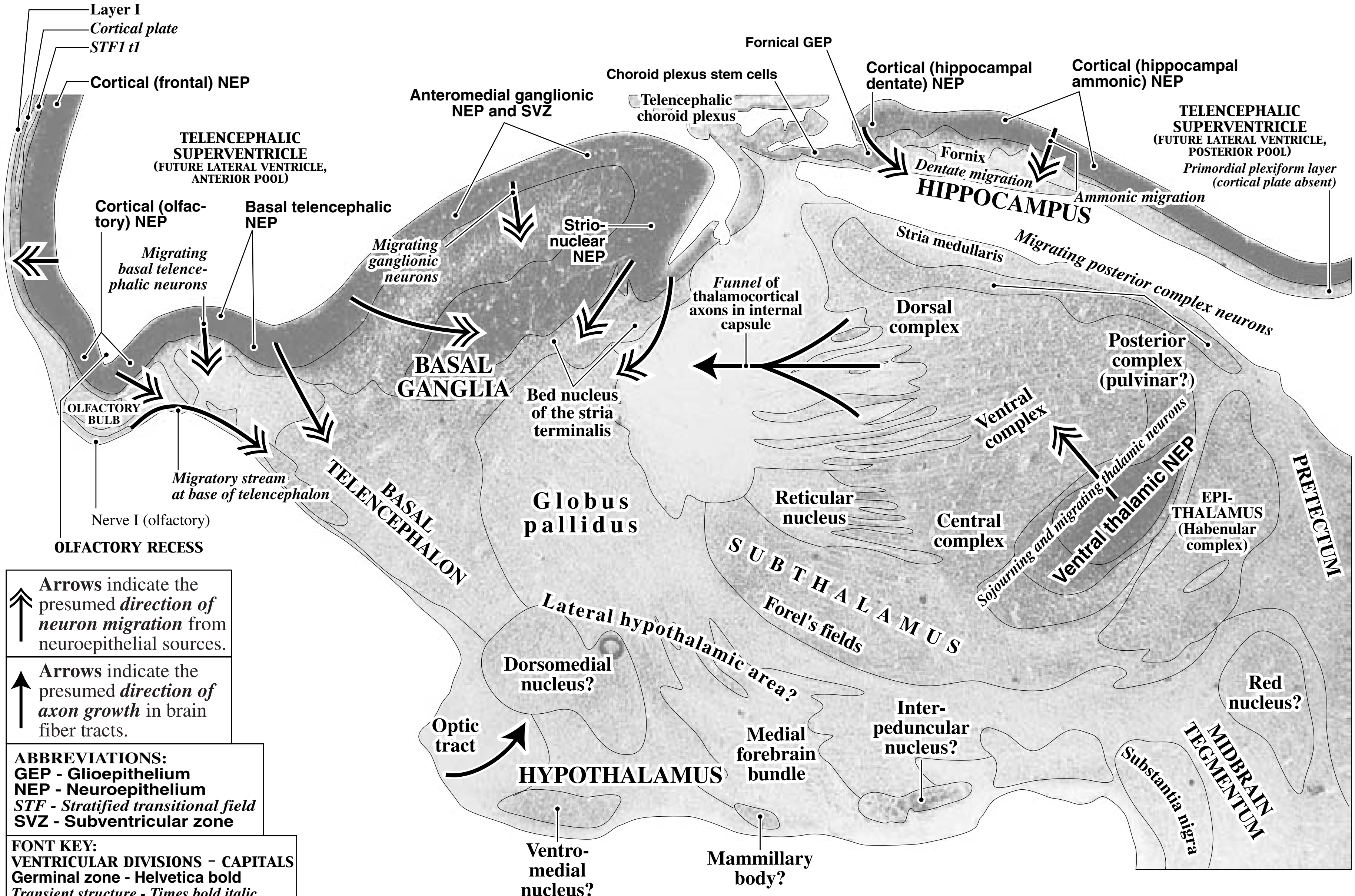


Cortical (frontal) neuroepithelium (NEP)
TELENCEPHALIC SUPERVENTRICLE (FUTURE LATERAL VENTRICLE, ANTERIOR POOL)
Telencephalic choroid plexus
Choroid plexus stem cells
Fornical GEP
Cortical (hippocampal dentate) NEP
Cortical (hippocampal ammonic) NEP
TELENCEPHALIC SUPERVENTRICLE (FUTURE LATERAL VENTRICLE, POSTERIOR POOL)
Primordial plexiform layer (cortical plate absent)
Fornix
Dentate migration
Ammonic migration
HIPPOCAMPUS
Stria medullaris
Migrating posterior complex neurons
Anteromedial ganglionic NEP and subventricular zone (SVZ)
Basal telencephalic NEP
Cortical (olfactory) NEP
Migrating basal telencephalic neurons
Migrating striatal neurons
Strionuclear NEP
Funnel of thalamocortical axons in internal capsule
Dorsal complex
Posterior complex (pulvinar?)
OLFACTORY BULB
BASAL GANGLIA
THALAMUS
Habenulo-interpeduncular tract
Migratory stream at base of telencephalon
Bed nucleus of the stria terminalis
BASAL TELENCEPHALON
Nerve I (olfactory)
OLFACTORY RECESS
Reticular nucleus
Ventral complex
Sojourning and migrating thalamic neurons
Ventral thalamic NEP
EPITHALAMUS (Habenular complex)
SUBTHALAMUS
Subthalamic NEP
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Lateral preoptic/hypothalamic areas
Forel's fields
Arrows indicate the presumed direction of axon growth in brain fiber tracts.
Preoptic NEP
PREOPTIC AREA
Migrating preoptic neurons
PREOPTIC RECESS
Medial forebrain bundle
Optic tract
Optic chiasm
HYPOTHALAMUS
Glioepithelium (GEP) (optic chiasm and tract)
Interpeduncular nucleus
Medial forebrain bundle
Substantia nigra
MIDBRAIN TEGMENTUM
Ventromedial nucleus
Mammillary body
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold



See the entire section in Plates 126A-D.

PLATE 136B



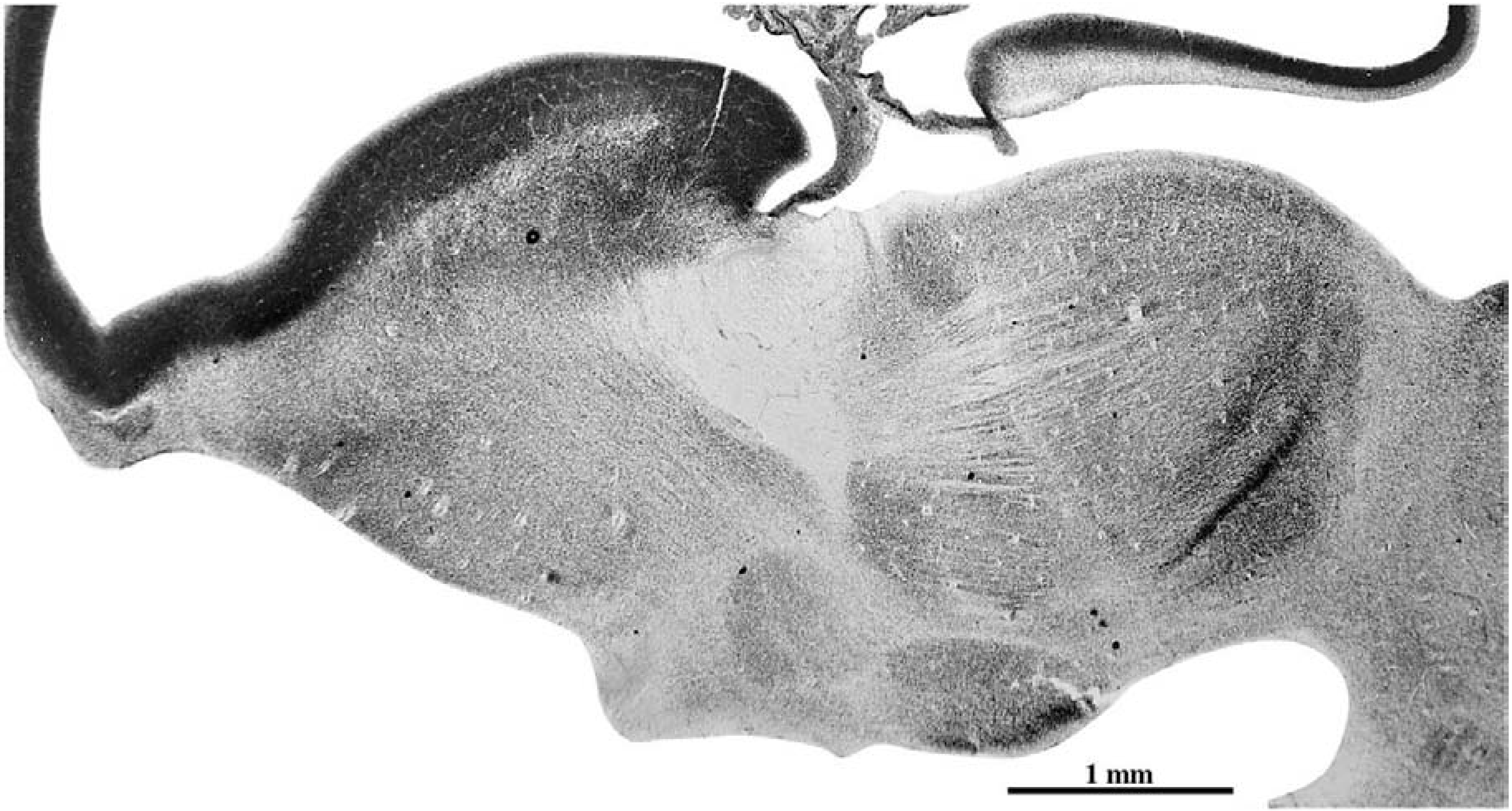
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
STF - Stratified transitional field
SVZ - Subventricular zone

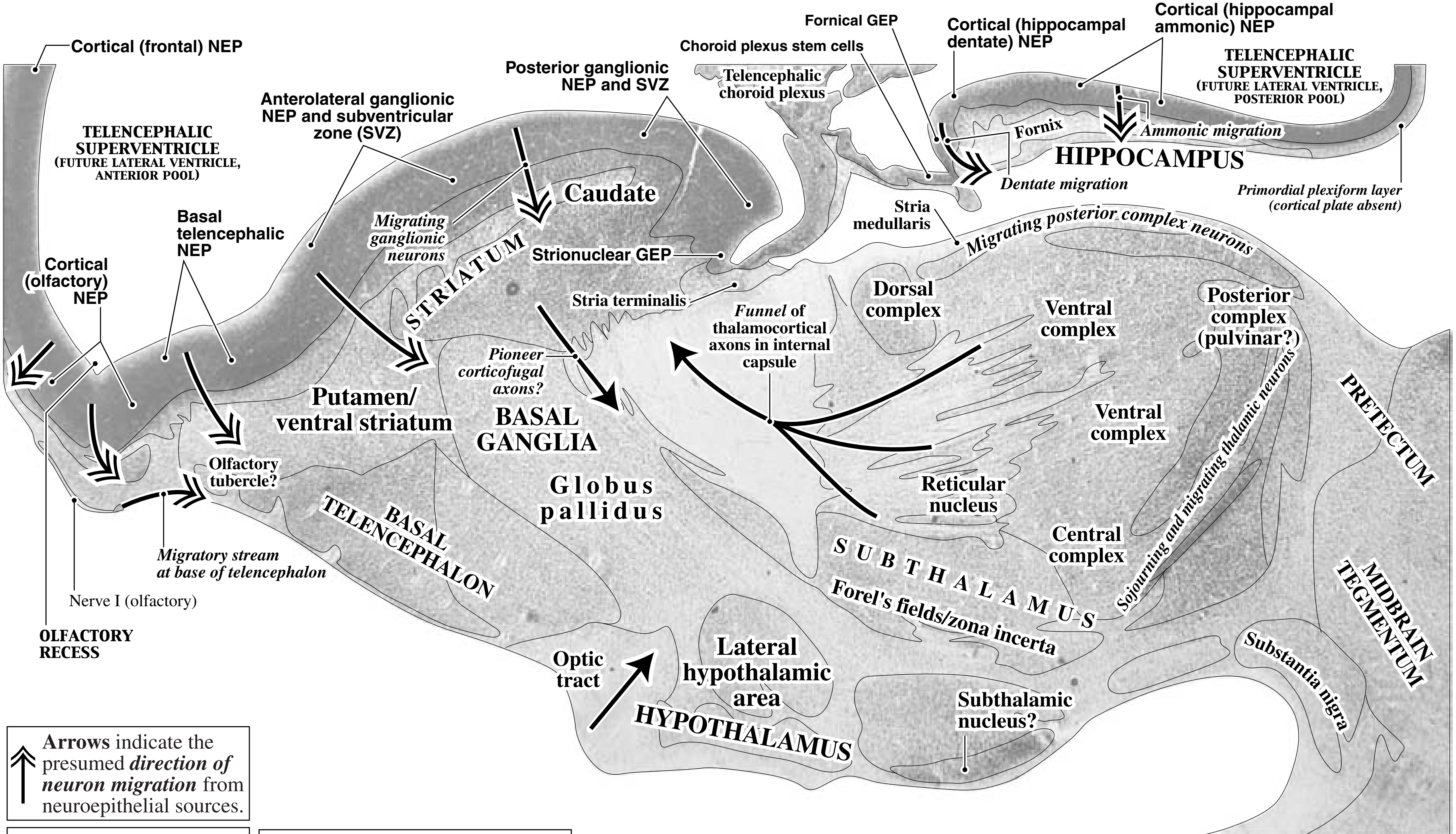
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 137A **GW8 Sagittal, CR 33 mm, C145** **BASAL TELENCEPHALON AND DIENCEPHALON**
Between levels 5 and 6:
Slide 17, Section 2



See level 5 in Plates 126A-D, level 6 in Plates 127A-D.

PLATE 137B



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

PLATE 138A **GW8 Sagittal, CR 33 mm, C145**
Medial to level 1:
Slide 24, Section 2

MIDBRAIN TECTUM AND TEGMENTUM

See level 1 in
Plates 122A-D.

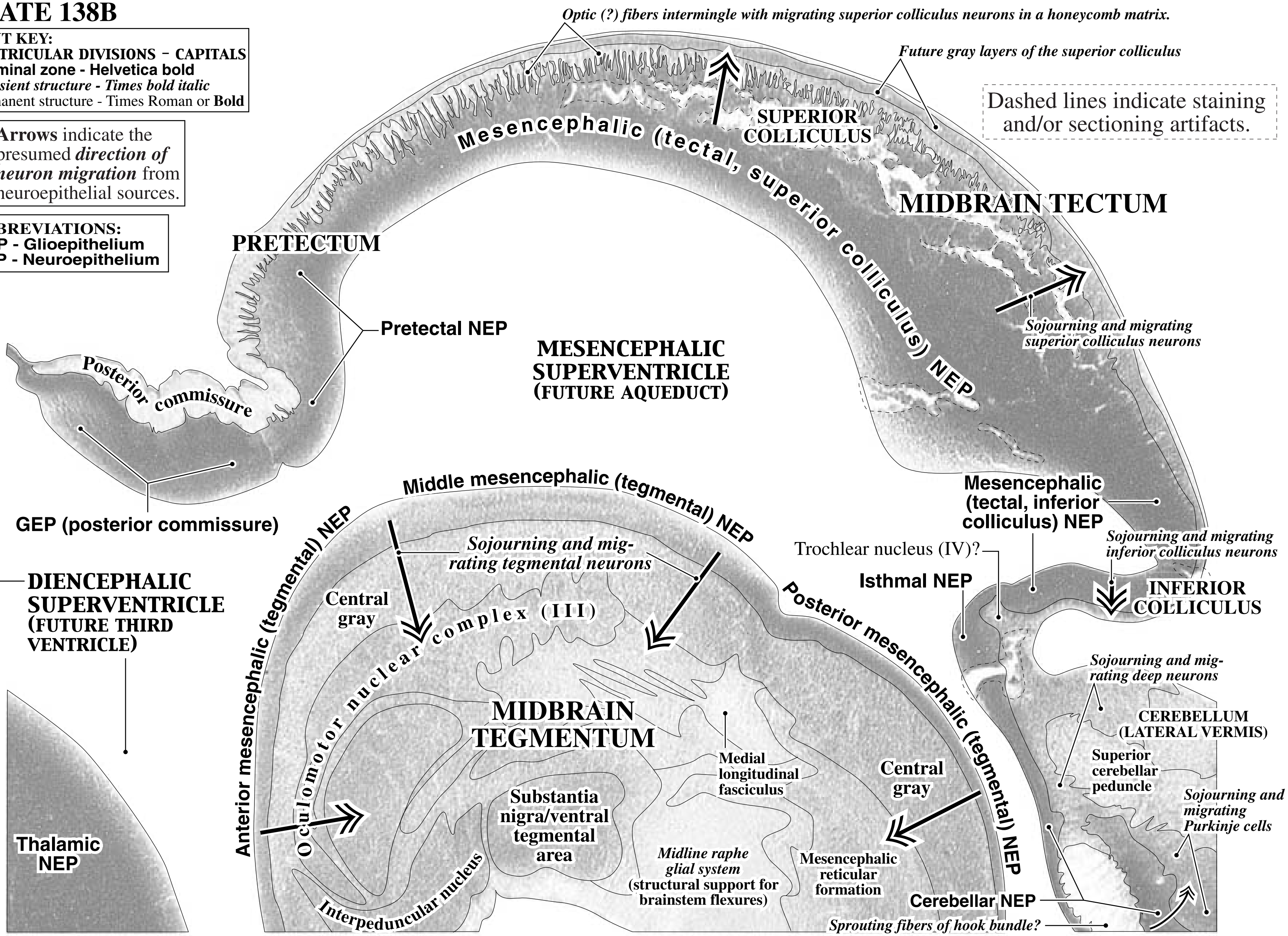
PLATE 138B

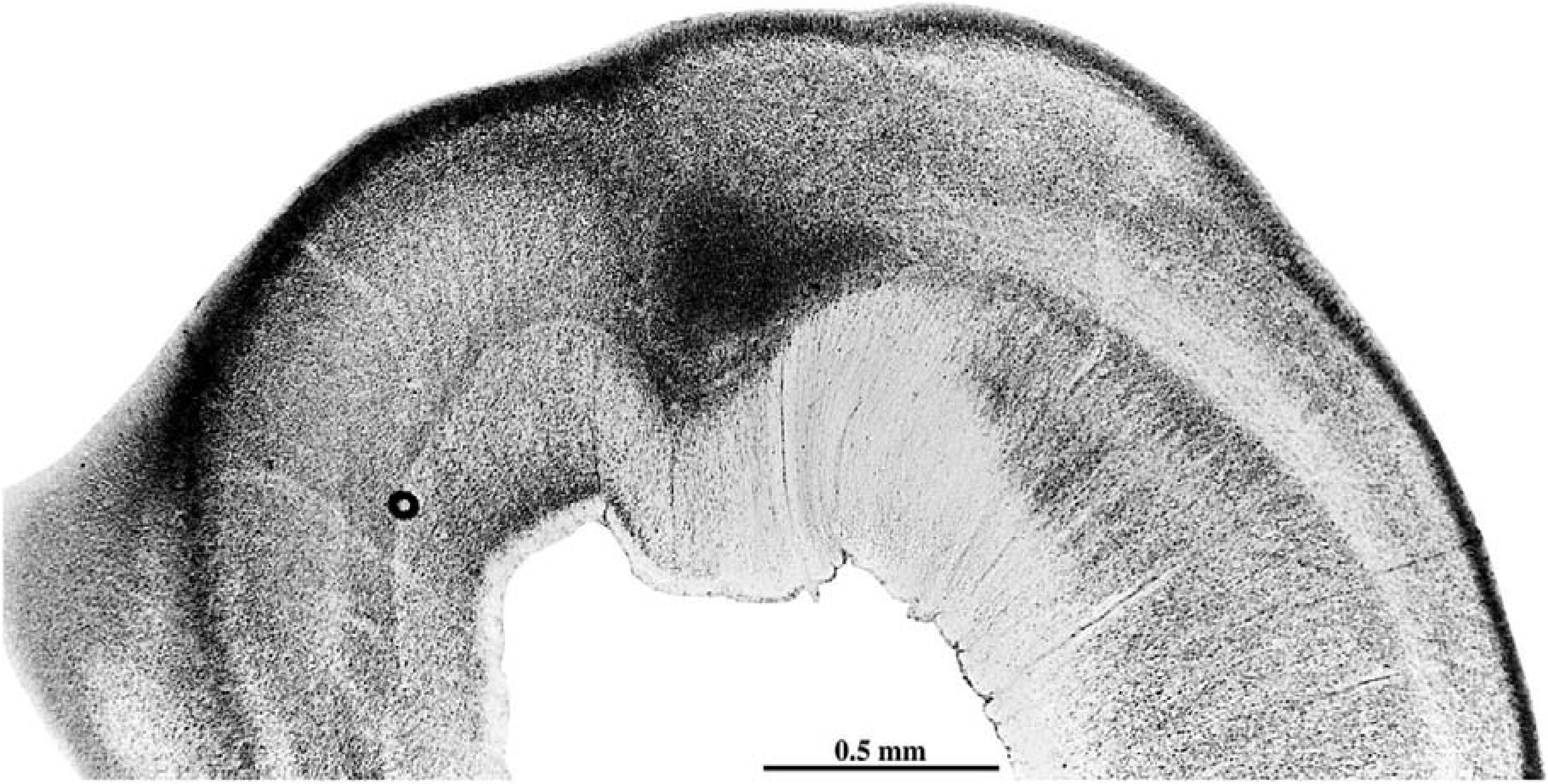
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

Dashed lines indicate staining and/or sectioning artifacts.





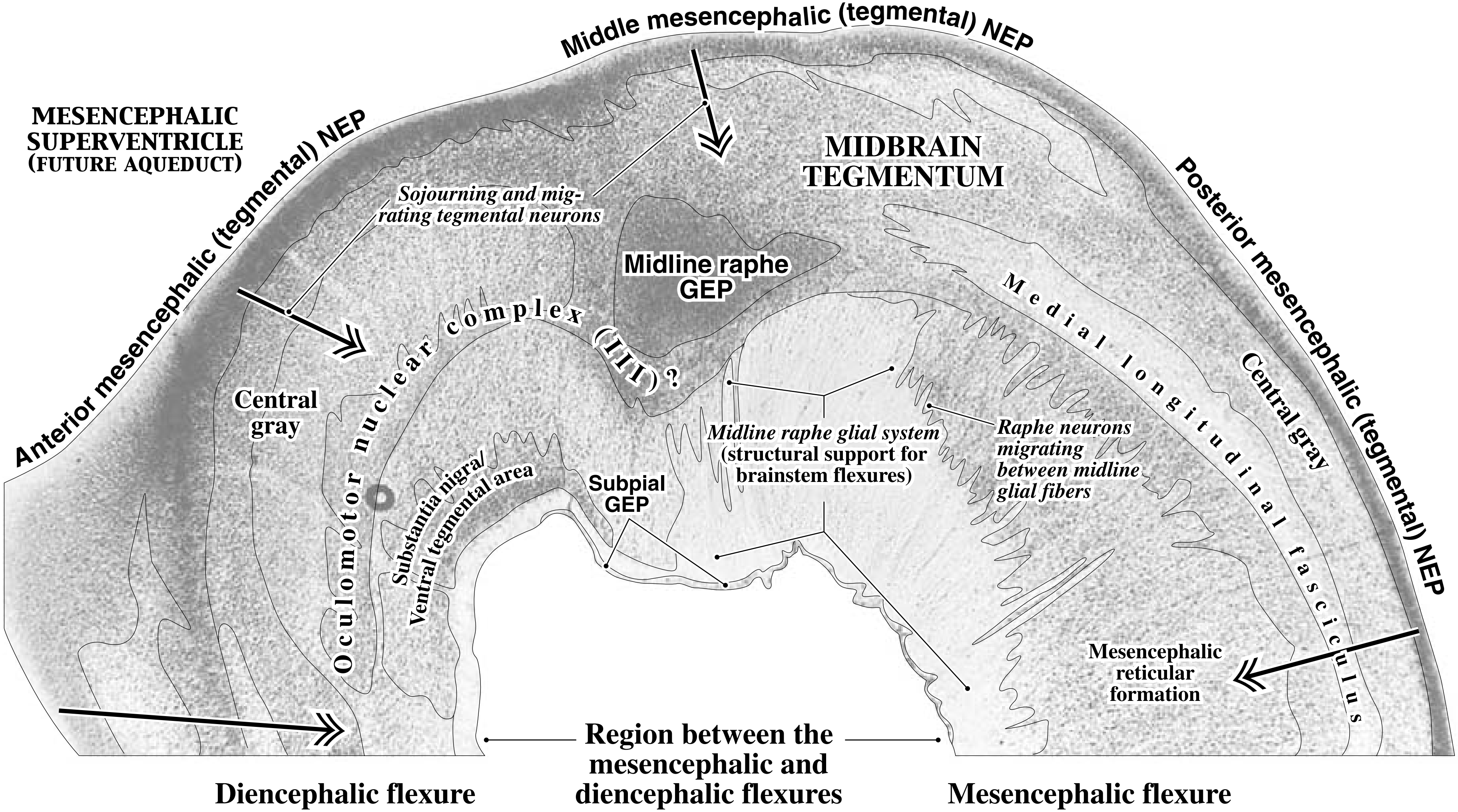
See the entire section in Plates 122A-D.

PLATE 139B

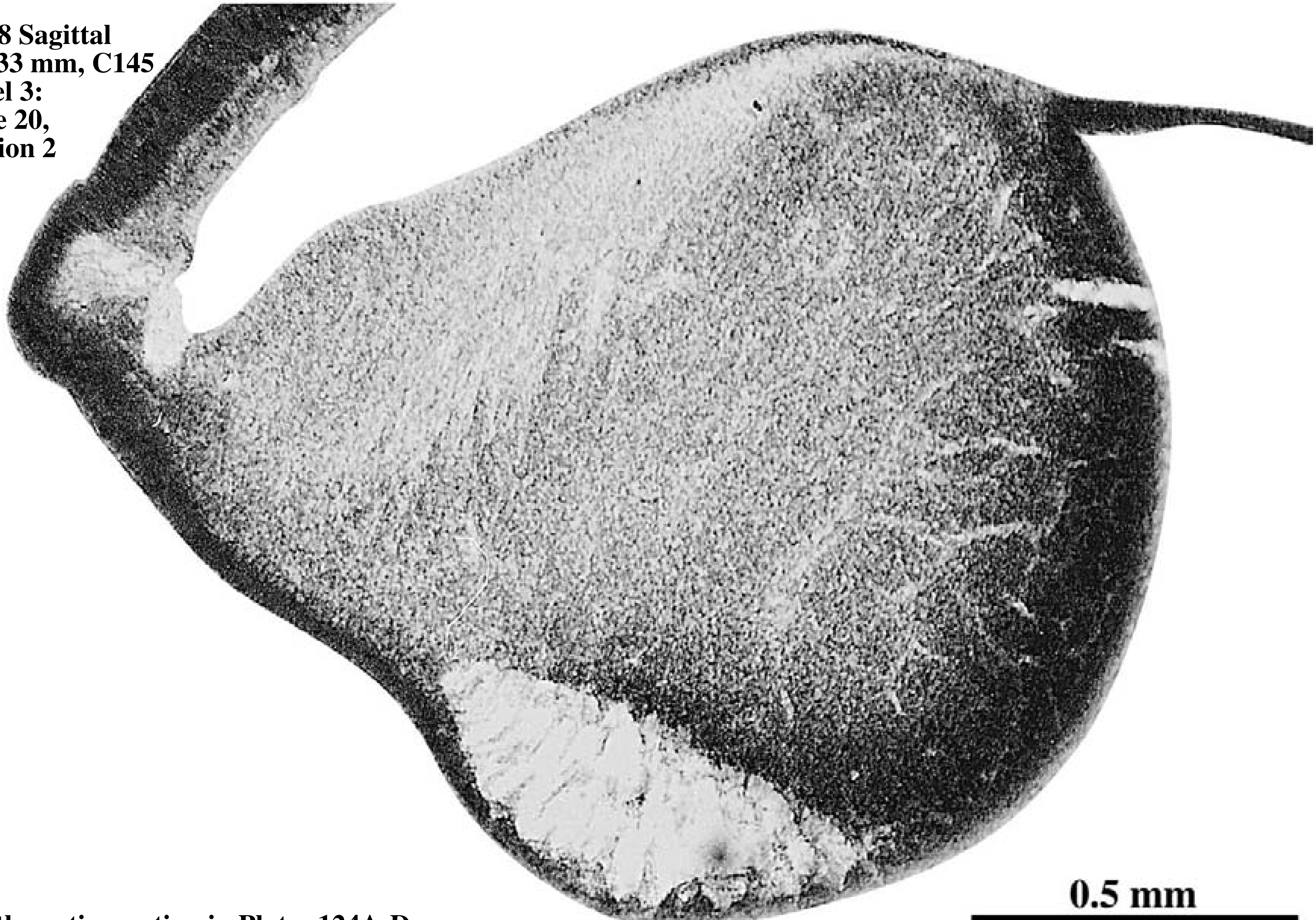
⇑ **Arrows** indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

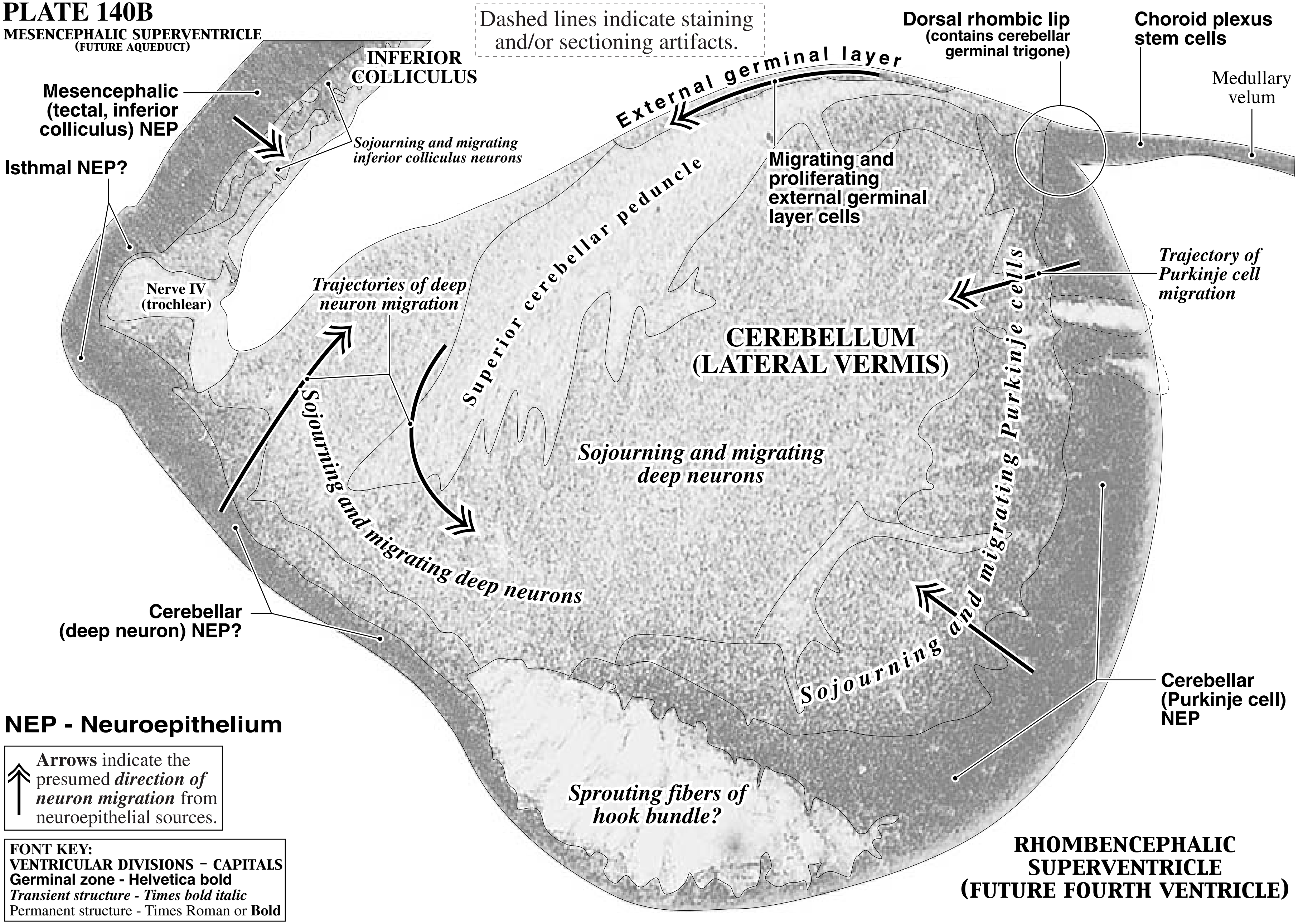


GW8 Sagittal
CR 33 mm, C145
Level 3:
Slide 20,
Section 2



See the entire section in Plates 124A-D.

PLATE 140B



NEP - Neuroepithelium

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

GW8 Sagittal
CR 33 mm, C145
Level 9: Slide 12, Section 4

See the entire section in Plates 130A-D.

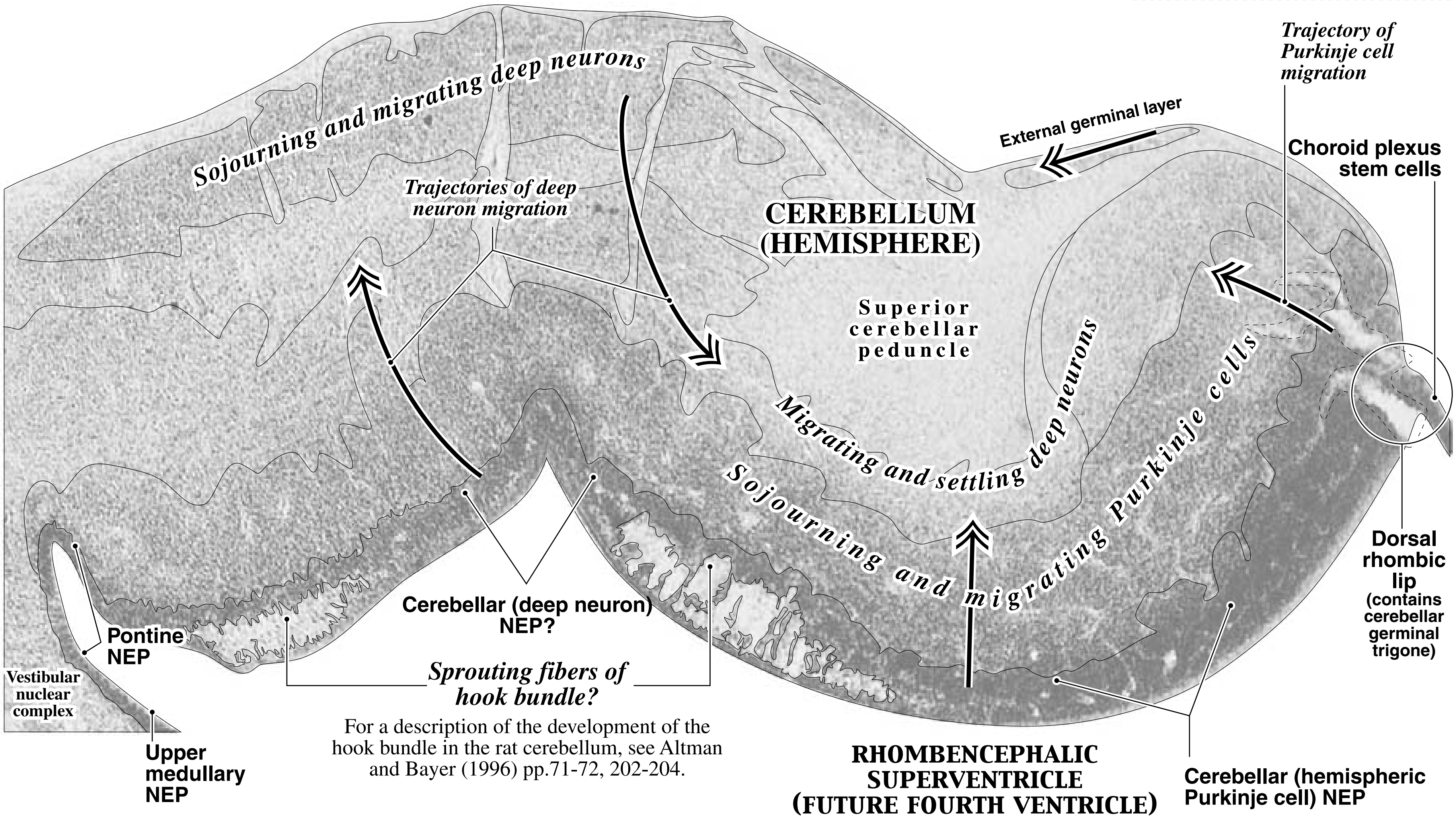
PLATE 141B

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

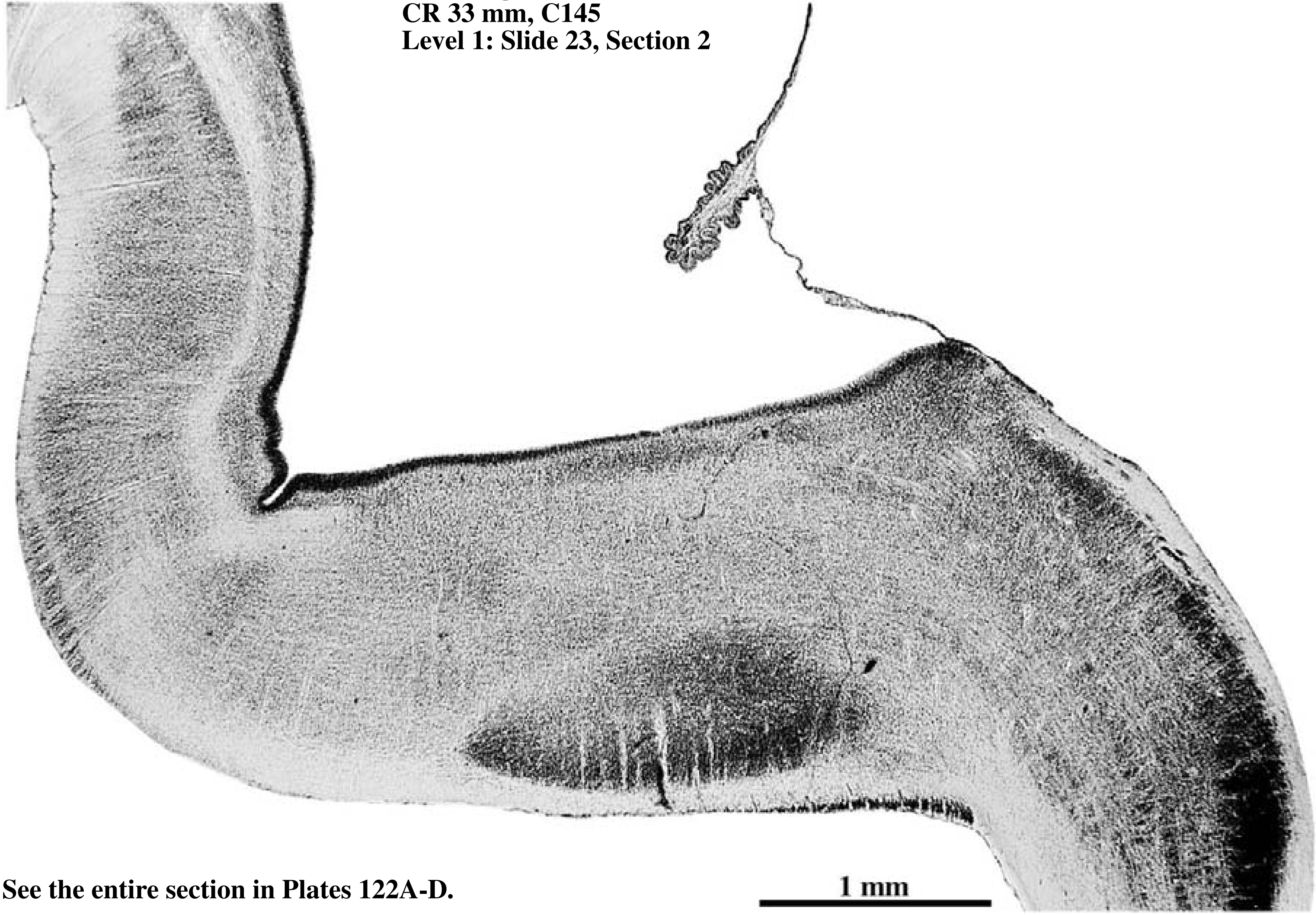
NEP - Neuroepithelium

Dashed lines indicate staining and/or sectioning artifacts.



For a description of the development of the hook bundle in the rat cerebellum, see Altman and Bayer (1996) pp.71-72, 202-204.

GW8 Sagittal
CR 33 mm, C145
Level 1: Slide 23, Section 2



See the entire section in Plates 122A-D.

PLATE 142B

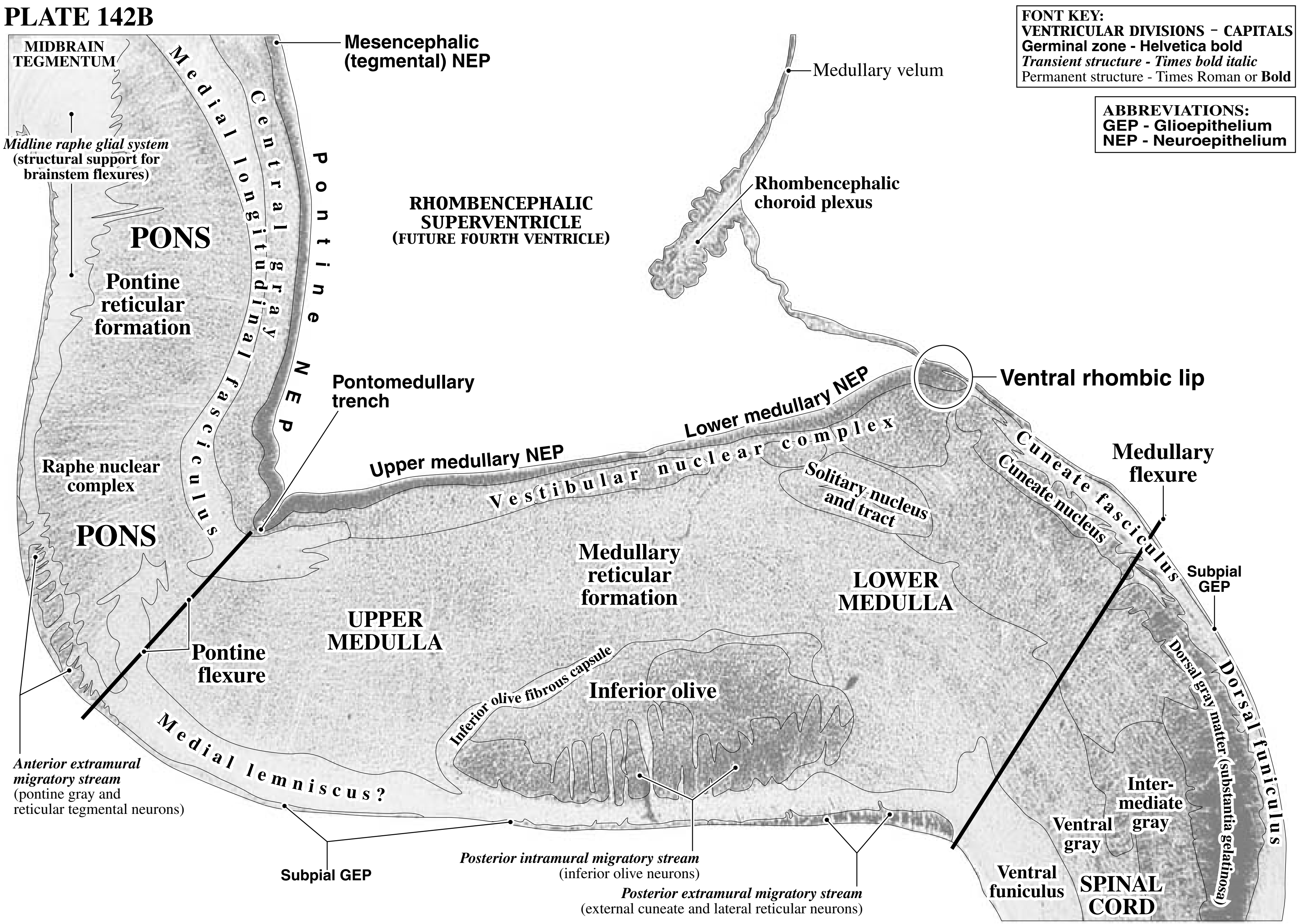
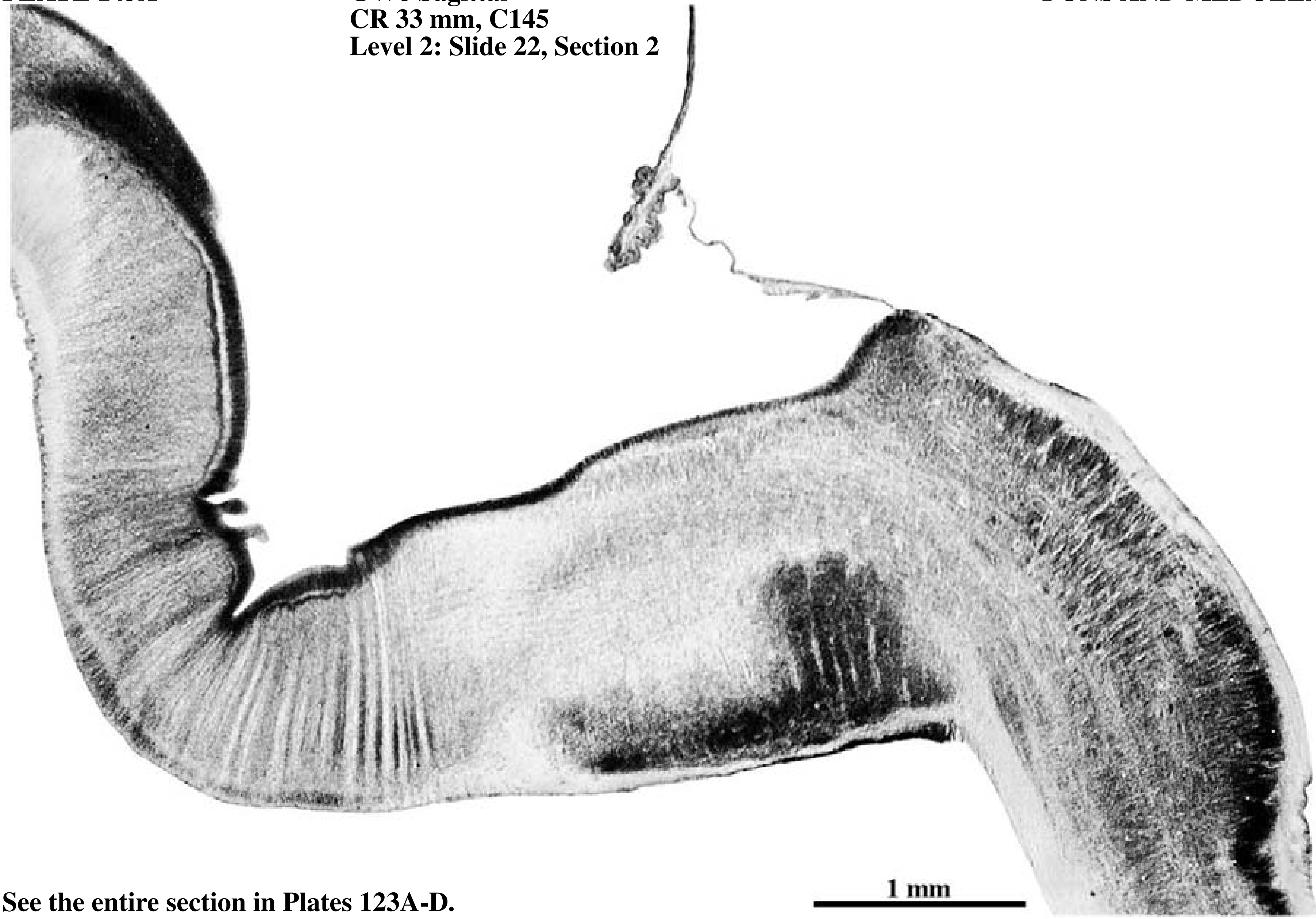

FONT KEY:
VERTICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
MIDBRAIN TEGMENTUM
Mesencephalic (tegmental) NEP
Medullary velum
Midline raphe glial system (structural support for brainstem flexures)
Medial longitudinal fasciculus
Central gray
Pontine NEP
RHOMBENCEPHALIC SUPERVENTRICLE (FUTURE FOURTH VENTRICLE)
Rhombencephalic choroid plexus
PONS
Pontine reticular formation
Pontomedullary trench
Ventral rhombic lip
Lower medullary NEP
Upper medullary NEP
Vestibular nuclear complex
Solitary nucleus and tract
Cuneate fasciculus
Cuneate nucleus
Medullary flexure
Raphe nuclear complex
PONS
Medullary reticular formation
LOWER MEDULLA
Subpial GEP
UPPER MEDULLA
Pontine flexure
Inferior olive fibrous capsule
Inferior olive
Dorsal gray matter (substantia gelatinosa)
Dorsal funiculus
Medial lemniscus?
Inter-mediate gray
Ventral gray
Anterior extramural migratory stream (pontine gray and reticular tegmental neurons)
Subpial GEP
Posterior intramural migratory stream (inferior olive neurons)
Posterior extramural migratory stream (external cuneate and lateral reticular neurons)
Ventral funiculus
SPINAL CORD

PLATE 143A

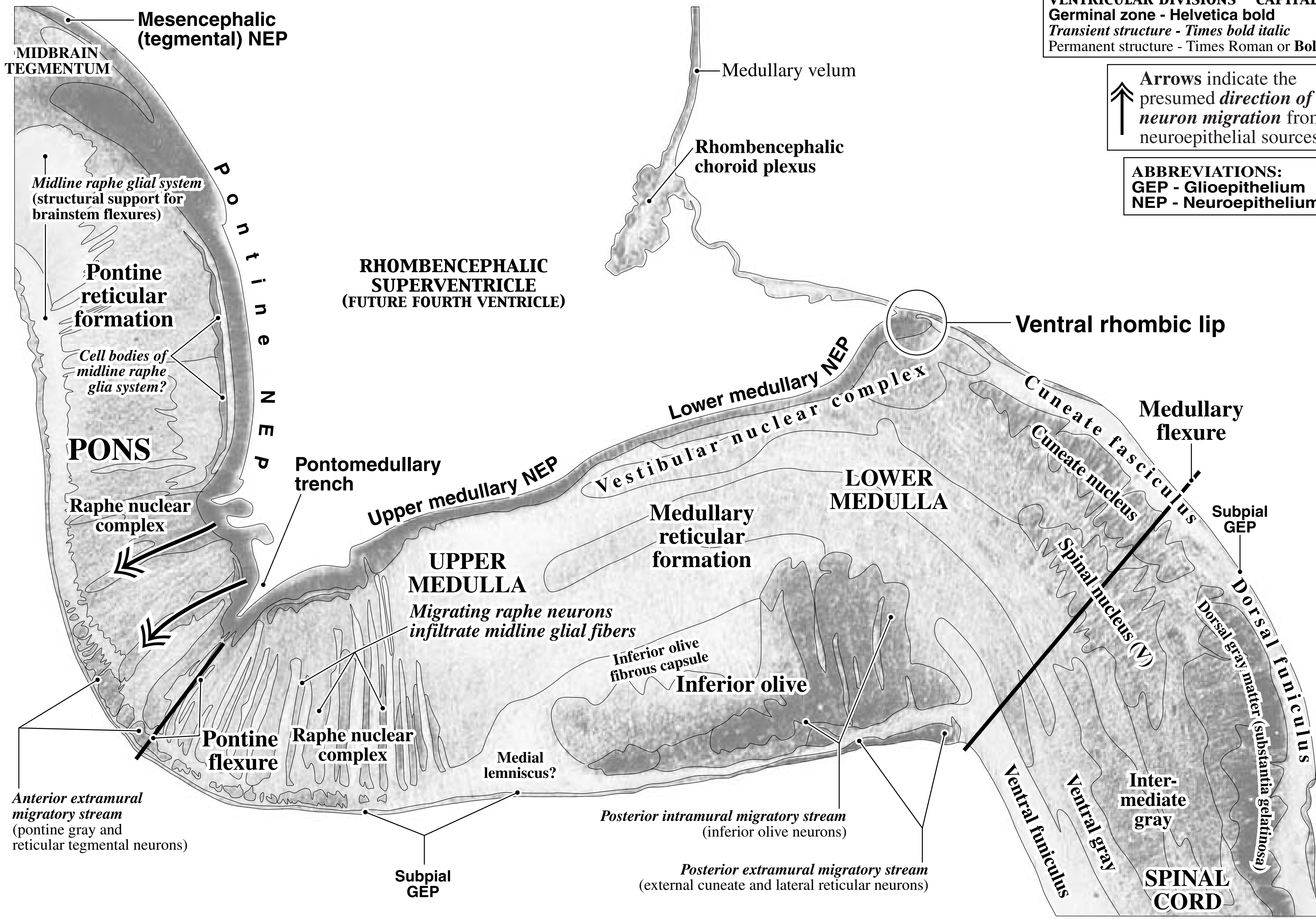
GW8 Sagittal
CR 33 mm, C145
Level 2: Slide 22, Section 2

PONS AND MEDULLA



See the entire section in Plates 123A-D.

PLATE 143B

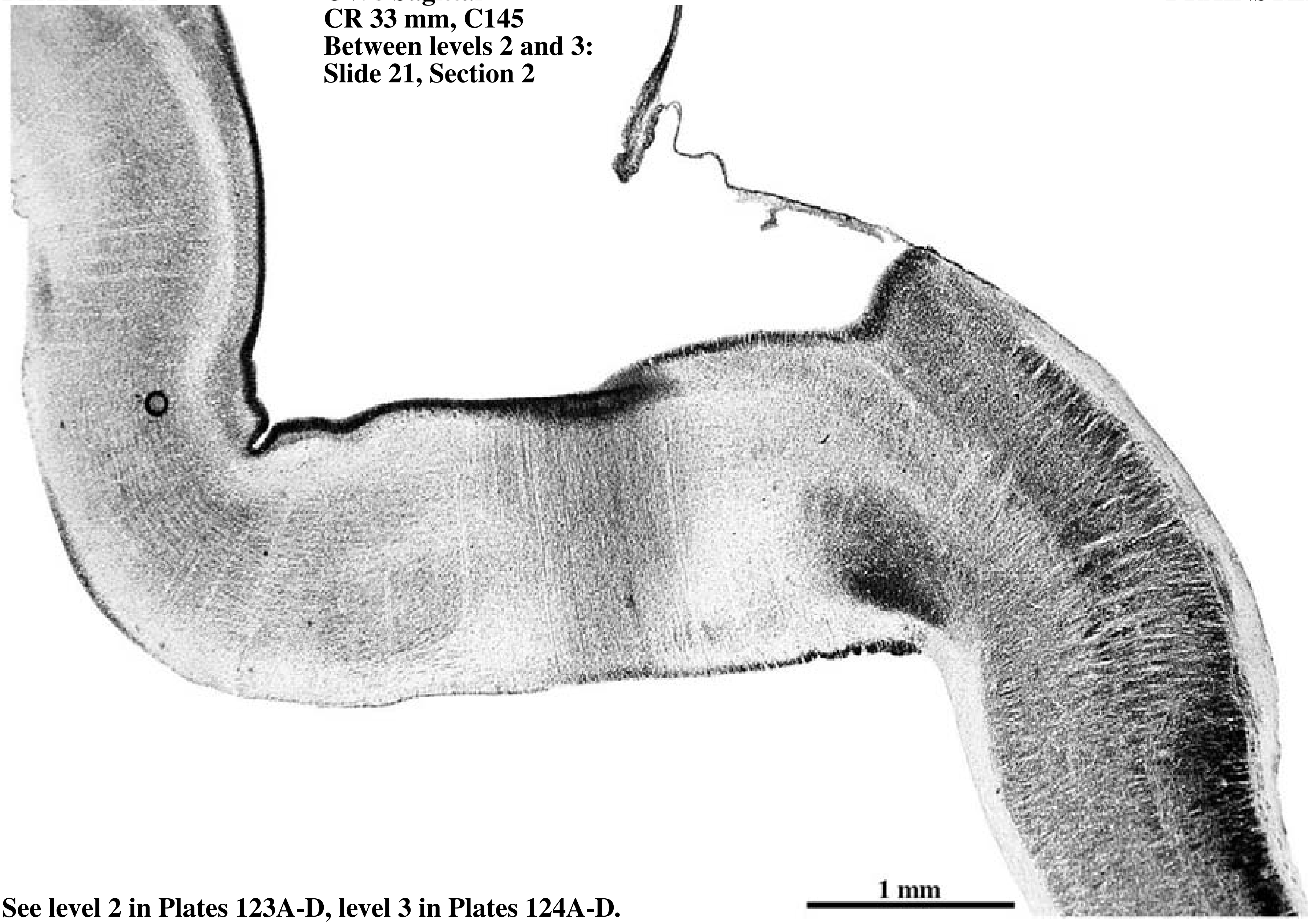


FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

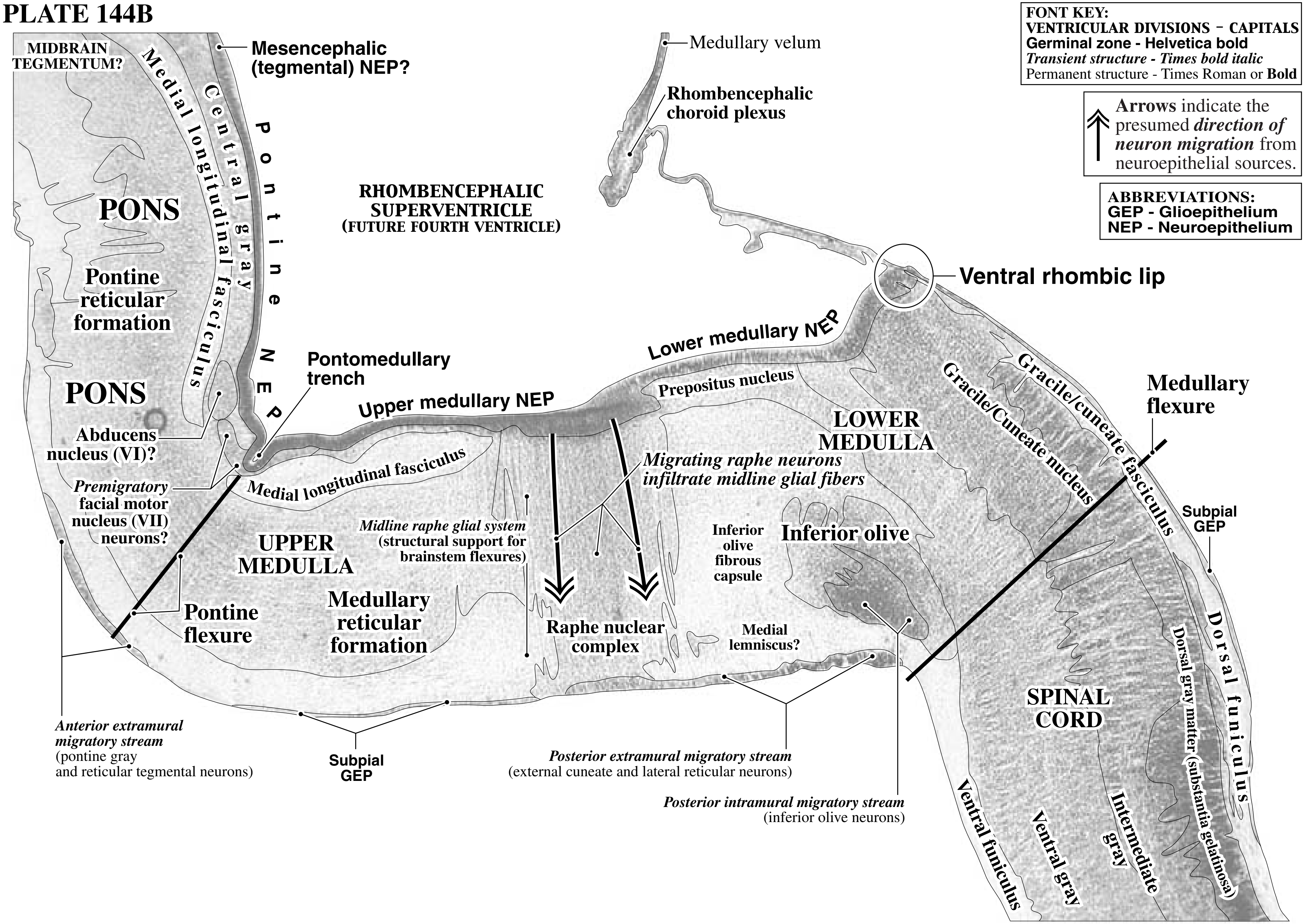
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

GW8 Sagittal
CR 33 mm, C145
Between levels 2 and 3:
Slide 21, Section 2



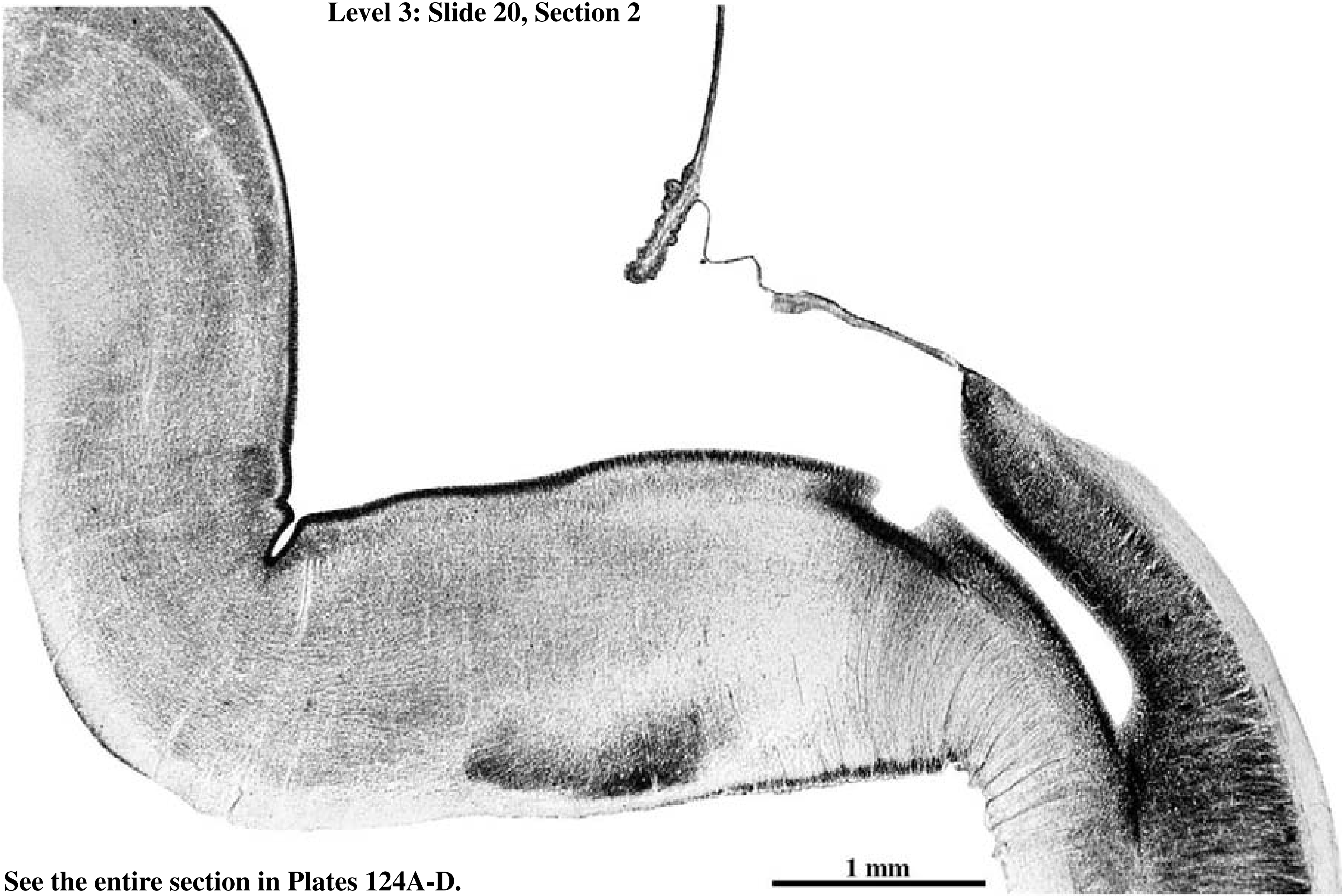
See level 2 in Plates 123A-D, level 3 in Plates 124A-D.

PLATE 144B



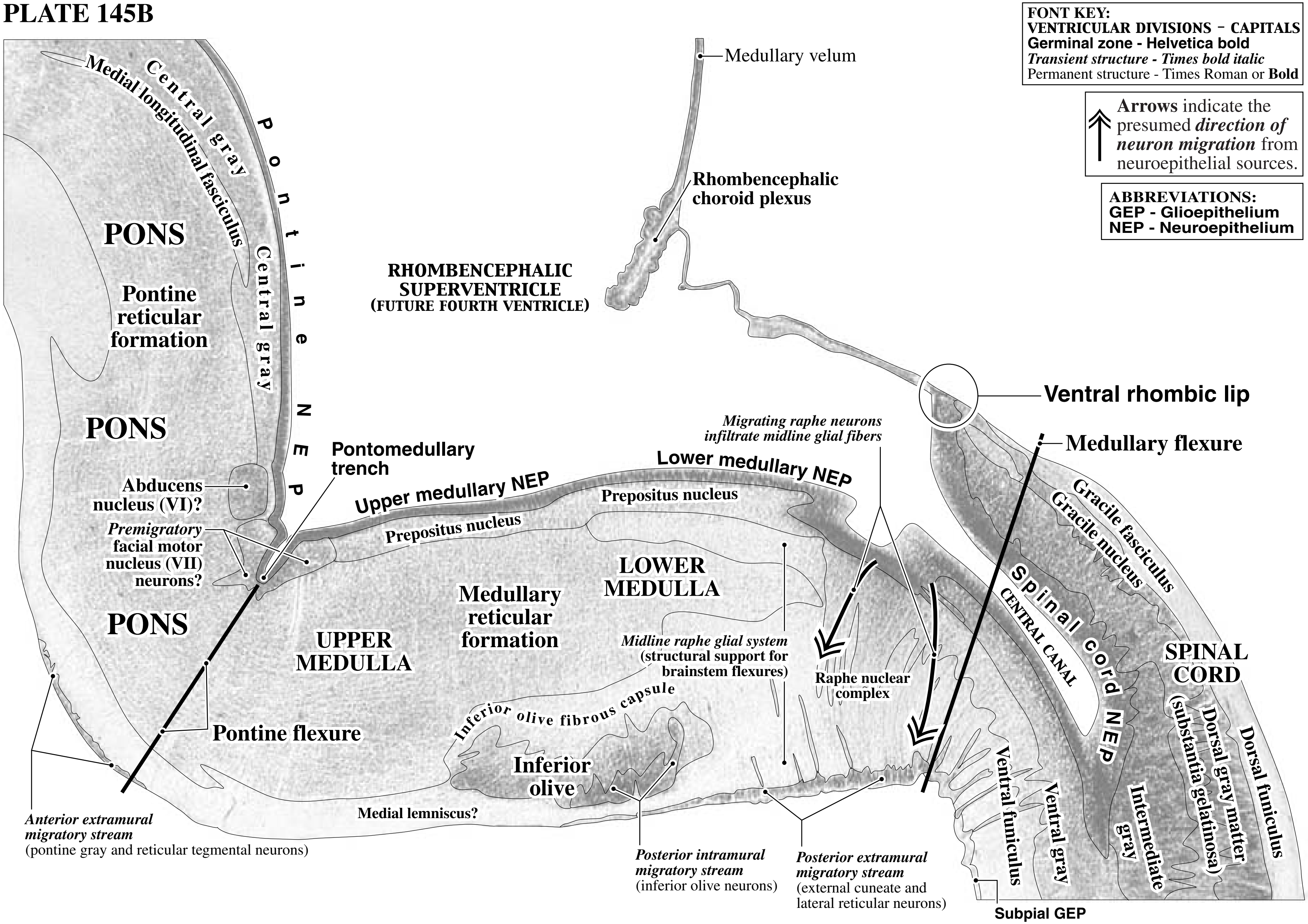
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
MIDBRAIN TEGMENTUM?
Medial longitudinal fasciculus
Central gray
Pontine NEP
Mesencephalic (tegmental) NEP?
Medullary velum
Rhombencephalic choroid plexus
RHOMBENCEPHALIC SUPERVENTRICLE (FUTURE FOURTH VENTRICLE)
PONS
Pontine reticular formation
PONS
Abducens nucleus (VI)?
Premigratory facial motor nucleus (VII) neurons?
Pontomedullary trench
Upper medullary NEP
Medial longitudinal fasciculus
Lower medullary NEP
Prepositus nucleus
Ventral rhombic lip
LOWER MEDULLA
Gracile/cuneate fasciculus
Gracile/Cuneate nucleus
Medullary flexure
Migrating raphe neurons infiltrate midline glial fibers
Midline raphe glial system (structural support for brainstem flexures)
UPPER MEDULLA
Medullary reticular formation
Pontine flexure
Raphe nuclear complex
Inferior olive fibrous capsule
Inferior olive
Medial lemniscus?
Subpial GEP
Anterior extramural migratory stream (pontine gray and reticular tegmental neurons)
Subpial GEP
Posterior extramural migratory stream (external cuneate and lateral reticular neurons)
Posterior intramural migratory stream (inferior olive neurons)
SPINAL CORD
Dorsal funiculus
Dorsal gray matter (substantia gelatinosa)
Intermediate gray
Ventral gray
Ventral funiculus

PLATE 145A **GW8 Sagittal**
CR 33 mm, C145
Level 3: Slide 20, Section 2 **BRAINSTEM**



See the entire section in Plates 124A-D.

PLATE 145B


FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
Medullary velum
Rhombencephalic choroid plexus
RHOMBENCEPHALIC SUPERVENTRICLE
(FUTURE FOURTH VENTRICLE)
Ventral rhombic lip
Medullary flexure
Central gray
Medial longitudinal fasciculus
Pontine NEP
PONS
Pontine reticular formation
Central gray
PONS
Pontomedullary trench
Abducens nucleus (VI)?
Premigratory facial motor nucleus (VII) neurons?
Upper medullary NEP
Lower medullary NEP
Migrating raphe neurons infiltrate midline glial fibers
Prepositus nucleus
Prepositus nucleus
LOWER MEDULLA
Medullary reticular formation
UPPER MEDULLA
PONS
Midline raphe glial system (structural support for brainstem flexures)
Raphe nuclear complex
Gracile fasciculus
Gracile nucleus
Spinal cord NEP
CENTRAL CANAL
SPINAL CORD
Inferior olive fibrous capsule
Pontine flexure
Inferior olive
Medial lemniscus?
Anterior extramural migratory stream
(pontine gray and reticular tegmental neurons)
Posterior intramural migratory stream
(inferior olive neurons)
Posterior extramural migratory stream
(external cuneate and lateral reticular neurons)
Ventral funiculus
Ventral gray
Intermediate gray
Dorsal gray matter (substantia gelatinosa)
Dorsal funiculus
Subpial GEP

GW8 Sagittal
CR 33 mm, C145
Similar to Levels 8, 9, and 10:
Slide 27, Section 3

See similar areas from the left side of the brain in Plates 129A-D to 132A-D.

PLATE 146B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

Neuroepithelium - NEP

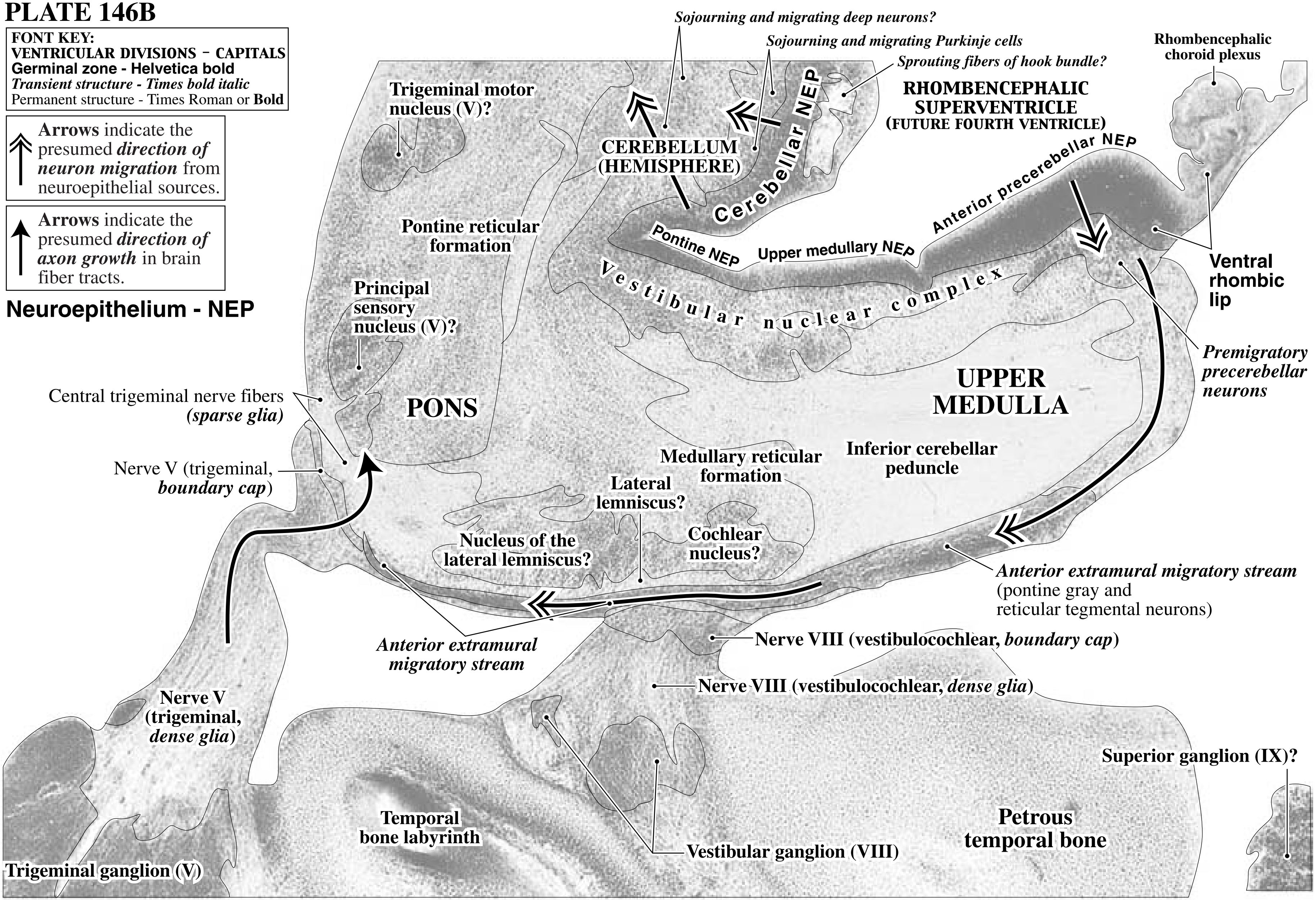
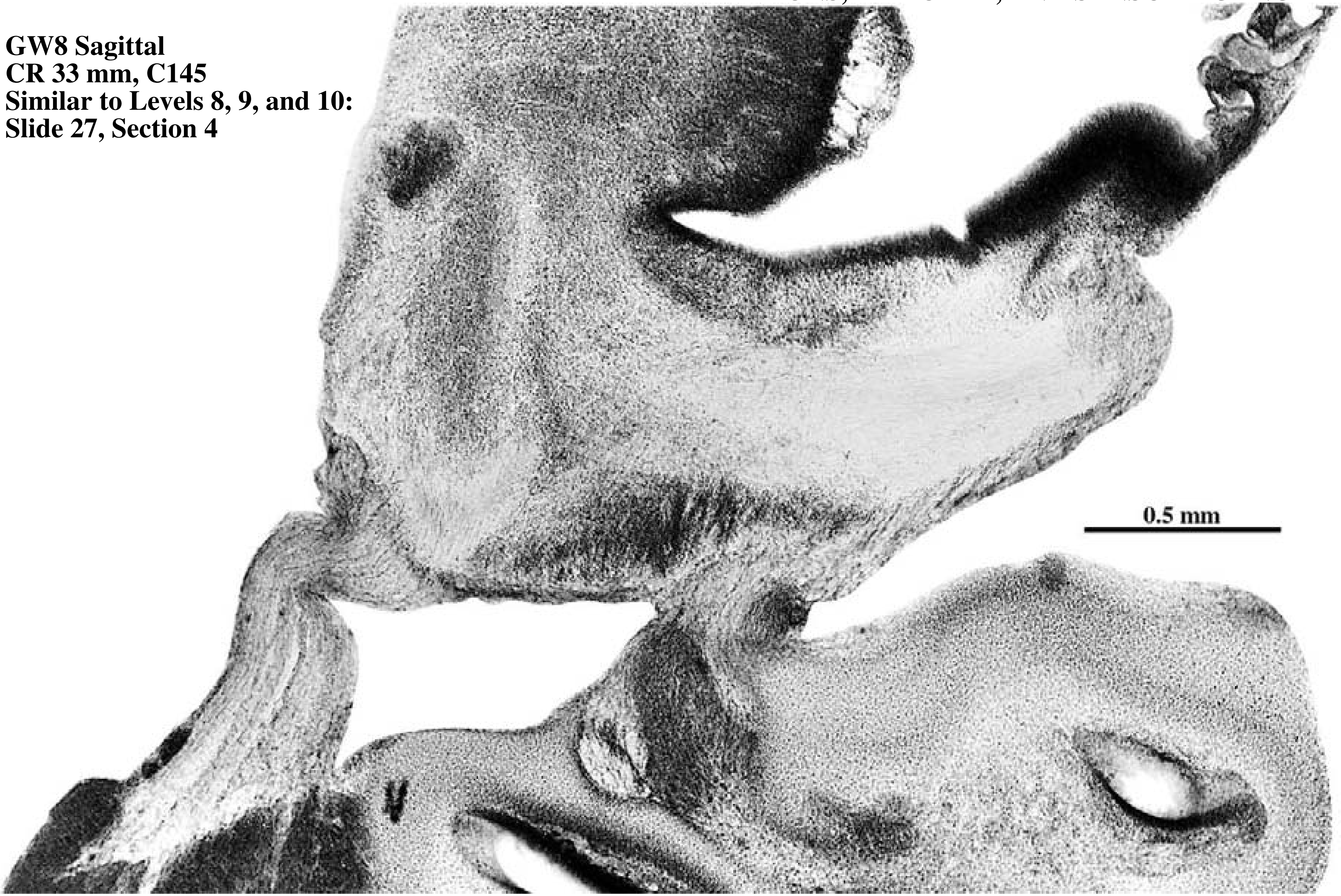


PLATE 147A

LATERAL PONS, MEDULLA, AND SENSORY GANGLIA

GW8 Sagittal
CR 33 mm, C145
Similar to Levels 8, 9, and 10:
Slide 27, Section 4



See similar areas from the left side of the brain in Plates 129A-D to 132A-D.

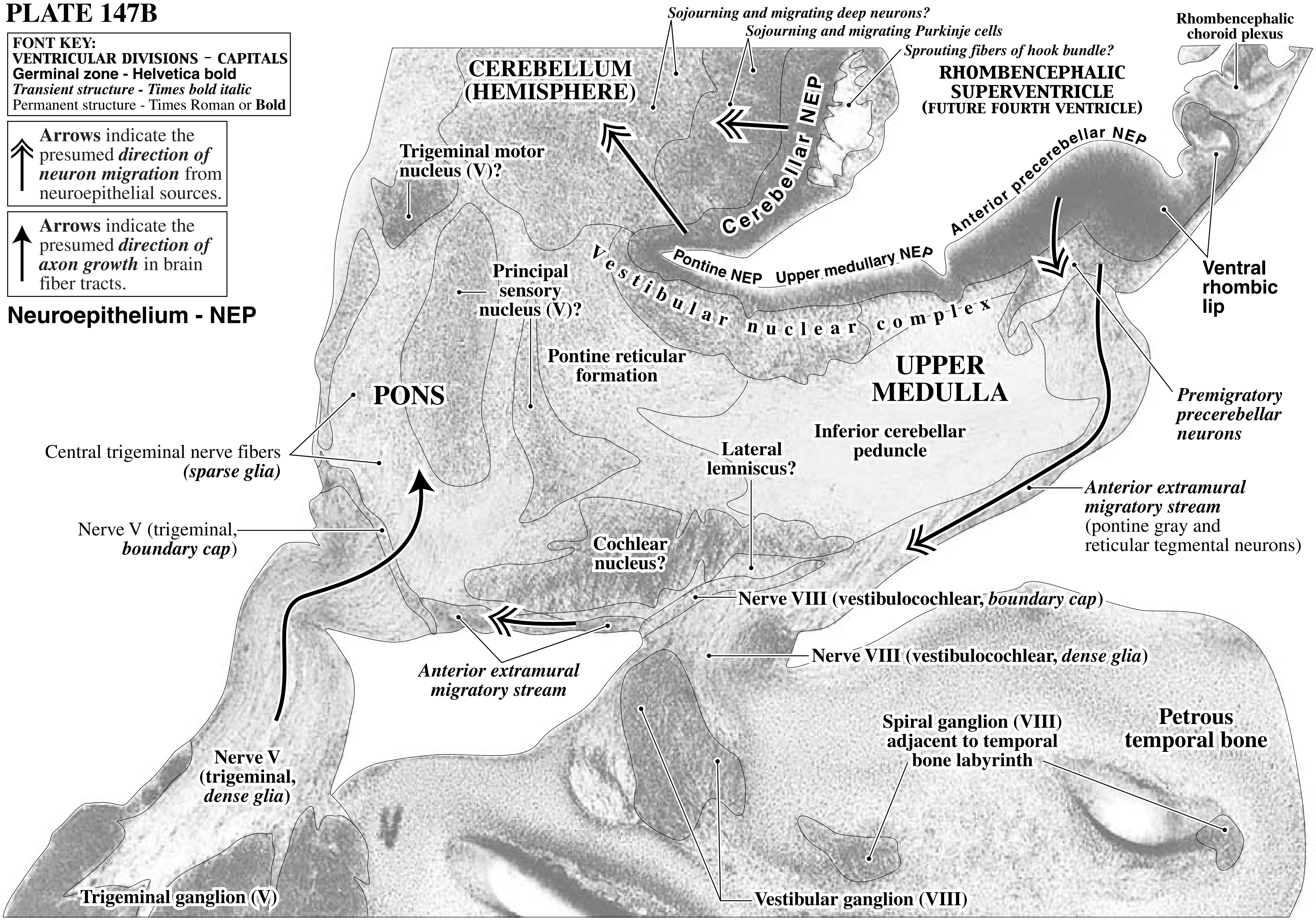
PLATE 147B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

Arrows indicate the presumed ***direction of axon growth*** in brain fiber tracts.

Neuroepithelium - NEP



PART VIII: GW8 CORONAL

This is specimen number 9226 in the Carnegie Collection, designated here as C9226. A normal male fetus with a crown-rump length (CR) of 31 mm was collected in 1954, and is estimated to be in gestational week (GW) 8. The entire fetus was embedded in paraffin mixed with 8% celloidin, cut transversely in 10 µm thick sections, and stained with azan. The histology of this specimen is remarkable, and the sections are nearly perfectly bilateral. Since there is no photograph of this brain before it was embedded and cut, a specimen from Hochstetter (1919) that is only partially comparable to C9226 has been modified to show the approximate section plane and external features of the brain at GW8 (**Figure 7**). Like most of the specimens in this Volume, the sections are not cut exactly in one plane; C9226's cortex is cut midway between coronal and horizontal planes. Since the cerebral cortex is in every section and the brainstem is cut in a more horizontal orientation, the brain more closely resembles a coronally sectioned brain. Unfortunately, the Hochstetter specimen is less mature (CR27 mm) and we could not find a drawing of a brain specimen that would fit C9226. The C9226 sections through the cortex and brainstem are not in the same plane when transferred to Hochstetter's CR27 mm specimen. Instead, brainstem planes of section appear to fan upward and downward from sections in the cortex. We interpret this to indicate that the brain flexures are more loosely folded in the Hochstetter specimen than in C9226. If one "squeezes" the brainstem to make the folds tighter, the cortex and brainstem planes would line up. Photographs of 23 sections (**Levels 1-23**) are illustrated at low magnification in **Plates 148-167**. High-magnification views of different areas of the cerebral cortex are shown in **Plates 168-169**.

C9226 is similar to the other GW8 specimens and shows brain maturation in a different perspective. Each of the brain's major subdivisions has a large ***superventricle*** in the cores, especially the telencephalon and the rhombencephalon. Midline sagittal sections have large diencephalic and mesencephalic superventricles because the cuts are parallel to their dorsoventral and anteroposterior axes (*see* C145 in **Part VII**). C9226's coronal sections show the slit-like shapes of the diencephalic and mesencephalic superventricles in the midline.

The parenchyma, the area between the superficial border of the ***neuroepithelium (NEP) / subventricular zone (SVZ)*** and the pial membrane, is the region where neurons migrate, settle, and differentiate. The thicknesses of the neuroepithelium and the parenchyma are clues to the level of maturation of a developing brain structure.

The parenchyma is thick and bordered by a thin NEP in the medulla, pons, and midbrain tegmentum, indicating that most neurons have been generated in these structures. Furthermore, the lack of dense accumulations of cells just outside the NEP in the midbrain tegmentum, pons, and medulla indicate that very few neurons are being generated, few are migrating, and most are settled and differentiating. There are two exceptions in the medulla and pons. First, near the pontomedullary trench, presumptive facial motor neurons are migrating toward their ventral pontine/medullary settling sites. Second, the ***precerebellar neuroepithelium*** in the medulla is thicker and generating pontine gray (and possibly other neurons); many precerebellar neurons are migrating in the ***anterior and posterior extramural migratory streams***. The cerebellar NEP is thicker than that in the pons and medulla. The cerebellar parenchyma contains a very dense Purkinje cell sojourn zone outside the NEP and presumptive earlier-generated deep neurons lie in a superficial position. Like C145, the ***external germinal layer (egl)*** is barely visible emanating from the germinal trigone in the dorsal rhombic lip. The mesencephalic tectal NEP is thicker than the tegmental NEP and its very thin parenchyma contains dense sojourning and migrating tectal neurons adjacent to the NEP. The tectum is one of the most immature brain structures.

The diencephalic NEP is thicker indicating that many neurons are still being generated even though there is also a thick parenchyma, especially in the thalamus. That is because the thalamus is very large in the mature human brain. There are dense accumulations of young neurons in sojourn zones outside the hypothalamic and thalamic NEPs, indicating that cell migration is more active than final settling and differentiation.

Within the telencephalon, the cerebral cortex has a thick NEP and a very thin parenchyma, indicating that it is the most immature brain structure. The cerebral cortical NEP is the sole germinal matrix. The ***stratified transitional field (STF)*** contains ***STF1*** and ***STF5*** only in lateral areas. The pronounced anterolateral (thicker) to dorsomedial (thinner) maturation gradient is evident in both the ***cortical plate*** and the ***STF*** layers. In contrast, both the basal telencephalic NEP/SVZ and parenchyma are thick. That is because the basal telencephalon contains many early-generated neuronal populations (for example, globus pallidus and substantia innominata) and massive late-generated populations (striatal neurons in the caudate and putamen). Most of the neurons settling in the basal telencephalon at GW8 are those of the early-generated populations.

GW8 "CORONAL" SECTION PLANES

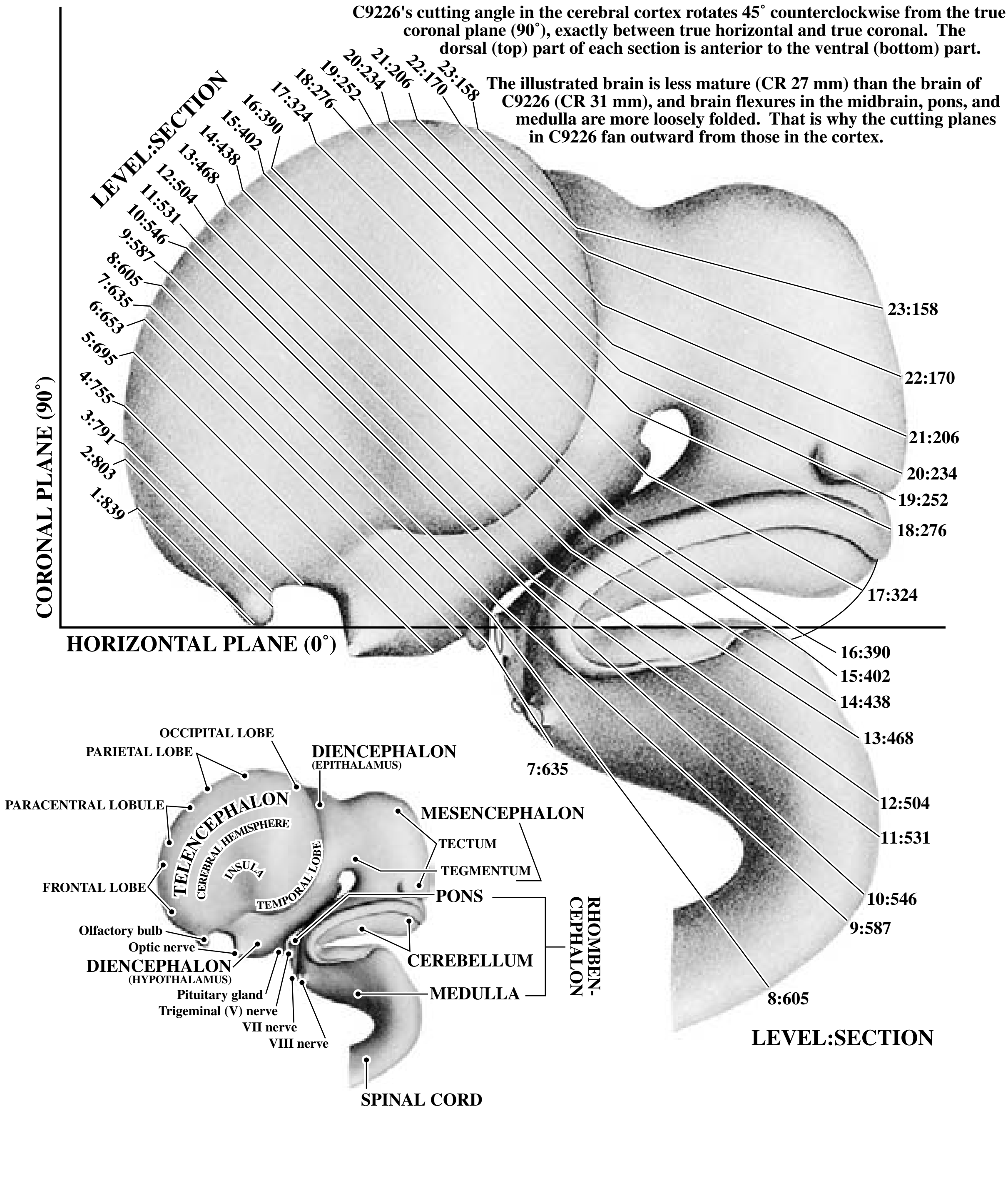
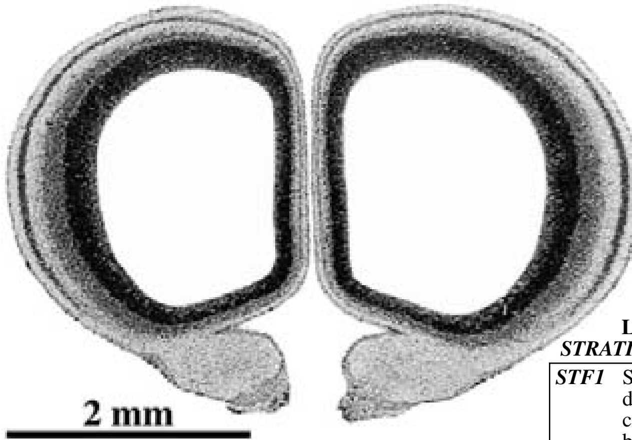


Figure 7. The lateral view of the brain and upper cervical spinal cord from a specimen with a crown-rump length of 27 mm (modified from Figure 37, Table VII, Hochstetter, 1919) serves to show the approximate locations and cutting angles of the illustrated sections of C9226 in the following pages. The small inset identifies the major structural features. The line in the cerebellum and dorsal edges of the pons and medulla is the cut edge of the medullary velum.

PLATE 148A

GW8 Coronal
CR 31 mm
C9226

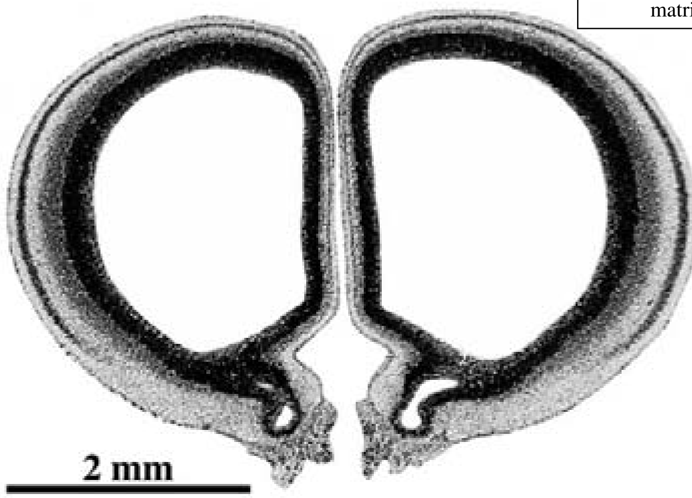
Level 1: Section 820



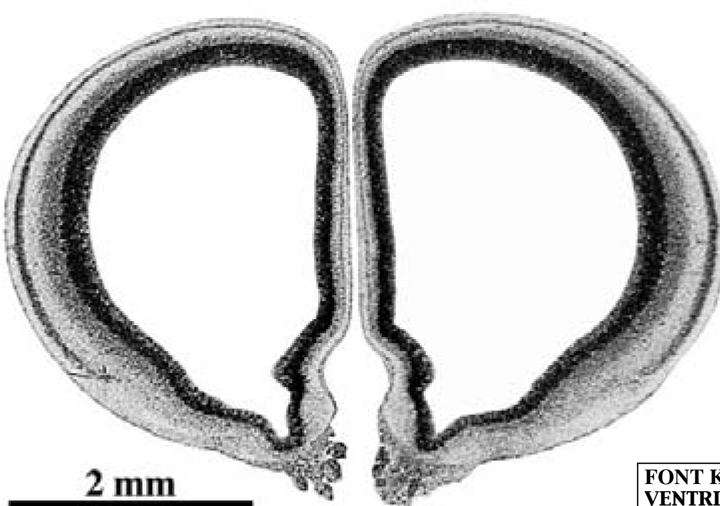
LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

Level 2: Section 803



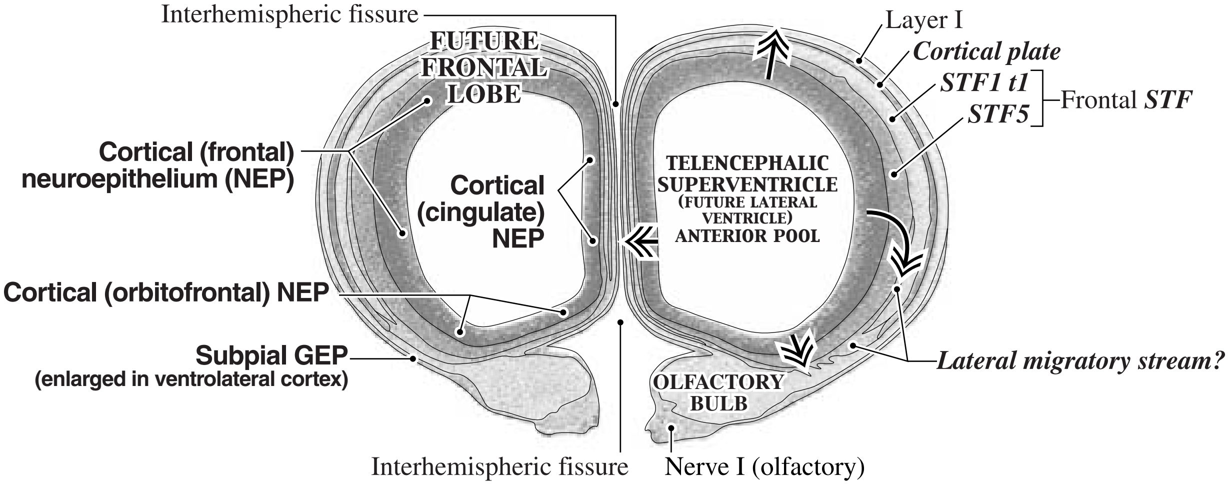
Level 3: Section 791



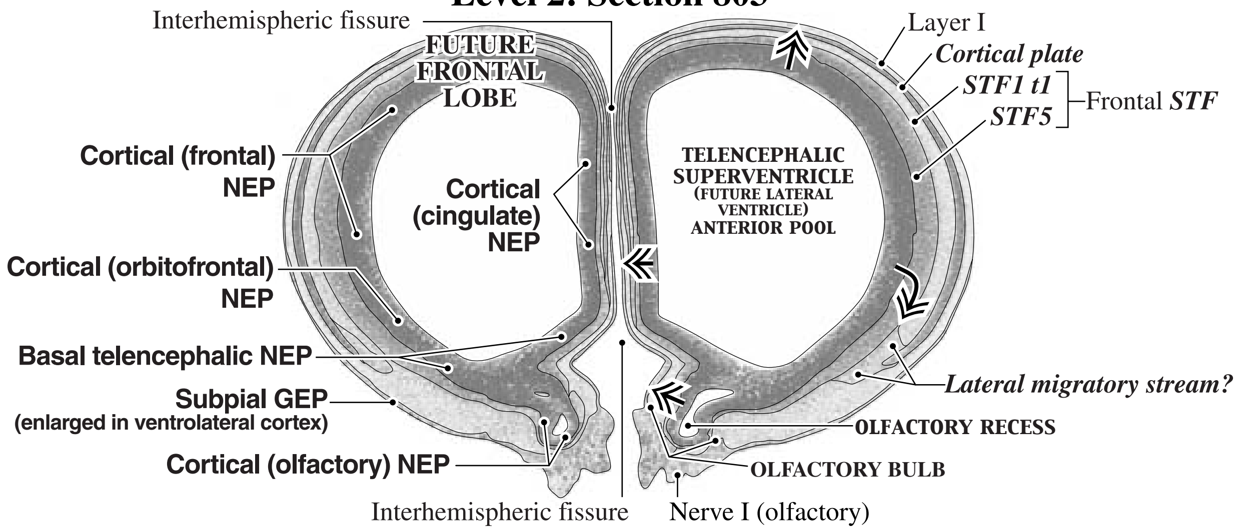
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 148B

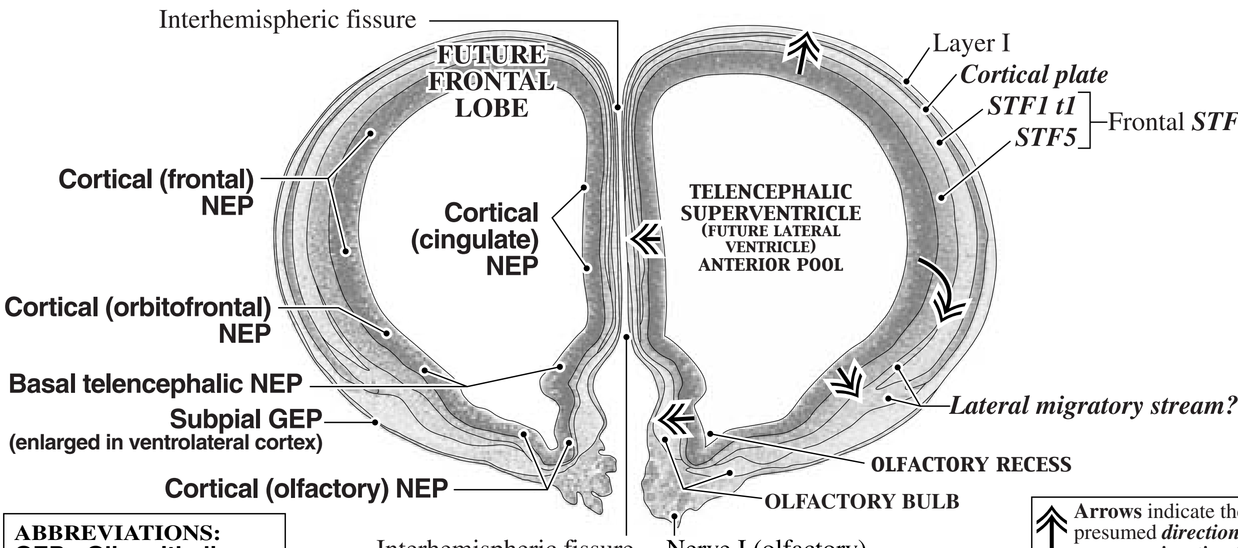
Level 1: Section 820



Level 2: Section 803



Level 3: Section 791



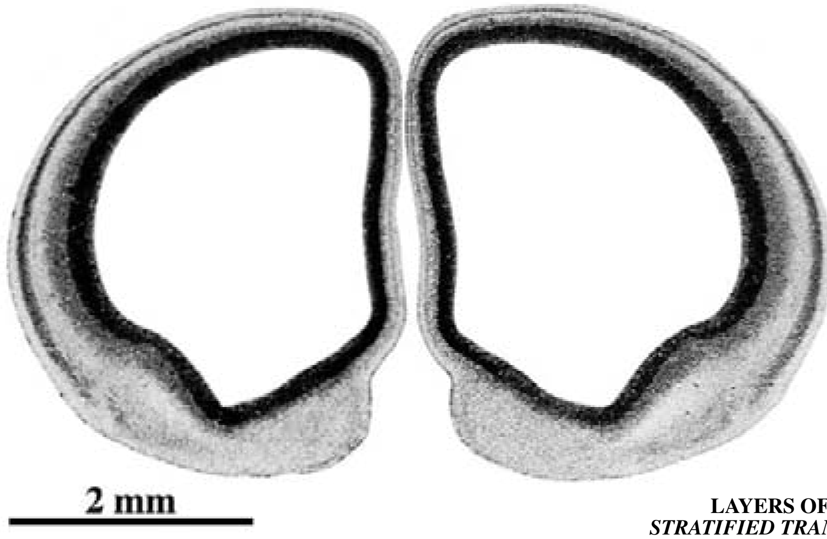
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 149A

GW8 Coronal
CR 31 mm
C9226

Level 4: Section 755

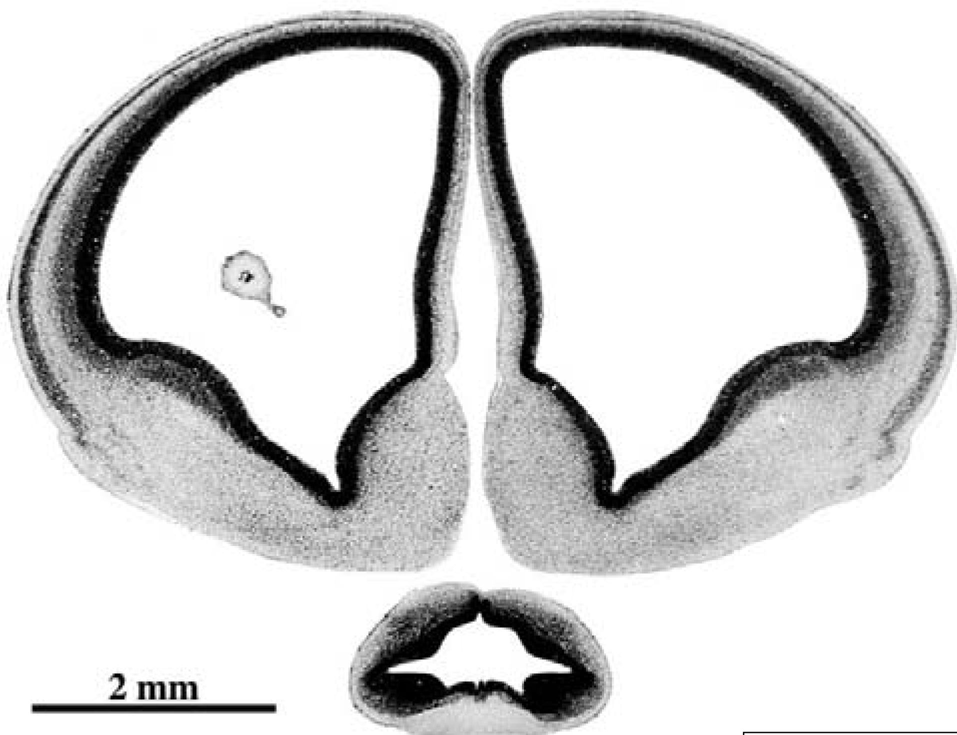


LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1 Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.

STF5 Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

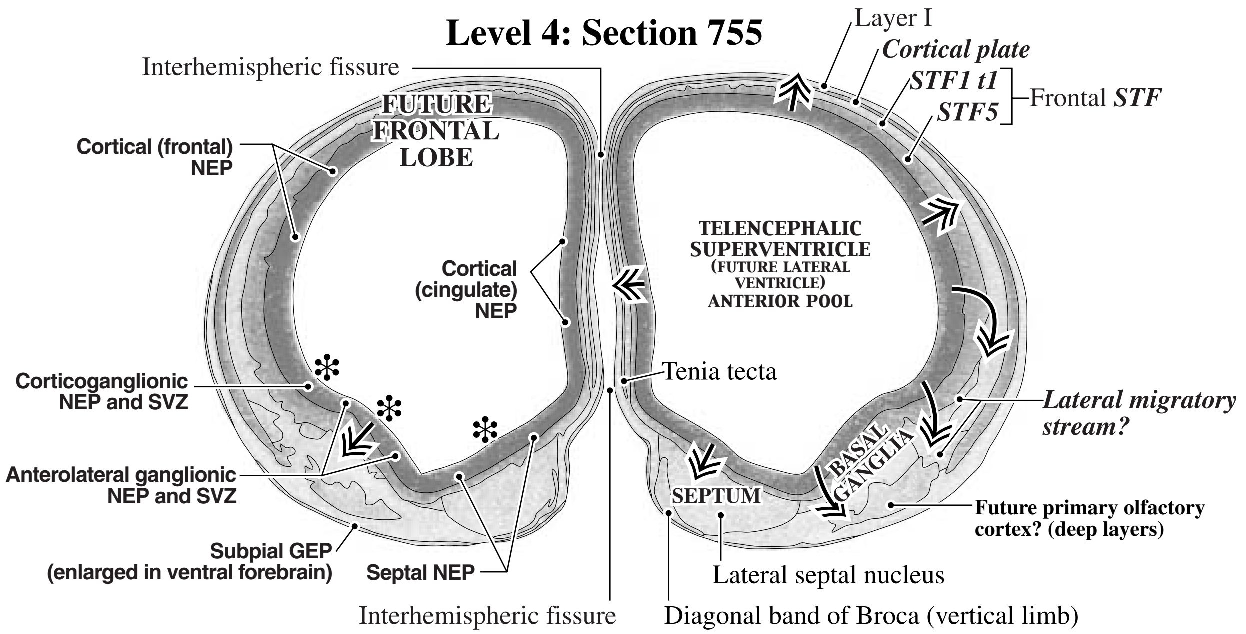
Level 5: Section 695



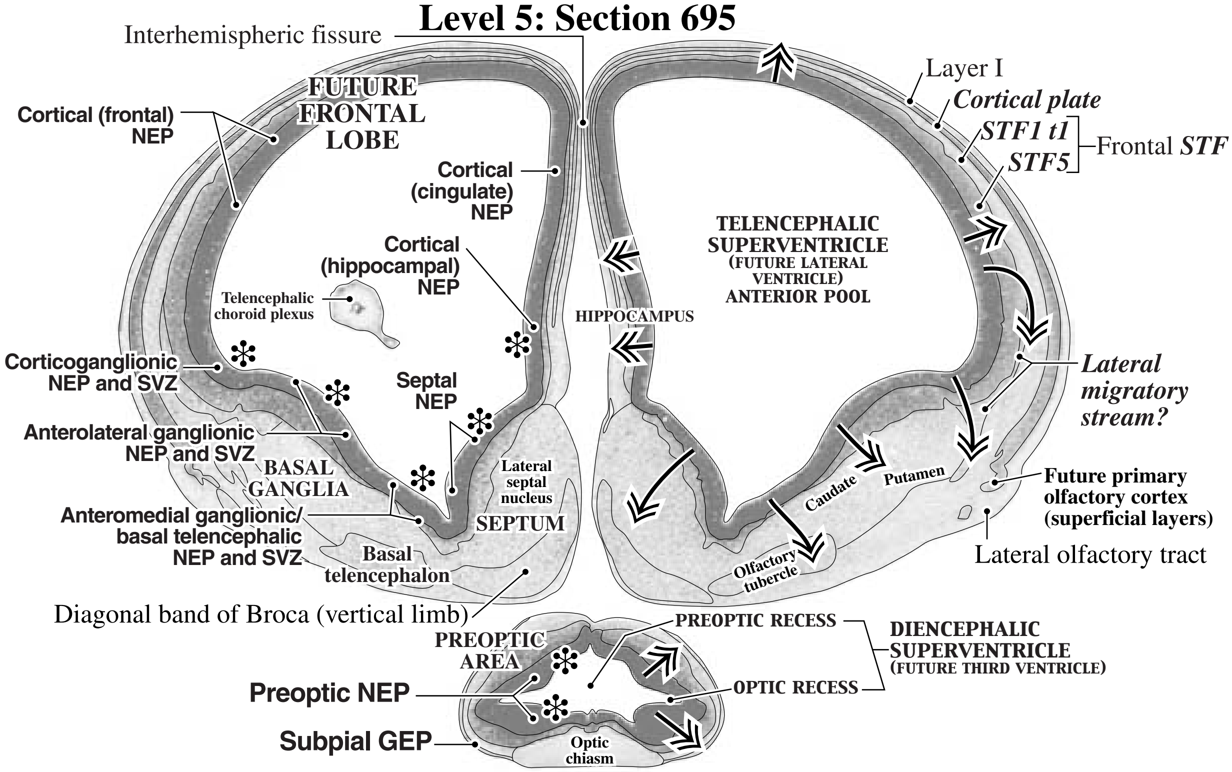
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 149B

Level 4: Section 755



Level 5: Section 695



❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

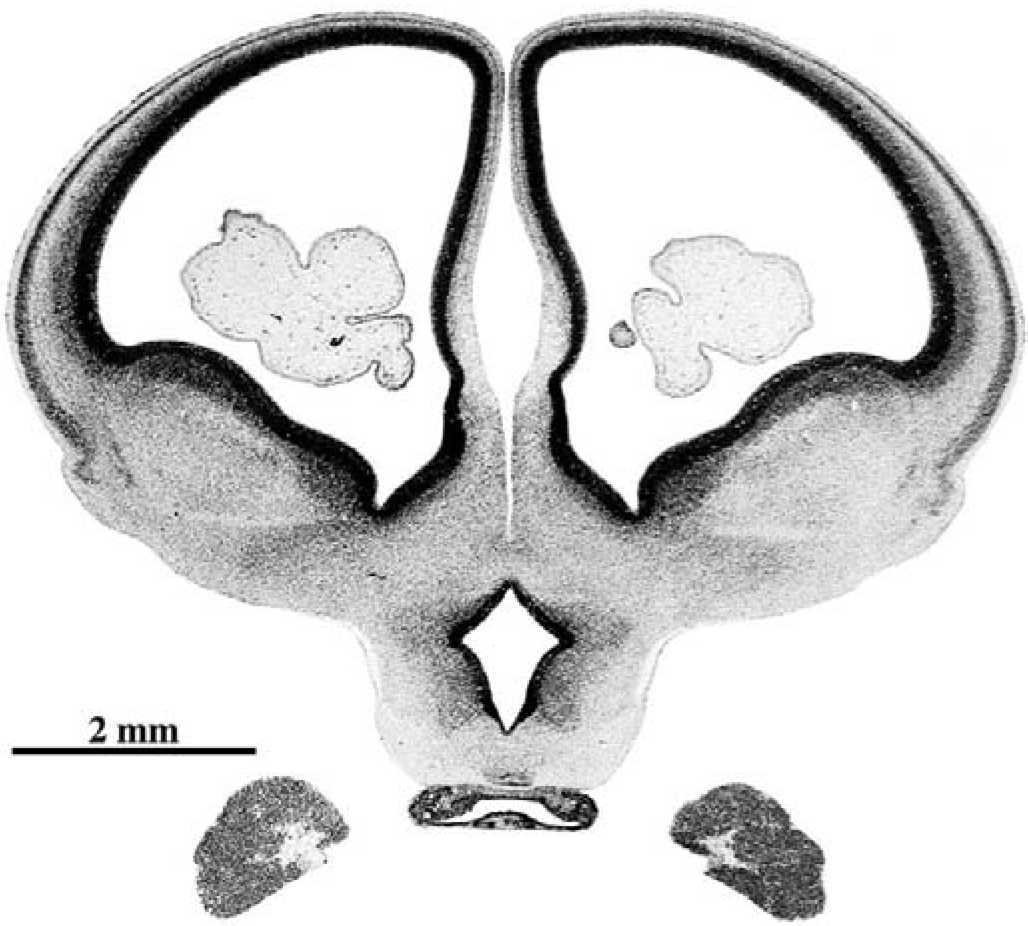
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 150A

GW8 Coronal
CR 31 mm
C9226
Level 6: Section 653

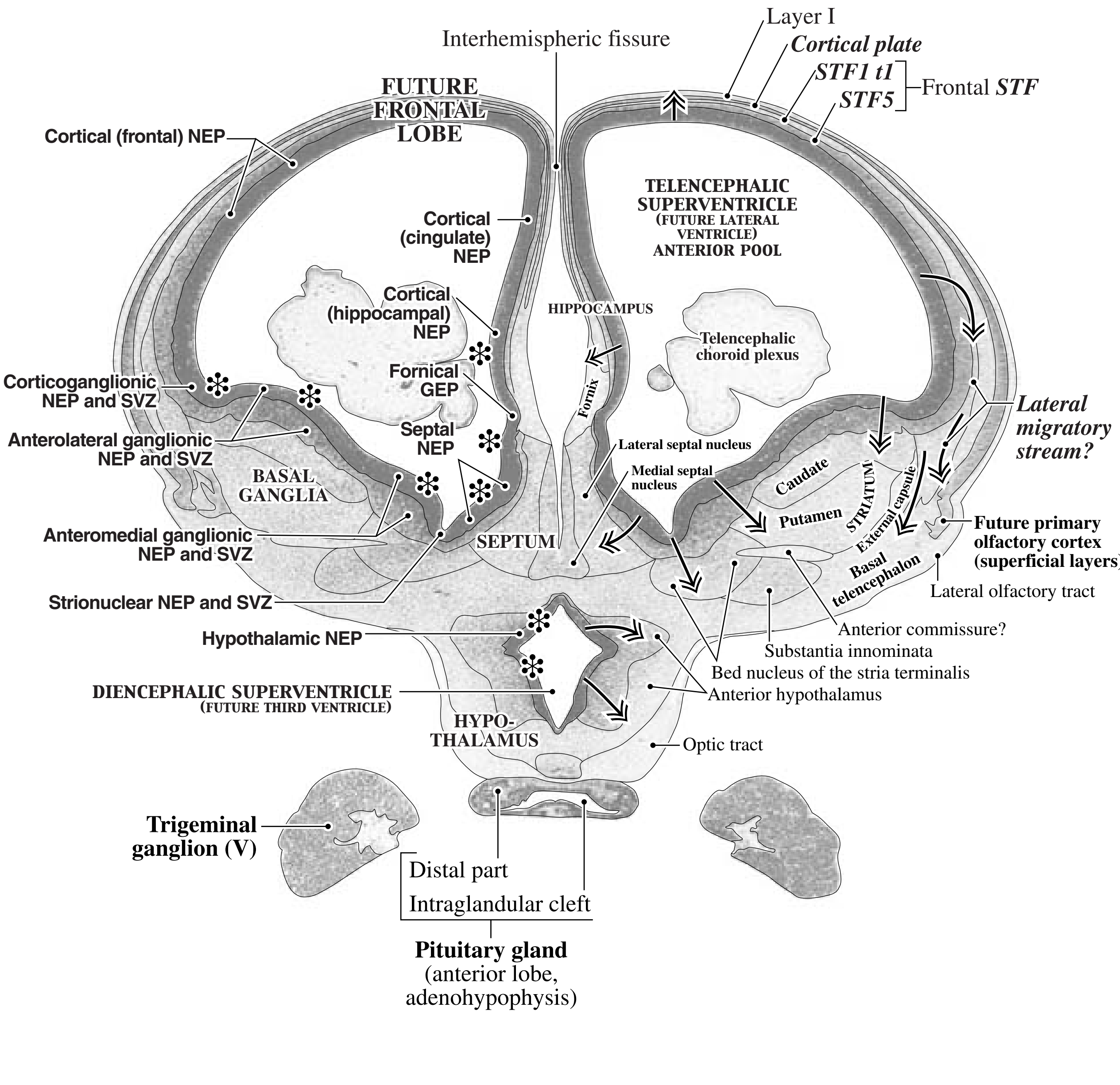
LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.



FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 150B



❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 151A

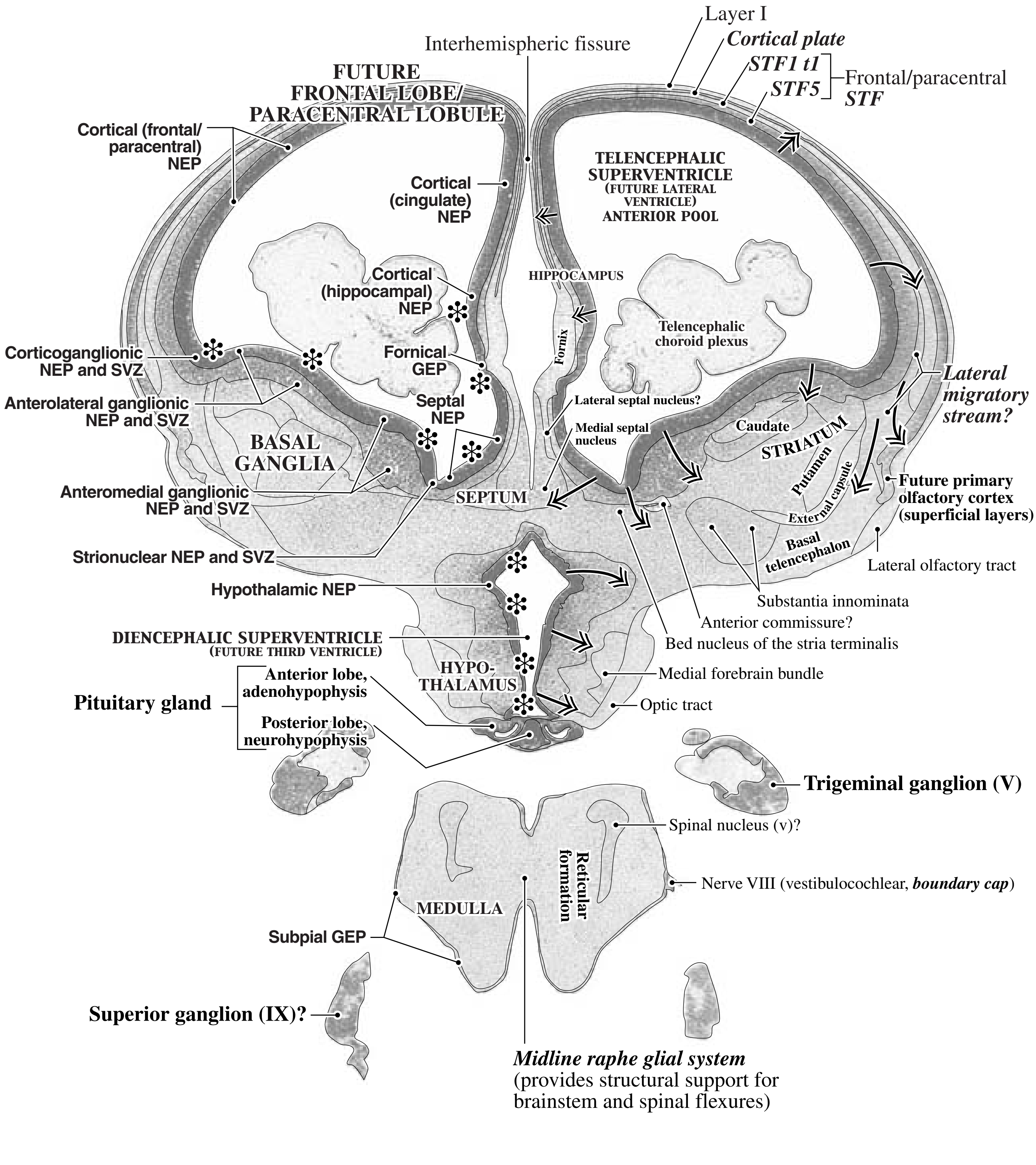
GW8 Coronal
CR 31 mm
C9226
Level 7: Section 635

LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 151B



✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 152A

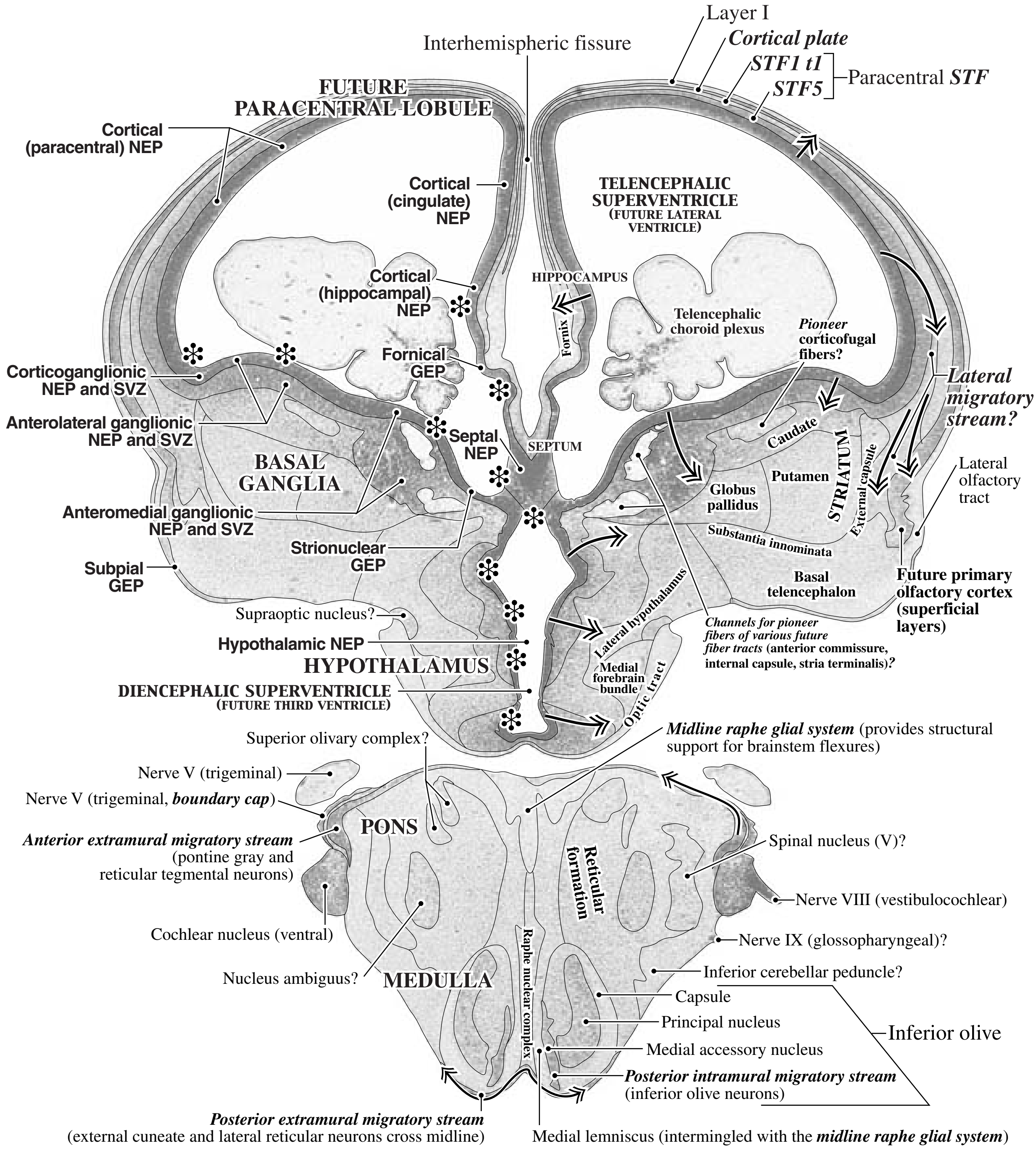
GW8 Coronal
CR 31 mm
C9226
Level 8: Section 605

LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 152B



❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

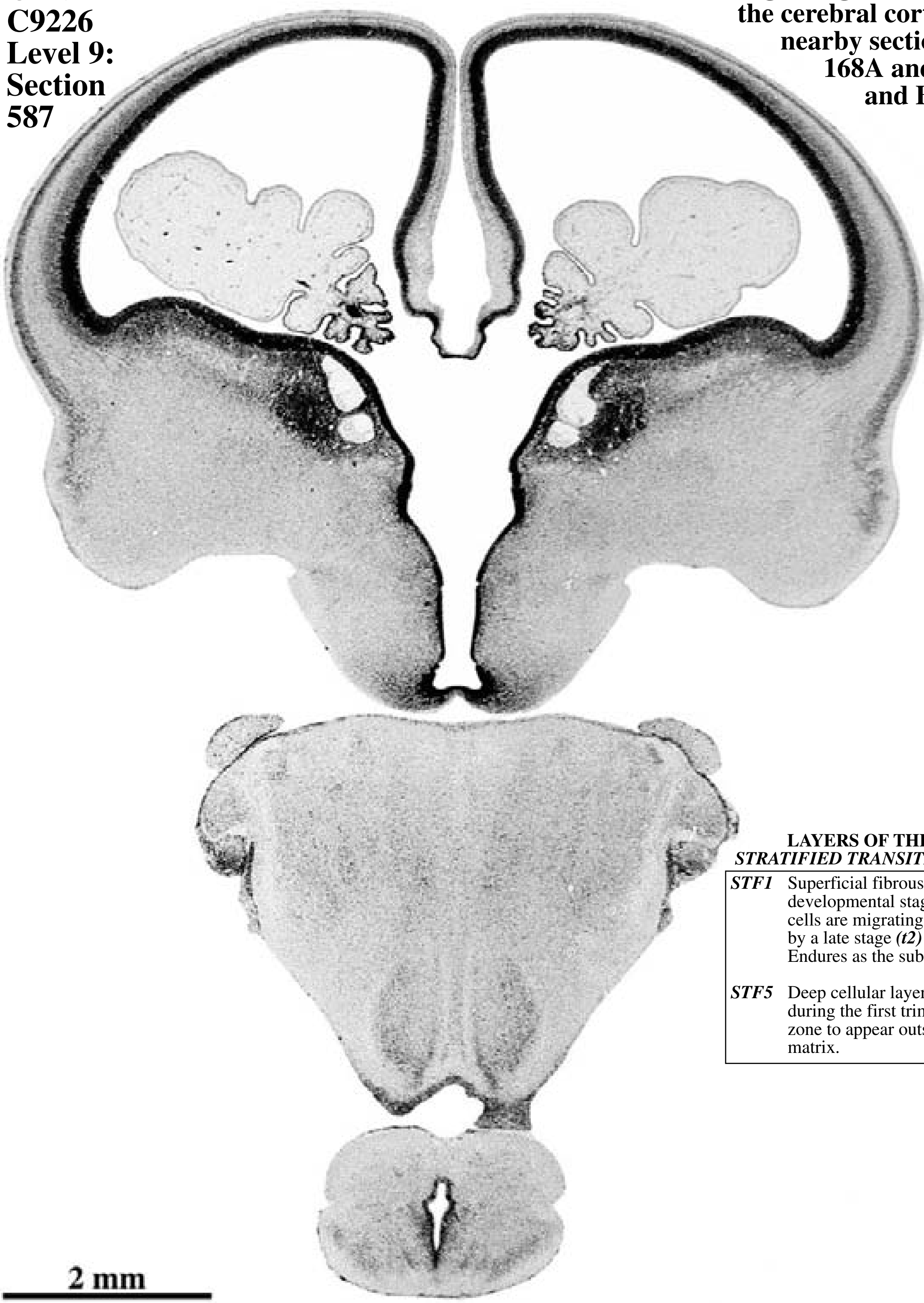
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 153A

GW8 Coronal
CR 31 mm
C9226
Level 9:
Section
587

See high-magnification views of the cerebral cortex from nearby sections in Plates 168A and B to 169A and B.

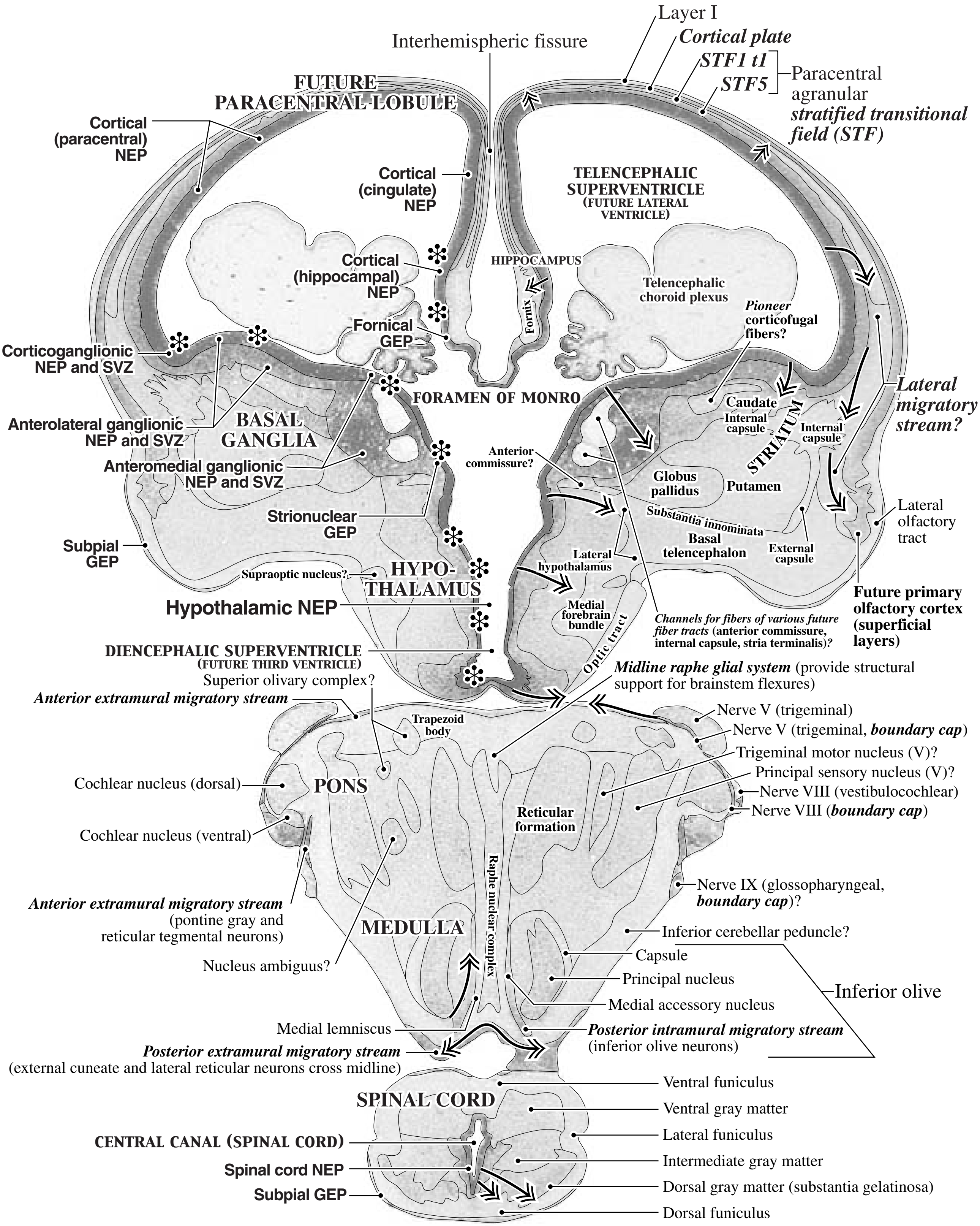


LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 153B



❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

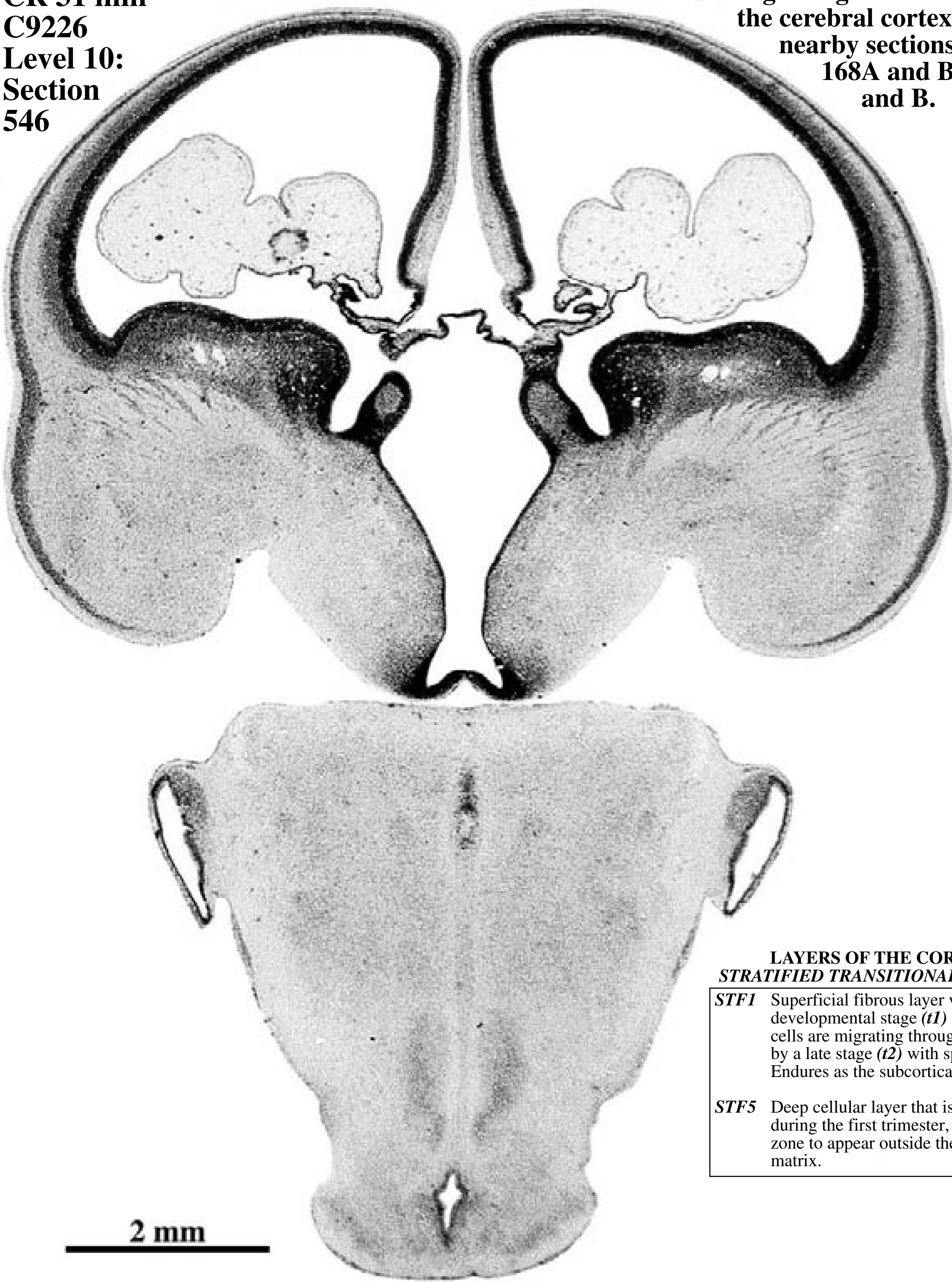
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 154A

GW8 Coronal
CR 31 mm
C9226
Level 10:
Section
546

See high-magnification views of the cerebral cortex from nearby sections in Plates 168A and B to 169A and B.

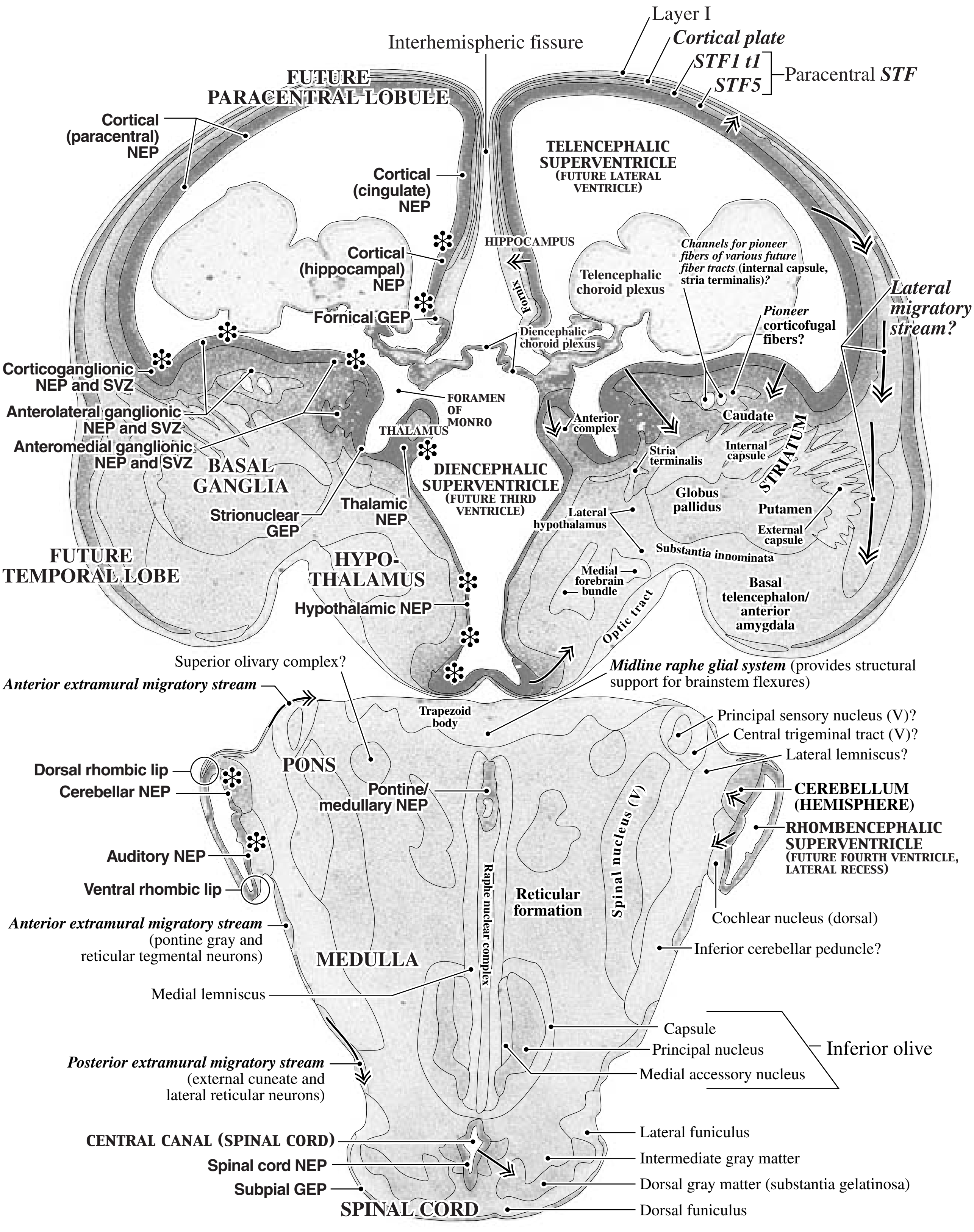


LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 154B



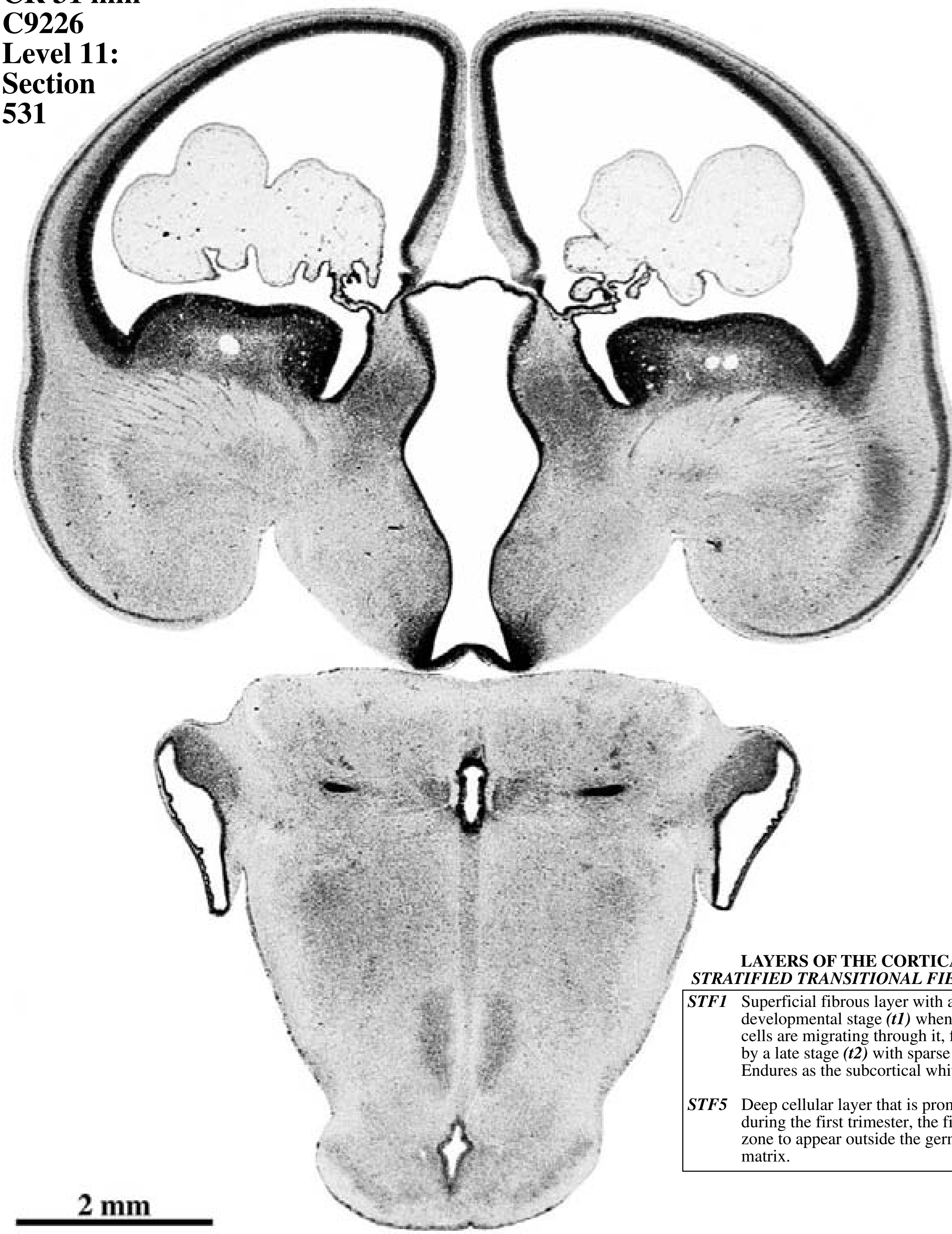
✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 155A

GW8 Coronal
CR 31 mm
C9226
Level 11:
Section
531



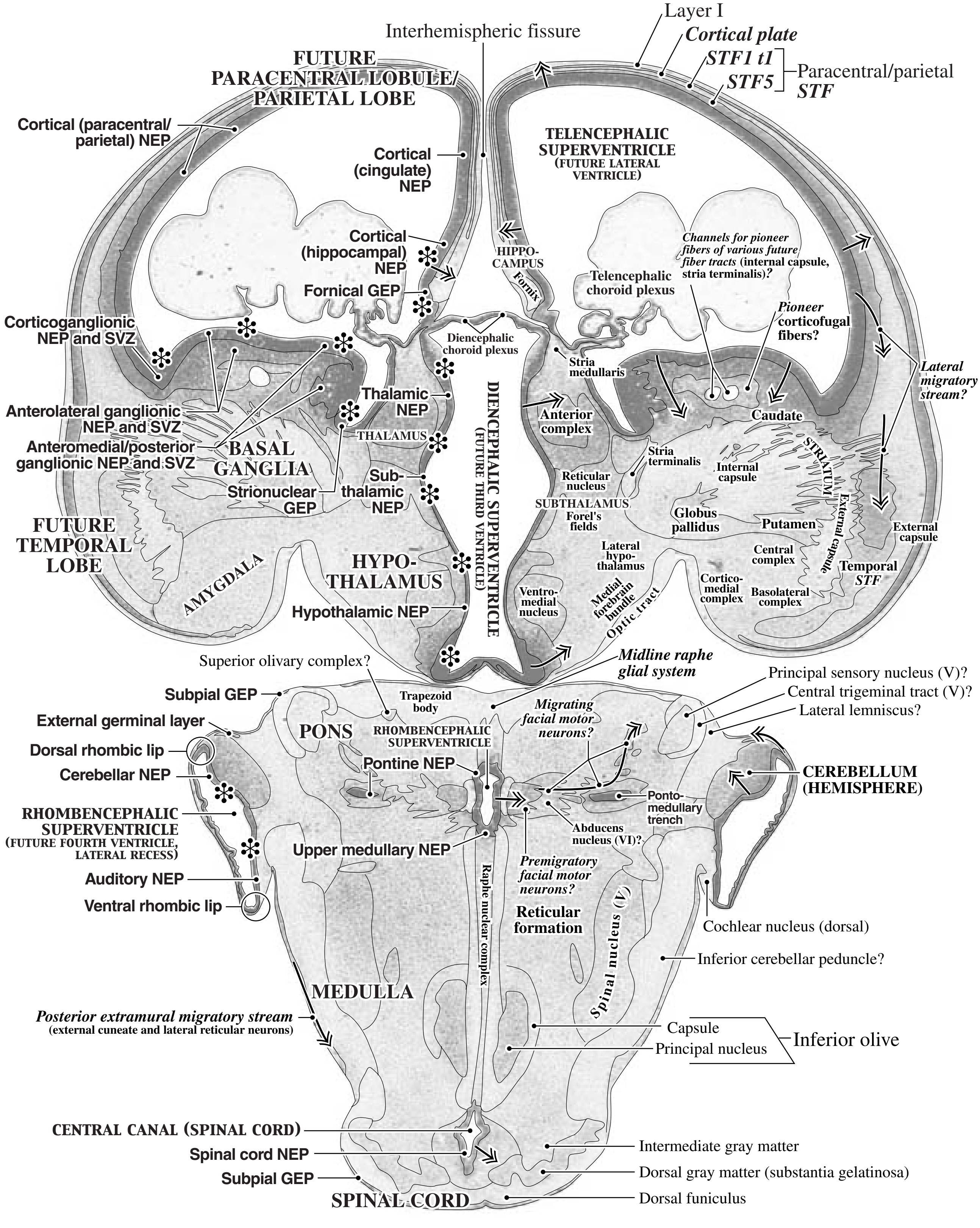
2 mm

LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 155B



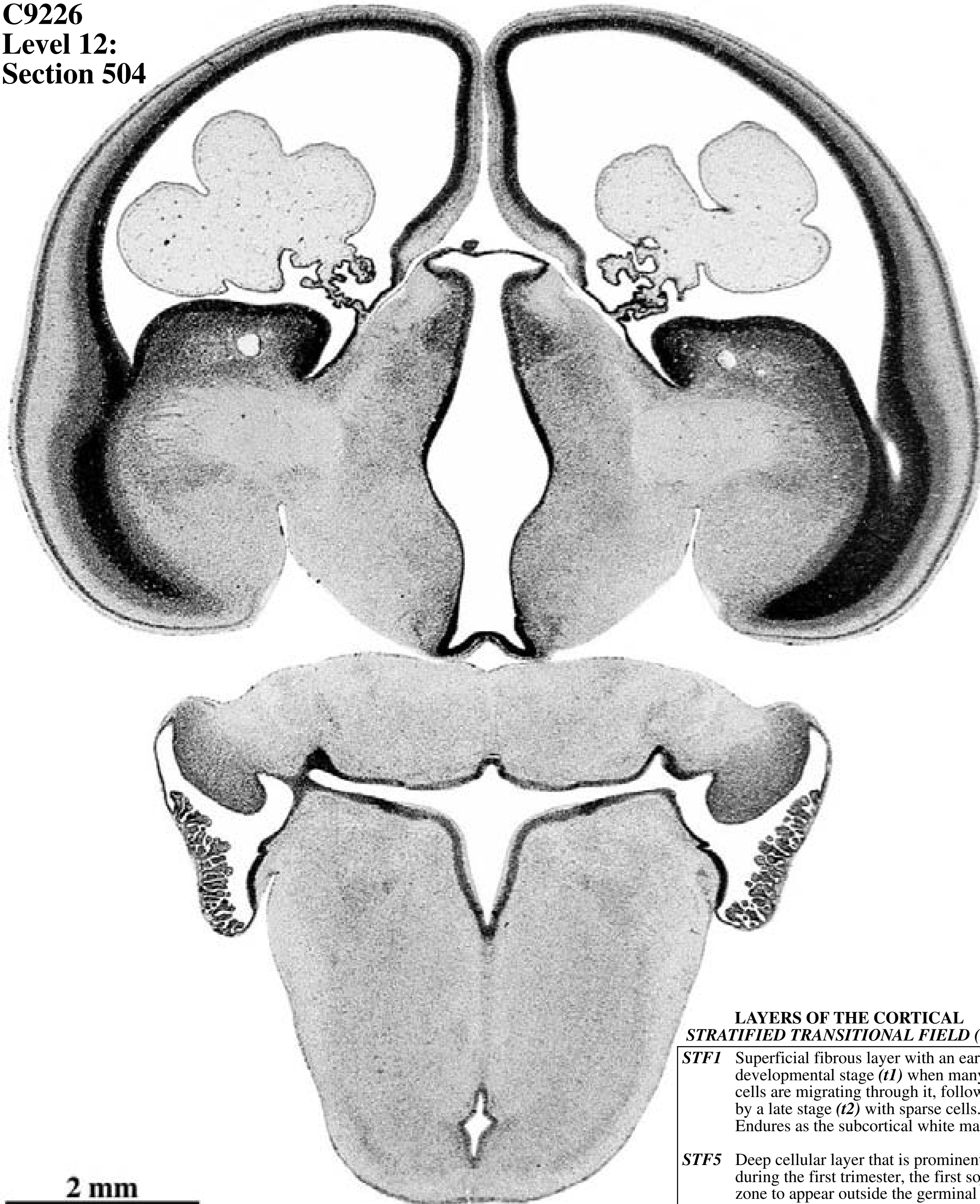
✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 156A

GW8 Coronal
CR 31 mm
C9226
Level 12:
Section 504



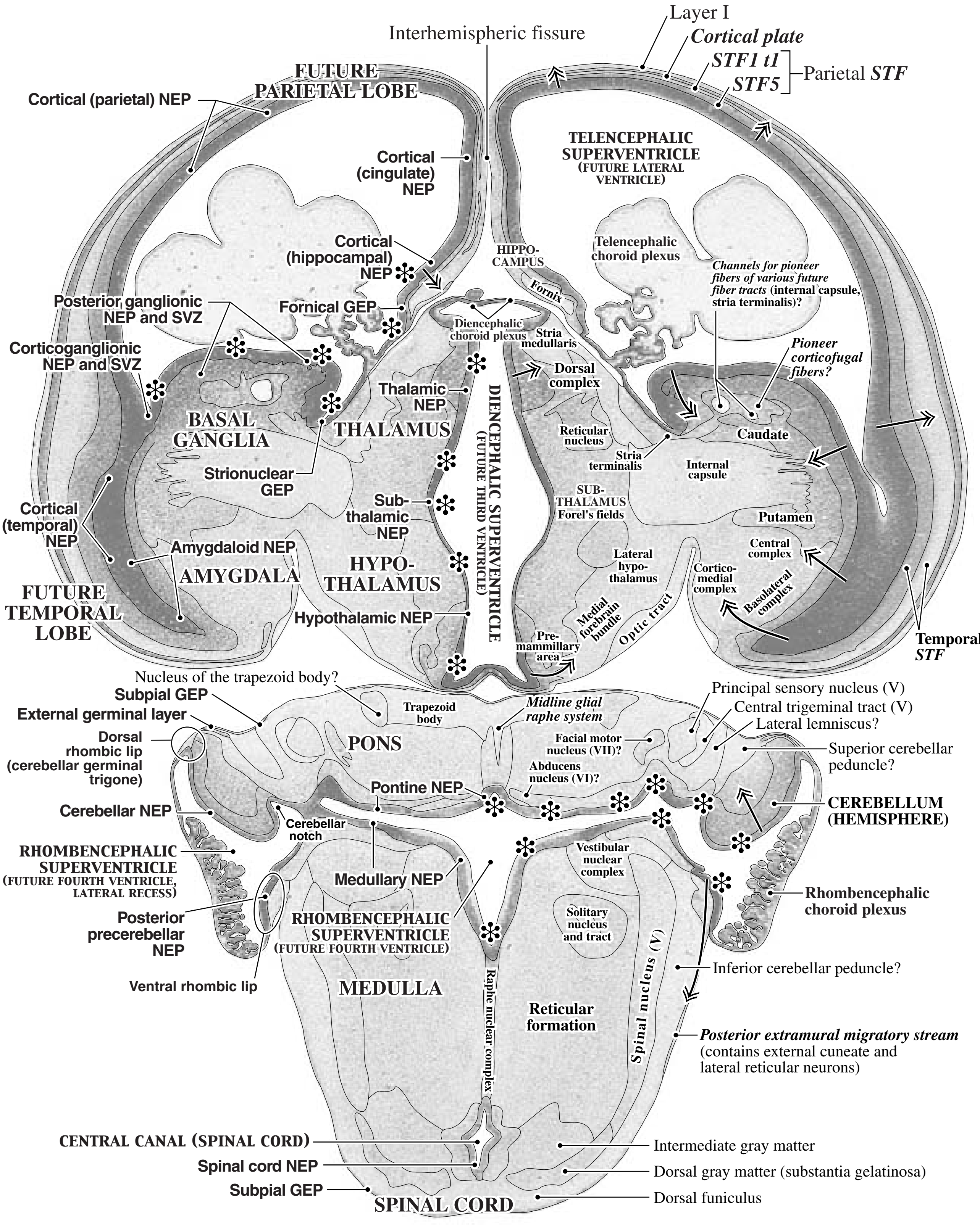
2 mm

LAYERS OF THE CORTICAL
STRATIFIED TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 156B



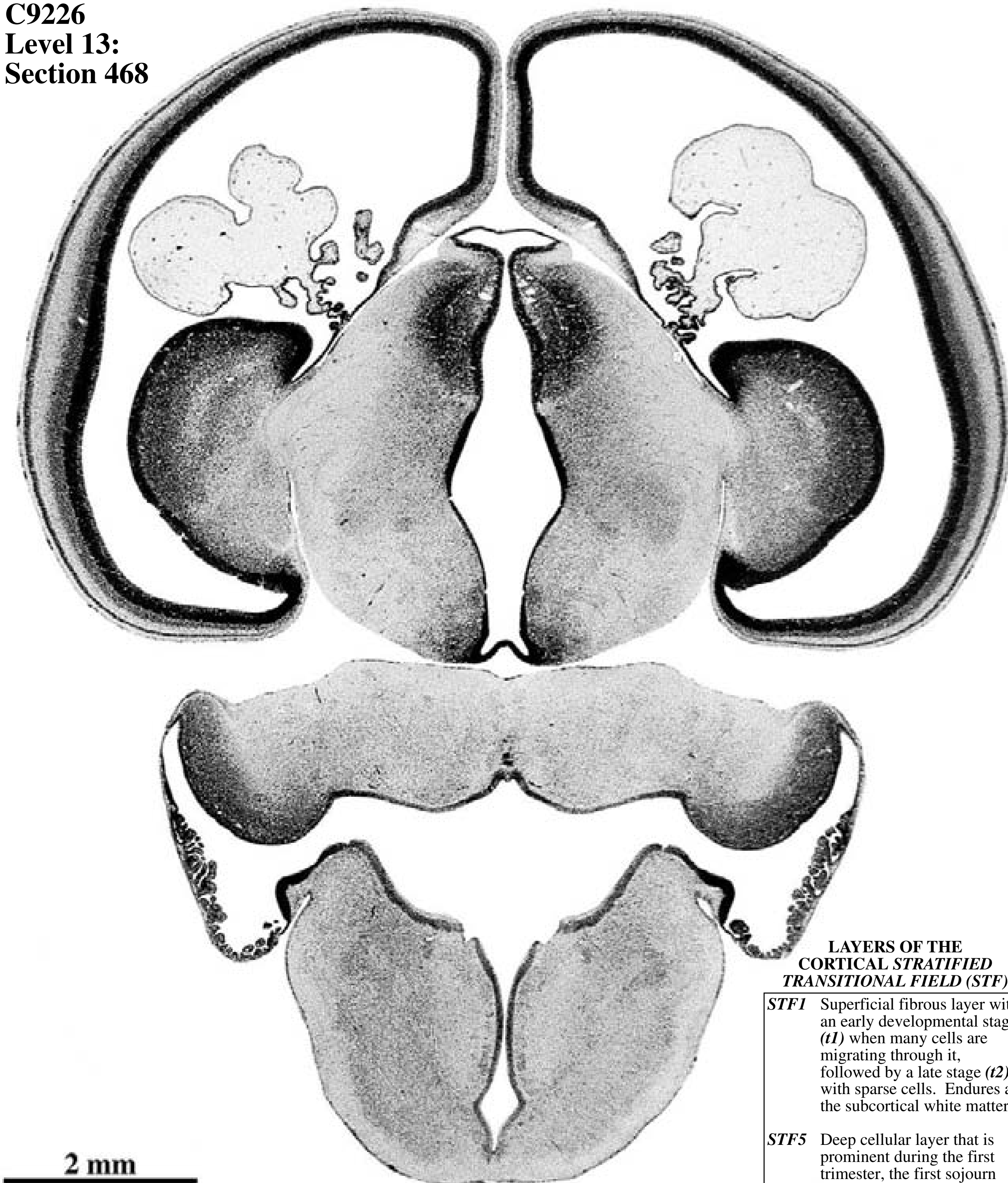
✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 157A

GW8 Coronal
CR 31 mm
C9226
Level 13:
Section 468



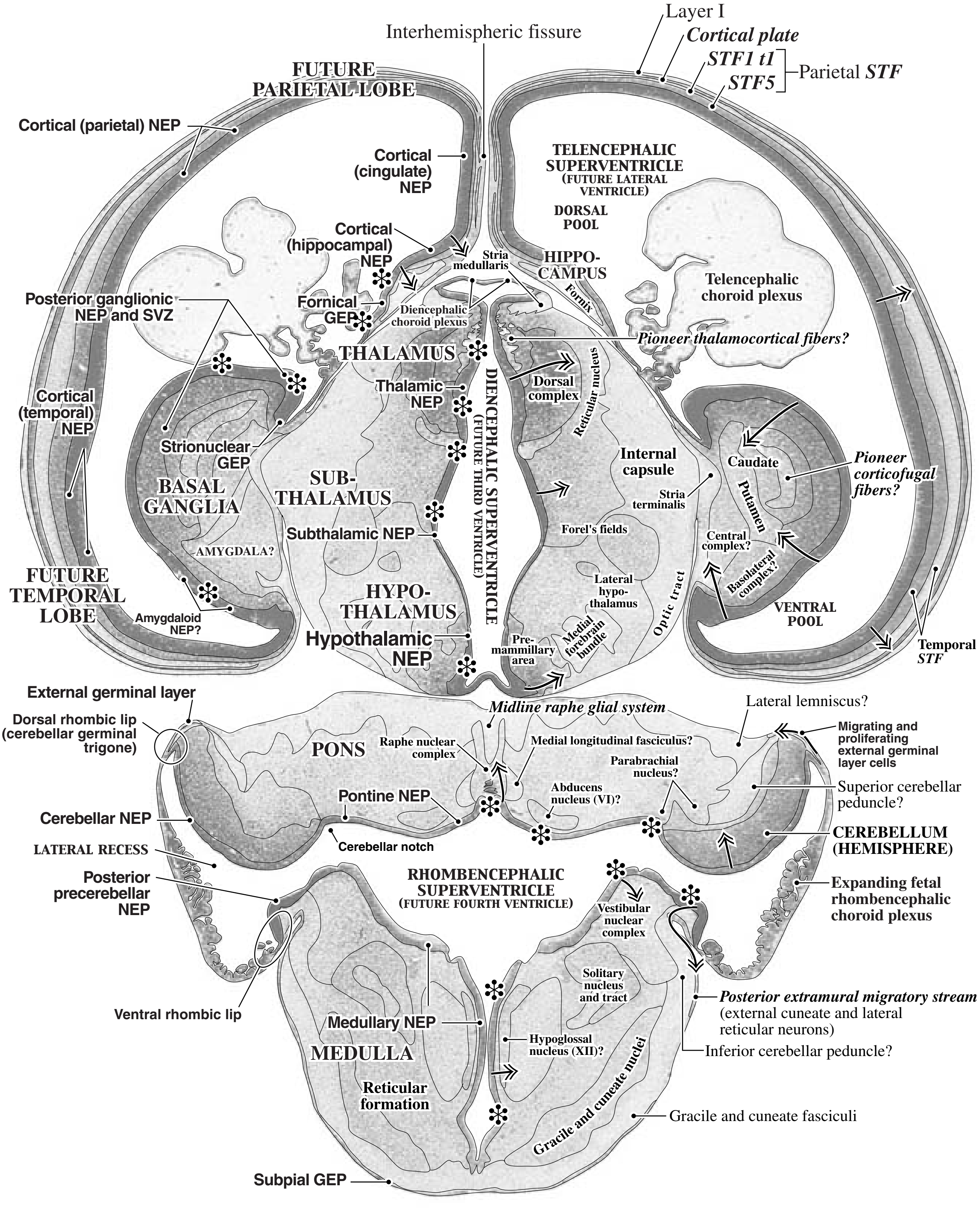
2 mm

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 157B



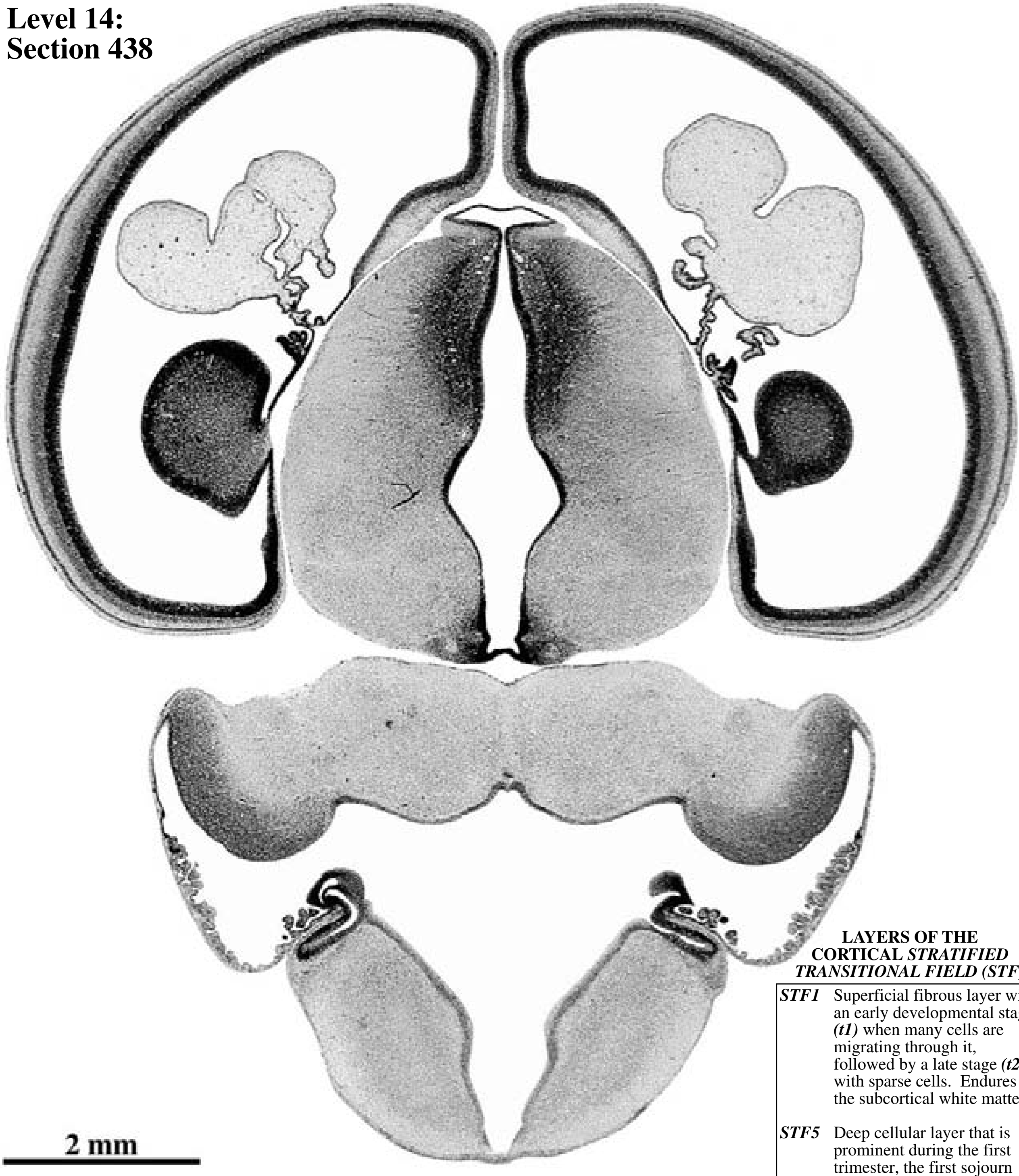
✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 158A

GW8 Coronal
CR 31 mm
C9226
Level 14:
Section 438

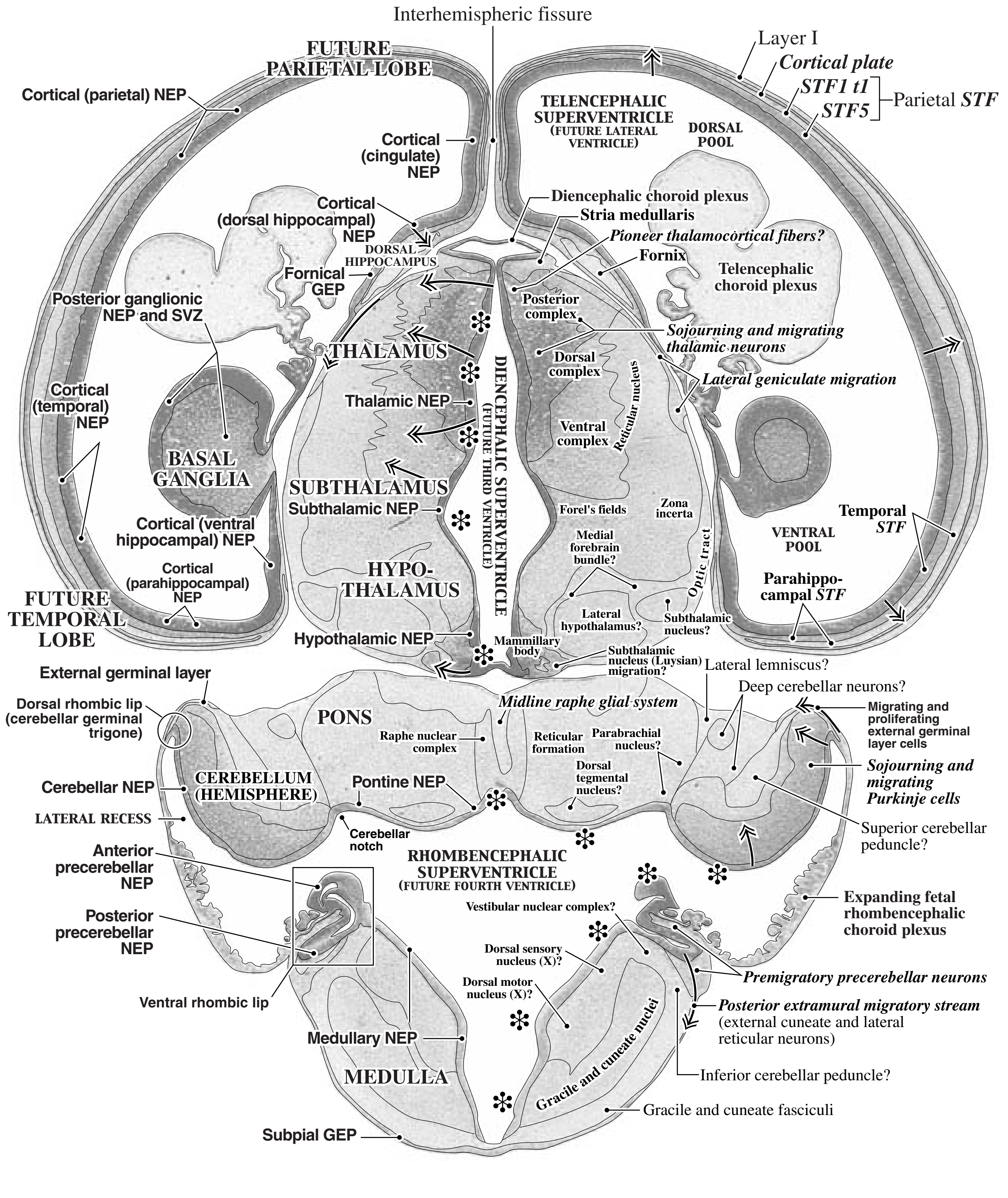


LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 158B



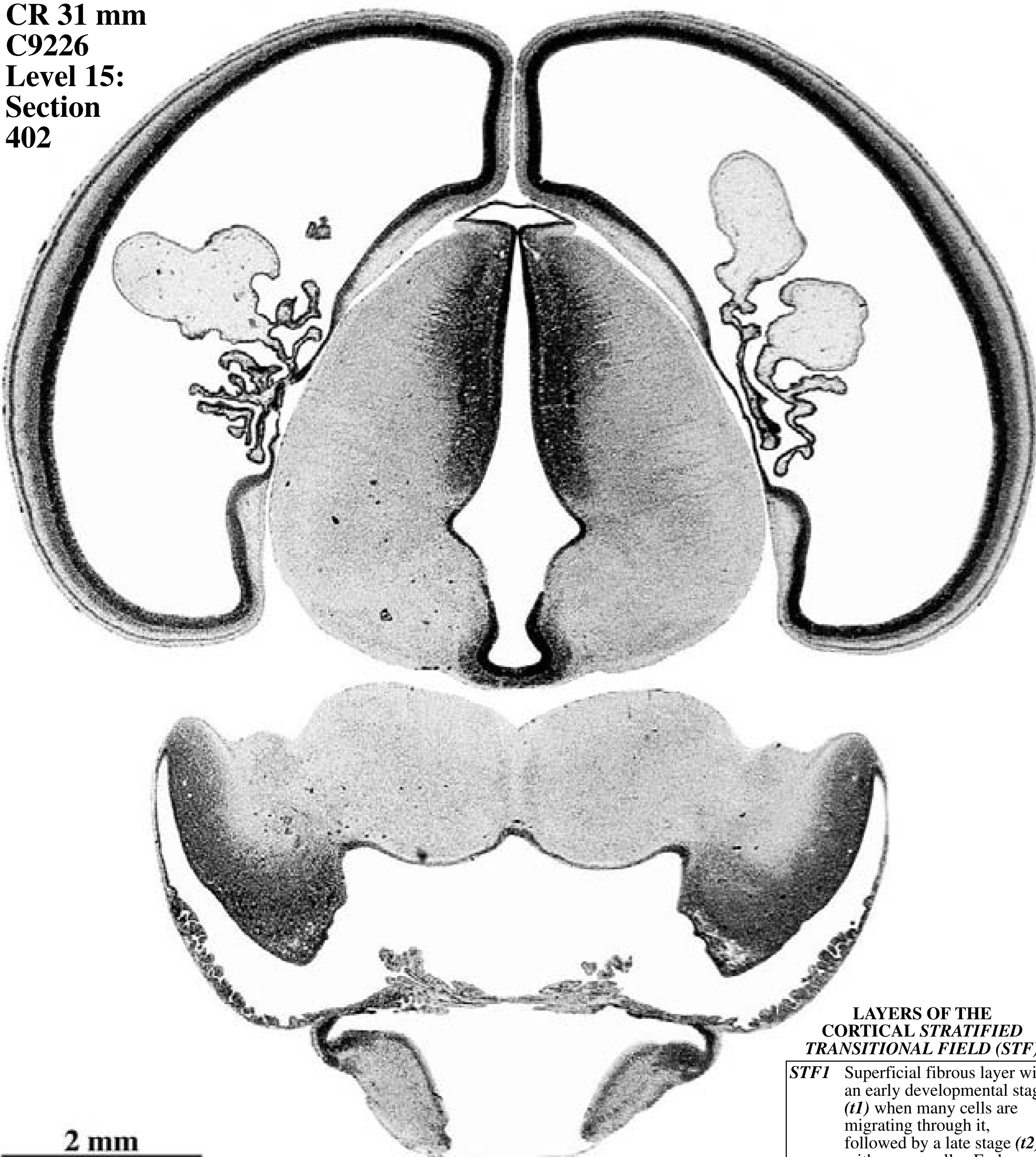
❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 159A

GW8 Coronal
CR 31 mm
C9226
Level 15:
Section
402



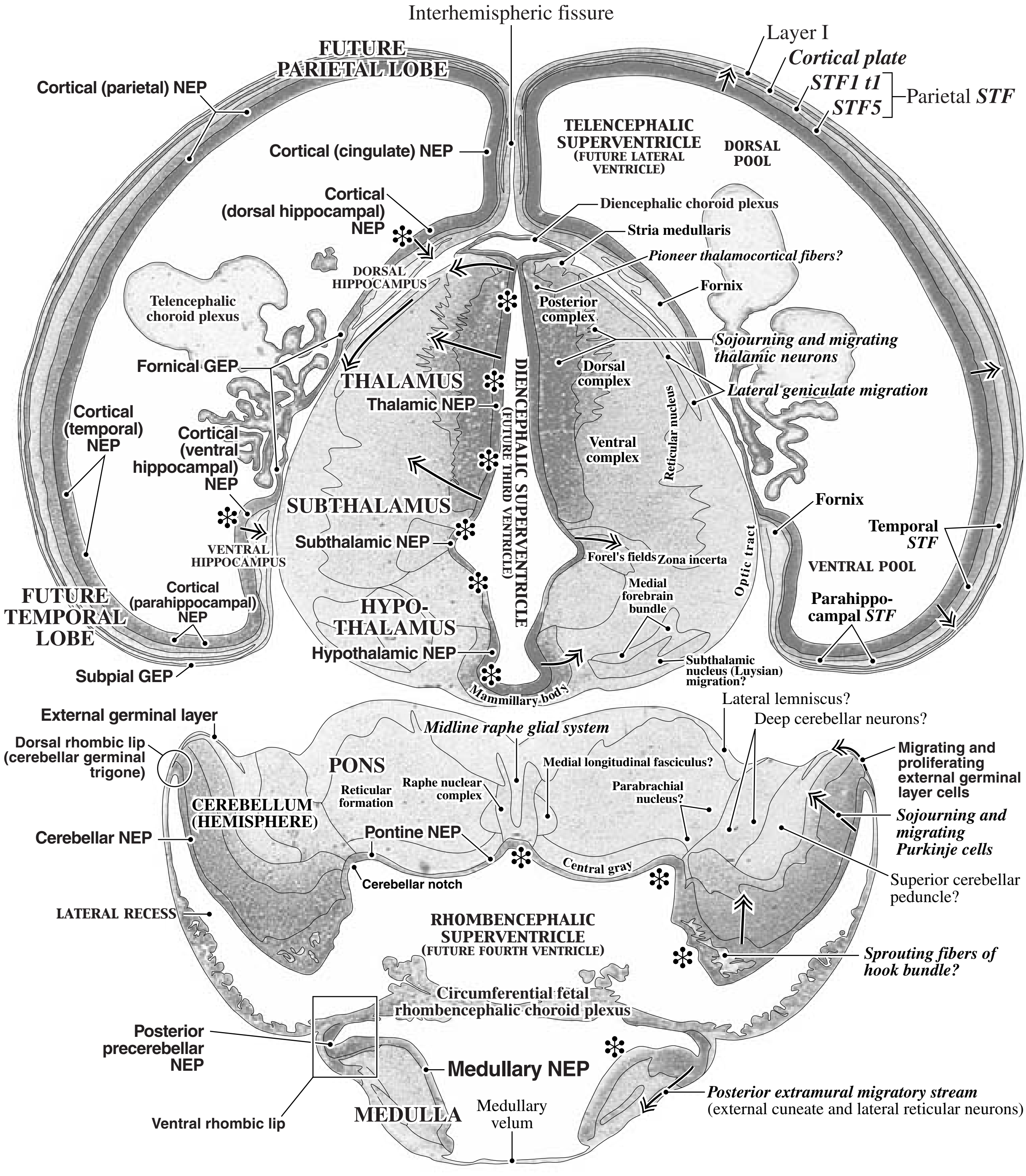
2 mm

LAYERS OF THE
CORTICAL *STRATIFIED*
TRANSITIONAL FIELD (STF)

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 159B



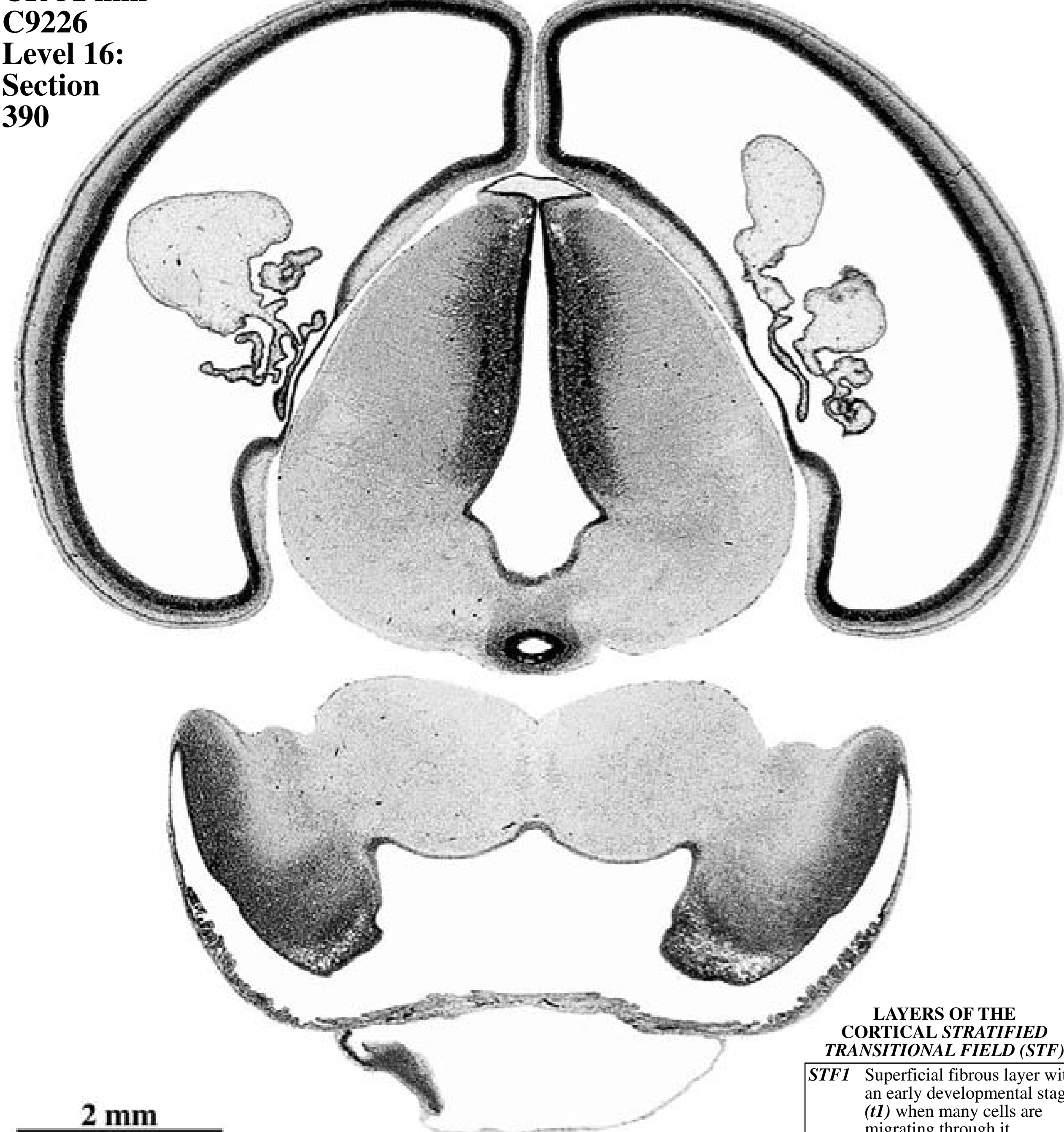
❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 160A

GW8 Coronal
CR 31 mm
C9226
Level 16:
Section
390

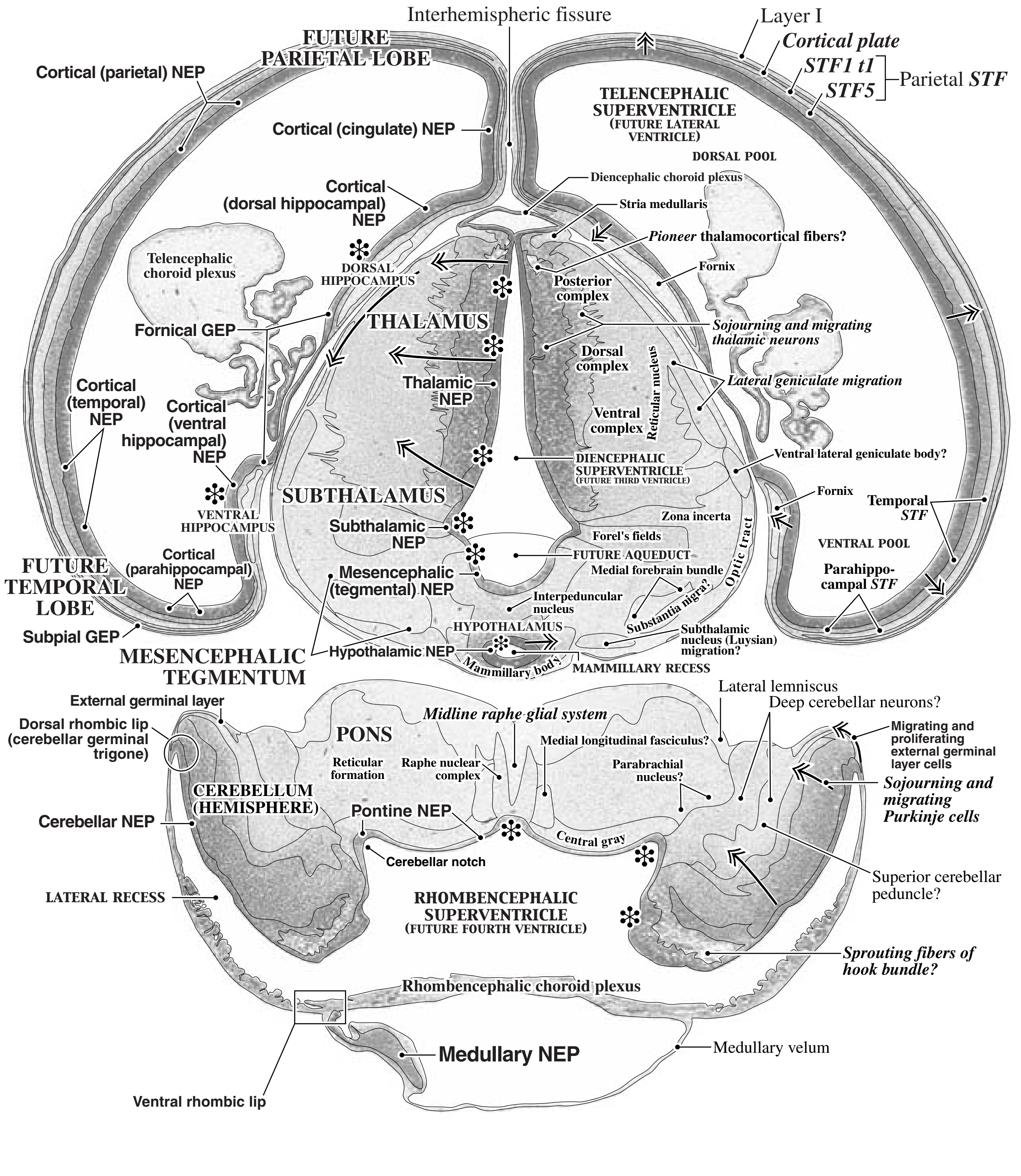


LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 160B



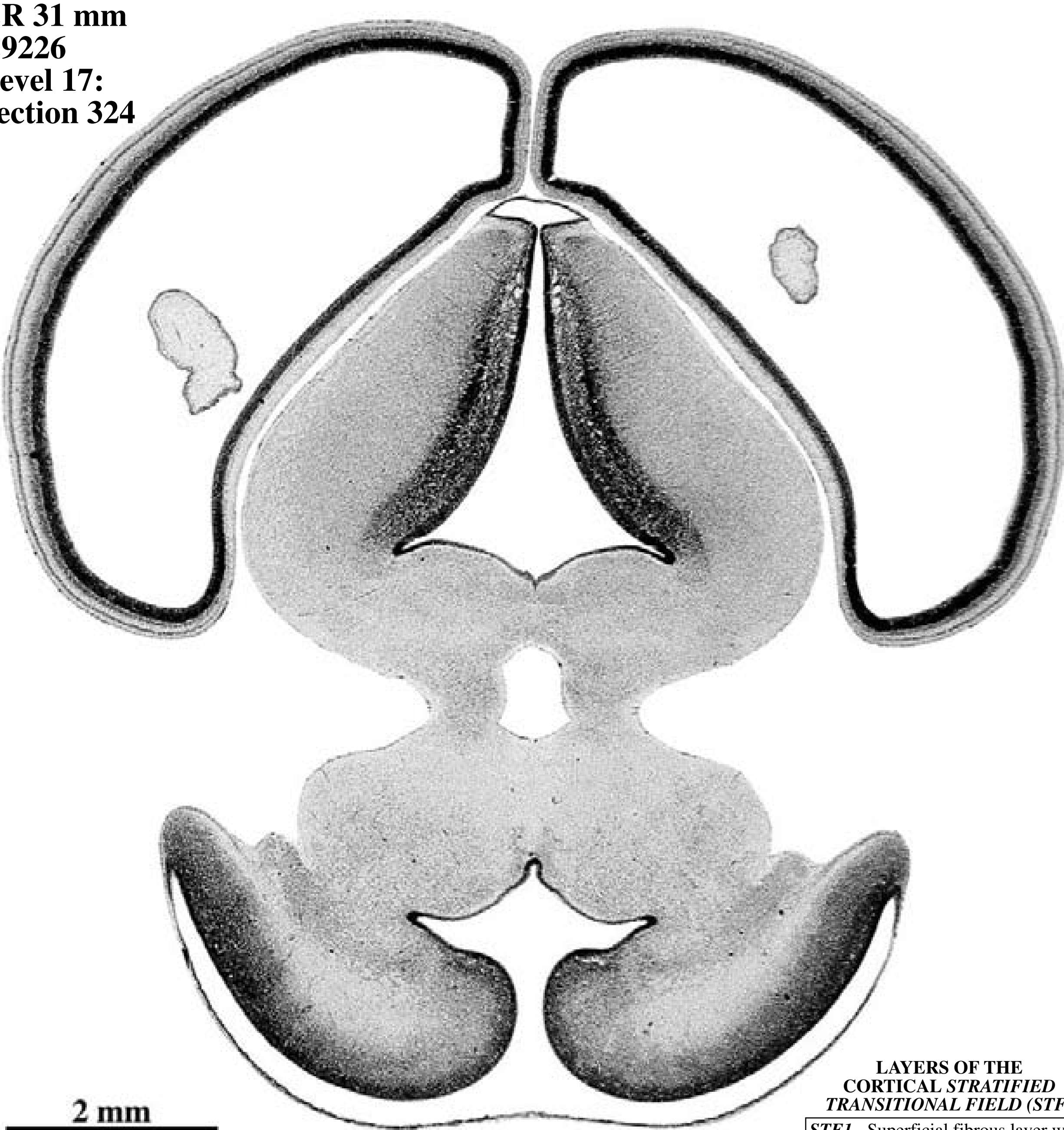
❋ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 161A

GW8 Coronal
CR 31 mm
C9226
Level 17:
Section 324

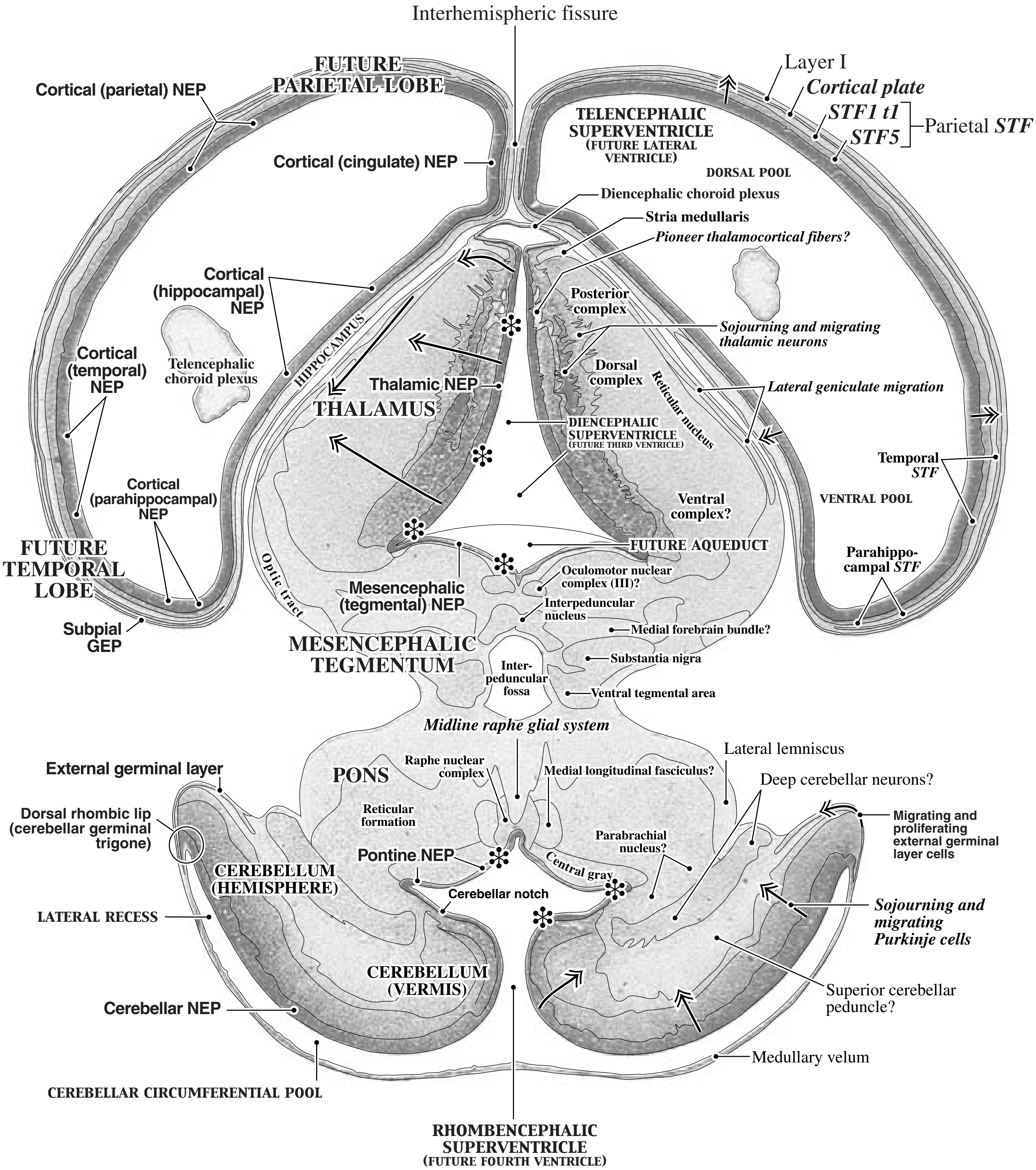


LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 161B



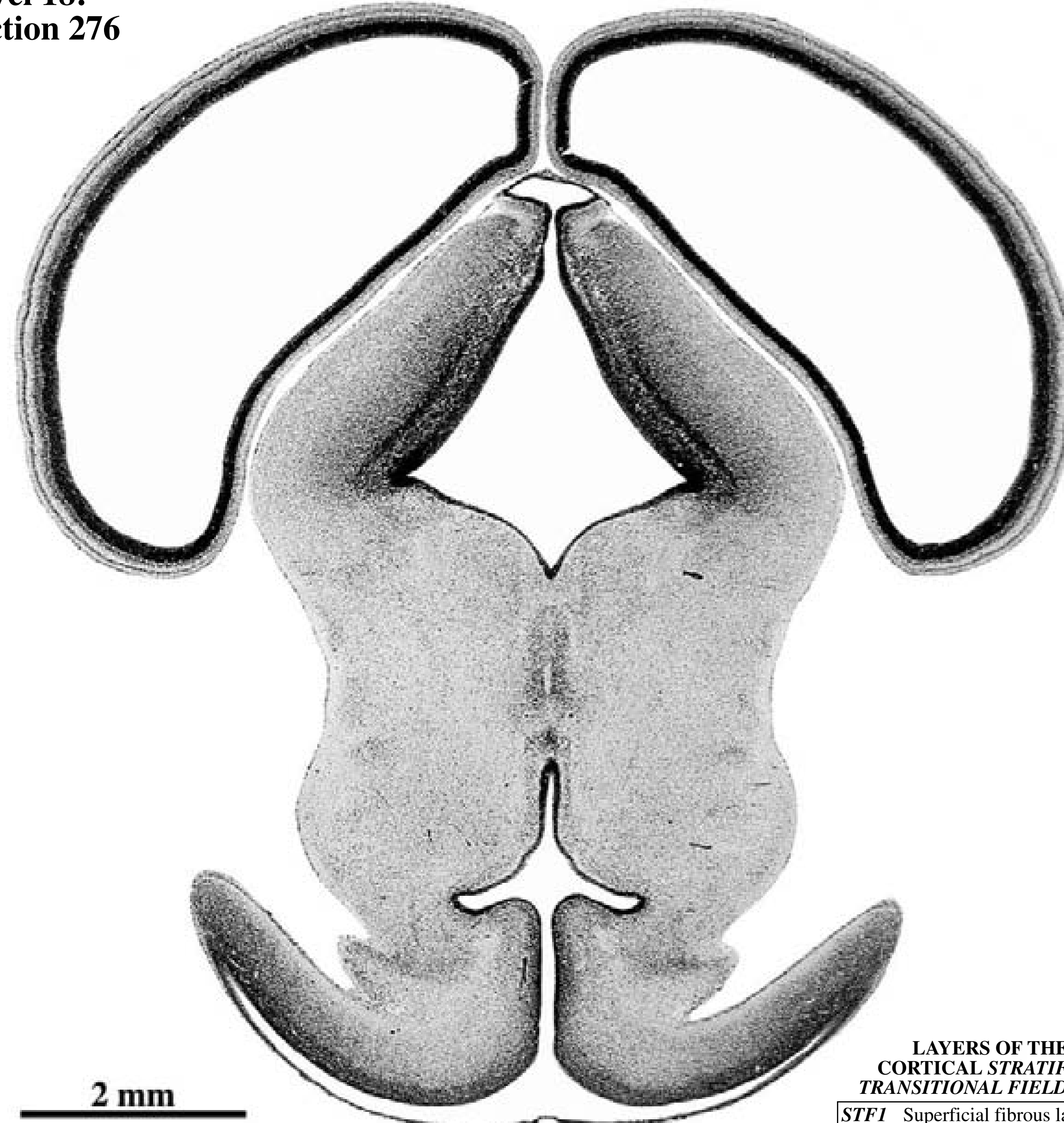
❋ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 162A

GW8 Coronal
CR 31 mm
C9226
Level 18:
Section 276

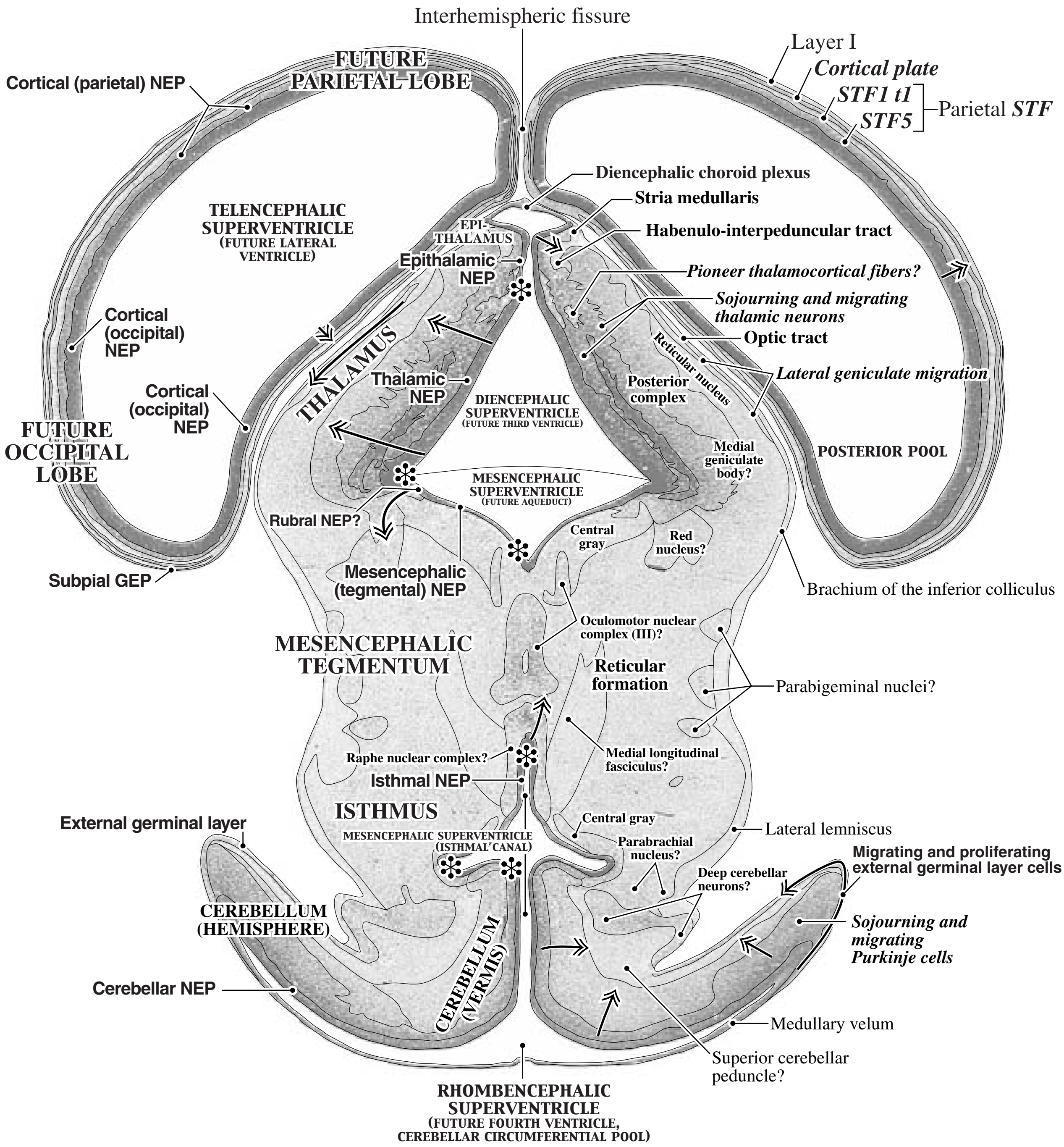


LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 162B



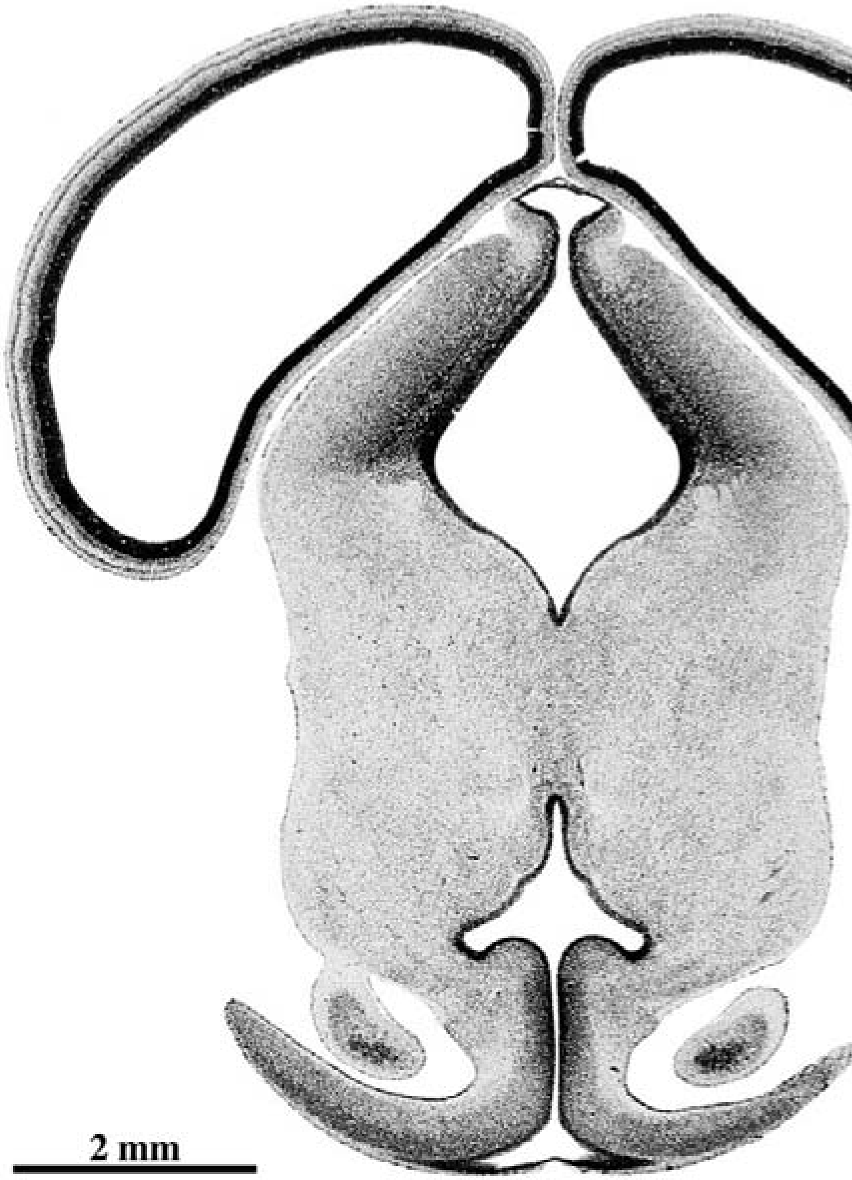
❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 163A

GW8 Coronal
CR 31 mm
C9226
Level 19:
Section 252

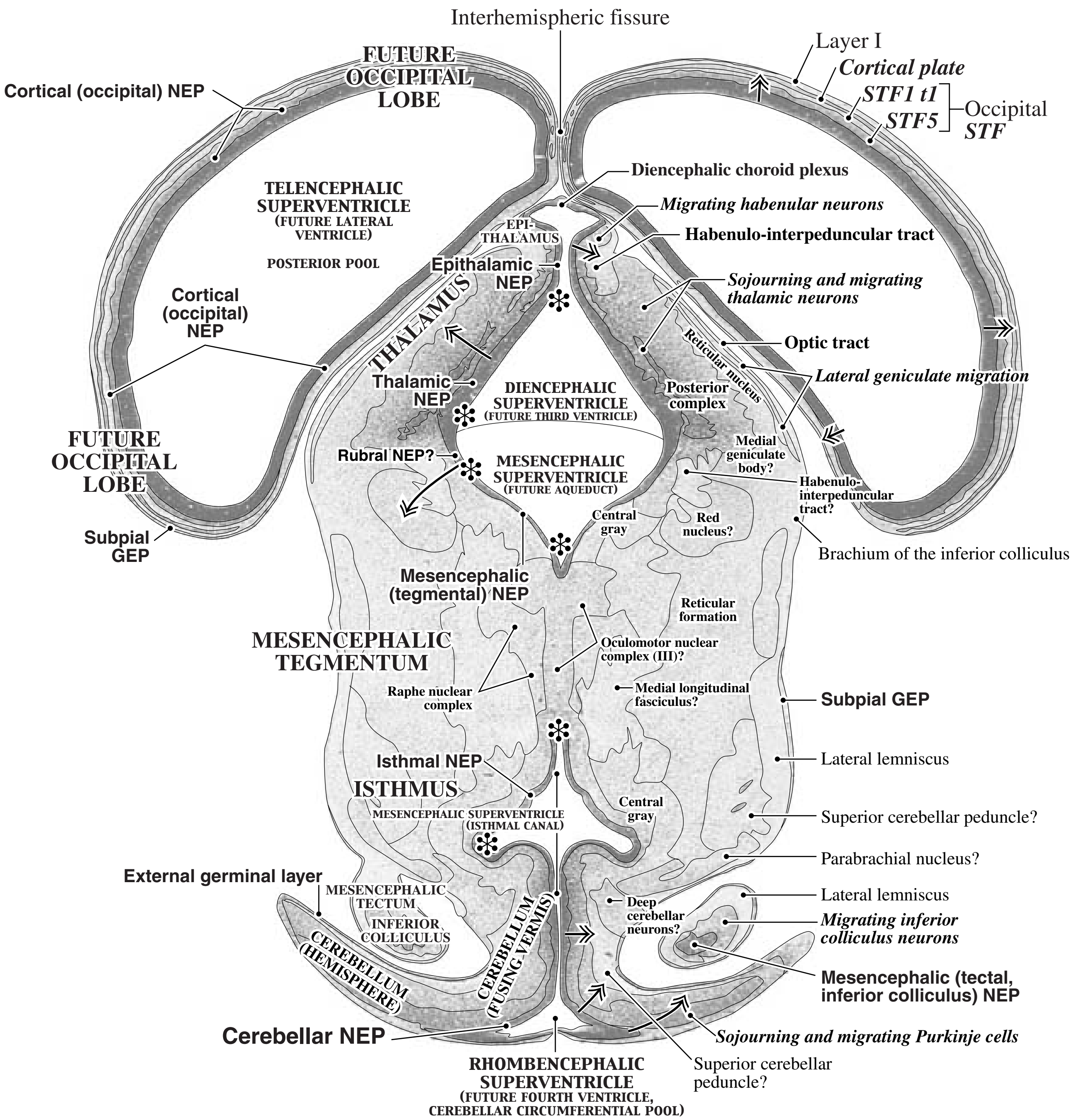


LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 163B



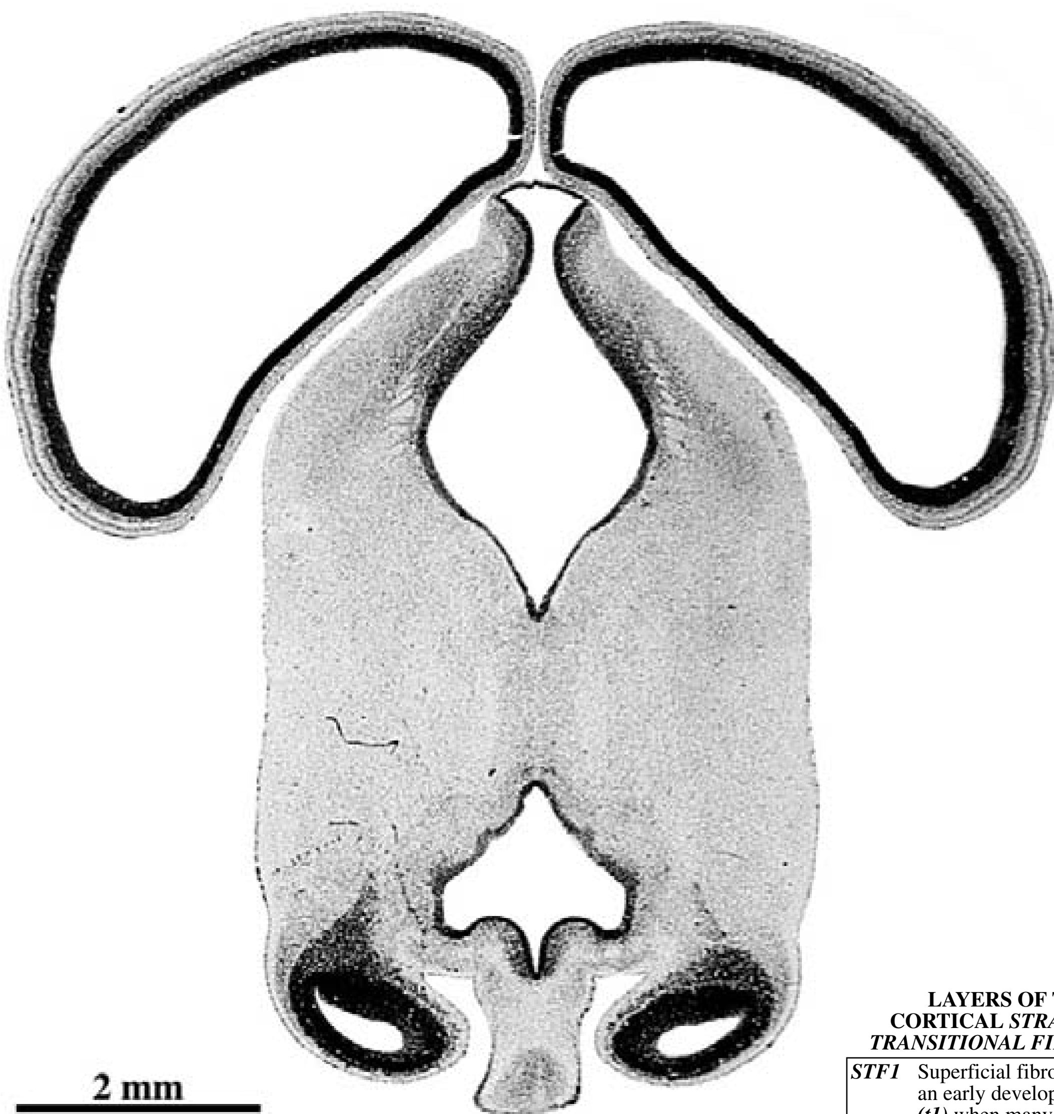
❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP -Glioepithelium
NEP - Neuroepithelium

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 164A

GW8 Coronal
CR 31 mm
C9226
Level 20:
Section 234

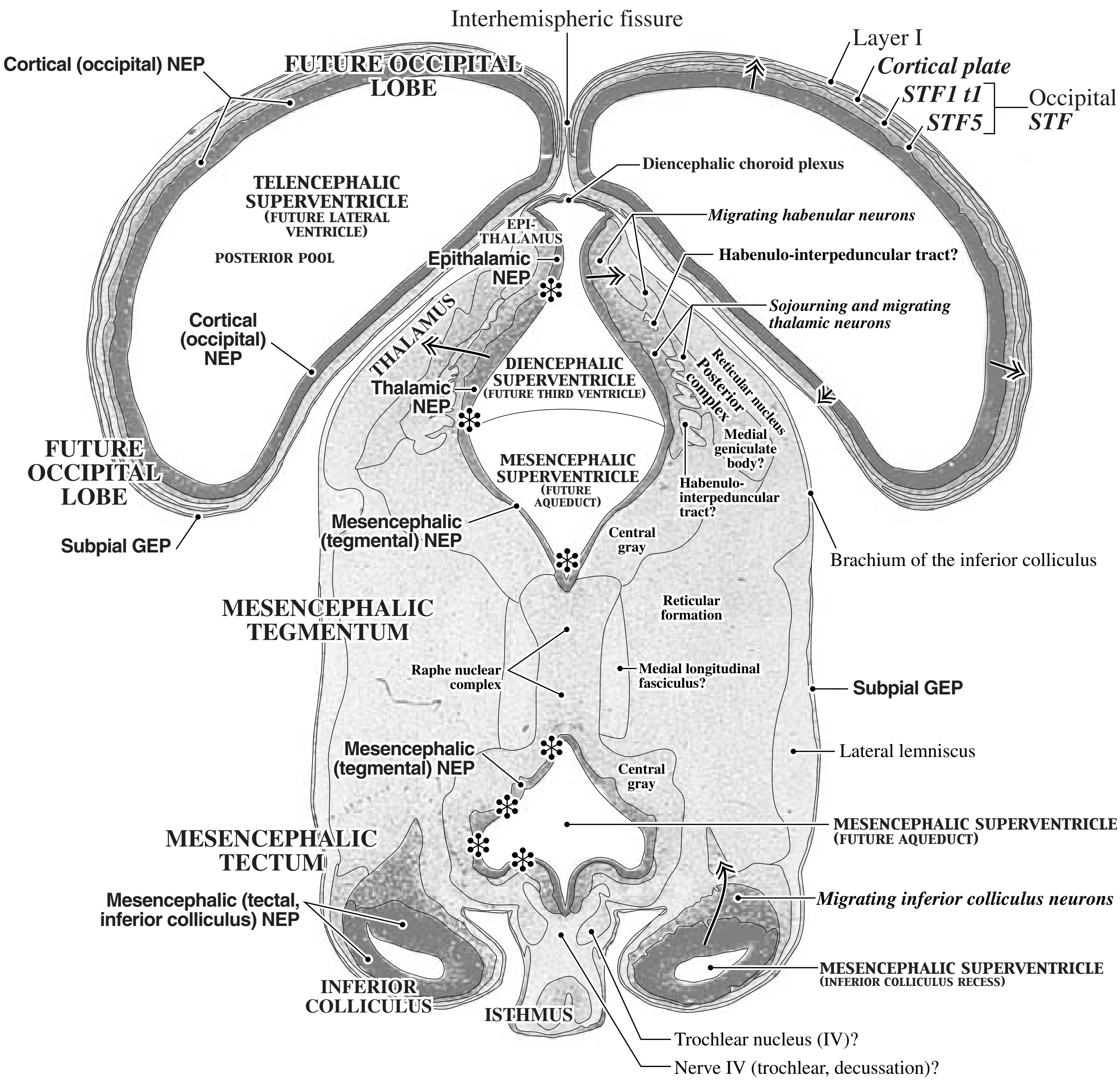


LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 164B



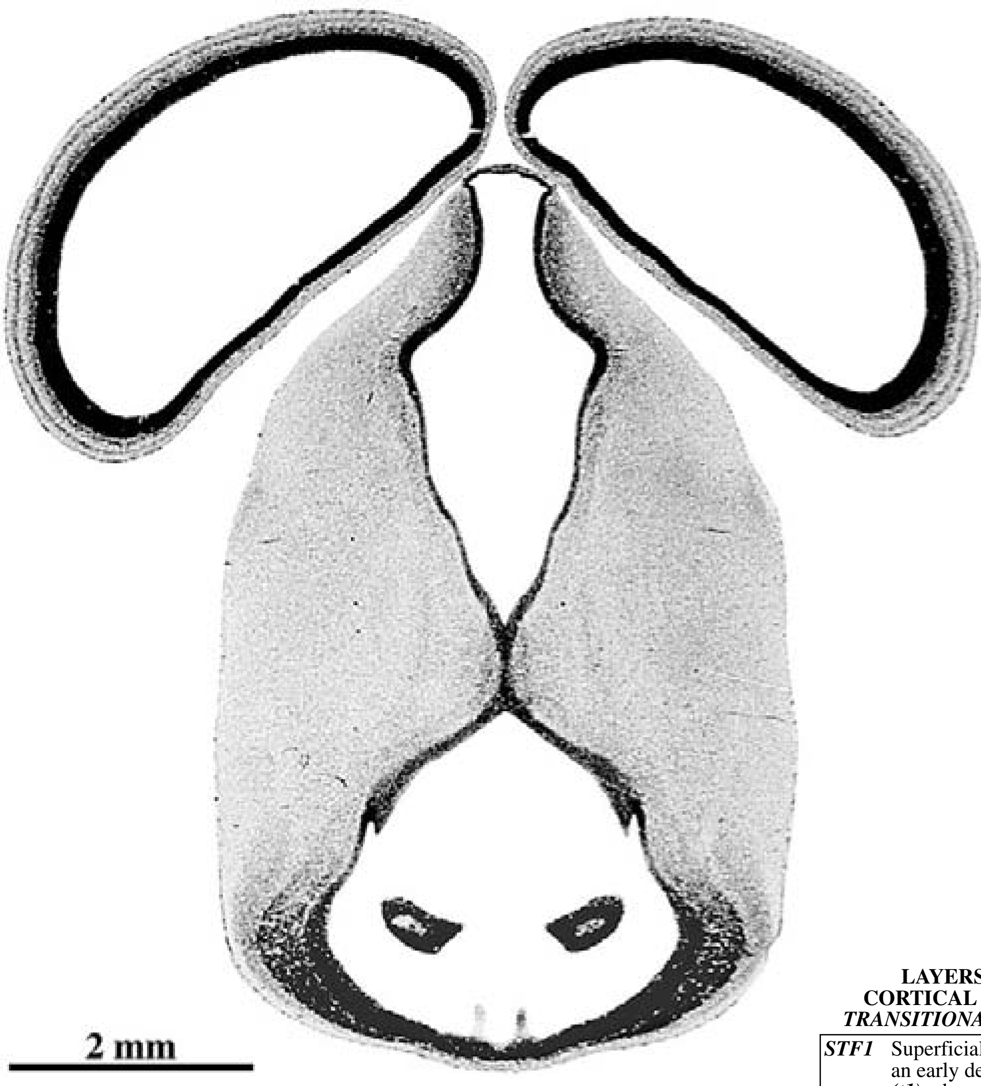
❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 165A

GW8 Coronal
CR 31 mm
C9226
Level 21:
Section 206

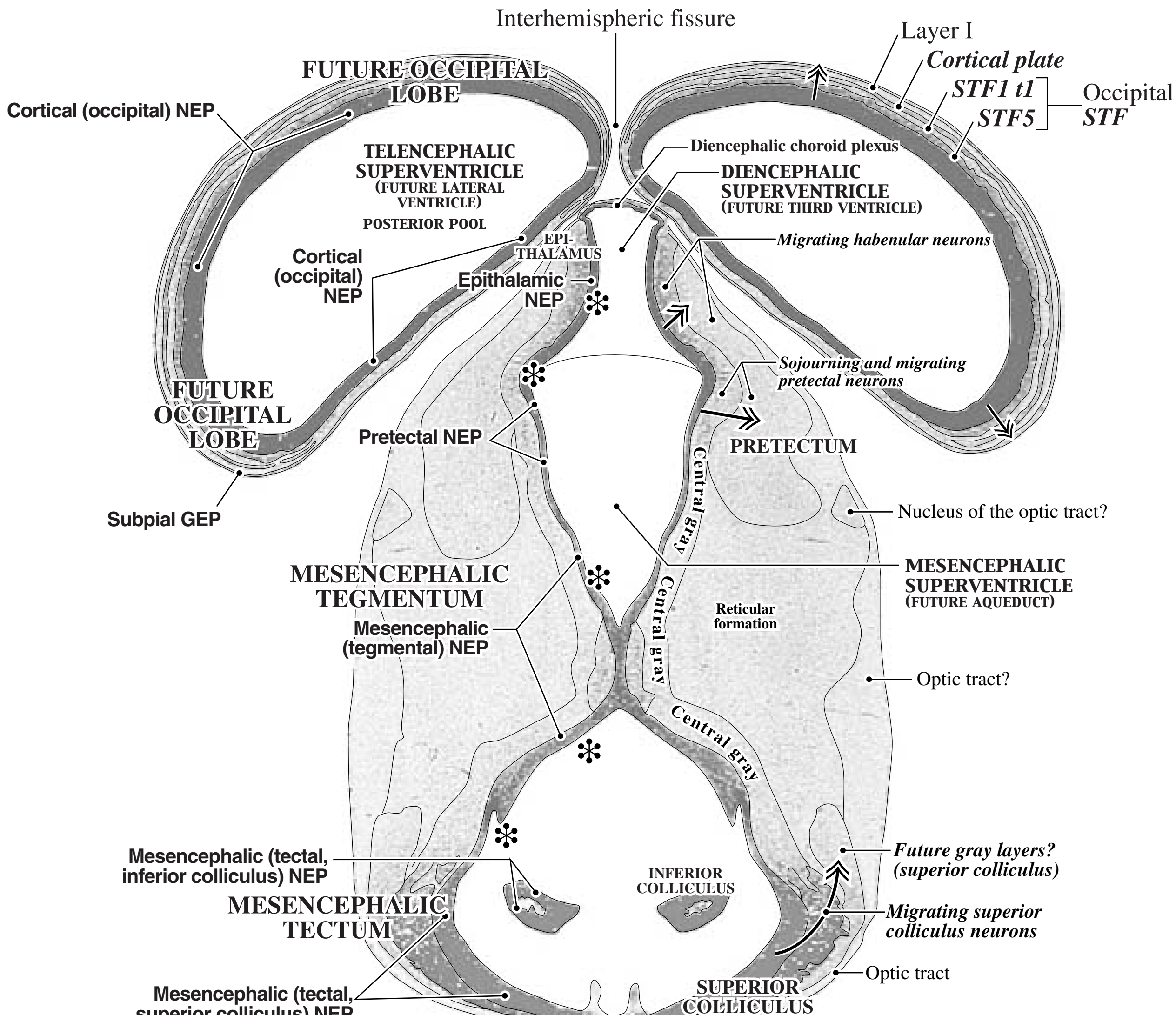


LAYERS OF THE
CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 165B



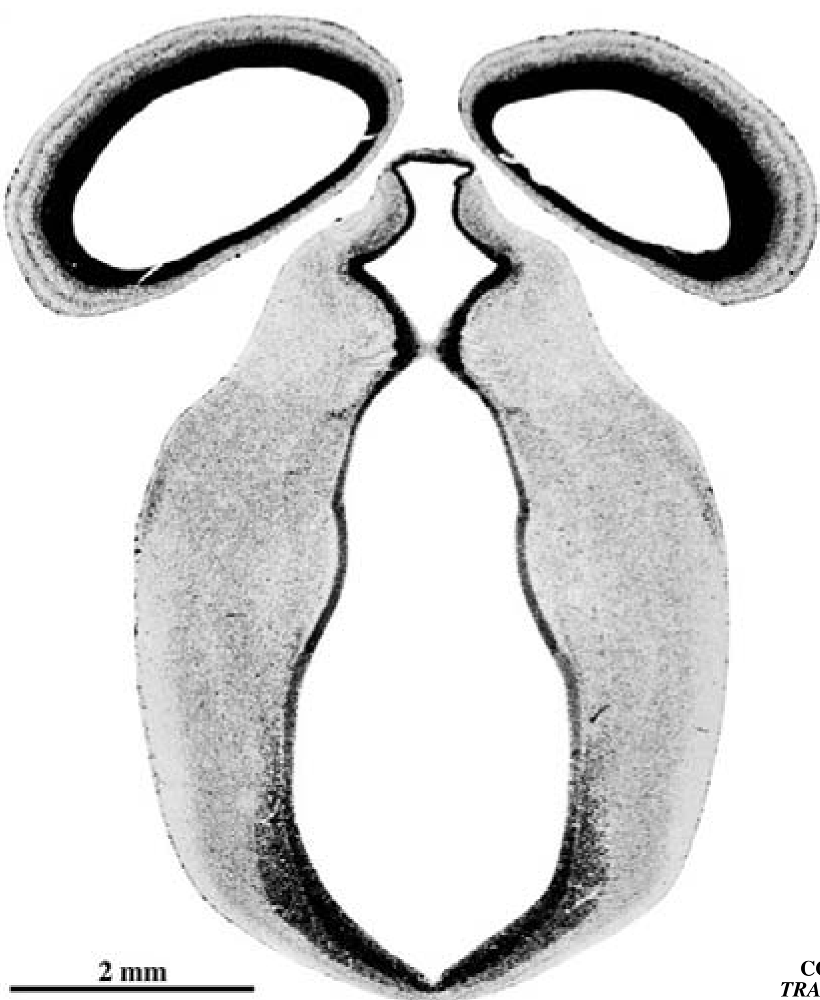
❈ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 166A

GW8 Coronal
CR 31 mm
C9226
Level 22:
Section 170

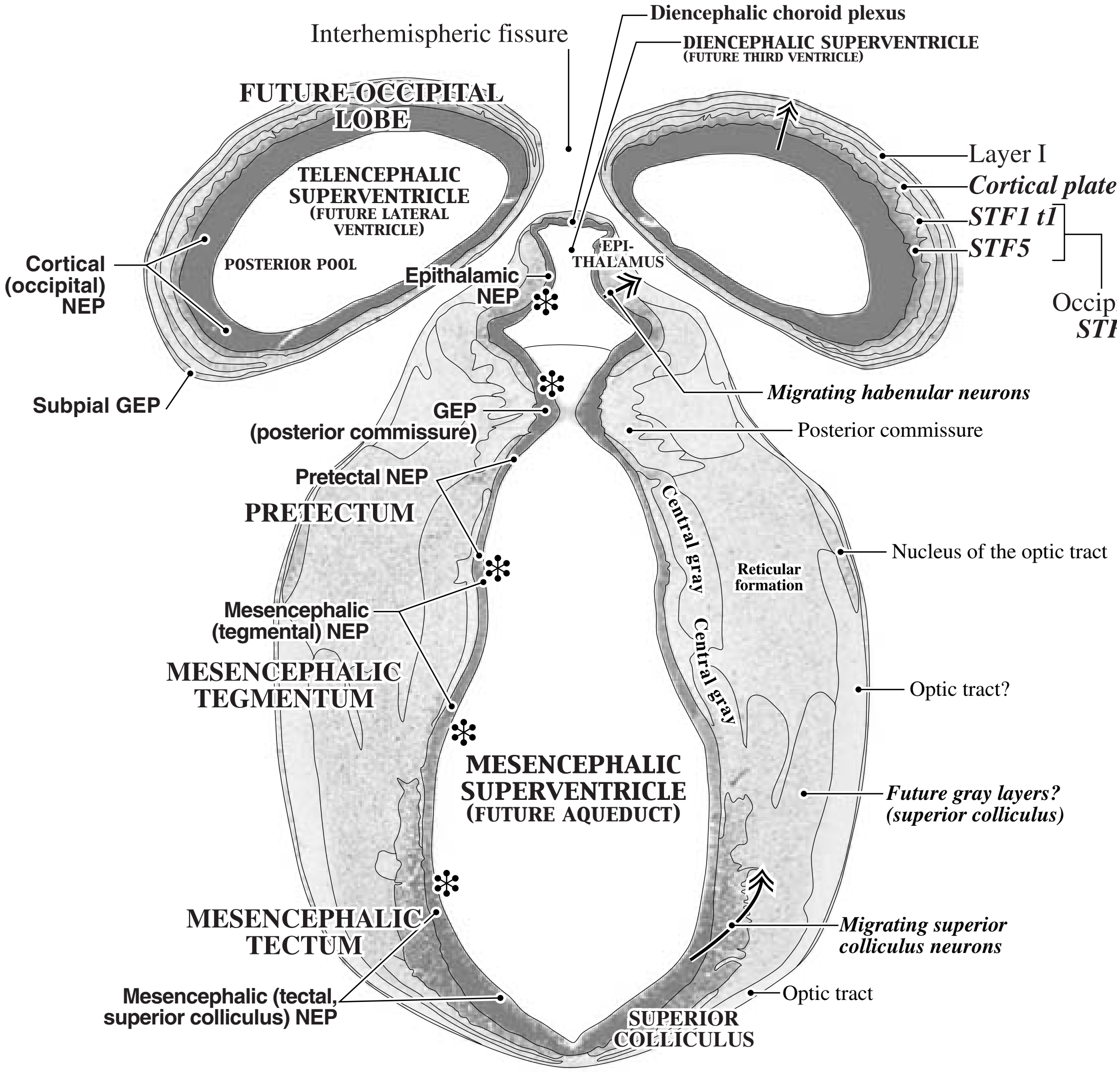


LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 166B



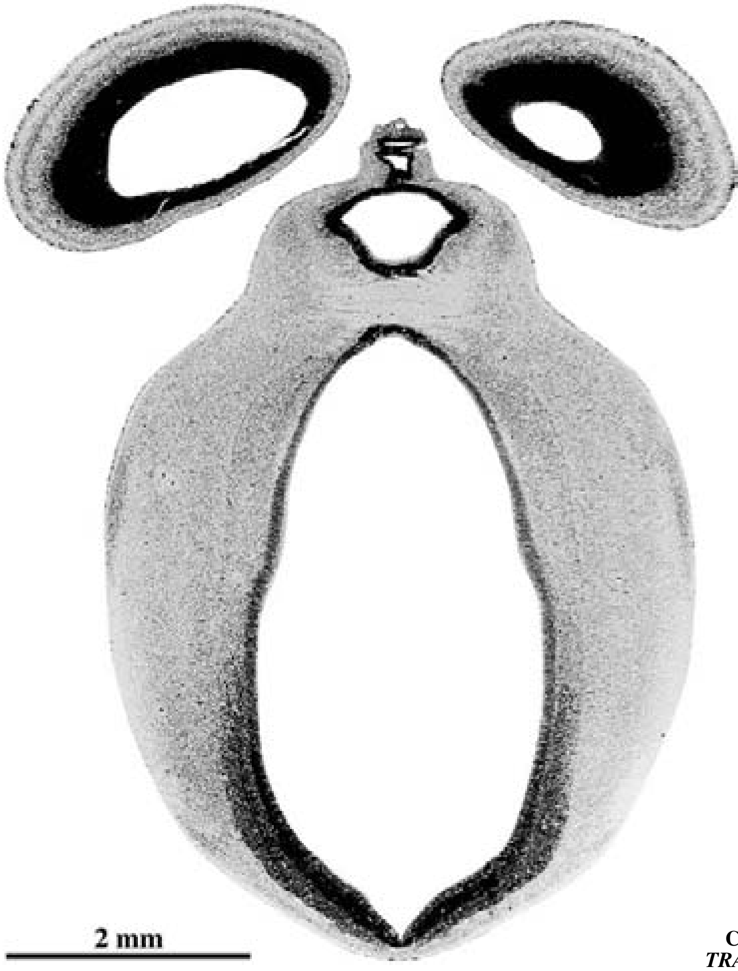
✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 167A

GW8 Coronal
CR 31 mm
C9226
Level 23:
Section 158

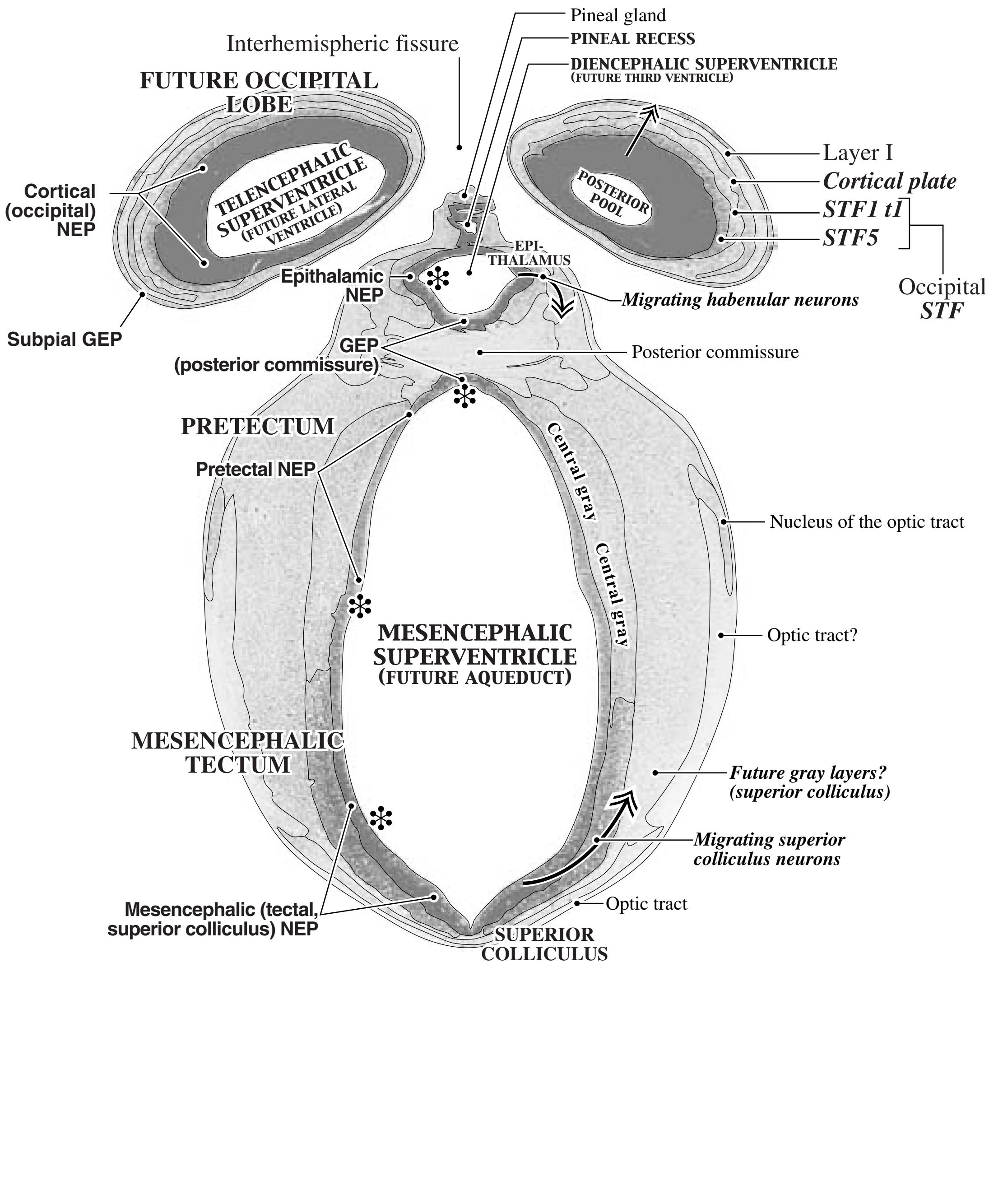


LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 167B



❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

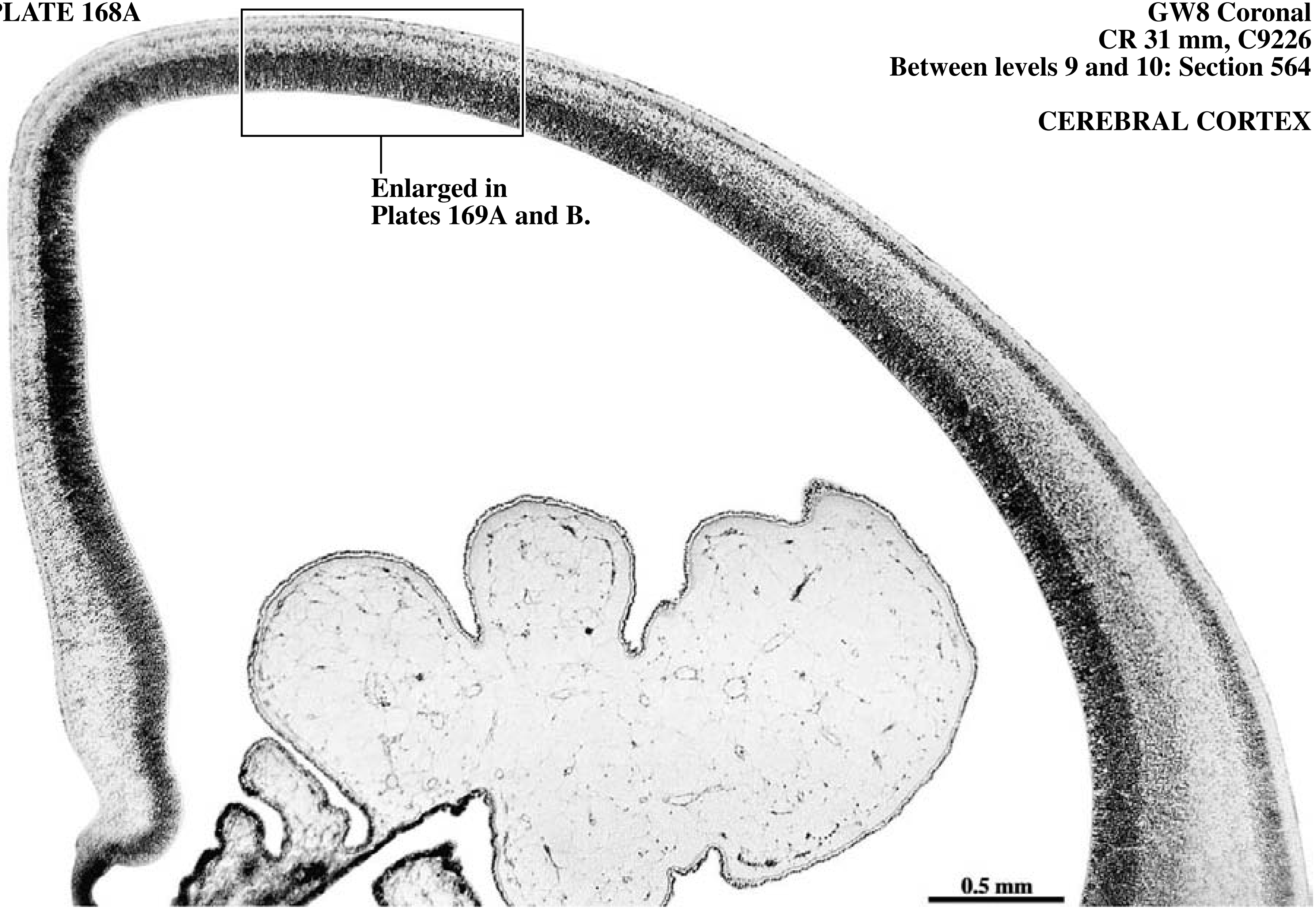
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 168A

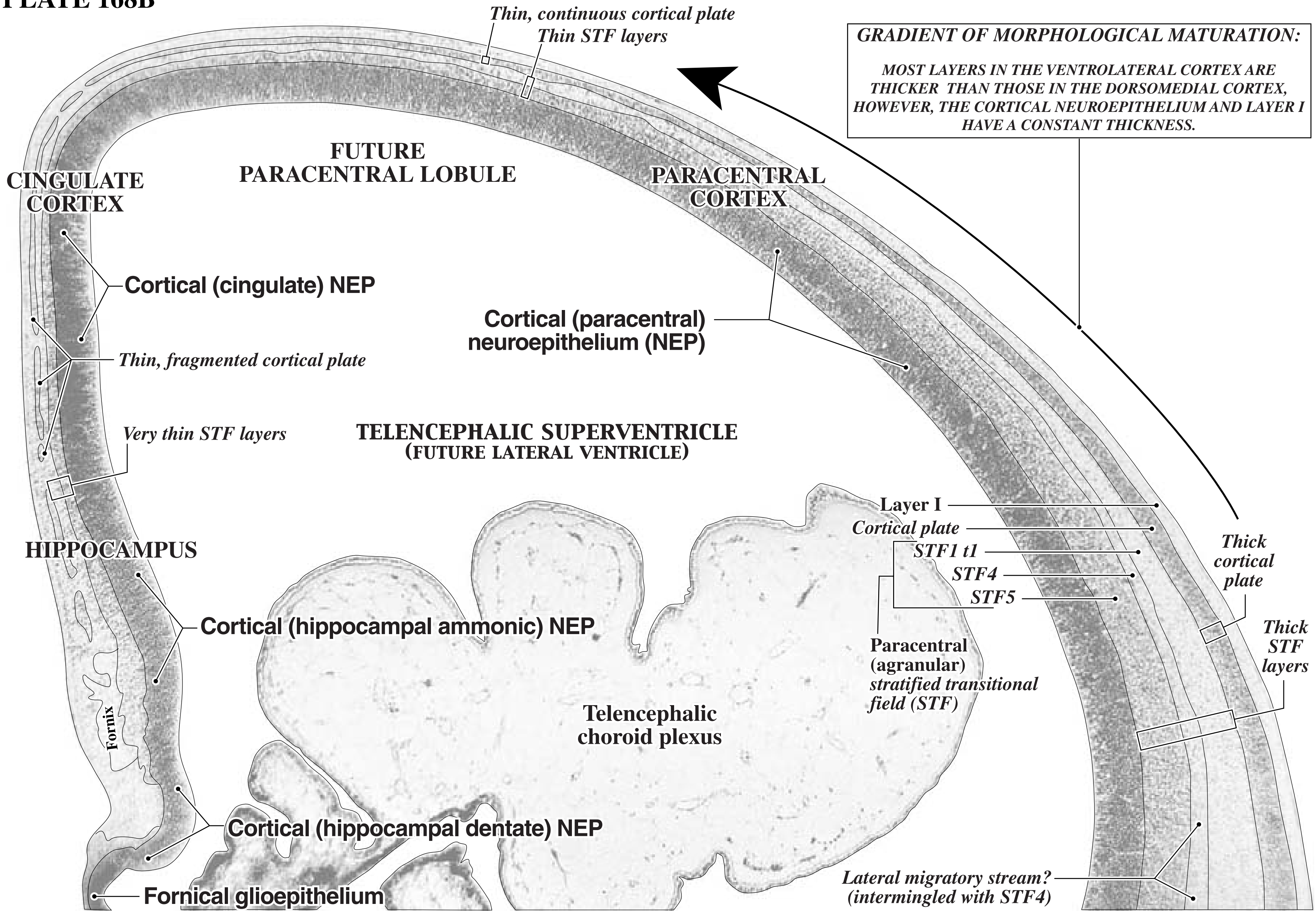
GW8 Coronal
CR 31 mm, C9226
Between levels 9 and 10: Section 564

CEREBRAL CORTEX



See levels 9 and 10 in Plates 153A and B to 154A and B.

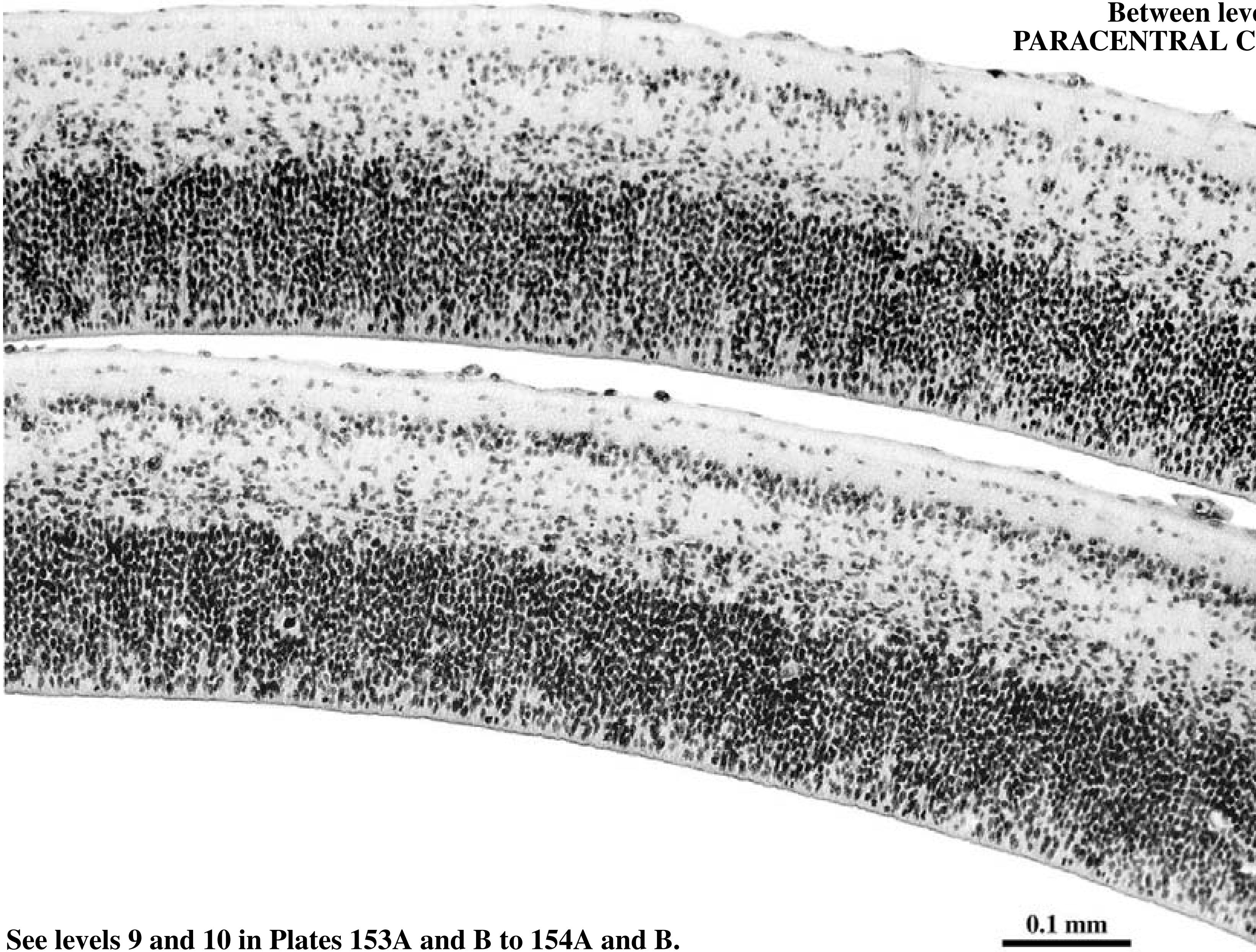
PLATE 168B



Thin, continuous cortical plate
Thin STF layers
GRADIENT OF MORPHOLOGICAL MATURATION:
MOST LAYERS IN THE VENTROLATERAL CORTEX ARE THICKER THAN THOSE IN THE DORSOMEDIAL CORTEX, HOWEVER, THE CORTICAL NEUROEPITHELIUM AND LAYER I HAVE A CONSTANT THICKNESS.
FUTURE PARACENTRAL LOBULE
CINGULATE CORTEX
PARACENTRAL CORTEX
Cortical (cingulate) NEP
Cortical (paracentral) neuroepithelium (NEP)
Thin, fragmented cortical plate
Very thin STF layers
TELENCEPHALIC SUPERVENTRICLE
(FUTURE LATERAL VENTRICLE)
Layer I
Cortical plate
STF1 t1
STF4
STF5
Thick cortical plate
HIPPOCAMPUS
Cortical (hippocampal ammonic) NEP
Paracentral (agranular) stratified transitional field (STF)
Thick STF layers
Fornix
Telencephalic choroid plexus
Cortical (hippocampal dentate) NEP
Lateral migratory stream? (intermingled with STF4)
Fornical glioepithelium

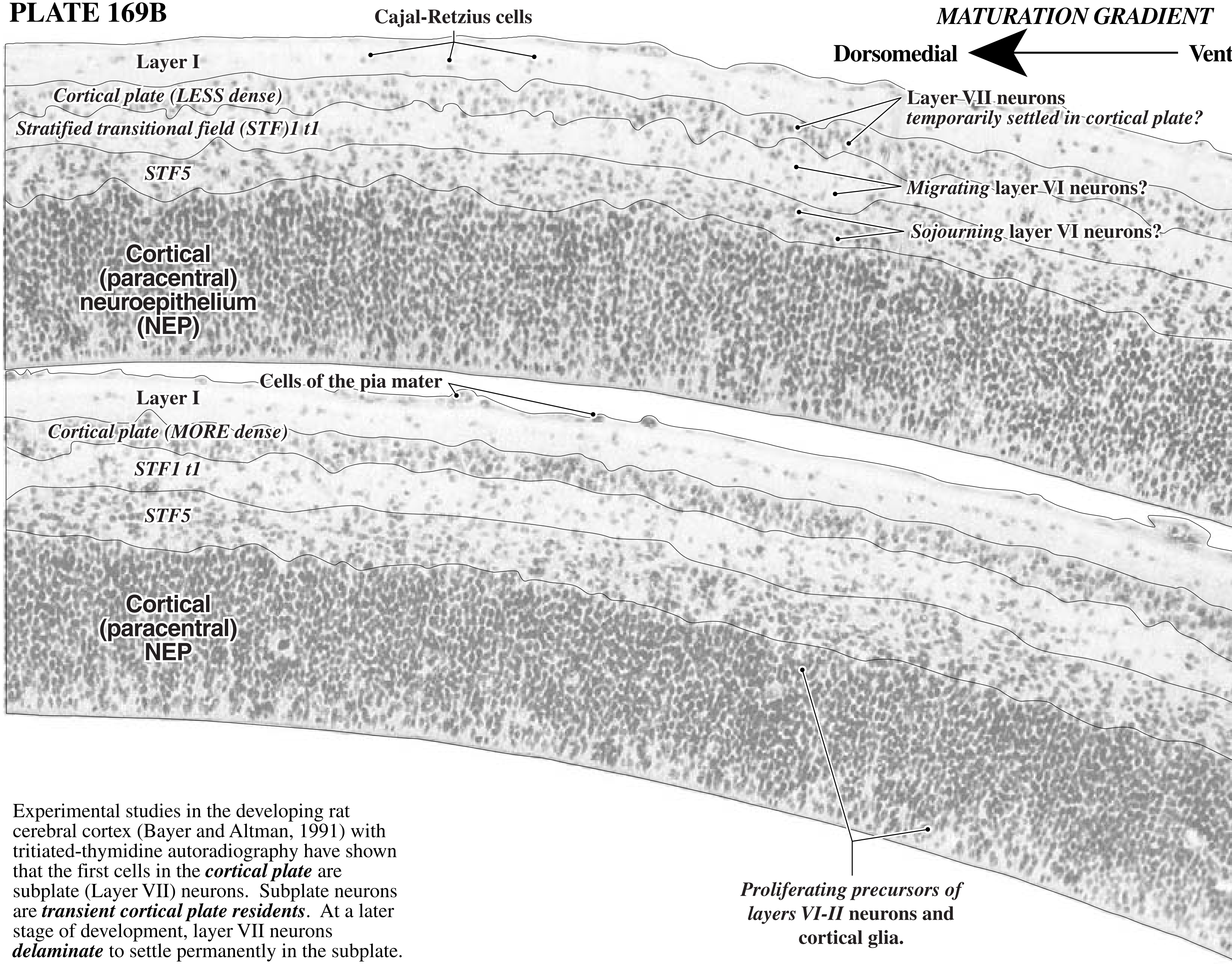
PLATE 169A

GW8 Coronal, CR 31 mm, C9226
Between levels 9 and 10
PARACENTRAL CEREBRAL CORTEX



See levels 9 and 10 in Plates 153A and B to 154A and B.

PLATE 169B



Section 564
This area of cortex is dorsomedial to the area from Section 570 and is slightly less mature.

Section 570
This area of cortex is ventrolateral to the area from Section 564 and is slightly more mature.

Experimental studies in the developing rat cerebral cortex (Bayer and Altman, 1991) with tritiated-thymidine autoradiography have shown that the first cells in the ***cortical plate*** are subplate (Layer VII) neurons. Subplate neurons are ***transient cortical plate residents***. At a later stage of development, layer VII neurons ***delaminate*** to settle permanently in the subplate.

PART IX: GW8 HORIZONTAL

This is specimen number 609 in the Carnegie Collection, designated here as C609. A normal female fetus with a crown-rump length (CR) of 32 mm was collected in 1916, and is estimated to be in gestational week (GW) 8. The entire fetus was embedded in paraffin, cut transversely in 50 µm thick sections, and stained with aluminum cochineal. Since there is no photograph of this brain before it was embedded and cut, a specimen from Hochstetter (1919) that is only partially comparable to C609 has been modified to show the approximate section plane and external features of the brain at GW8 (**Figure 8**). Like most of the specimens in this Volume, the sections are not cut exactly in one plane; C609's cortex is cut midway between coronal and horizontal planes, and is presented as a "horizontal" brain. The C609 section planes through the cortex and brainstem are not at the same angle when transferred to Hochstetter's CR27 mm specimen. Instead, brainstem planes of section appear to fan upward and downward from sections in the cortex apparently around a fulcrum centering in the invagination of the medullary velum overlying the rhombencephalic superventricle. We interpret this to indicate that the brain flexures are more loosely folded in the Hochstetter specimen than in C609. But it is difficult to determine how the brainstem is folded in C609 to make the section planes line up with those in the cortex. Photographs of 23 sections (**Levels 1-10**) are illustrated at low magnification in **Plates 170-179**. High-magnification views of different areas of the brain are shown in **Plates 180-185**. To maximize image size within page space, all of C609's sections are rotated 90˚ (landscape orientation). The anterior part of each section is on the left (page bottom), and the posterior part of each section is on the right (page top).

C609 is similar to the other GW8 specimens and shows brain maturation in still another perspective. The telencephalic and rhombencephalic ***superventricles*** are obvious, along with the slit-like diencephalic and mesencephalic superventricles. The parenchyma, the area between the superficial border of the ***neuroepithelium (NEP) / subventricular zone (SVZ)*** and the pial membrane, is the region where neurons migrate, settle, and differentiate. The thicknesses of the neuroepithelium and the parenchyma are similar to those in C9226 throughout the brain indicating brain maturation in both specimens is similar.

The parenchyma is thick and bordered by a thin NEP in the medulla, pons, and midbrain tegmentum without surrounding dense sojourn zones. Most neurons have been generated here, few are migrating, and most are settled and differentiating. The two exceptions seen in C9226 are also seen in C145. First, presumptive facial motor neurons are clumped near the pontomedullary trench and some are migrating toward their ventral pontine/medullary settling sites. Second, the thicker ***precerebellar neuroepithelium*** in the medulla is generating predominantly pontine gray neurons; many precerebellar neurons are migrating in the ***anterior and posterior extramural migratory streams***. The cerebellar NEP is thicker than that in the pons and medulla, and the cerebellar parenchyma has a dense Purkinje cell sojourn zone below presumptive earlier-generated deep neurons; the ***external germinal layer (egl)*** is rudimentary. The mesencephalic tectal NEP is thick adjacent to a thin parenchyma that contains dense sojourning and migrating neurons; substantial neurogenesis is ongoing in both the superior and inferior colliculi in the midbrain tectum.

The prominent diencephalic NEP and thick parenchyma filled with dense zones of sojourning and migrating neurons is remarkable in C609. Many migratory streams are visible in the thalamus, and migrating subthalamic nucleus neurons can be followed from the posterior hypothalamic NEP to the subthalamic nucleus. Although many diencephalic neurons have been generated by GW8, most of them are still migrating and few have settled. In spite of that, there are large accumulations of fibers (presumably thalamic axons) in the lateral thalamus and internal capsule, indicating that young thalamic neurons grow axons toward the cerebral cortex before settling and differentiating.

Within the telencephalon, the cerebral cortex has a thick NEP and a very thin parenchyma, indicating that most of its neurons are still not generated. The cerebral cortical NEP is the sole germinal matrix. The ***stratified transitional field (STF)*** contains ***STF1*** and ***STF5*** only in lateral areas. The pronounced anterolateral (thicker) to dorsomedial (thinner) maturation gradient is evident in the cerebral cortex. The basal telencephalic NEP/SVZ and parenchyma are both thick because there are large early-generated neuronal populations (for example, globus pallidus and substantia innominata) and massive late-generated populations (striatal neurons in the caudate and putamen). Most of the neurons settling in the basal telencephalon at GW8 are those of the early-generated populations, while many striatal neurons have not been generated yet.

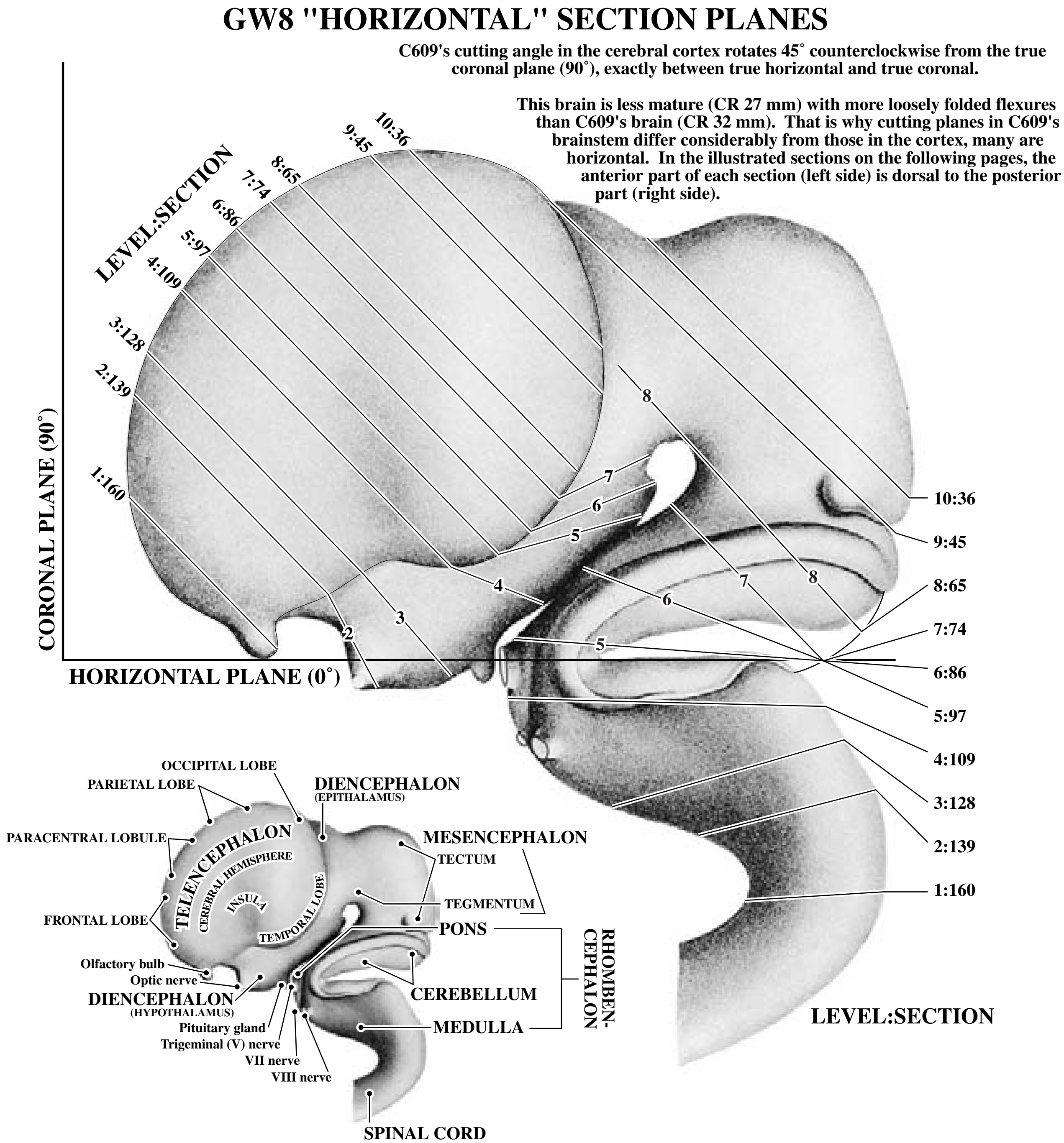


Figure 8. The lateral view of the brain and upper cervical spinal cord from a specimen with a crown-rump length of 27 mm (modified from Figure 37, Table VII, Hochstetter, 1919) serves to show the approximate locations and cutting angles of the illustrated sections of C609 in the following pages. The small inset identifies the major structural features. The line in the cerebellum and dorsal edges of the pons and medulla is the cut edge of the medullary velum.

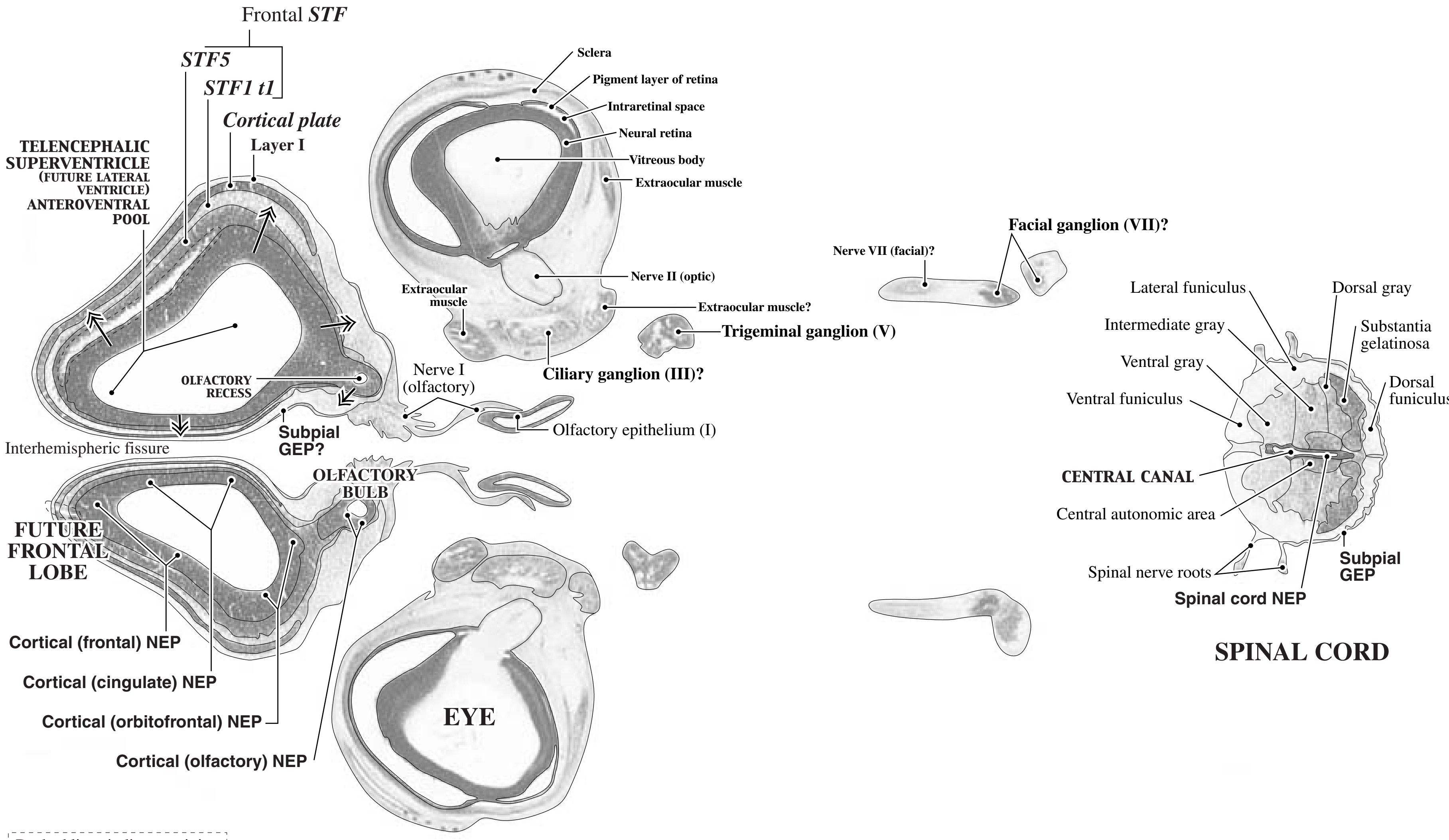
PLATE 170A

GW8 Horizontal
CR 32 mm
C609
Level 1:
Section 160

LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 170B



Dashed lines indicate staining and/or sectioning artifacts.

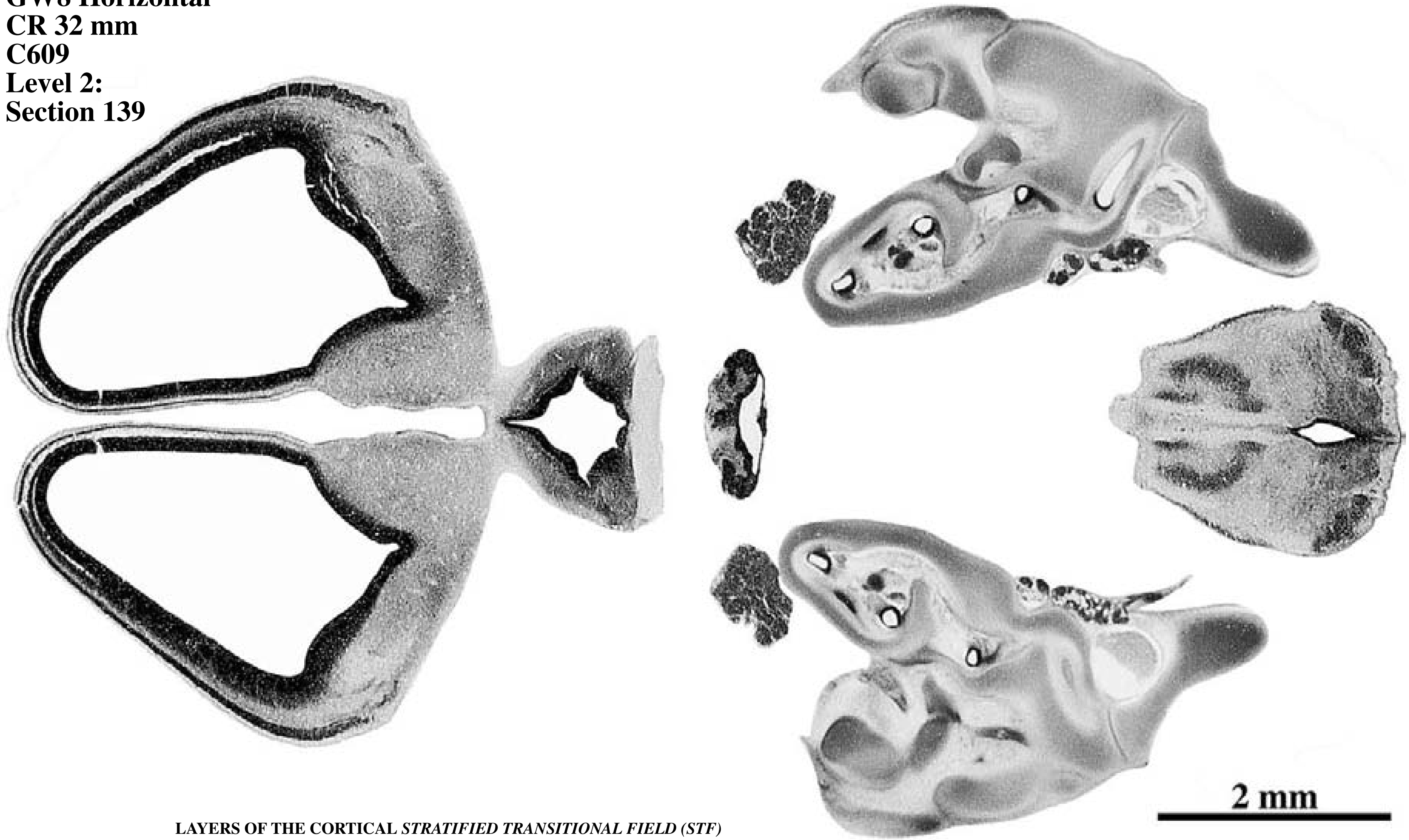
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 171A

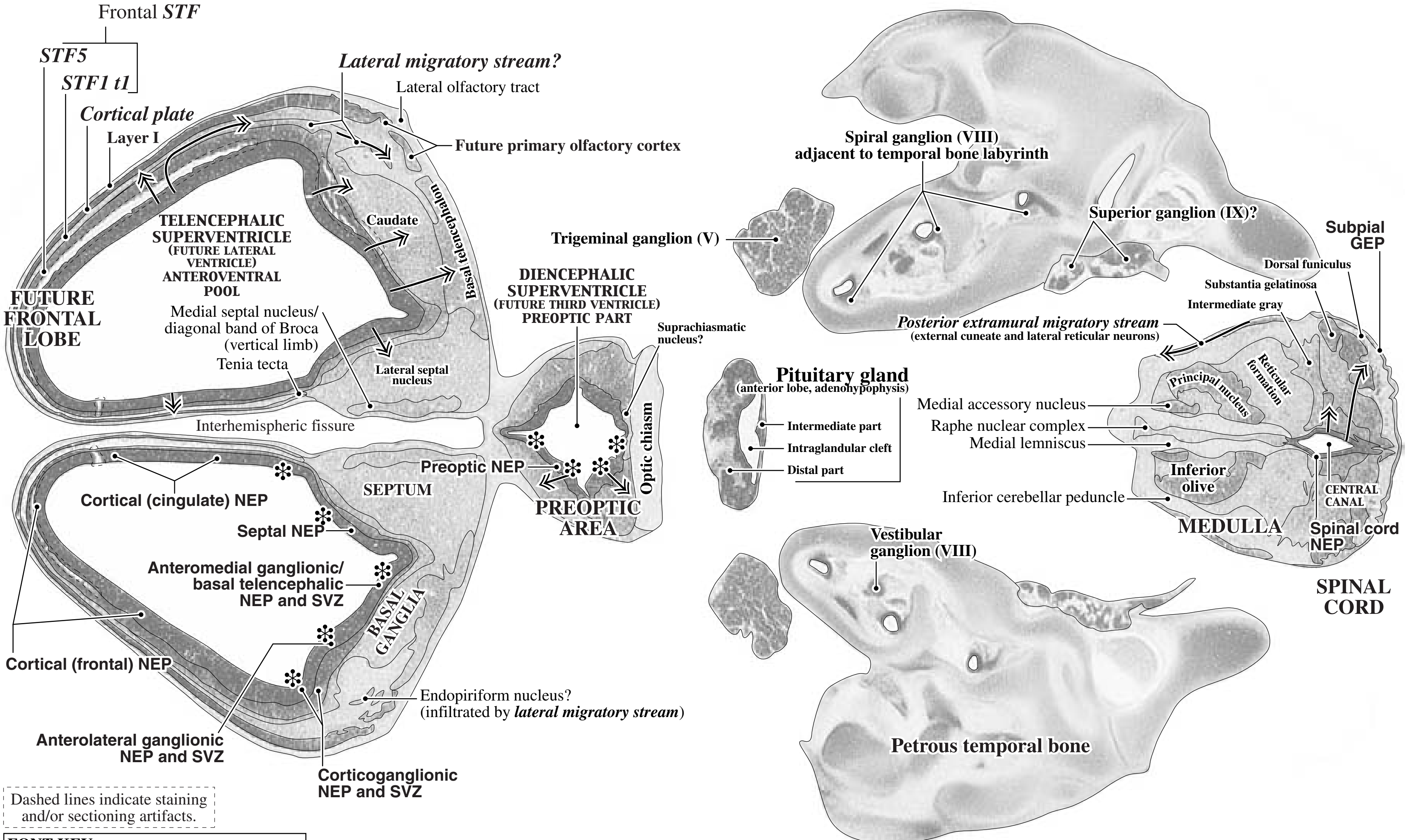
GW8 Horizontal
CR 32 mm
C609
Level 2:
Section 139



LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 171B



Dashed lines indicate staining and/or sectioning artifacts.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

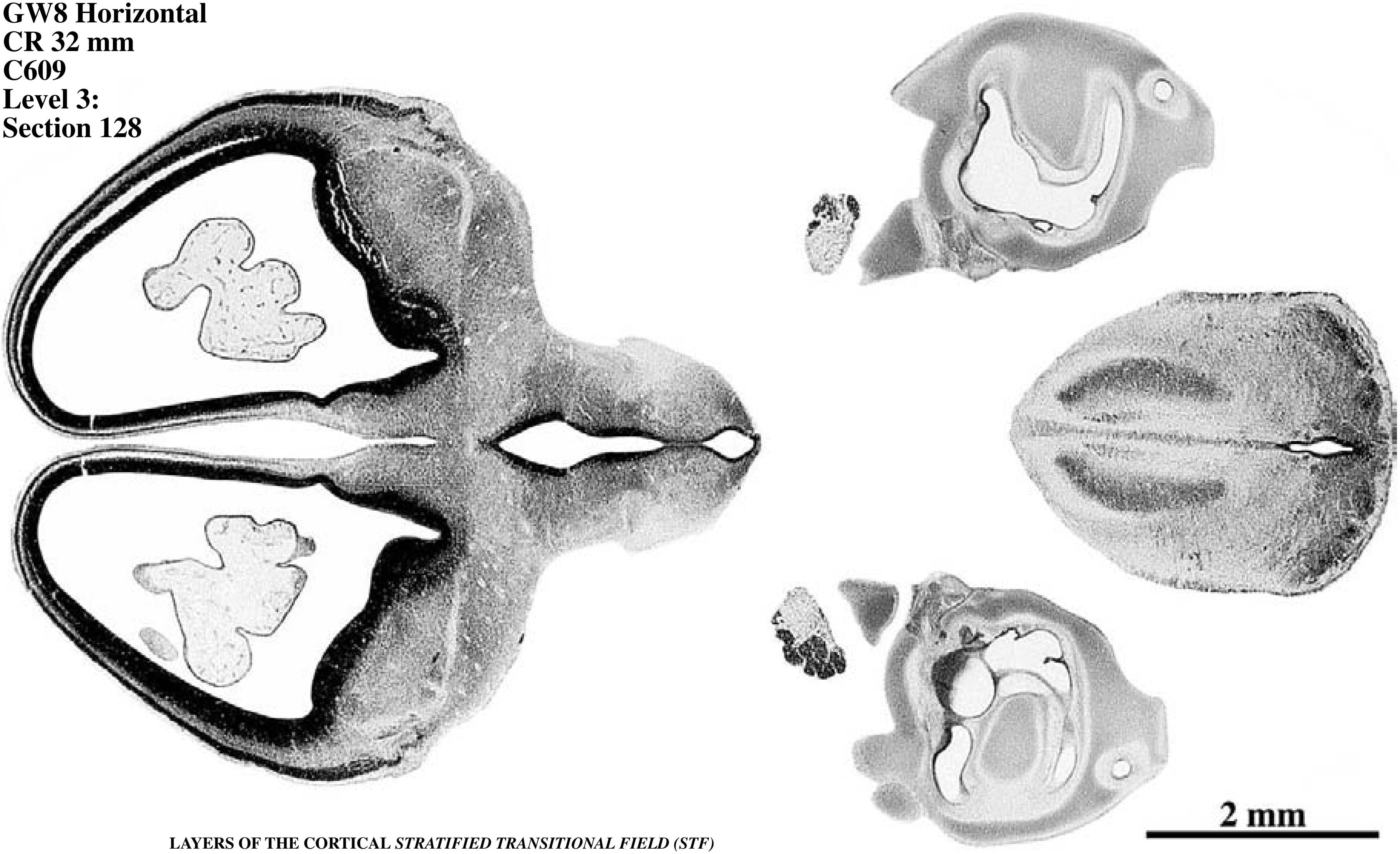
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 172A

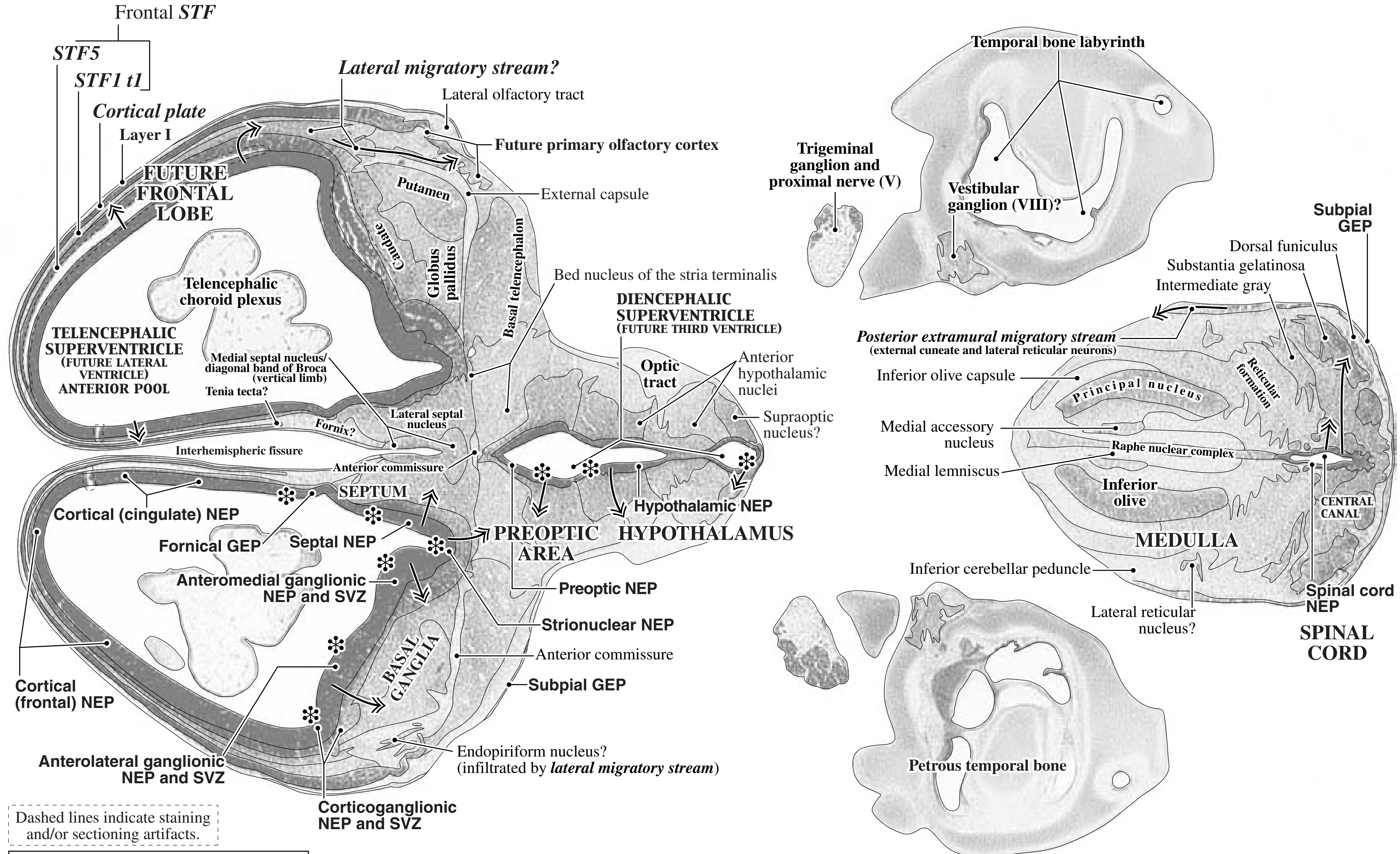
GW8 Horizontal
CR 32 mm
C609
Level 3:
Section 128



LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 172B



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

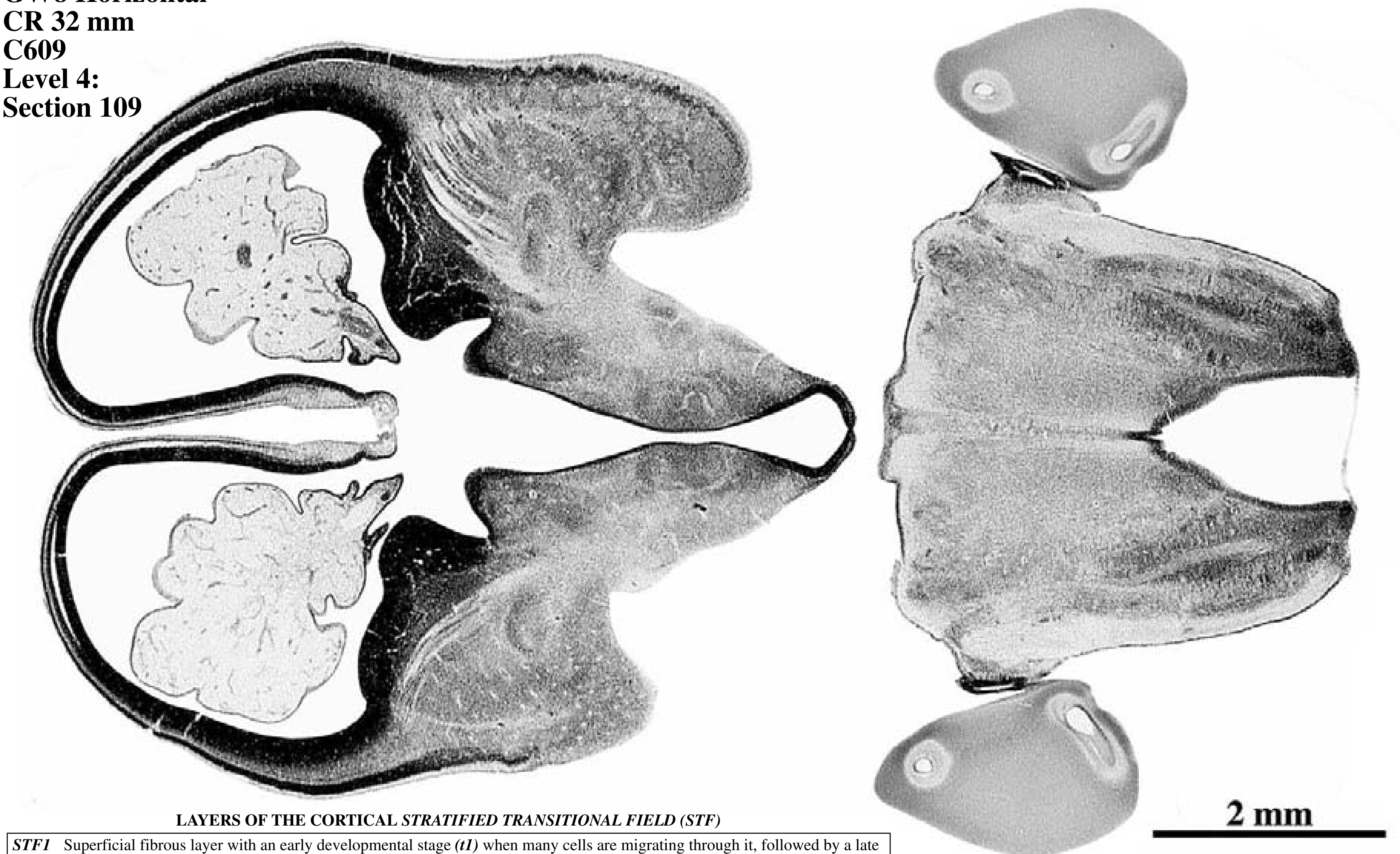
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

❋ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 173A

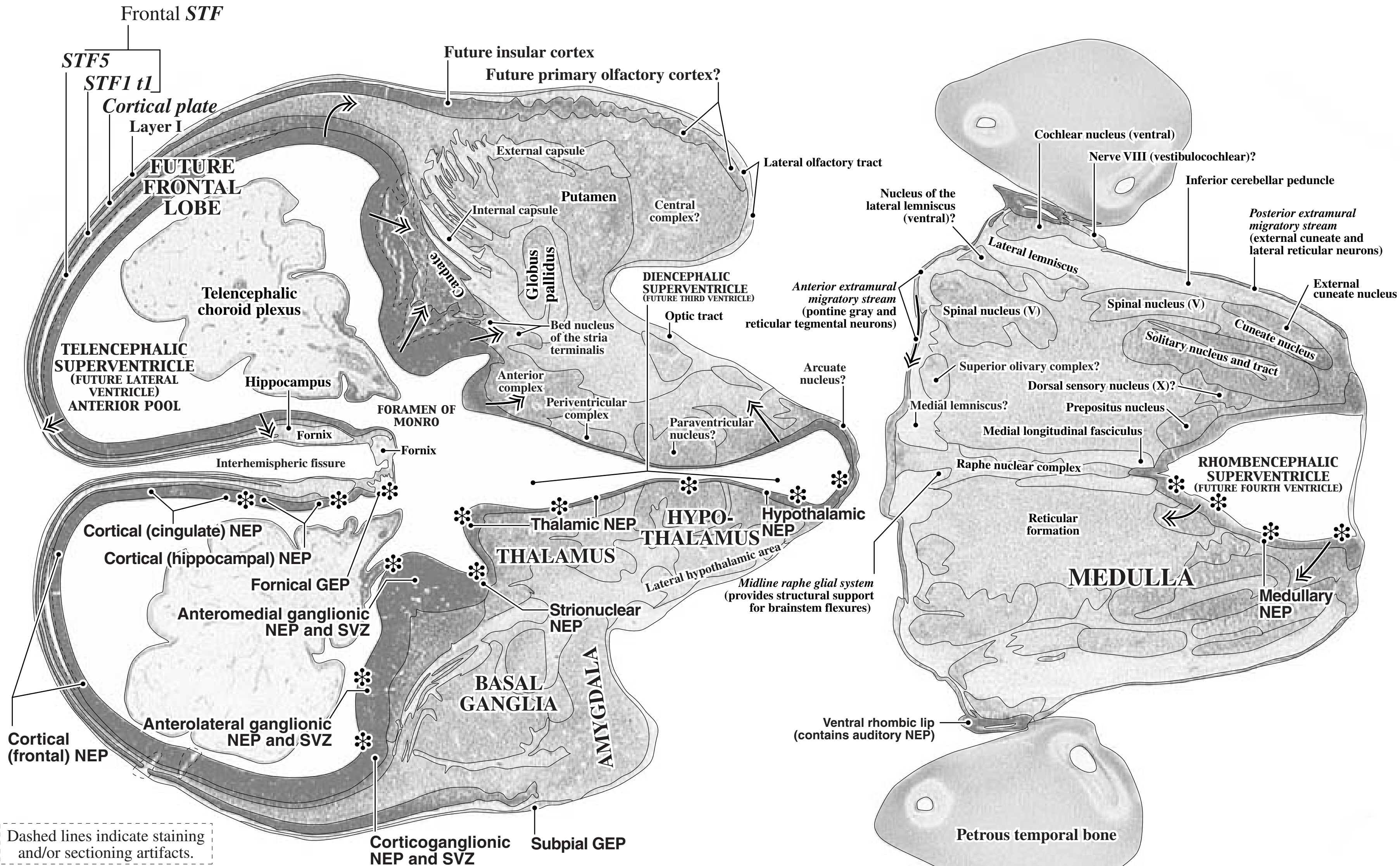
GW8 Horizontal
CR 32 mm
C609
Level 4:
Section 109



LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 173B



Dashed lines indicate staining and/or sectioning artifacts.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

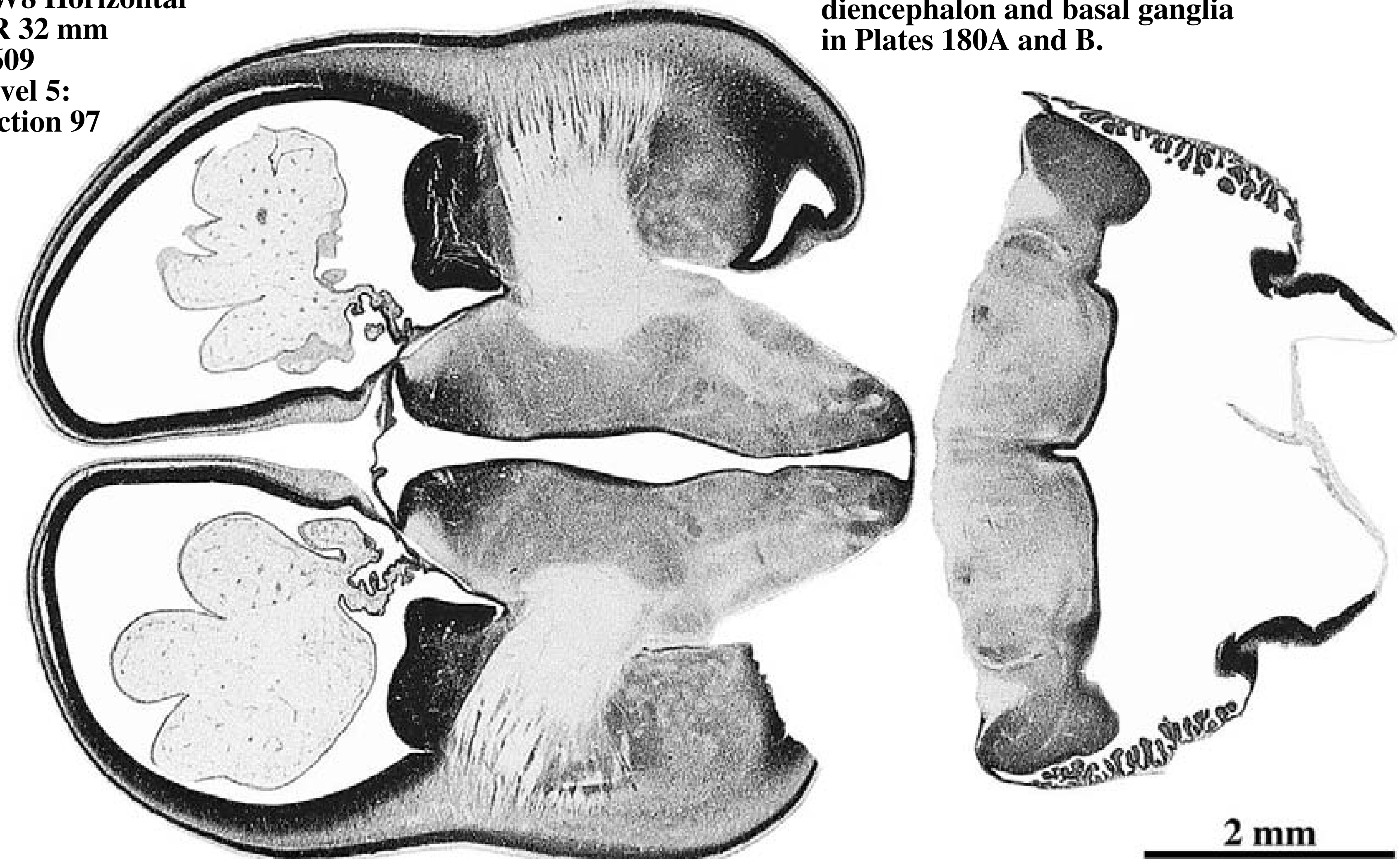
❋ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 174A

GW8 Horizontal
CR 32 mm
C609
Level 5:
Section 97

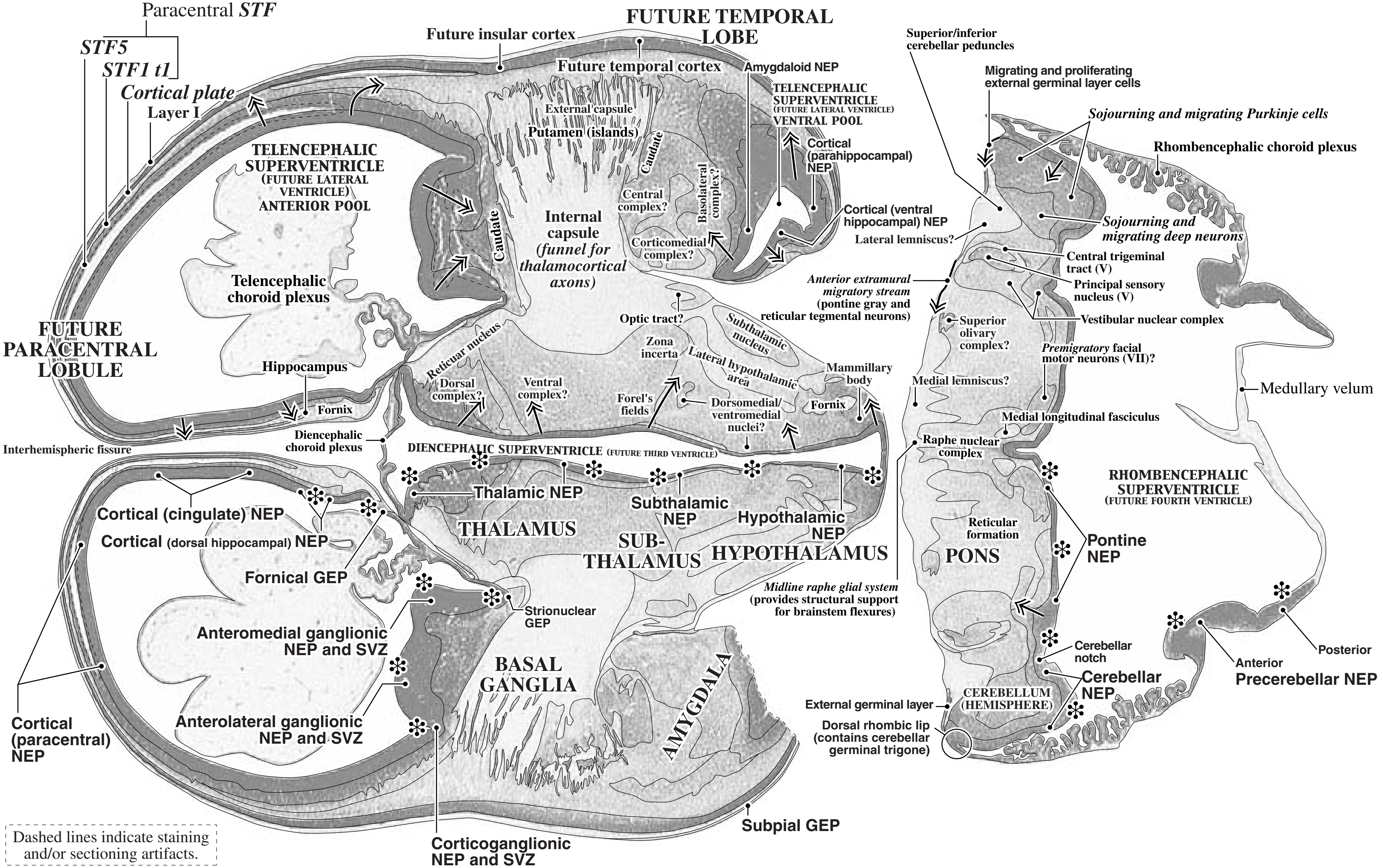
See a high-magnification view of the diencephalon and basal ganglia in Plates 180A and B.



LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 174B



Dashed lines indicate staining and/or sectioning artifacts.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

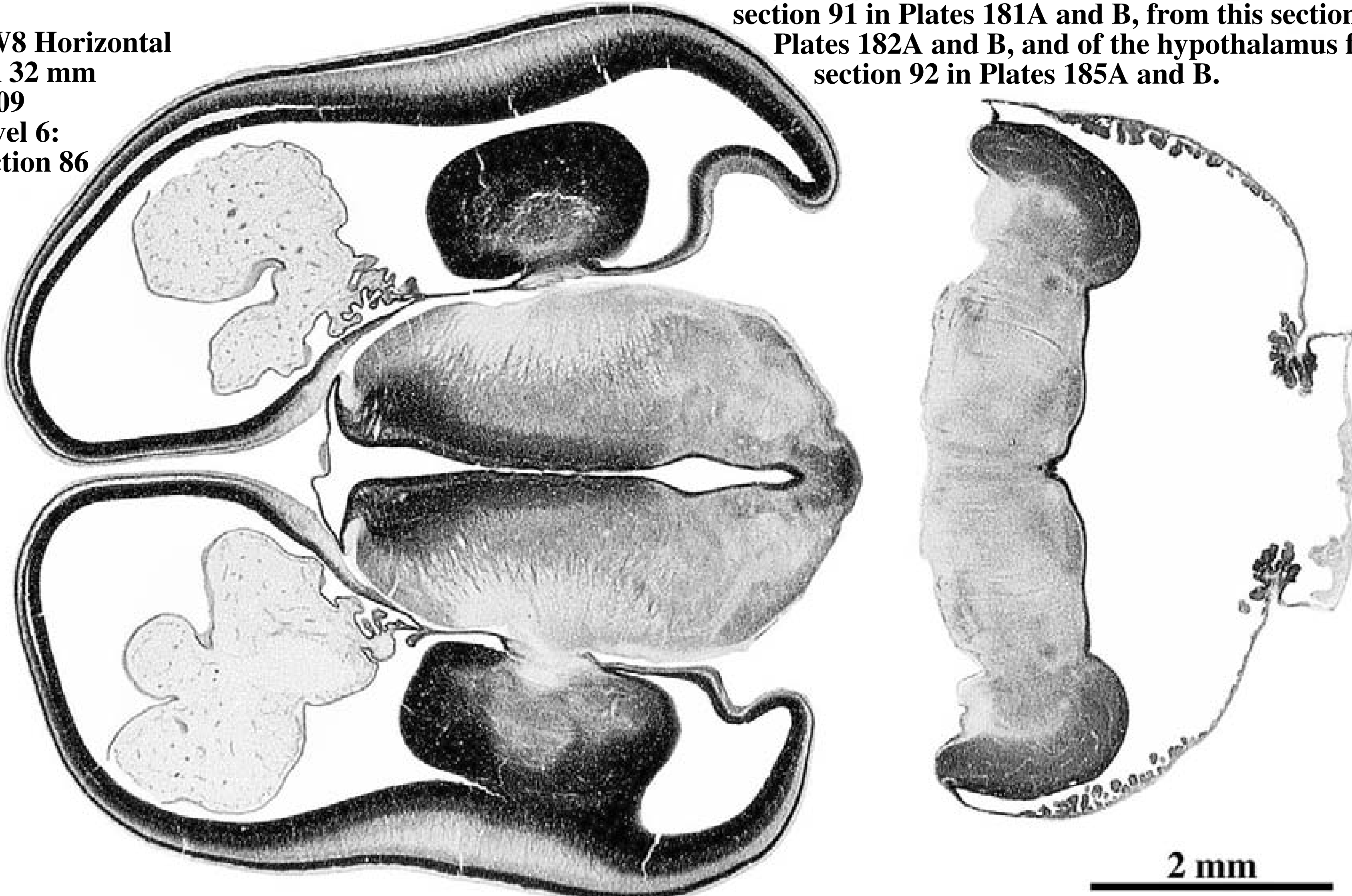
❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 175A

GW8 Horizontal
CR 32 mm
C609
Level 6:
Section 86

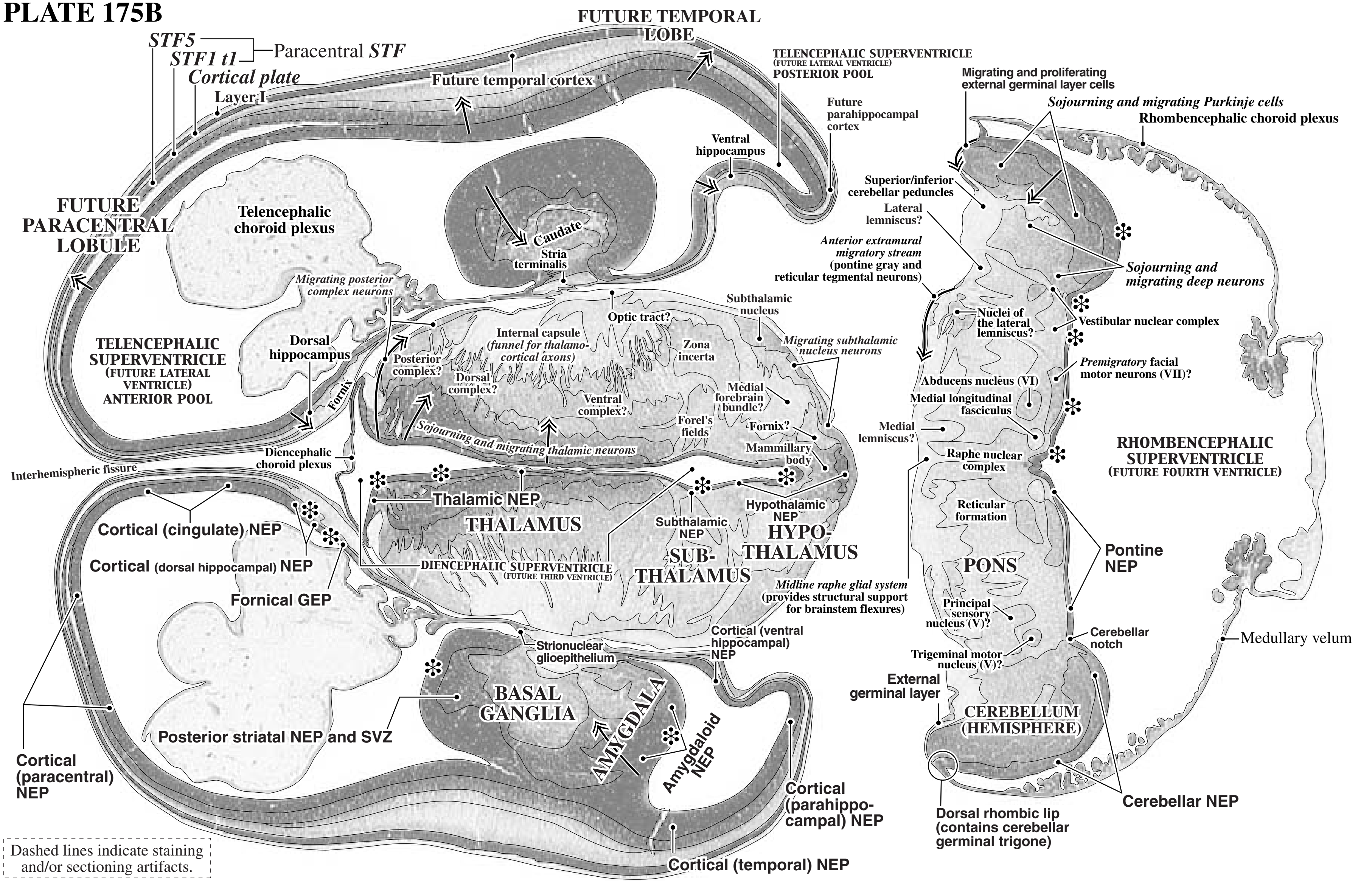
See high-magnification views of the diencephalon from section 91 in Plates 181A and B, from this section in Plates 182A and B, and of the hypothalamus from section 92 in Plates 185A and B.



LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 175B



Dashed lines indicate staining and/or sectioning artifacts.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

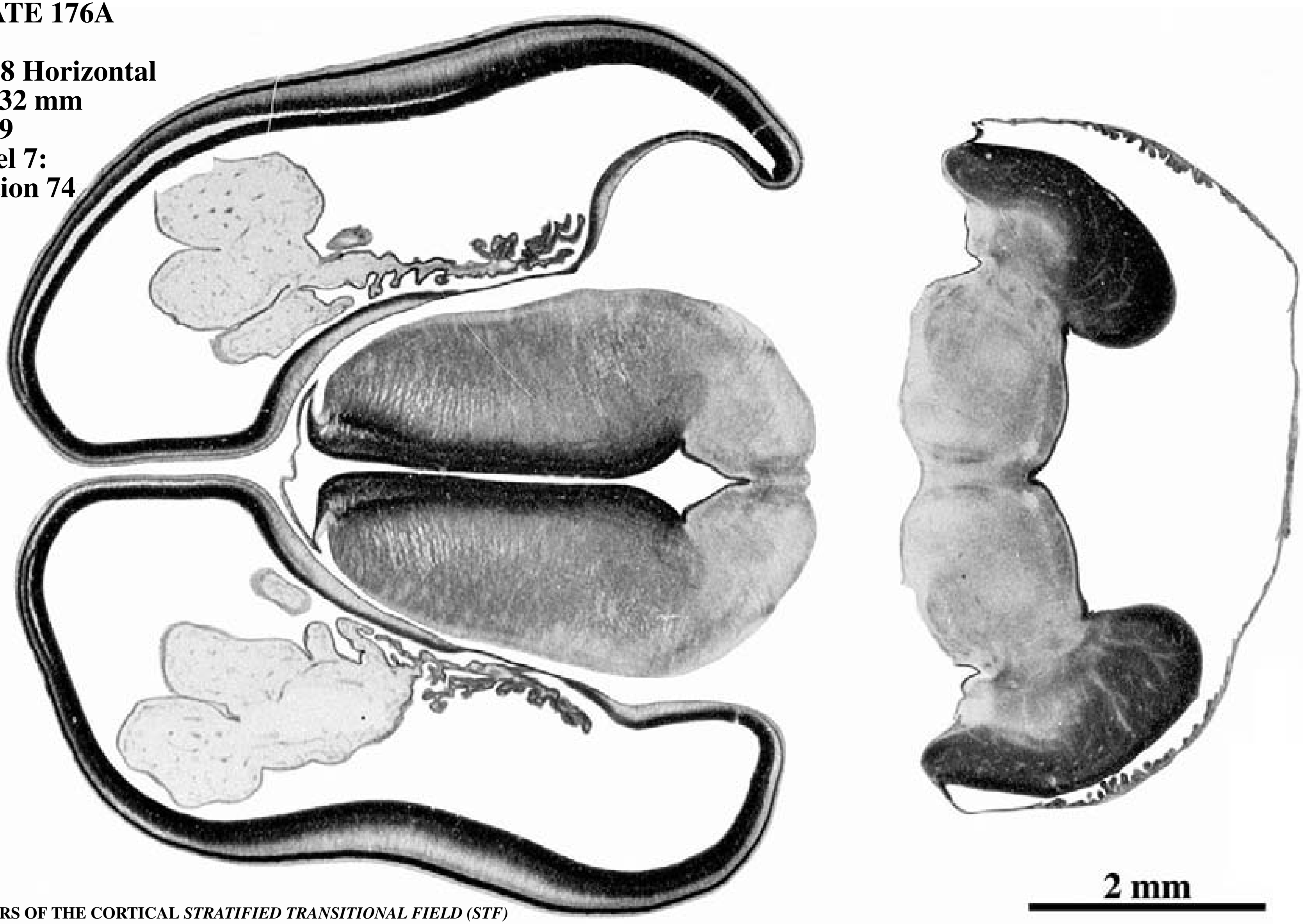
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone

✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 176A

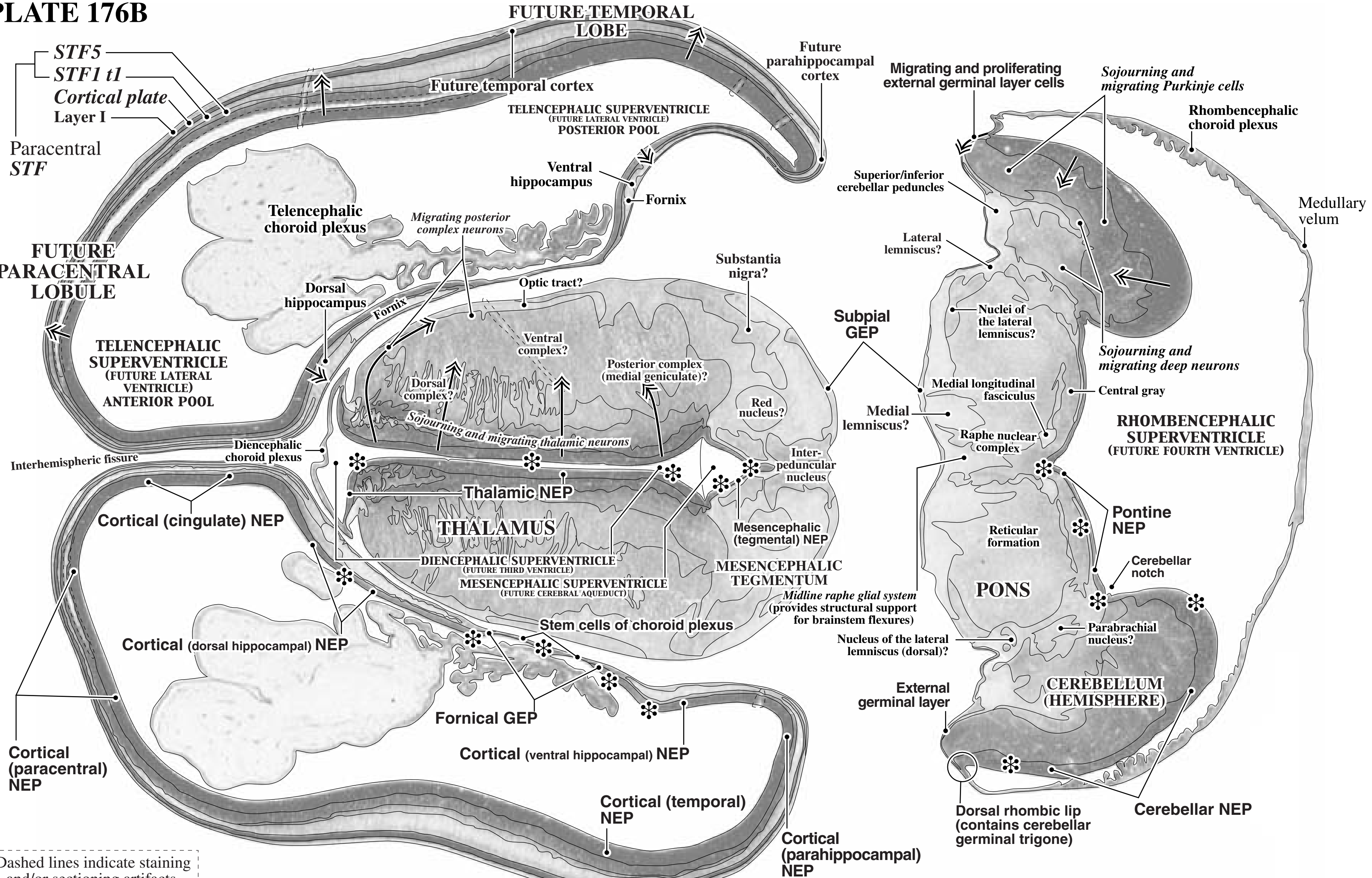
GW8 Horizontal
CR 32 mm
C609
Level 7:
Section 74



LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 176B



Dashed lines indicate staining and/or sectioning artifacts.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

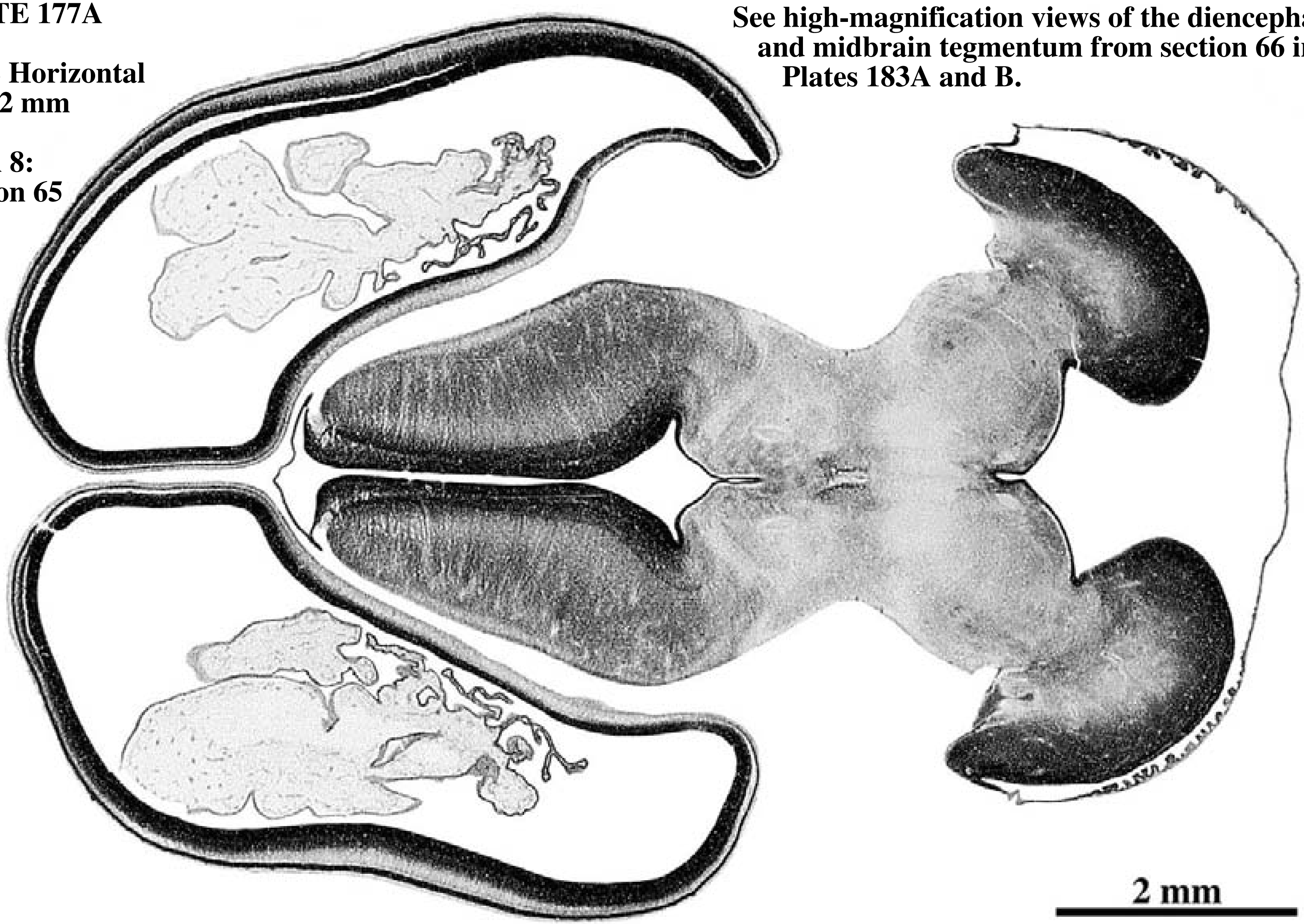
❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 177A

GW8 Horizontal
CR 32 mm
C609
Level 8:
Section 65

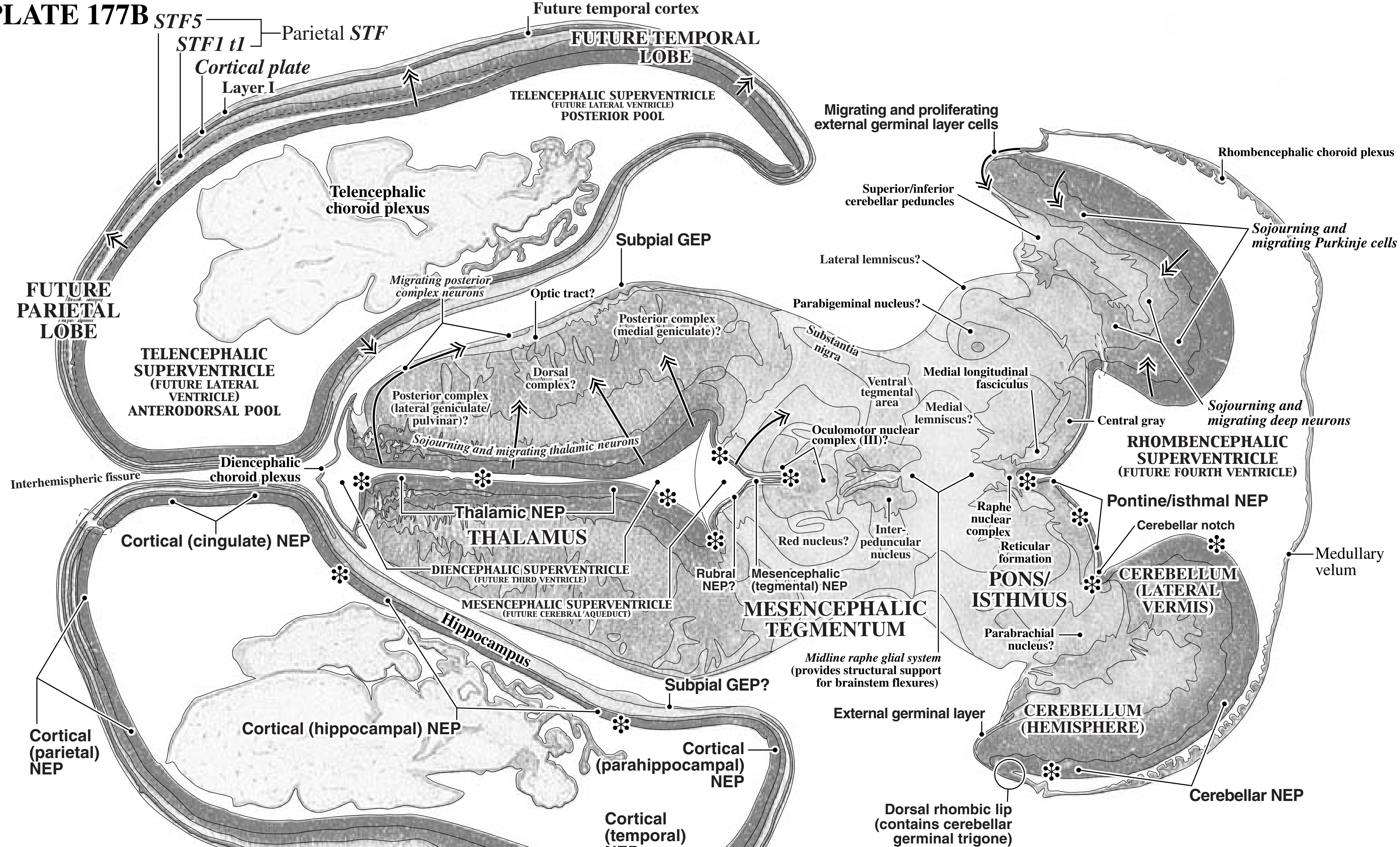
See high-magnification views of the diencephalon and midbrain tegmentum from section 66 in Plates 183A and B.



LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 177B



Dashed lines indicate staining and/or sectioning artifacts.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

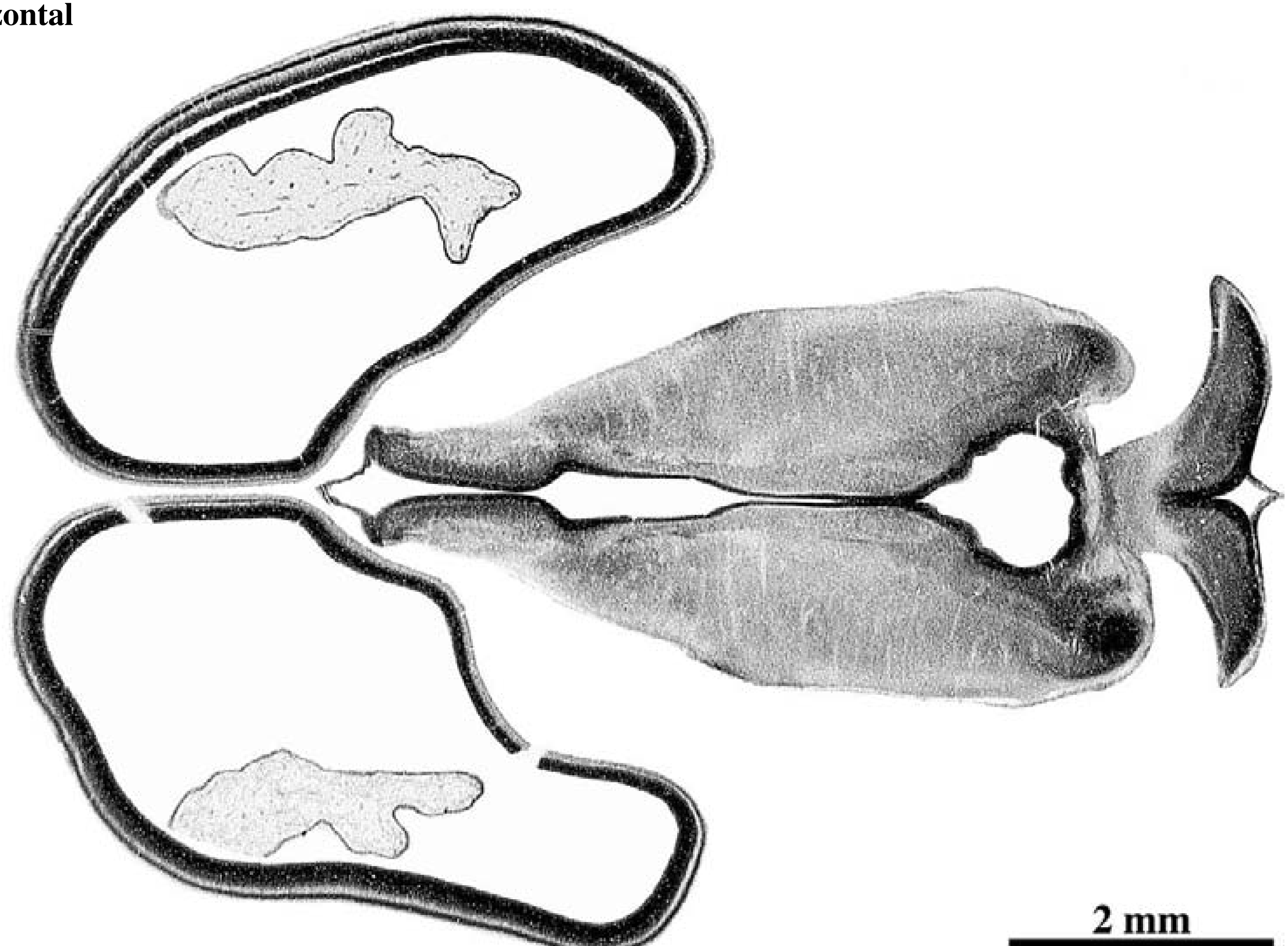
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 178A

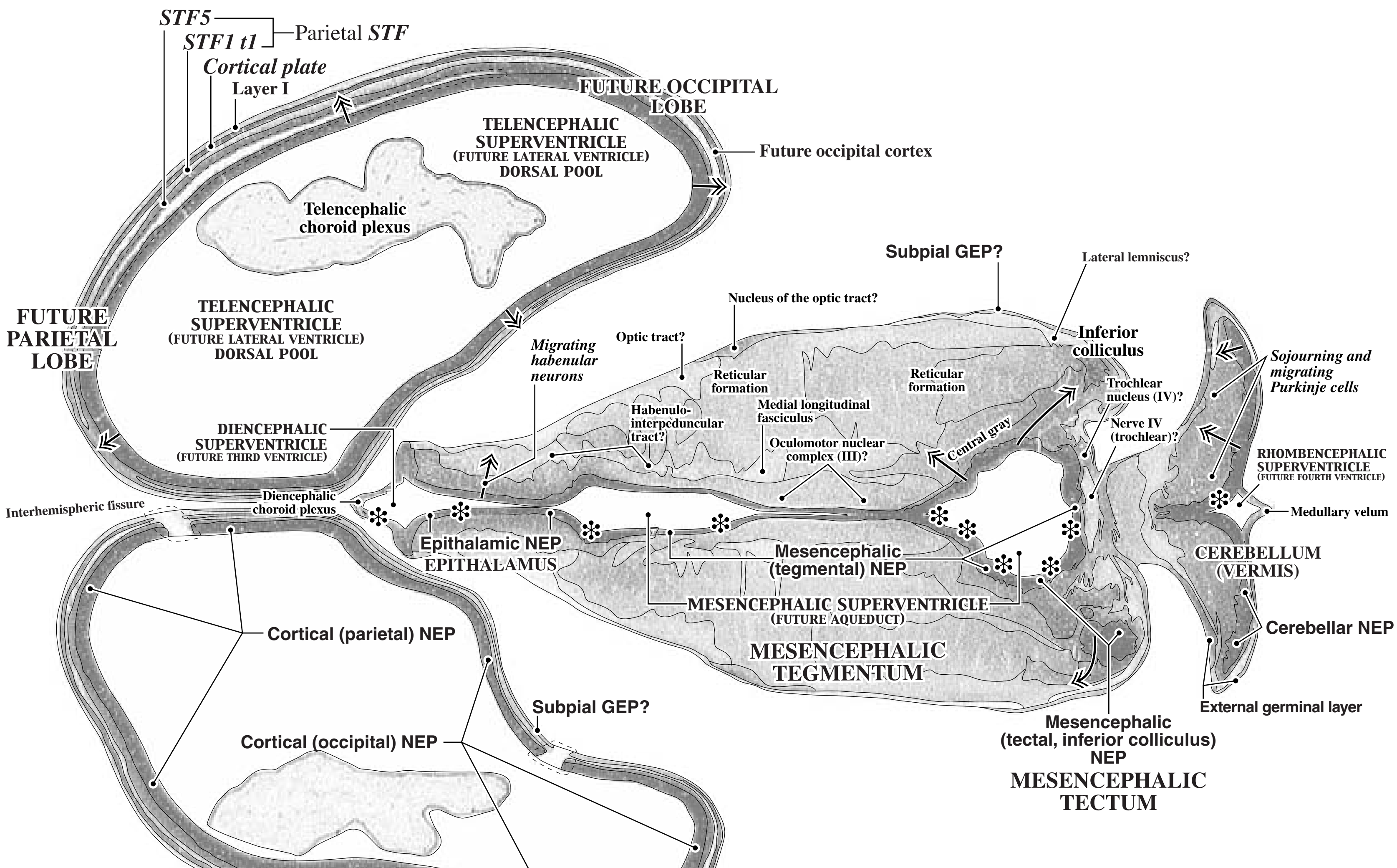
GW8 Horizontal
CR 32 mm
C609
Level 9:
Section 45



LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 178B



Dashed lines indicate staining and/or sectioning artifacts.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

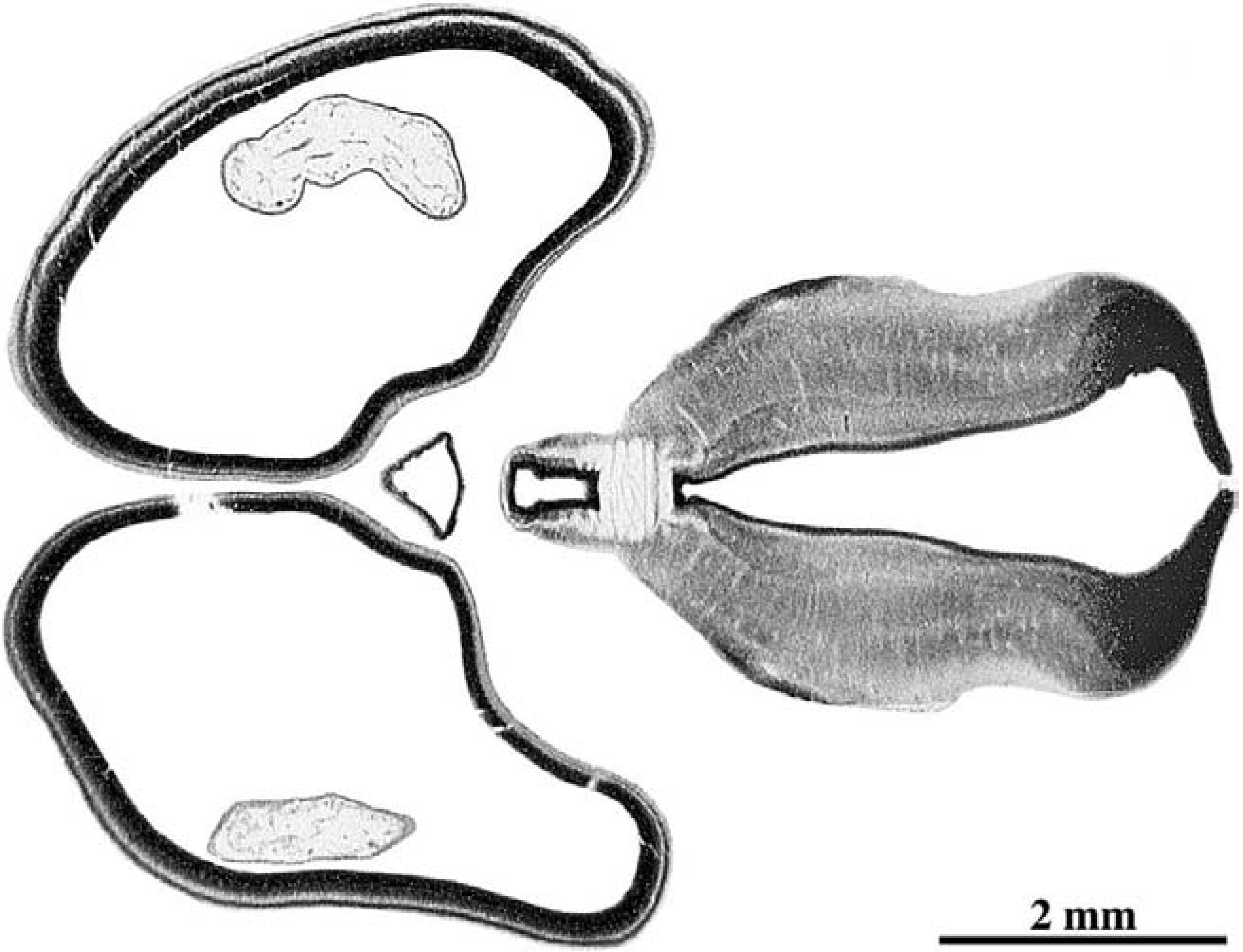
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 179A

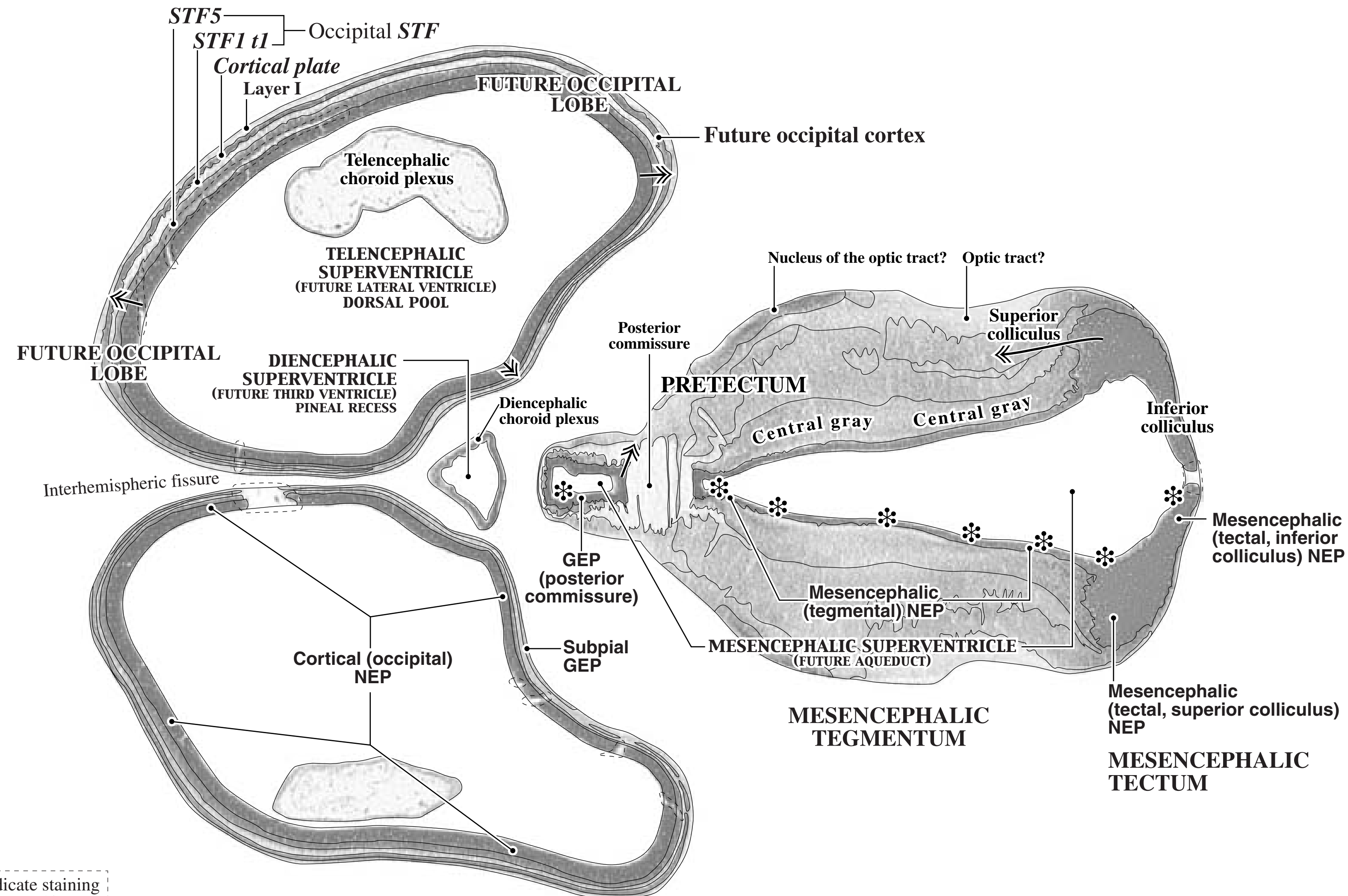
GW8 Horizontal
CR 32 mm
C609
Level 10:
Section 36



LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

PLATE 179B



Dashed lines indicate staining and/or sectioning artifacts.

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

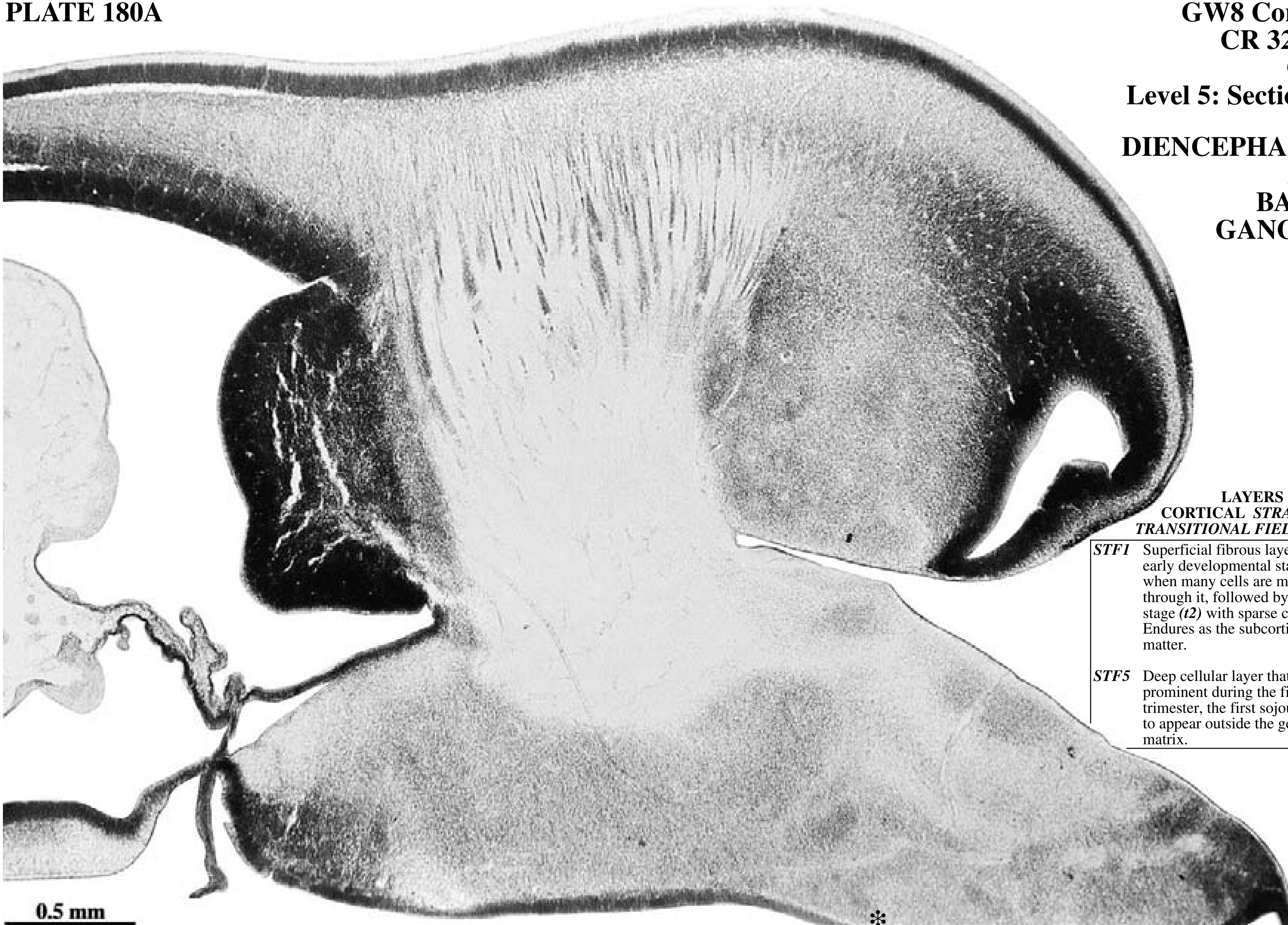
❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 180A

GW8 Coronal
CR 32 mm
C609
Level 5: Section 97

DIENCEPHALON AND BASAL GANGLIA

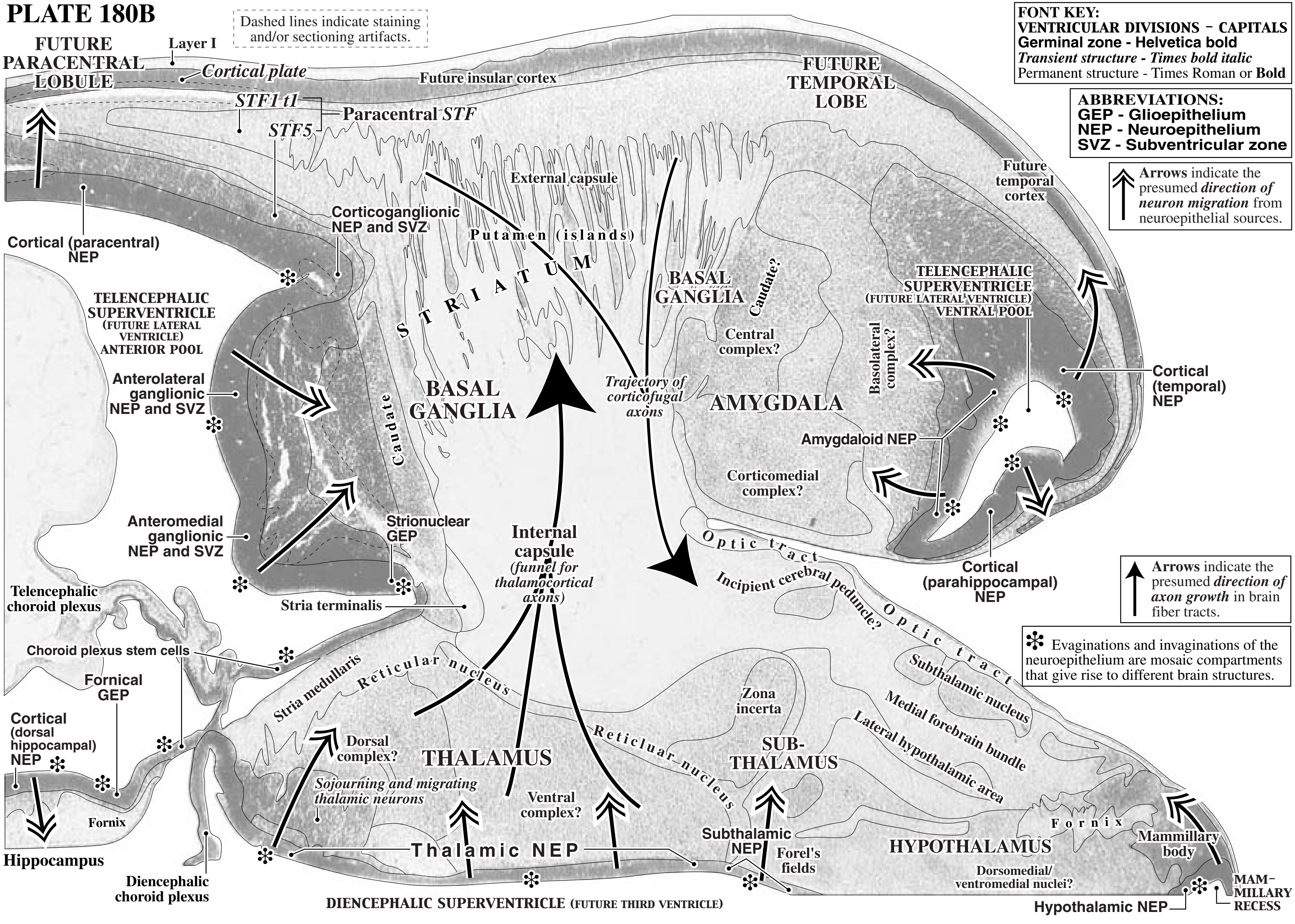


LAYERS OF THE CORTICAL *STRATIFIED TRANSITIONAL FIELD (STF)*

STF1	Superficial fibrous layer with an early developmental stage ***(t1)*** when many cells are migrating through it, followed by a late stage ***(t2)*** with sparse cells. Endures as the subcortical white matter.
STF5	Deep cellular layer that is prominent during the first trimester, the first sojourn zone to appear outside the germinal matrix.

See level 5 in Plates 174A and B.

PLATE 180B

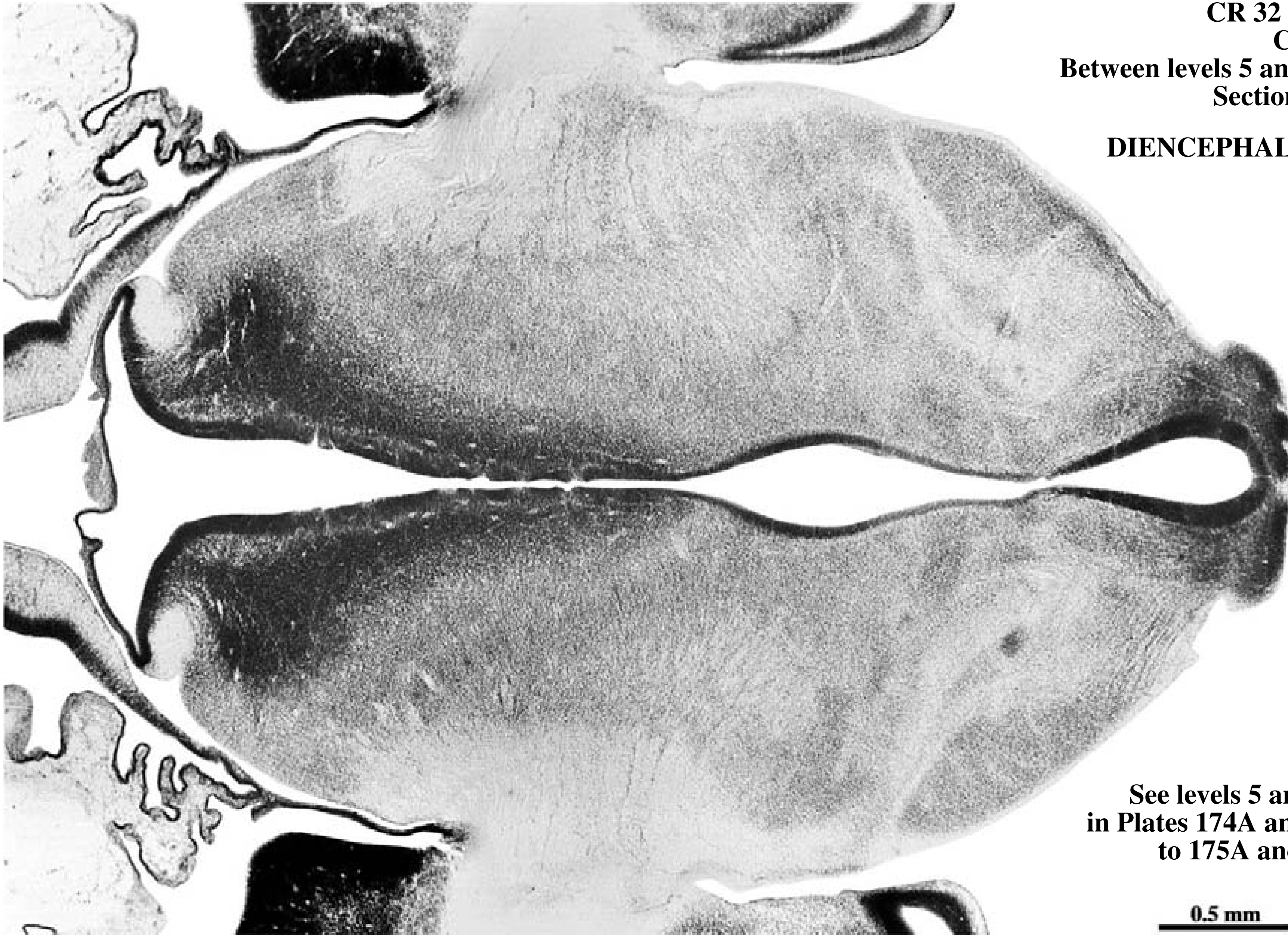


Dashed lines indicate staining and/or sectioning artifacts.
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Arrows indicate the presumed direction of axon growth in brain fiber tracts.
Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.
FUTURE PARACENTRAL LOBULE
Layer I
Cortical plate
Future insular cortex
STF1 t1
STF5
Paracentral STF
FUTURE TEMPORAL LOBE
Future temporal cortex
External capsule
Corticoganglionic NEP and SVZ
Putamen (islands)
Cortical (paracentral) NEP
STRIATUM
BASAL GANGLIA
Caudate?
TELENCEPHALIC SUPERVENTRICLE (FUTURE LATERAL VENTRICLE) VENTRAL POOL
TELENCEPHALIC SUPERVENTRICLE (FUTURE LATERAL VENTRICLE) ANTERIOR POOL
Central complex?
Basolateral complex?
Cortical (temporal) NEP
Anterolateral ganglionic NEP and SVZ
Caudate
BASAL GANGLIA
Trajectory of corticofugal axons
AMYGDALA
Amygdaloid NEP
Corticomedial complex?
Anteromedial ganglionic NEP and SVZ
Strionuclear GEP
Internal capsule (funnel for thalamocortical axons)
Optic tract
Cortical (parahippocampal) NEP
Incipient cerebral peduncle?
Telencephalic choroid plexus
Stria terminalis
Optic tract
Choroid plexus stem cells
Stria medullaris
Reticular nucleus
Subthalamic nucleus
Fornical GEP
Zona incerta
Medial forebrain bundle
Cortical (dorsal hippocampal) NEP
Dorsal complex?
THALAMUS
Reticluar nucleus
SUB-THALAMUS
Lateral hypothalamic area
Sojourning and migrating thalamic neurons
Ventral complex?
Fornix
Fornix
Mammillary body
Hippocampus
Thalamic NEP
Subthalamic NEP
Forel's fields
HYPOTHALAMUS
Dorsomedial/ ventromedial nuclei?
Diencephalic choroid plexus
DIENCEPHALIC SUPERVENTRICLE (FUTURE THIRD VENTRICLE)
Hypothalamic NEP
MAM-MILLARY RECESS

PLATE 181A

GW8 Coronal
CR 32 mm
C609
Between levels 5 and 6:
Section 91

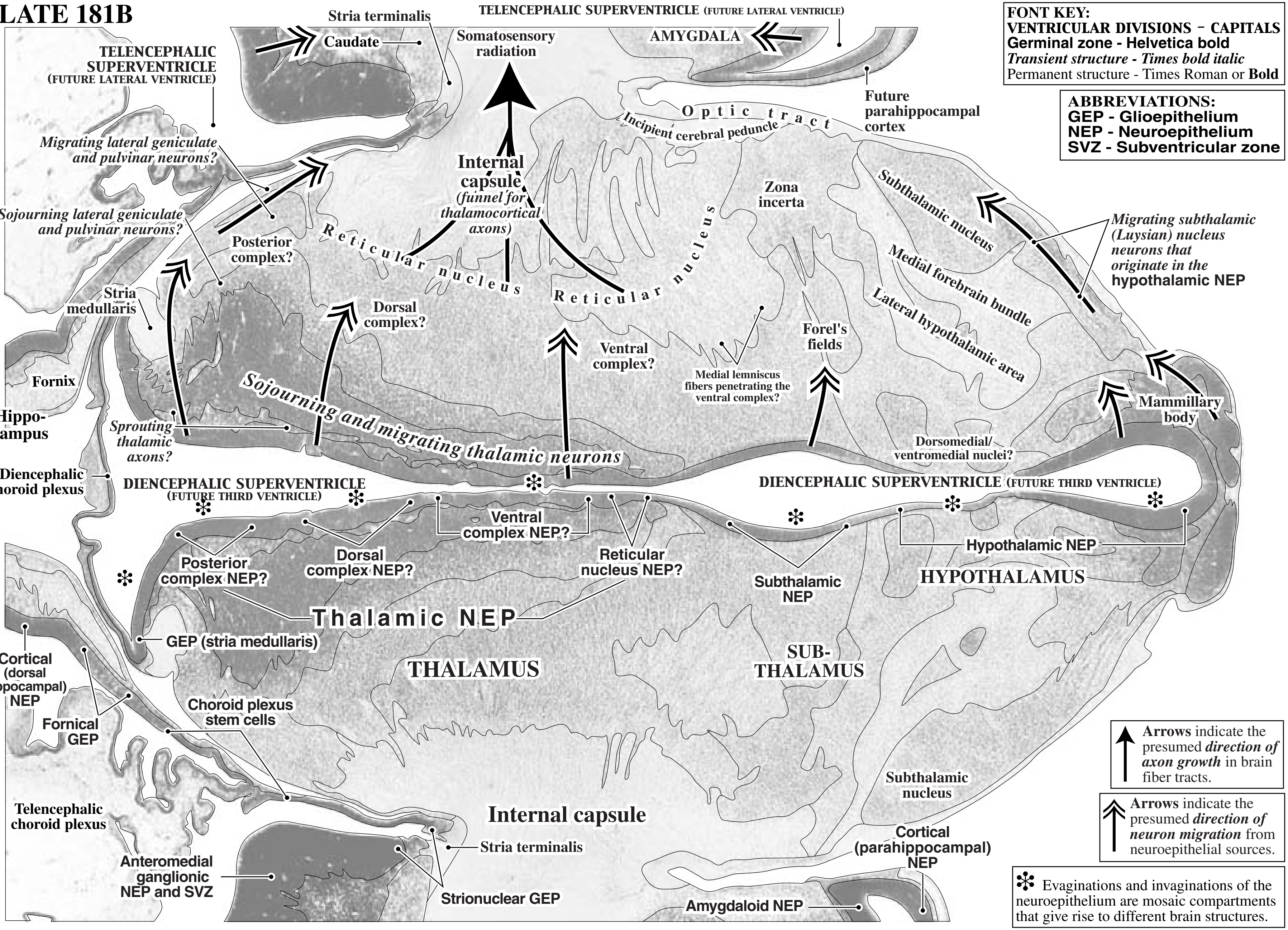
DIENCEPHALON



See levels 5 and 6
in Plates 174A and B
to 175A and B.

0.5 mm

PLATE 181B

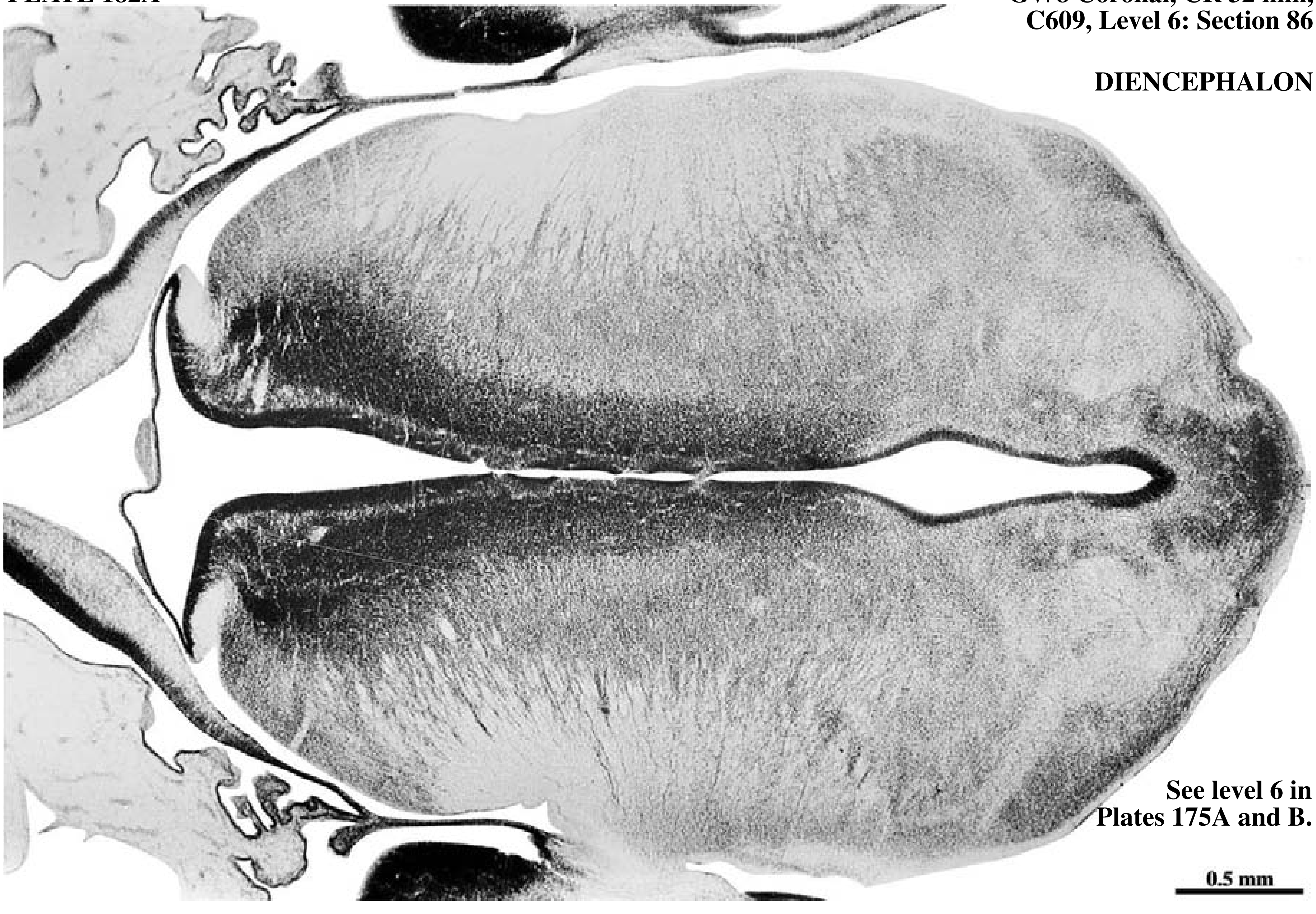


FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone
TELENCEPHALIC SUPERVENTRICLE (FUTURE LATERAL VENTRICLE)
Stria terminalis
Caudate
Somatosensory radiation
AMYGDALA
TELENCEPHALIC SUPERVENTRICLE (FUTURE LATERAL VENTRICLE)
Future parahippocampal cortex
Optic tract
Incipient cerebral peduncle
Migrating lateral geniculate and pulvinar neurons?
Internal capsule (funnel for thalamocortical axons)
Zona incerta
Subthalamic nucleus
Sojourning lateral geniculate and pulvinar neurons?
Posterior complex?
Reticular nucleus
Reticular nucleus
Migrating subthalamic (Luysian) nucleus neurons that originate in the hypothalamic NEP
Medial forebrain bundle
Stria medullaris
Dorsal complex?
Lateral hypothalamic area
Forel's fields
Ventral complex?
Medial lemniscus fibers penetrating the ventral complex?
Fornix
Sojourning and migrating thalamic neurons
Mammillary body
Hippo-campus
Sprouting thalamic axons?
Dorsomedial/ ventromedial nuclei?
Diencephalic choroid plexus
DIENCEPHALIC SUPERVENTRICLE (FUTURE THIRD VENTRICLE)
DIENCEPHALIC SUPERVENTRICLE (FUTURE THIRD VENTRICLE)
Ventral complex NEP?
Posterior complex NEP?
Dorsal complex NEP?
Reticular nucleus NEP?
Subthalamic NEP
Hypothalamic NEP
HYPOTHALAMUS
Thalamic NEP
GEP (stria medullaris)
THALAMUS
SUB-THALAMUS
Cortical (dorsal hippocampal) NEP
Fornical GEP
Choroid plexus stem cells
Subthalamic nucleus
Telencephalic choroid plexus
Internal capsule
Stria terminalis
Cortical (parahippocampal) NEP
Anteromedial ganglionic NEP and SVZ
Strionuclear GEP
Amygdaloid NEP
Arrows indicate the presumed direction of axon growth in brain fiber tracts.
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

PLATE 182A

GW8 Coronal, CR 32 mm,
C609, Level 6: Section 86

DIENCEPHALON



See level 6 in
Plates 175A and B.

0.5 mm

PLATE 182B

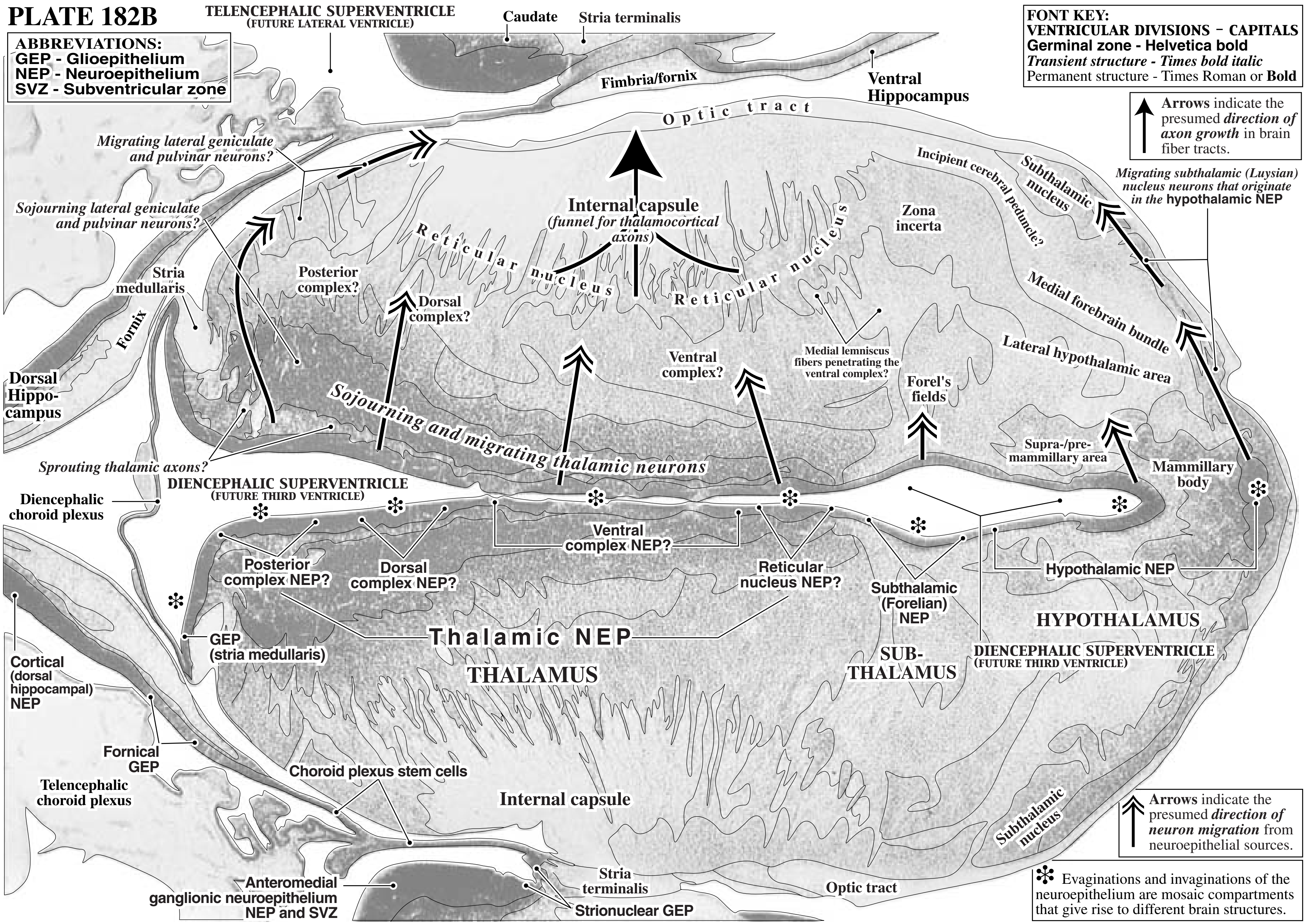
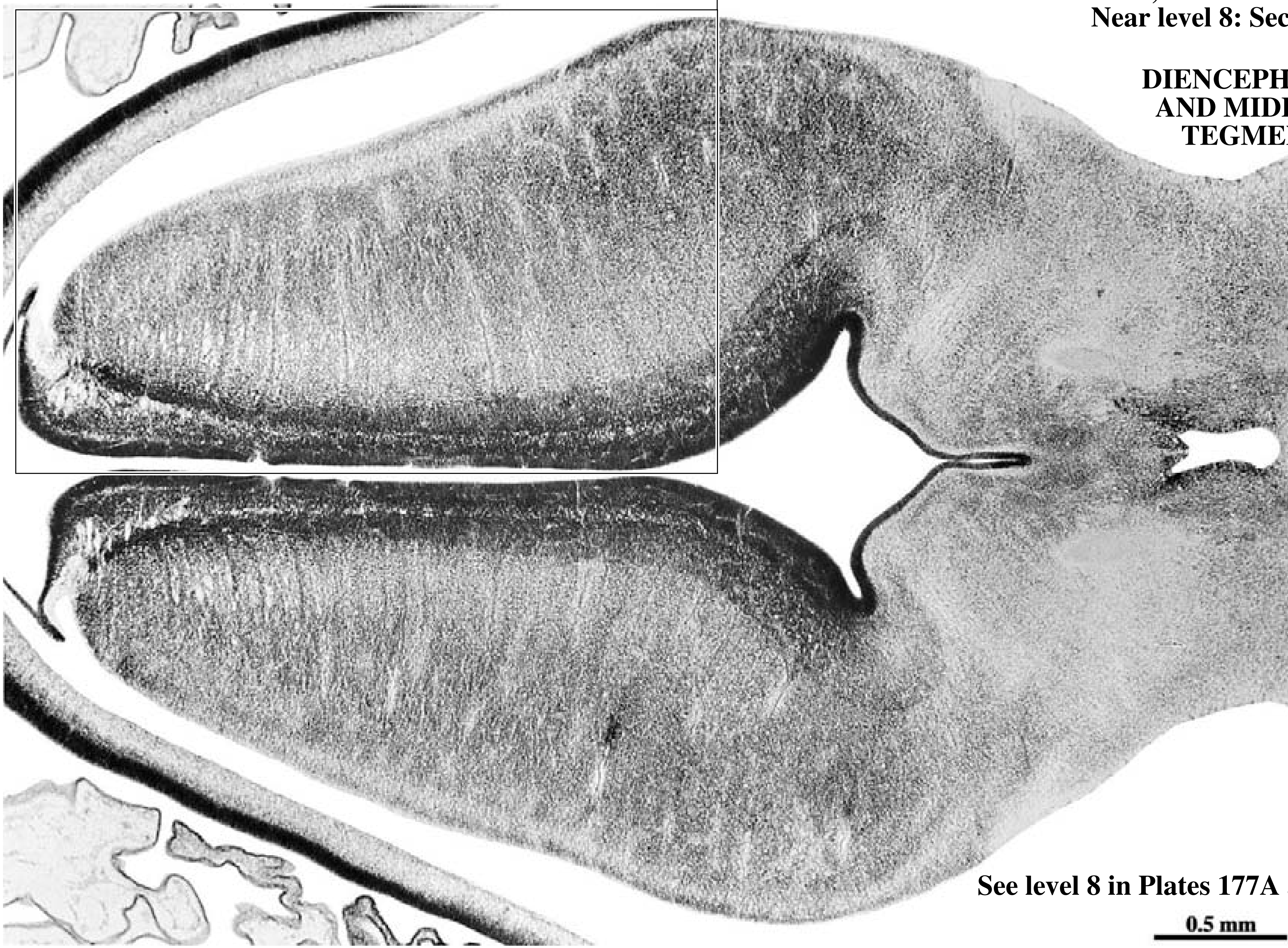

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone
TELENCEPHALIC SUPERVENTRICLE
(FUTURE LATERAL VENTRICLE)
Caudate
Stria terminalis
Fimbria/fornix
Ventral Hippocampus
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
Arrows indicate the presumed direction of axon growth in brain fiber tracts.
Optic tract
Migrating lateral geniculate and pulvinar neurons?
Sojourning lateral geniculate and pulvinar neurons?
Internal capsule
(funnel for thalamocortical axons)
Reticular nucleus
Reticular nucleus
Incipient cerebral peduncle?
Subthalamic nucleus
Migrating subthalamic (Luysian) nucleus neurons that originate in the hypothalamic NEP
Zona incerta
Stria medullaris
Fornix
Posterior complex?
Dorsal complex?
Medial forebrain bundle
Lateral hypothalamic area
Ventral complex?
Medial lemniscus fibers penetrating the ventral complex?
Forel's fields
Dorsal Hippo-campus
Sojourning and migrating thalamic neurons
Sprouting thalamic axons?
Supra-/pre-mammillary area
Mammillary body
DIENCEPHALIC SUPERVENTRICLE
(FUTURE THIRD VENTRICLE)
Diencephalic choroid plexus
Ventral complex NEP?
Posterior complex NEP?
Dorsal complex NEP?
Reticular nucleus NEP?
Subthalamic (Forelian) NEP
Hypothalamic NEP
HYPOTHALAMUS
Thalamic NEP
GEP (stria medullaris)
THALAMUS
SUB-THALAMUS
DIENCEPHALIC SUPERVENTRICLE
(FUTURE THIRD VENTRICLE)
Cortical (dorsal hippocampal) NEP
Fornical GEP
Telencephalic choroid plexus
Choroid plexus stem cells
Internal capsule
Subthalamic nucleus
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.
Anteromedial ganglionic neuroepithelium NEP and SVZ
Stria terminalis
Strionuclear GEP
Optic tract

PLATE 183A

GW8 Coronal, CR 32 mm, C609
Near level 8: Section 66

DIENCEPHALON AND MIDBRAIN TEGMENTUM

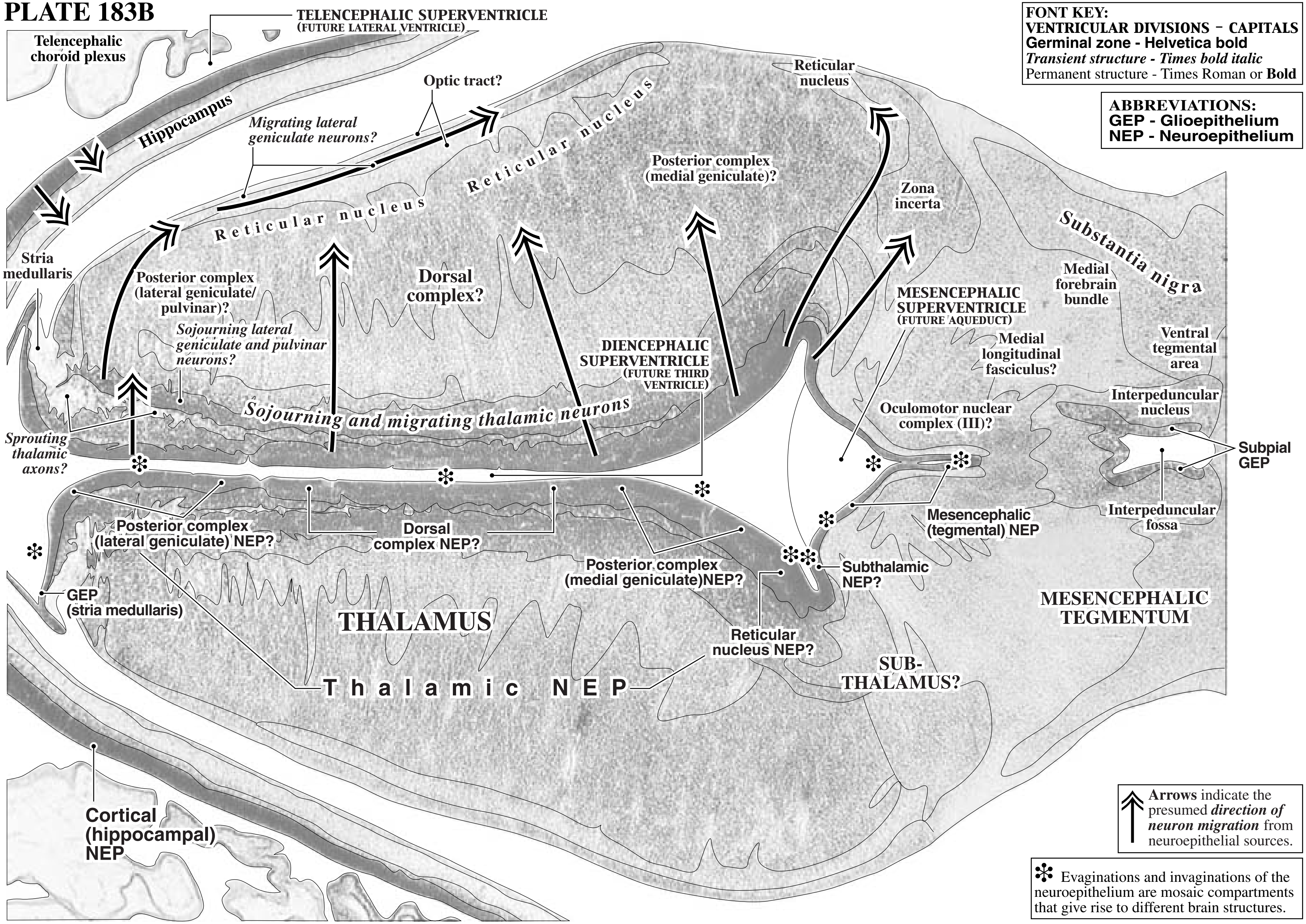
Enlarged in Plates 184A and B.



See level 8 in Plates 177A and B.

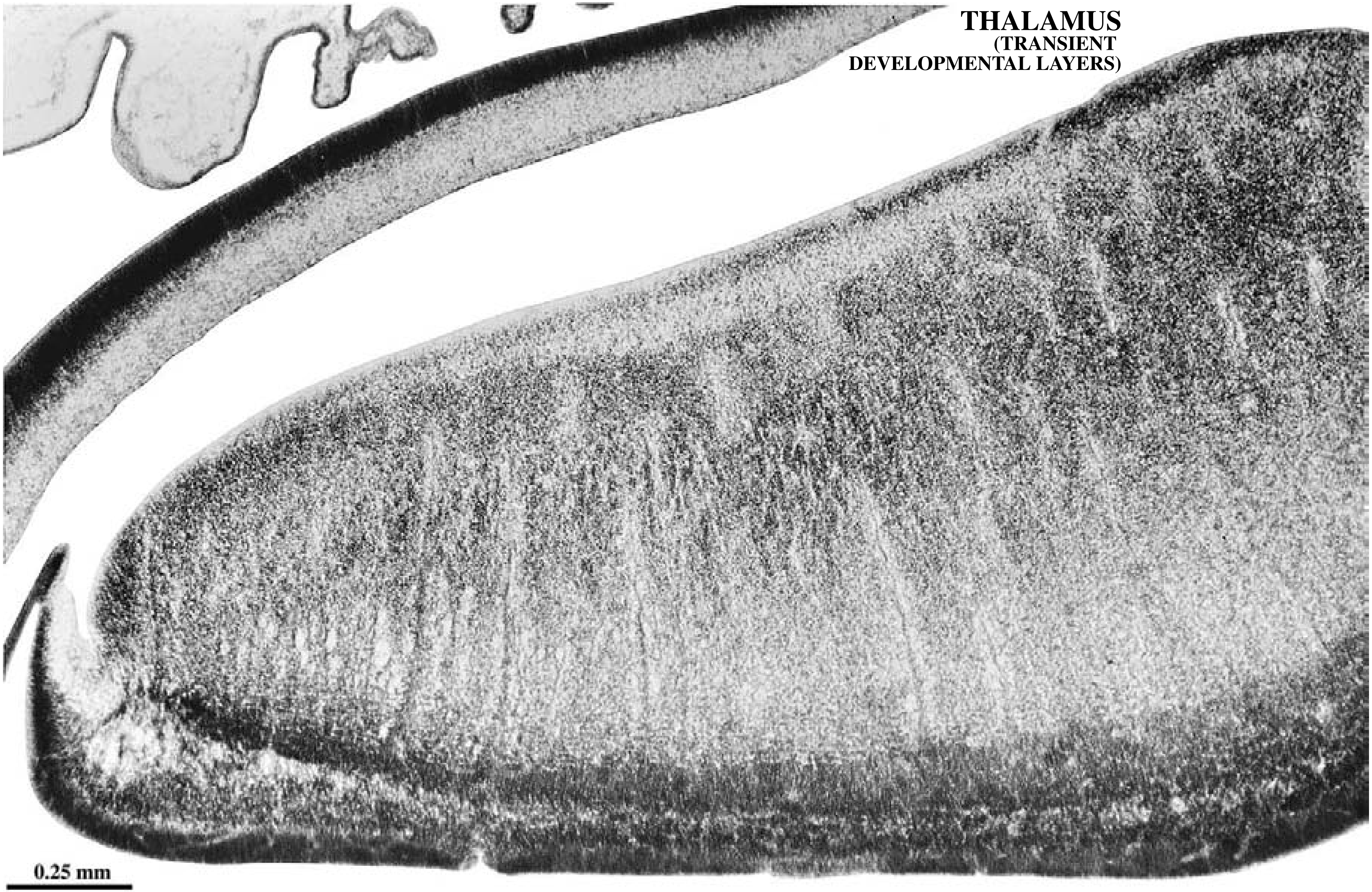
0.5 mm

PLATE 183B



TELENCEPHALIC SUPERVENTRICLE
(FUTURE LATERAL VENTRICLE)
Telencephalic choroid plexus
Hippocampus
Optic tract?
Migrating lateral geniculate neurons?
Reticular nucleus
Reticular nucleus
Reticular nucleus
Posterior complex (medial geniculate)?
Zona incerta
Stria medullaris
Posterior complex (lateral geniculate/ pulvinar)?
Sojourning lateral geniculate and pulvinar neurons?
Dorsal complex?
DIENCEPHALIC SUPERVENTRICLE
(FUTURE THIRD VENTRICLE)
MESENCEPHALIC SUPERVENTRICLE
(FUTURE AQUEDUCT)
Substantia nigra
Medial forebrain bundle
Medial longitudinal fasciculus?
Ventral tegmental area
Interpeduncular nucleus
Oculomotor nuclear complex (III)?
Sojourning and migrating thalamic neurons
Sprouting thalamic axons?
Subpial GEP
Mesencephalic (tegmental) NEP
Interpeduncular fossa
Posterior complex (lateral geniculate) NEP?
Dorsal complex NEP?
Posterior complex (medial geniculate)NEP?
Subthalamic NEP?
GEP (stria medullaris)
THALAMUS
MESENCEPHALIC TEGMENTUM
Reticular nucleus NEP?
SUB-THALAMUS?
Thalamic NEP
Cortical (hippocampal) NEP
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

PLATE 184A **GW8 Coronal, CR 32 mm, C609, Near level 8: Section 66**



See level 8 in Plates 177A and B.

PLATE 184B

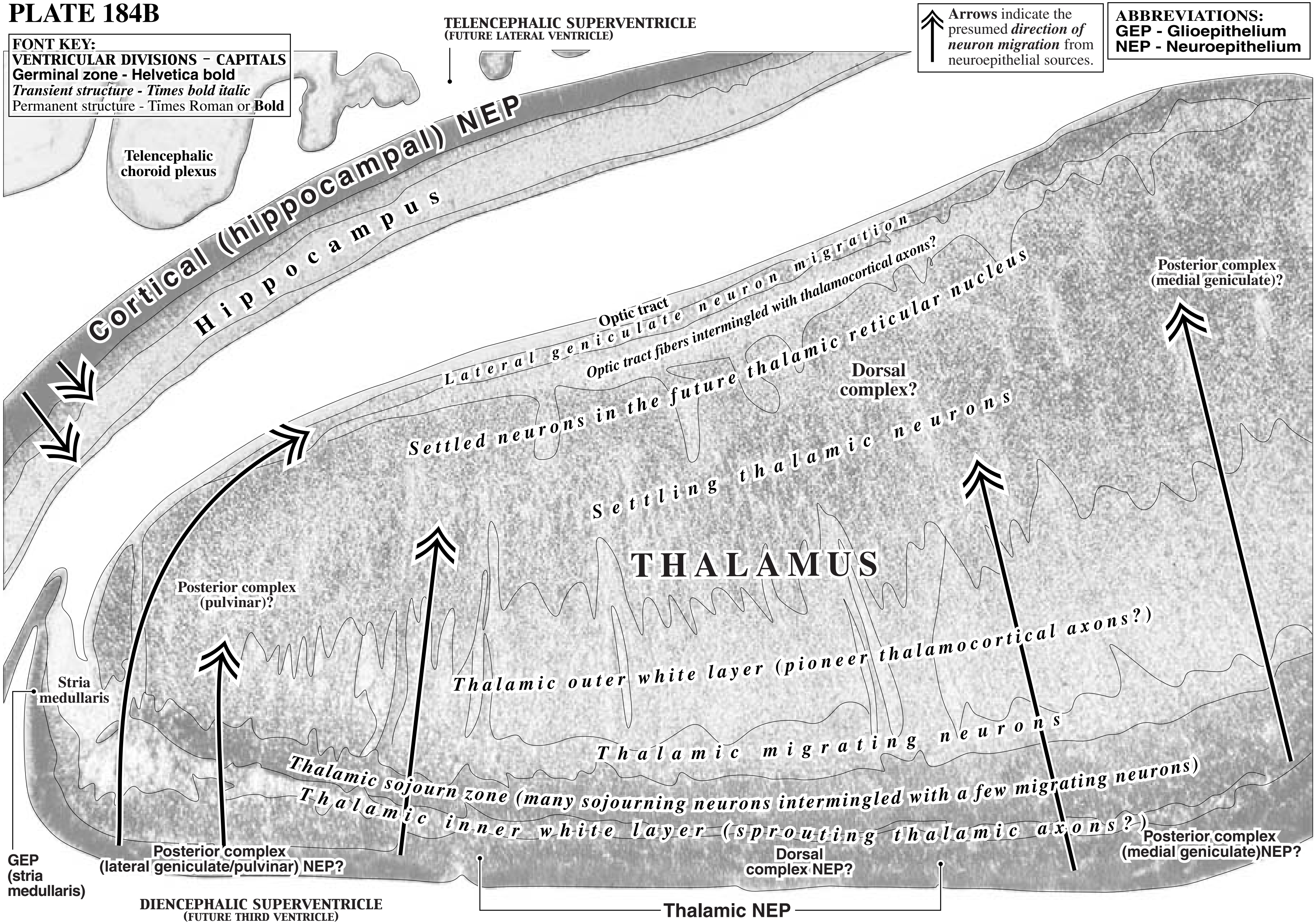
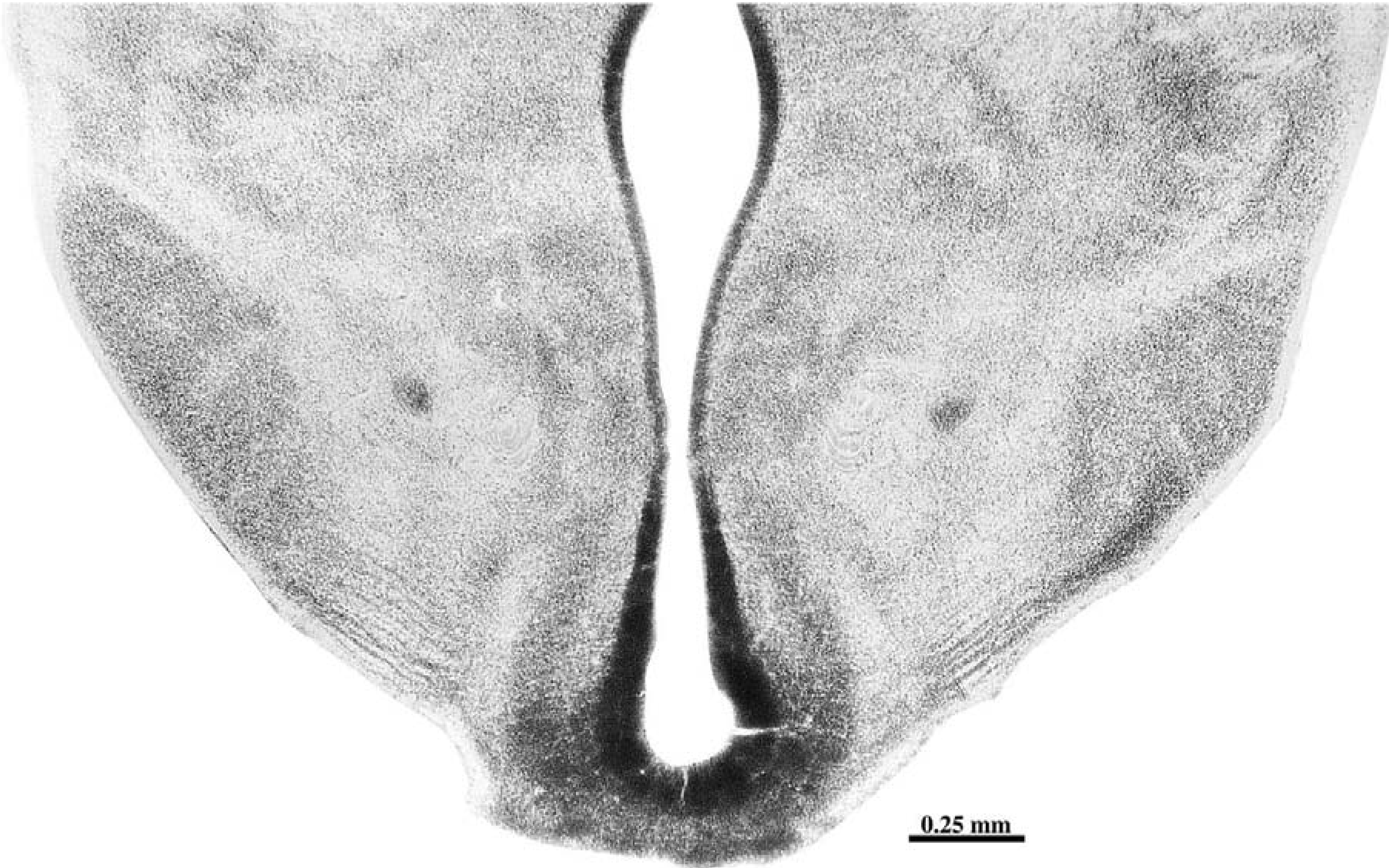

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
TELENCEPHALIC SUPERVENTRICLE
(FUTURE LATERAL VENTRICLE)
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
Telencephalic choroid plexus
Cortical (hippocampal) NEP
Hippocampus
Optic tract
Lateral geniculate neuron migration
Optic tract fibers intermingled with thalamocortical axons?
Settled neurons in the future thalamic reticular nucleus
Dorsal complex?
Settling thalamic neurons
Posterior complex (medial geniculate)?
THALAMUS
Posterior complex (pulvinar)?
Thalamic outer white layer (pioneer thalamocortical axons?)
Stria medullaris
Thalamic migrating neurons
Thalamic sojourn zone (many sojourning neurons intermingled with a few migrating neurons)
Thalamic inner white layer (sprouting thalamic axons?)
GEP (stria medullaris)
Posterior complex (lateral geniculate/pulvinar) NEP?
Dorsal complex NEP?
Posterior complex (medial geniculate)NEP?
Thalamic NEP
DIENCEPHALIC SUPERVENTRICLE
(FUTURE THIRD VENTRICLE)

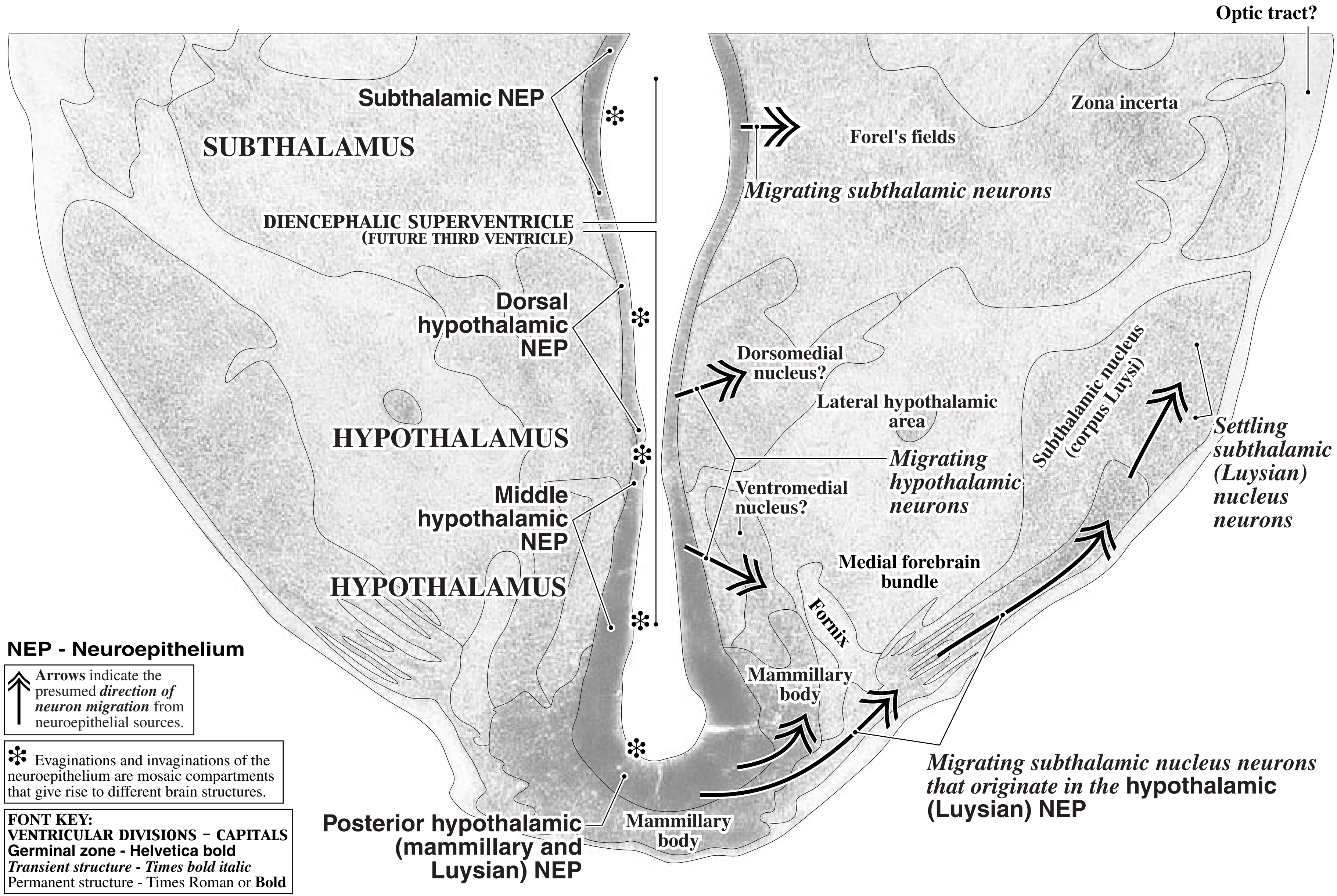
PLATE 185A

GW8 Coronal, CR 32 mm, C609
Between levels 5 and 6: Section 92
HYPOTHALAMUS AND SUBTHALAMUS



See levels 5 and 6 in Plates 174A and B to 175A and B.

PLATE 185B



Optic tract?
Subthalamic NEP
SUBTHALAMUS
Zona incerta
Forel's fields
Migrating subthalamic neurons
DIENCEPHALIC SUPERVENTRICLE
(FUTURE THIRD VENTRICLE)
Dorsal hypothalamic NEP
Dorsomedial nucleus?
Lateral hypothalamic area
Subthalamic nucleus (corpus Luysi)
Settling subthalamic (Luysian) nucleus neurons
HYPOTHALAMUS
Migrating hypothalamic neurons
Middle hypothalamic NEP
Ventromedial nucleus?
Medial forebrain bundle
HYPOTHALAMUS
Fornix
Mammillary body
Migrating subthalamic nucleus neurons that originate in the hypothalamic (Luysian) NEP
Posterior hypothalamic (mammillary and Luysian) NEP
Mammillary body
NEP - Neuroepithelium
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.
FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold

PART X: GW7.5 CORONAL

PART X: GW7.5 CORONAL

This is specimen number 966 in the Carnegie Collection, designated here as C966. A normal female fetus with a crown-rump length (CR) of 23 mm was collected in 1914. The fetus is estimated to be at gestational week (GW) 7.5. The entire fetus was fixed in bichloric acetic acid, embedded in celloidin, cut transversely in 40 µm sections, and was stained with aluminum cochineal. The histological preservation of this specimen is excellent, and the sections are cut nearly perfectly bilaterally. Several years ago, an excellent 3-D reconstruction of the brain and upper cervical spinal cord was done by piecing together cardboard cutouts of the brain outlines in each section and then gluing them together; the rhombencephalic superventricle was not included in that reconstruction. A photograph of that model (which is still part of the Carnegie Collection today) shows us the exact location and cutting plane of C966's sections (**Figure 9**). Like most of the specimens in this Volume, the sections are not cut exactly in one plane, but C966's sections are much closer to the coronal than the horizontal plane. Photographs of 21 sections (**Levels 1-21**) of the brain in the head are shown in **Plates 186-206**. Our computer-aided three-dimensional reconstructions of the brain, ventricles (including the rhombencephalic superventricle), and selected neuroepithelial components are shown on the cover and in **Figures 10-19**.

C966 is considerably less mature than the GW8 specimens. The ***superventricles*** are large in the centers of all brain structures, especially in the telencephalon and rhombencephon. Even though the diencephalic superventricle is approaching a slit-like shape, it is wider than that in the GW8 specimens, and the mesencephalic superventricle forms a more balloon-like expansion beneath the rudimentary tectum. Like the GW8 specimens, the respective thicknesses of the neuroepithelium (NEP) and parenchyma are keys to determining the degree of maturation of various brain structures.

The parenchyma is thick and bordered by a thin NEP in the medulla and pons, indicating that many neurons have been generated here, but the production of late-generated neurons continues. There are layers of dense cells adjacent to the lateral pontine NEP where vestibular nuclear neurons and trigeminal nuclear neurons may be sojourning prior to migration and settling. There is a larger accumulation of presumptive facial motor neurons near the midline NEP in the pontomedullary trench and some are migrating toward the indistinct facial motor nucleus. The ***precerebellar neuroepithelium*** in the medulla is thicker and generating more precerebellar neurons than at GW8; many neurons are entering the inferior olive after migrating in the ***posterior intramural migratory stream***, but the anterior and posterior extramural migratory streams are absent; that confirms neurogenetic data in rats that the inferior olive contains the earliest-generated precerebellar neurons. The cerebellar NEP is thick and difficult to distinguish from an adjacent dense sojourn zone in the cerebellar parenchyma, called ***cerebellar transitional field (CTF) 6***. The remaining ***CTF*** has alternating layers of cells and fibers (***CTF1-5***). The ***external germinal layer (egl)*** is completely absent. If one can extrapolate from data on cerebellar neurogenesis in rats, the human cerebellar NEP by GW7.5 has generated all of the deep neurons and is now producing "middle-aged" Purkinje cells; the oldest Purkinje cells are sojourning in ***CTF6***. Both the mesencephalic tegmental NEP and the isthmal NEP are nearly the same thickness as the pontine and medullary NEPs, but dense sojourn zones of young neurons are more obvious in the adjacent parenchyma. The superficial border of a thick mesencephalic tectal NEP is difficult to distinguish from dense wavefronts of young neurons extending into a thin parenchyma. The majority of neurons in both the superior and inferior colliculi have not yet been generated by GW7.5.

The diencephalic NEP is thicker at GW7.5 than at GW8, and the thin parenchyma is filled with dense zones of sojourning and migrating neurons. There is no internal capsule, but some pioneer axons are accumulating in inner and outer white layers in the thalamic parenchyma. The telencephalic NEP is thick in all areas, and the oldest basal telencephalic and basal ganglionic neurons are settling in the thick parenchyma. Most neurons in the septum and striatum have yet to be generated. In the cerebral cortex, the NEP is bordered by a thin primordial plexiform layer that contains the oldest cortical neurons (Cajal-Retzius cells) and subplate neurons; there is no cortical plate. The cortical NEP is expanding and increasing its number of neural stem cells as the telencephalic superventricle grows; nearly all cortical neurons in layers II-VI have still to be generated.

GW7.5 CORONAL SECTION PLANES

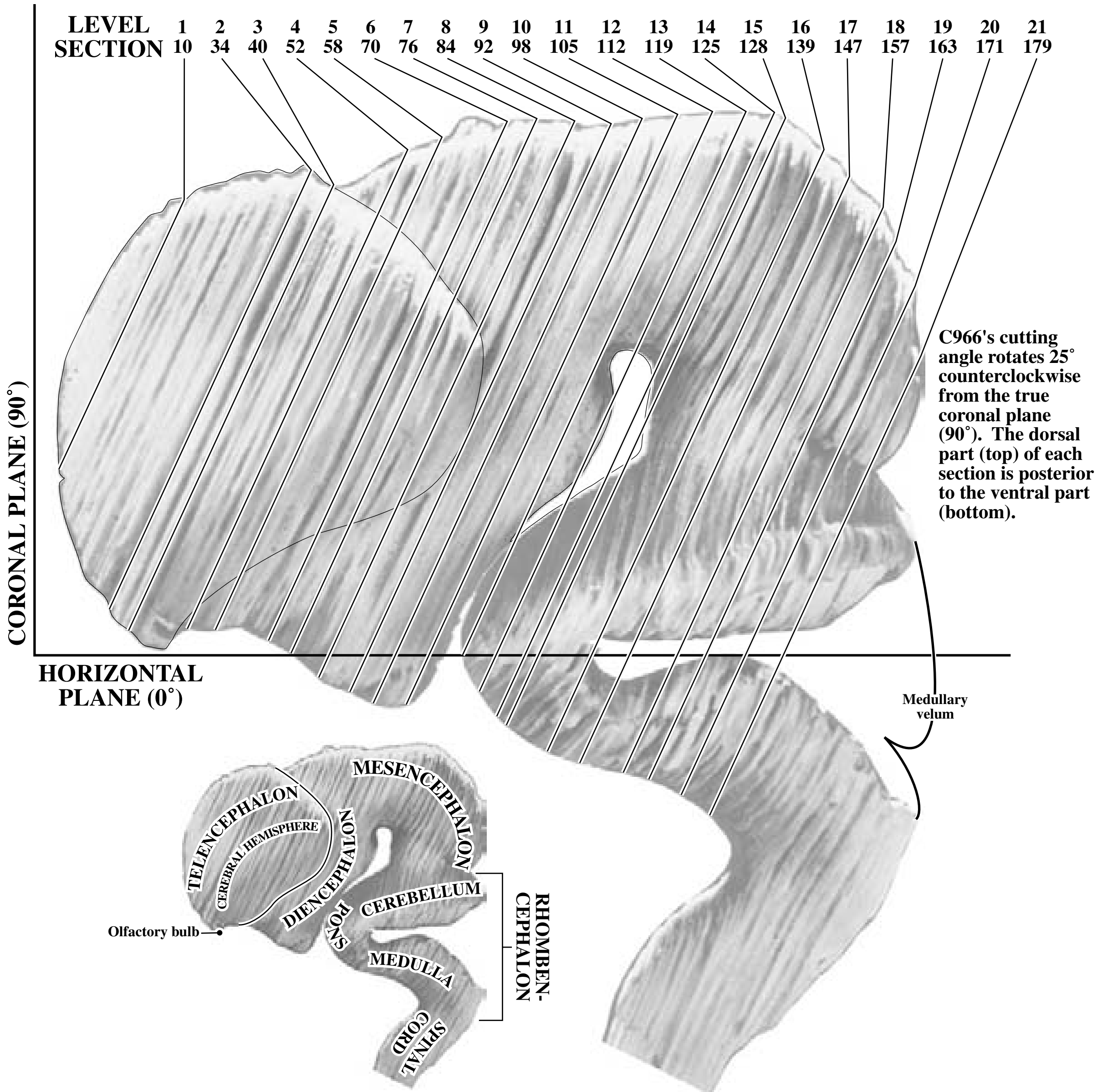
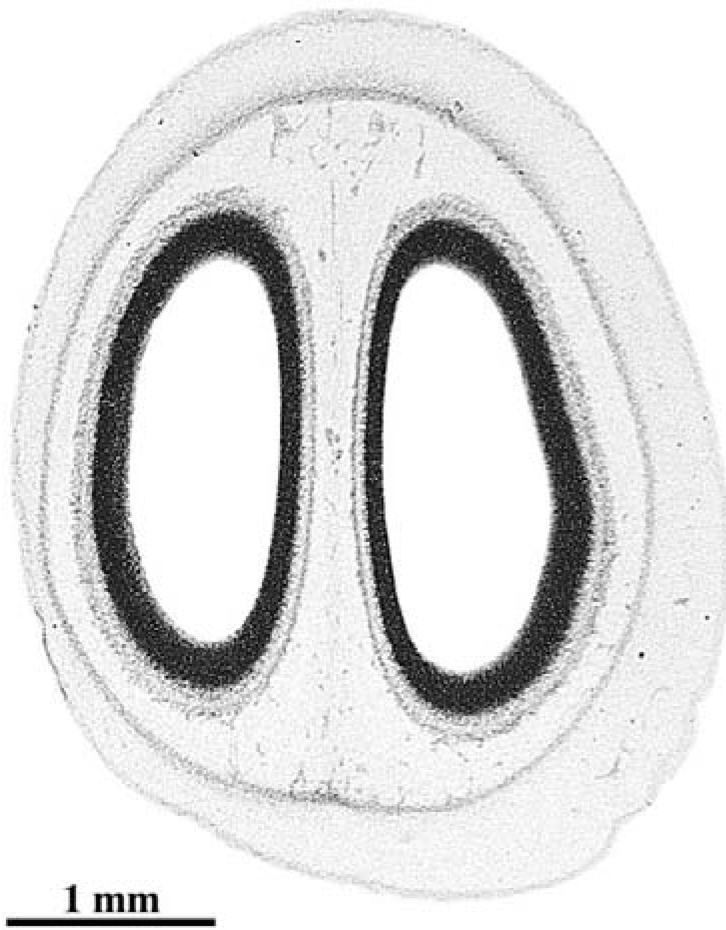


Figure 9. The lateral view of a 3-D model of C966's brain and upper cervical spinal cord (part of the Carnegie Collection at the National Museum of Health and Medicine) shows the exact locations and cutting angles of the illustrated sections of C966 in the following pages. The small inset identifies the major structural features. The medullary velum was not reconstructed so that the rhombencephalic superventricle appears as an open gap beneath the cerebellum.

PLATE 186A

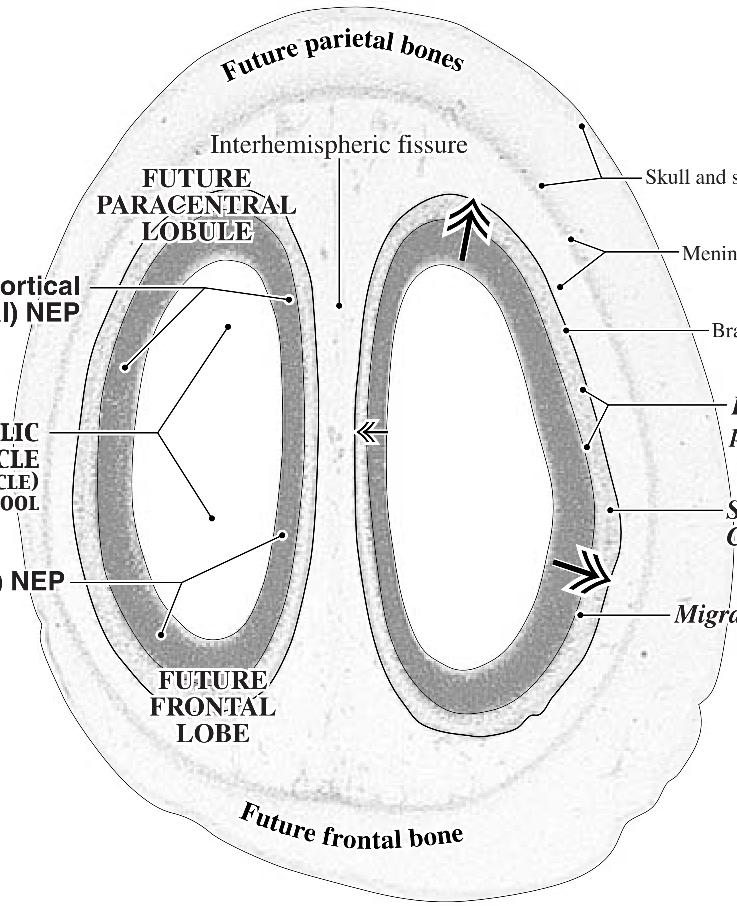
GW7.5 Coronal/horizontal
CR 23 mm
C966
Level 1: Section 10



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 186B

NEP - Neuroepithelium



The cerebral cortex in this specimen does not have a ***cortical plate*** and a ***stratified transitional field*** outside the cortical neuroepithelium. Instead, there is a ***primordial plexiform layer*** composed of early-generated Cajal-Retzius cells and the slightly later-generated subplate neurons.

The large Cajal-Retzius cells settle subjacent to the pia meninx and remain superficial in cortical Layer I throughout later development. The deep border of Layer I is not defined until a cortical plate appears.

Subplate neurons accumulate in a loosely defined network beneath the Cajal-Retzius cells. In later development they become radially aligned and are the pioneer neurons in the cortical plate. Eventually, they delaminate and settle in the subplate (cortical Layer VII).

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 187A

GW7.5 Coronal/horizontal
CR 23 mm
C966
Level 2: Section 34

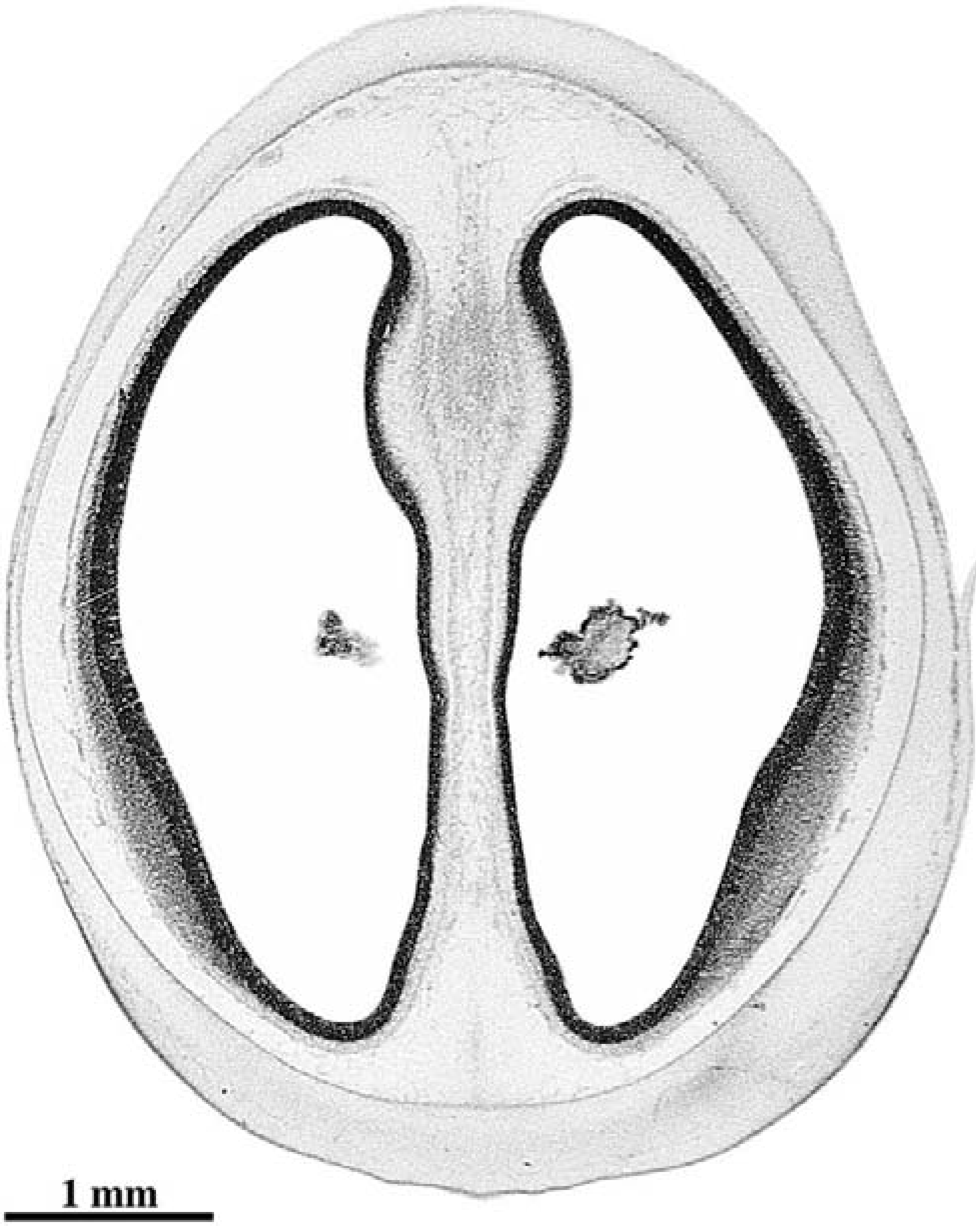
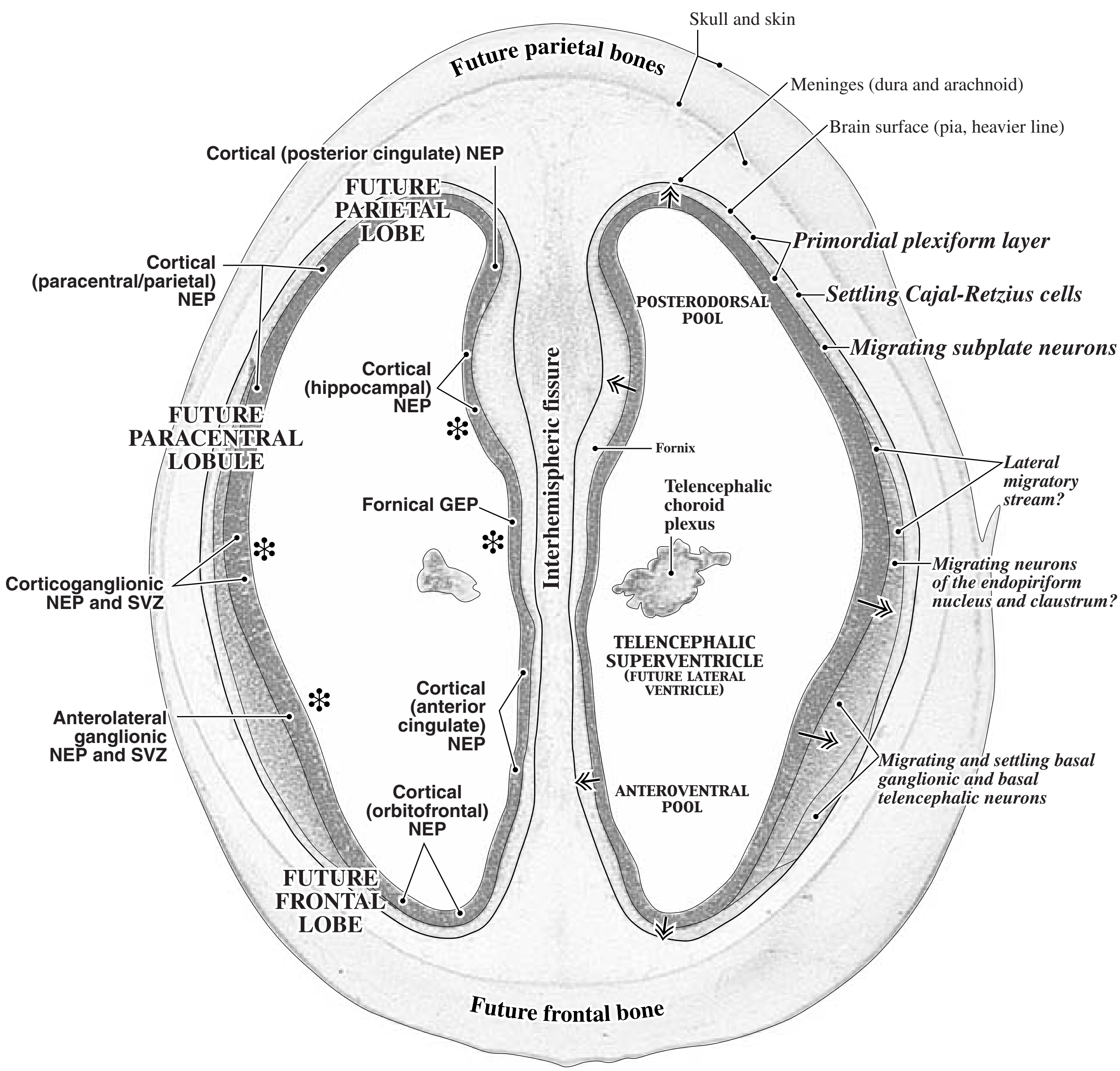


PLATE 187B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

PLATE 188A

GW7.5 Coronal/horizontal
CR 23 mm
C966
Level 3: Section 40

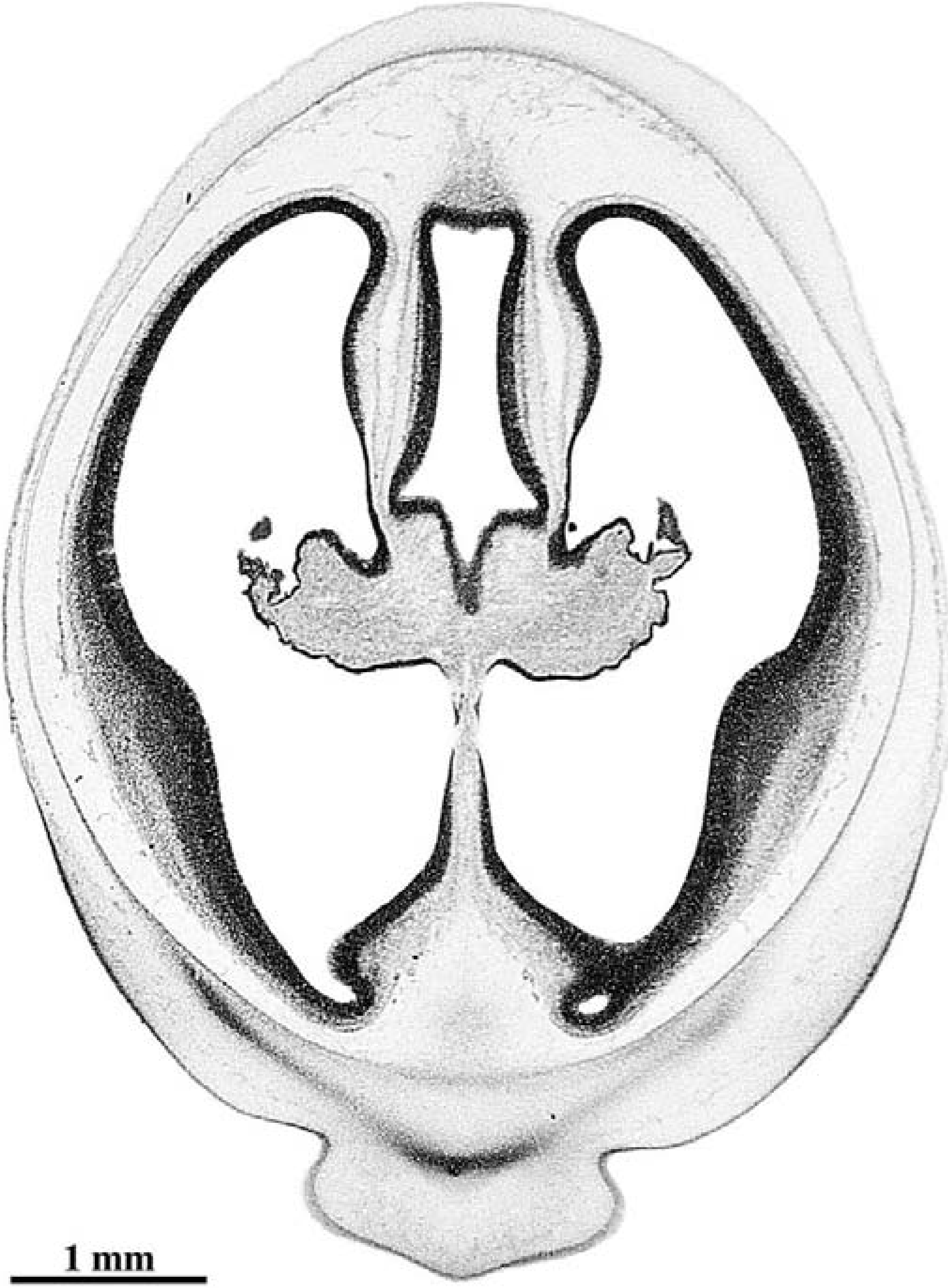
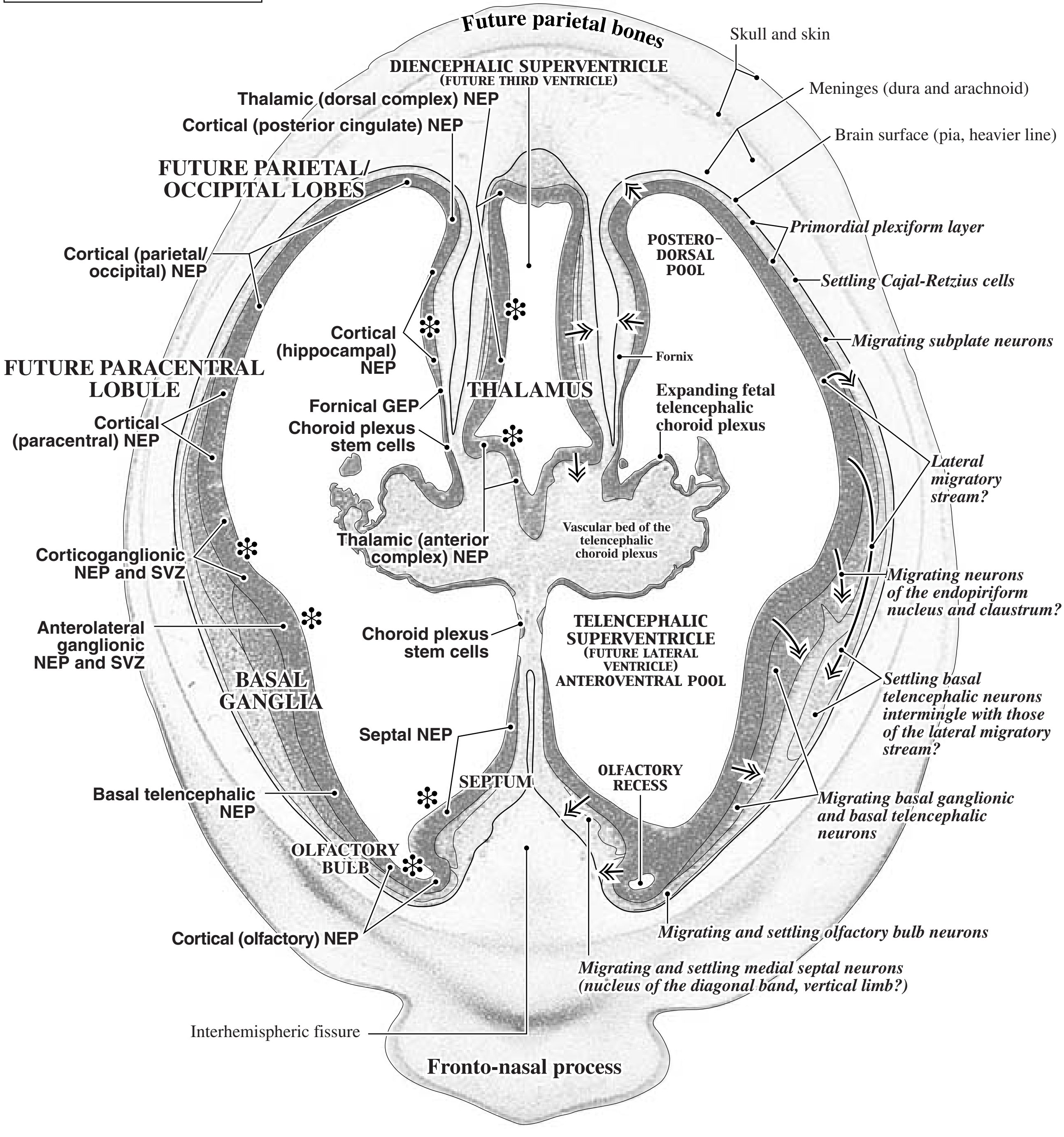


PLATE 188B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

❊ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

PLATE 189A

GW7.5 Coronal/horizontal
CR 23 mm
C966
Level 4: Section 52

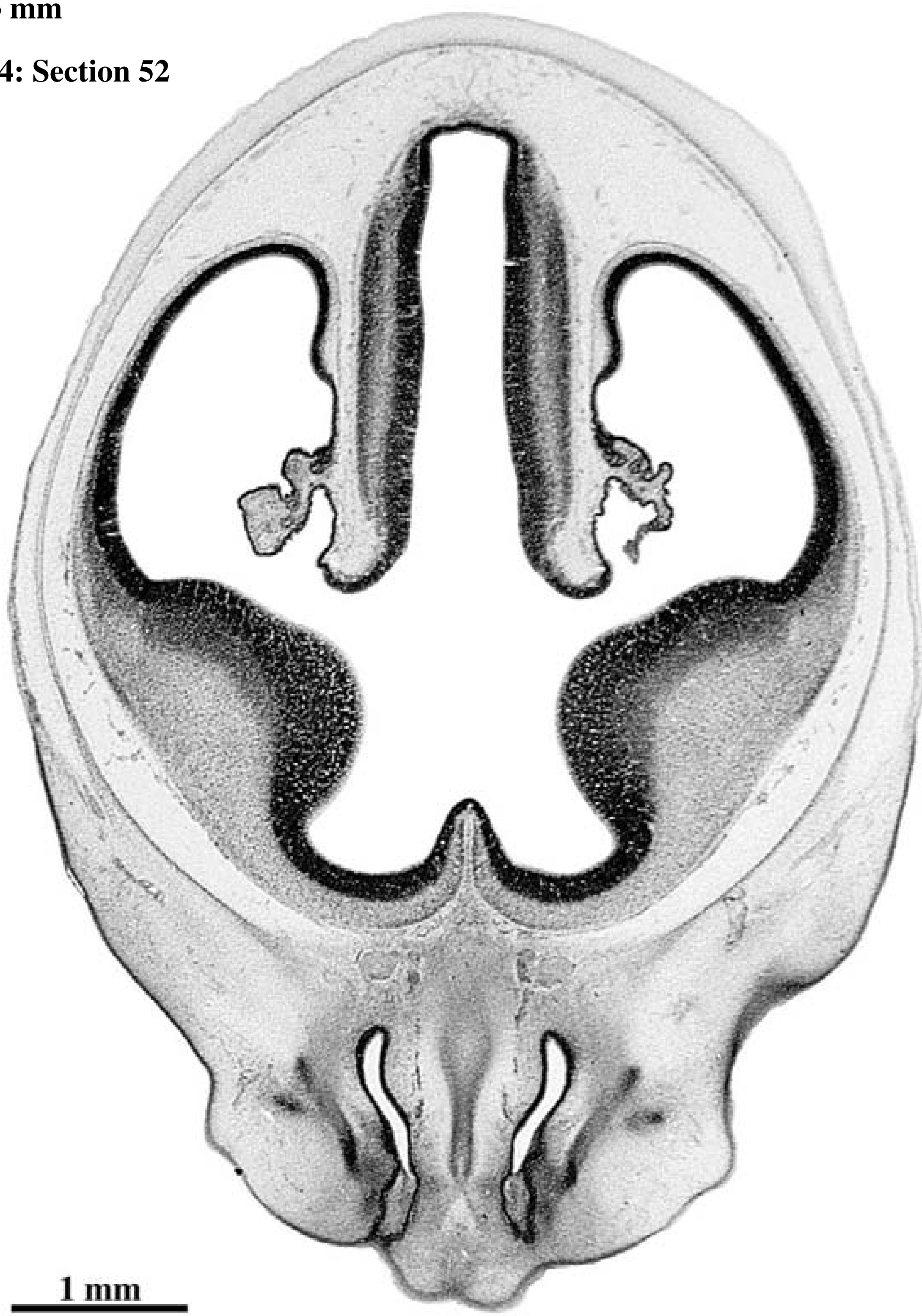
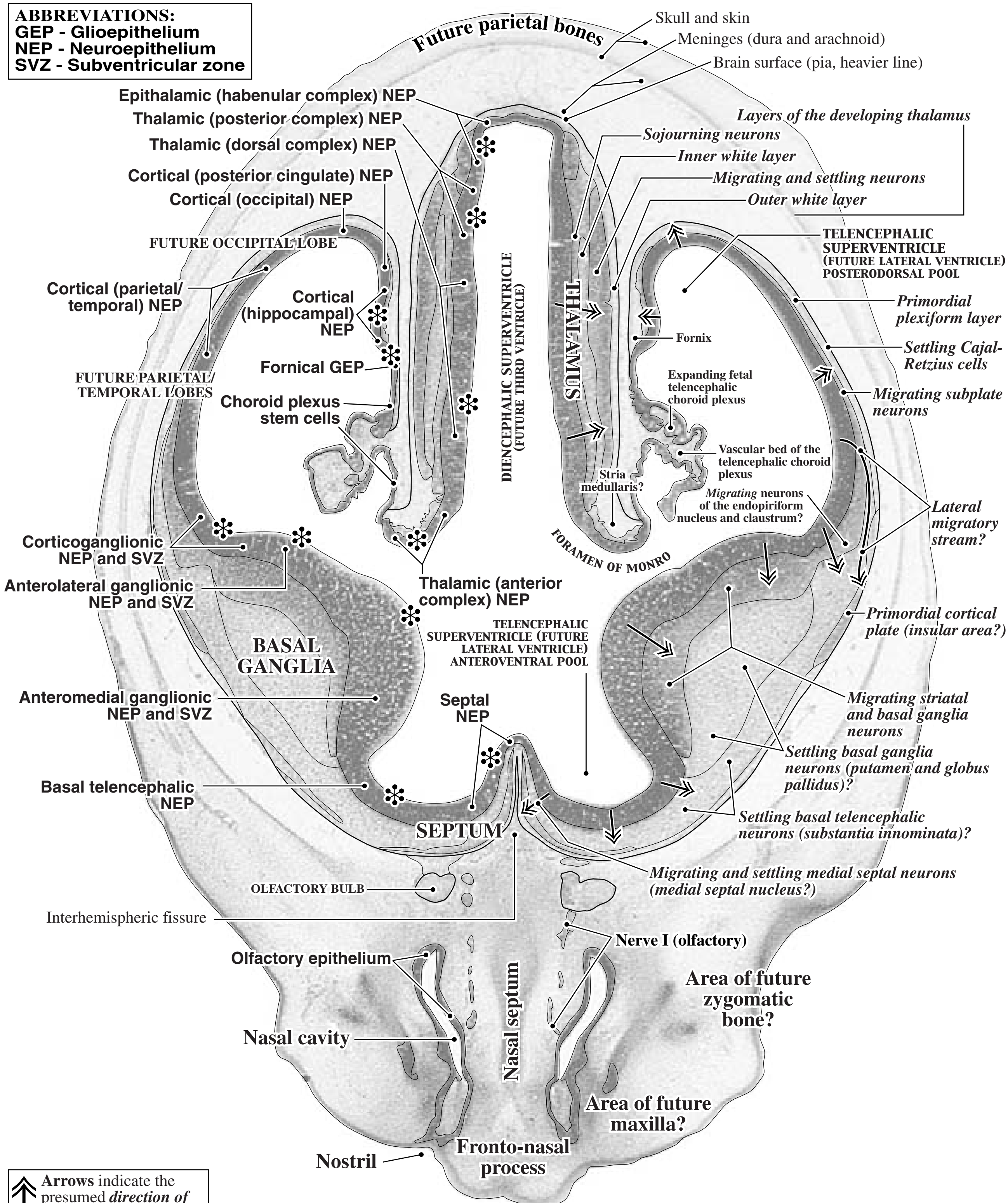


PLATE 189B

FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

PLATE 190A

GW7.5 Coronal/horizontal
CR 23 mm
C966
Level 5: Section 58

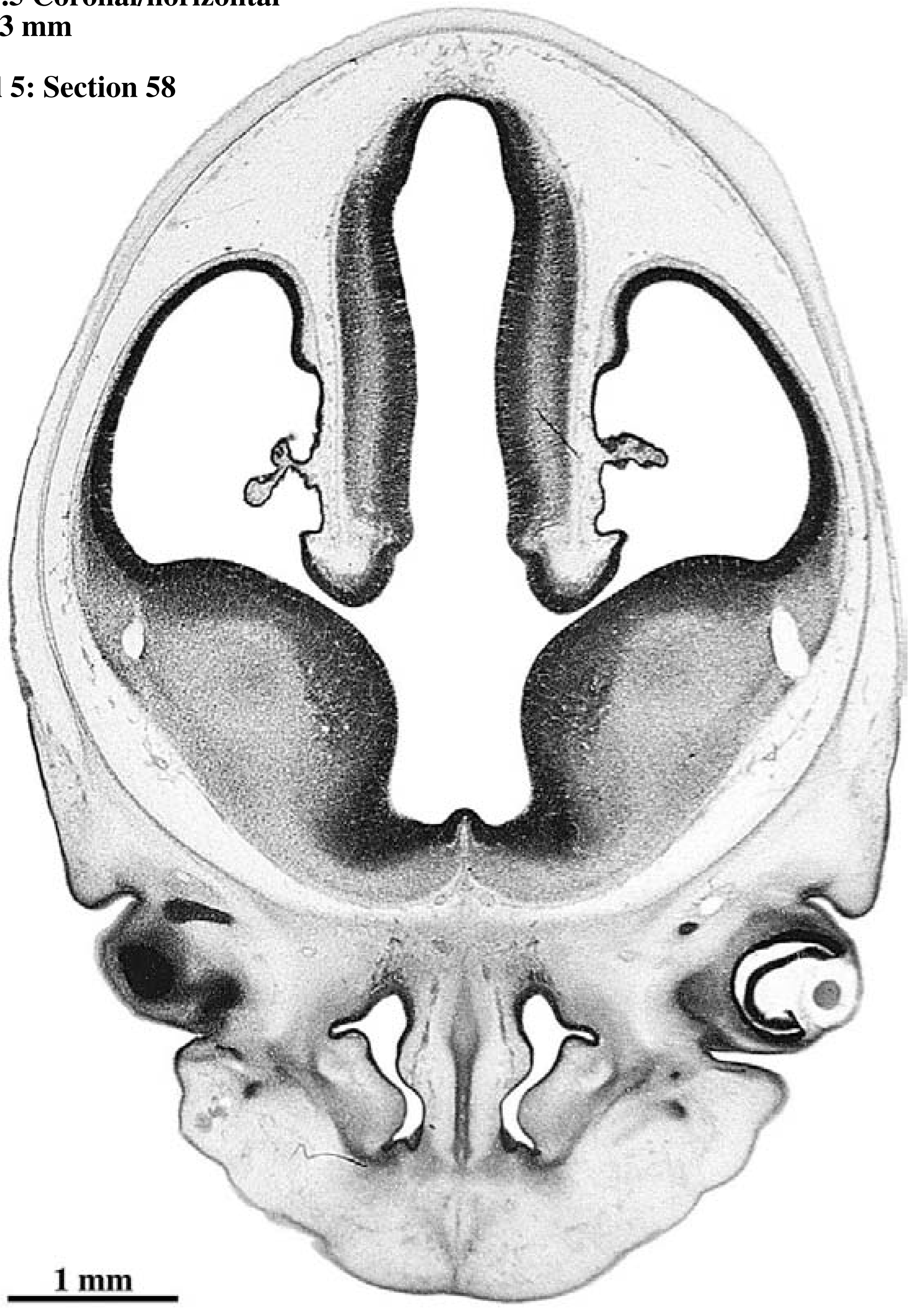
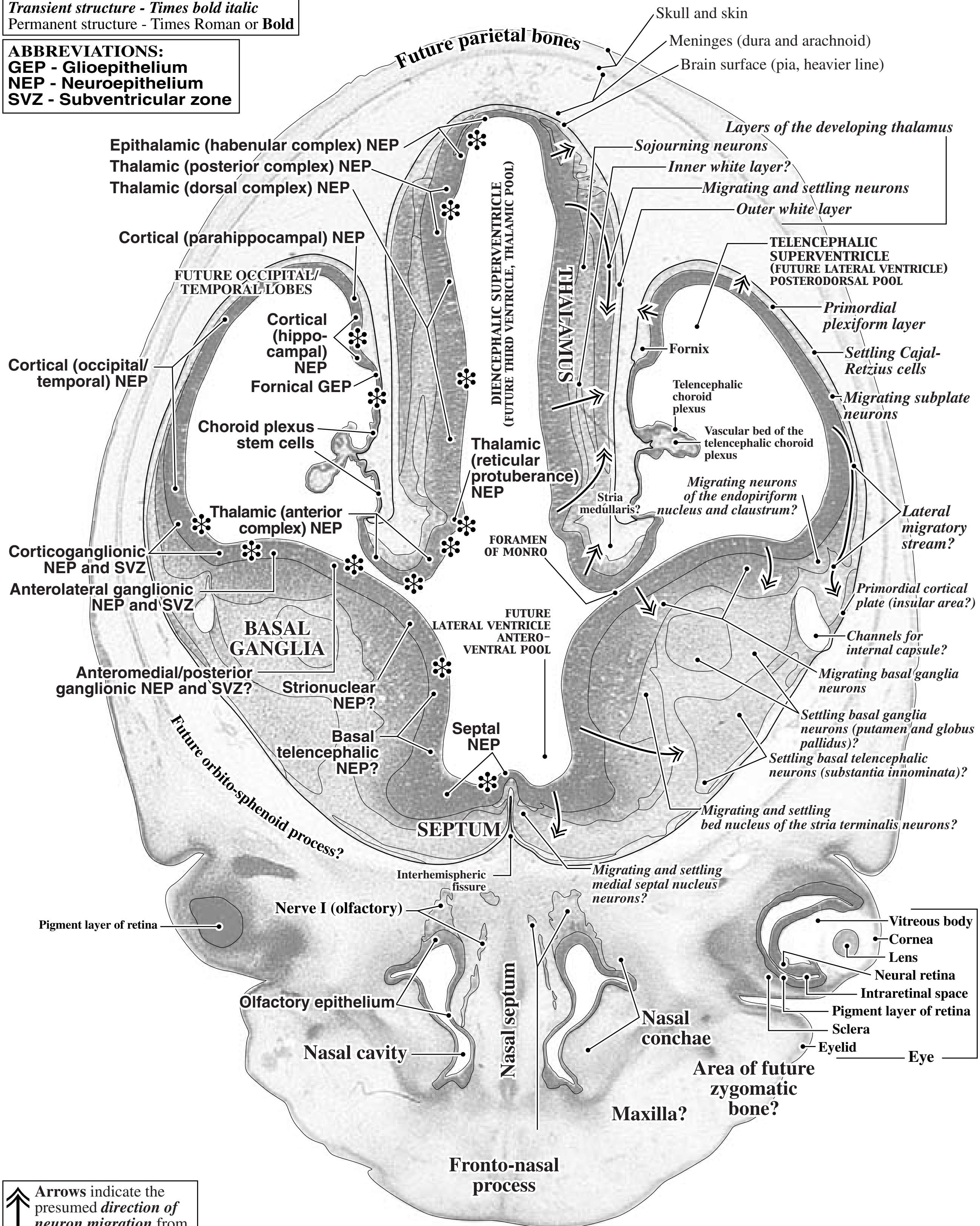


PLATE 190B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

PLATE 191A

GW7.5 Coronal/horizontal
CR 23 mm
C966
Level 6: Section 70

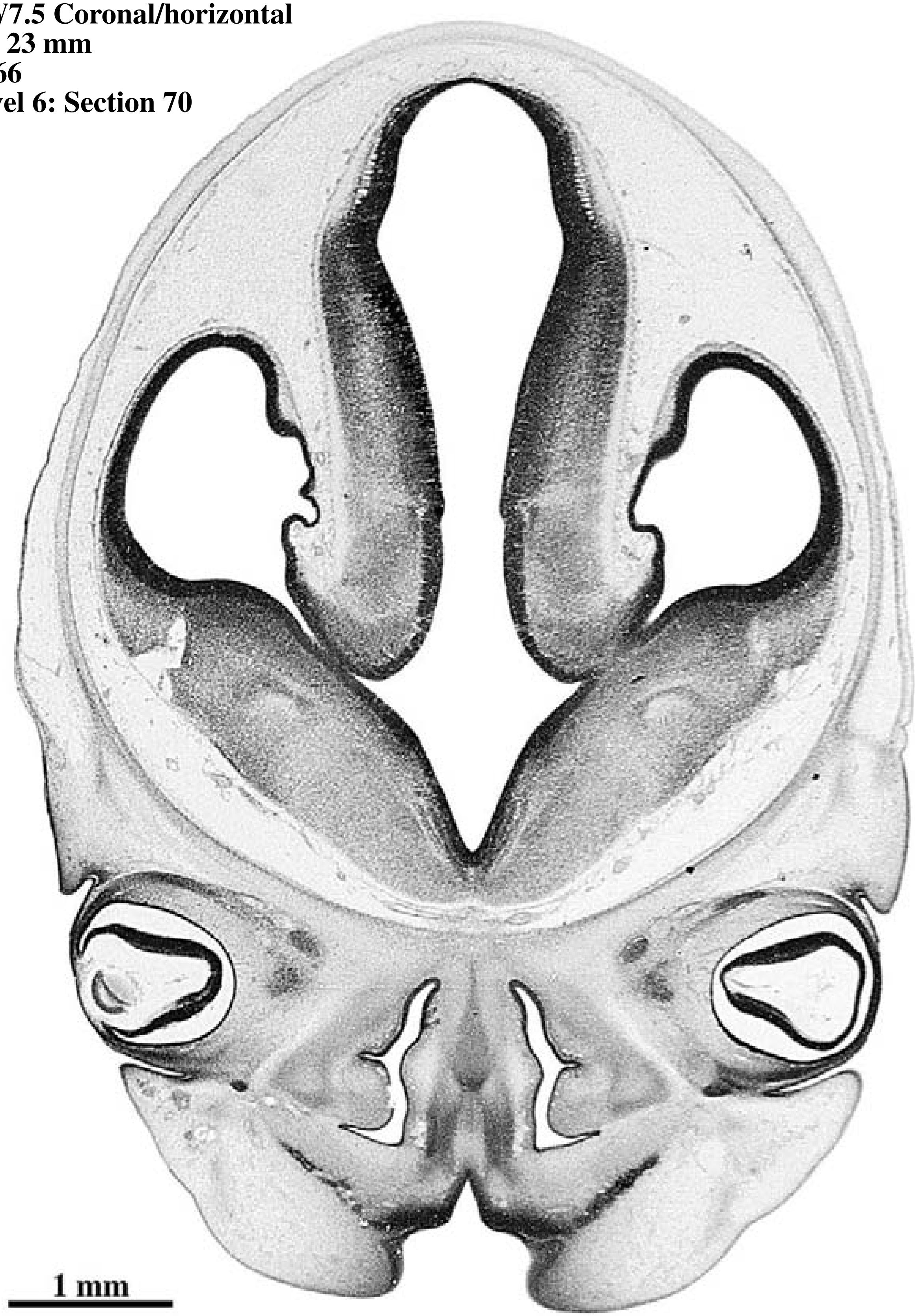
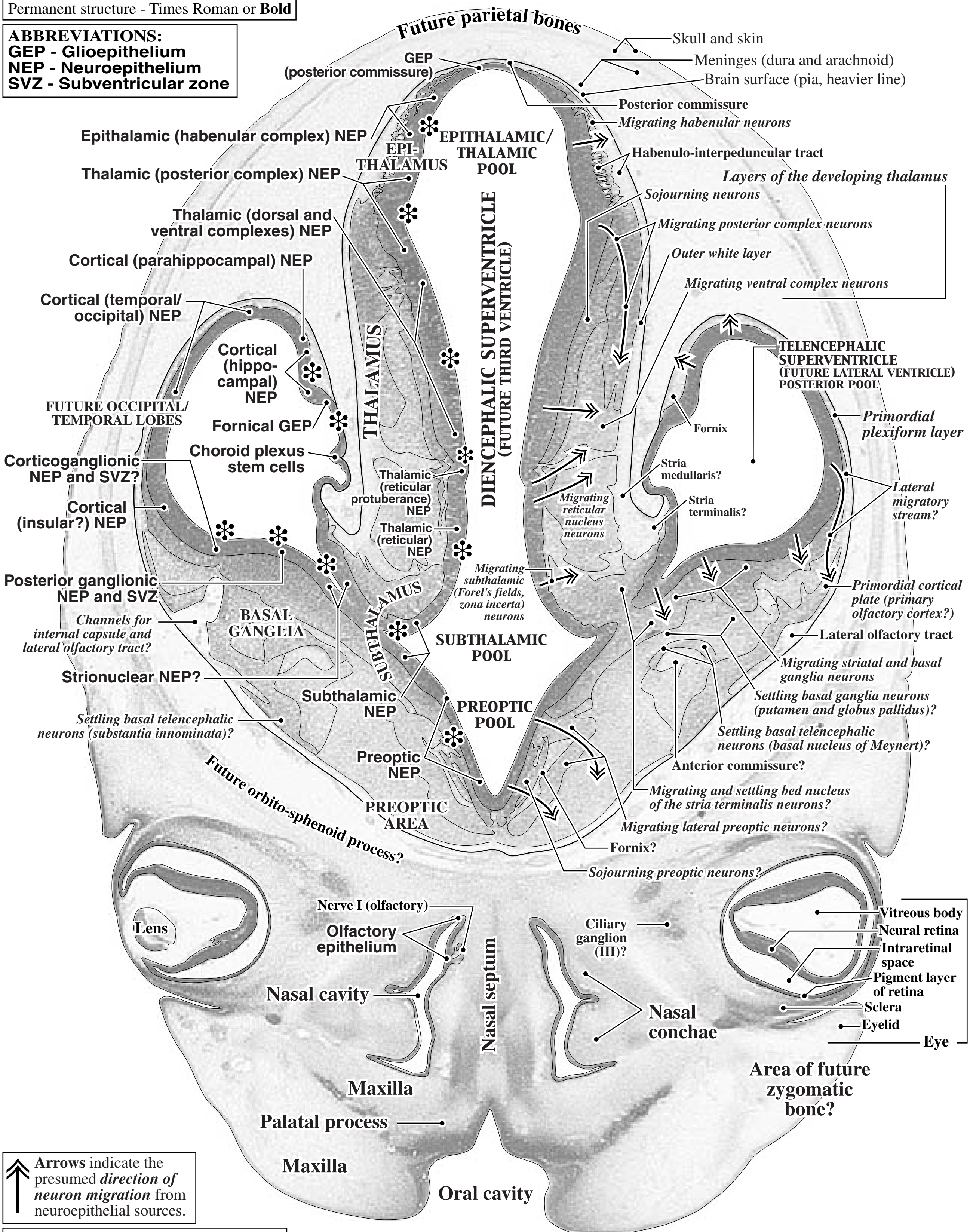


PLATE 191B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

PLATE 192A

GW7.5 Coronal/horizontal
CR 23 mm
C966
Level 7: Section 76

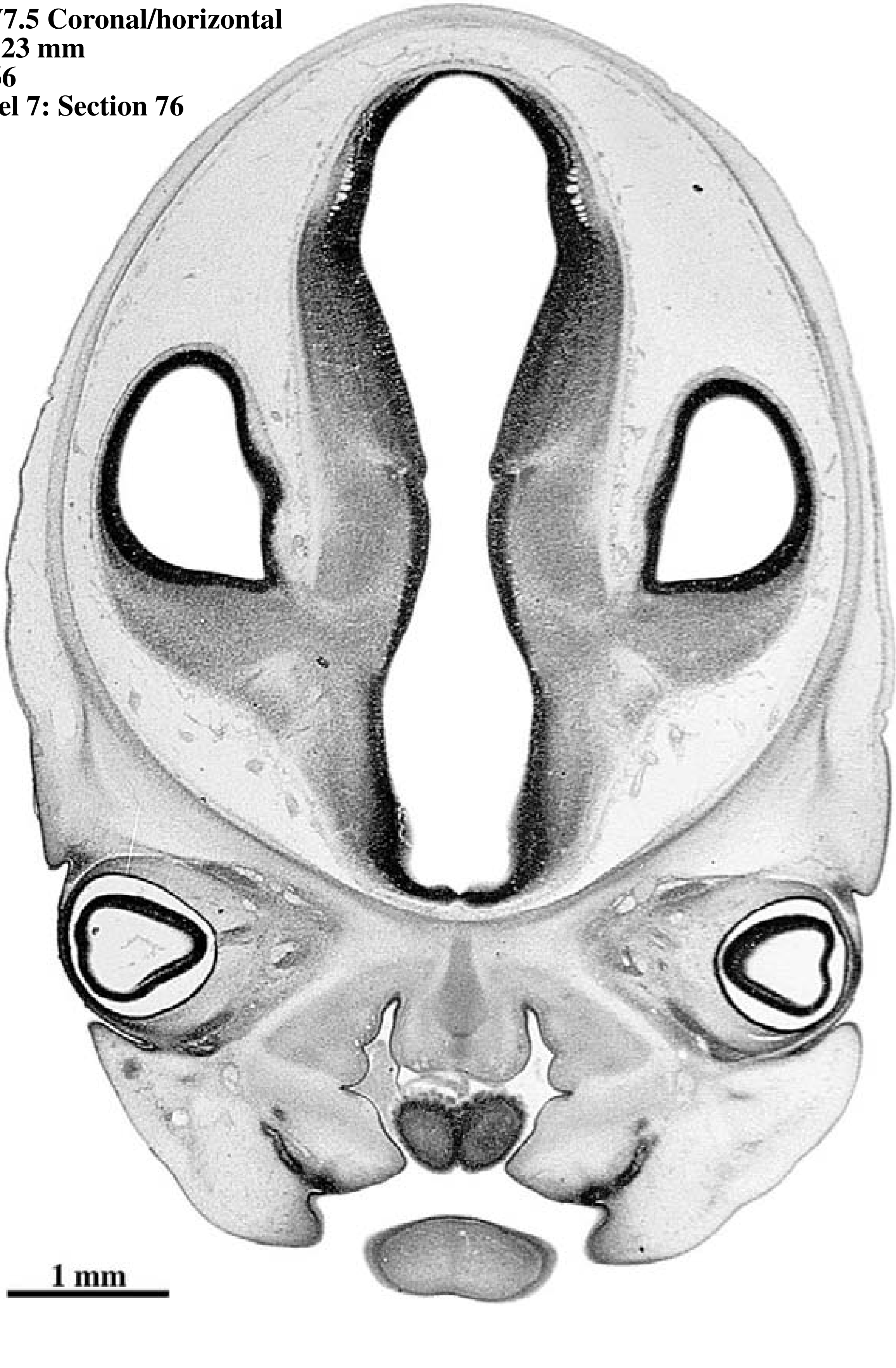
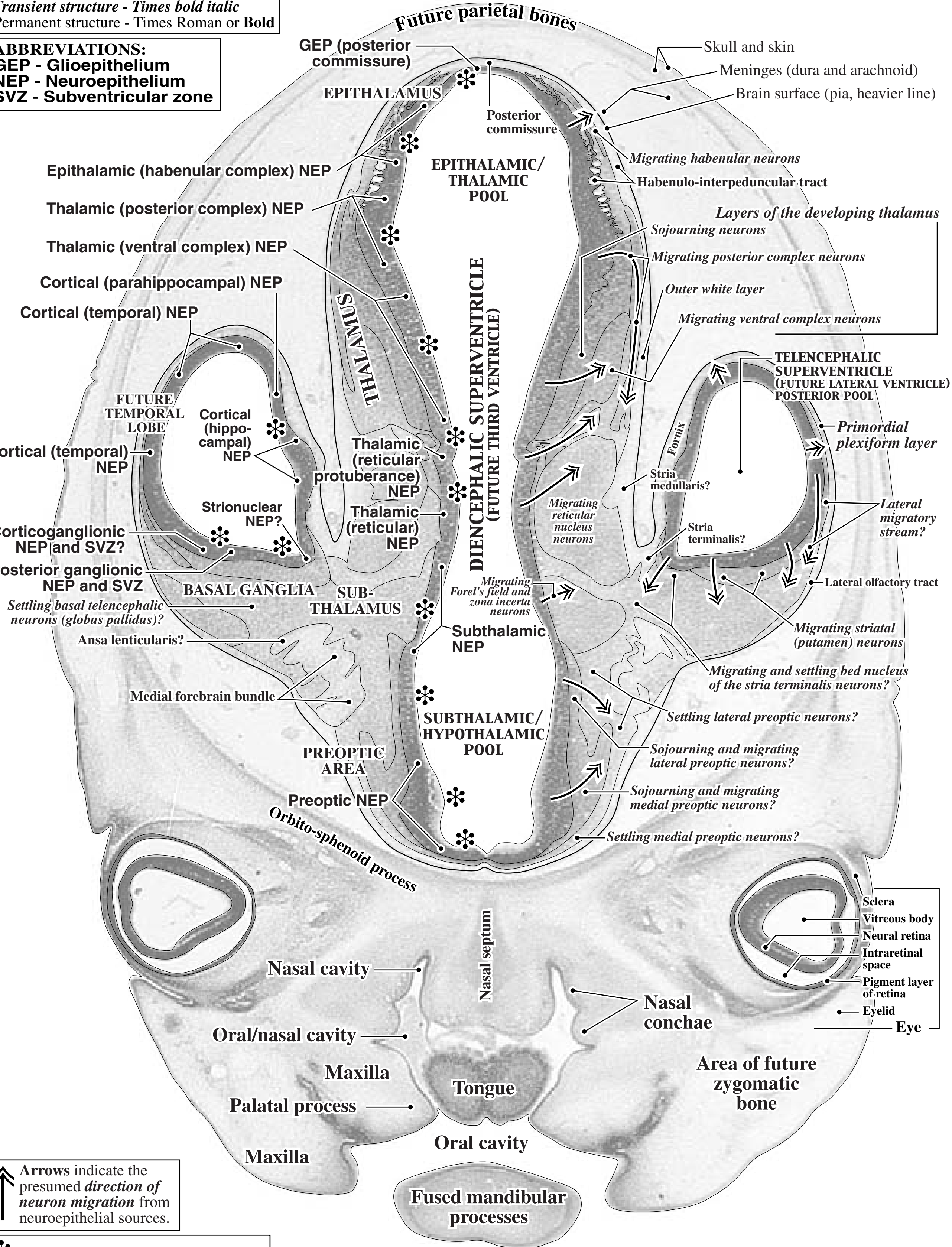


PLATE 192B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

PLATE 193A

GW7.5 Coronal/horizontal
CR 23 mm
C966
Level 8: Section 84

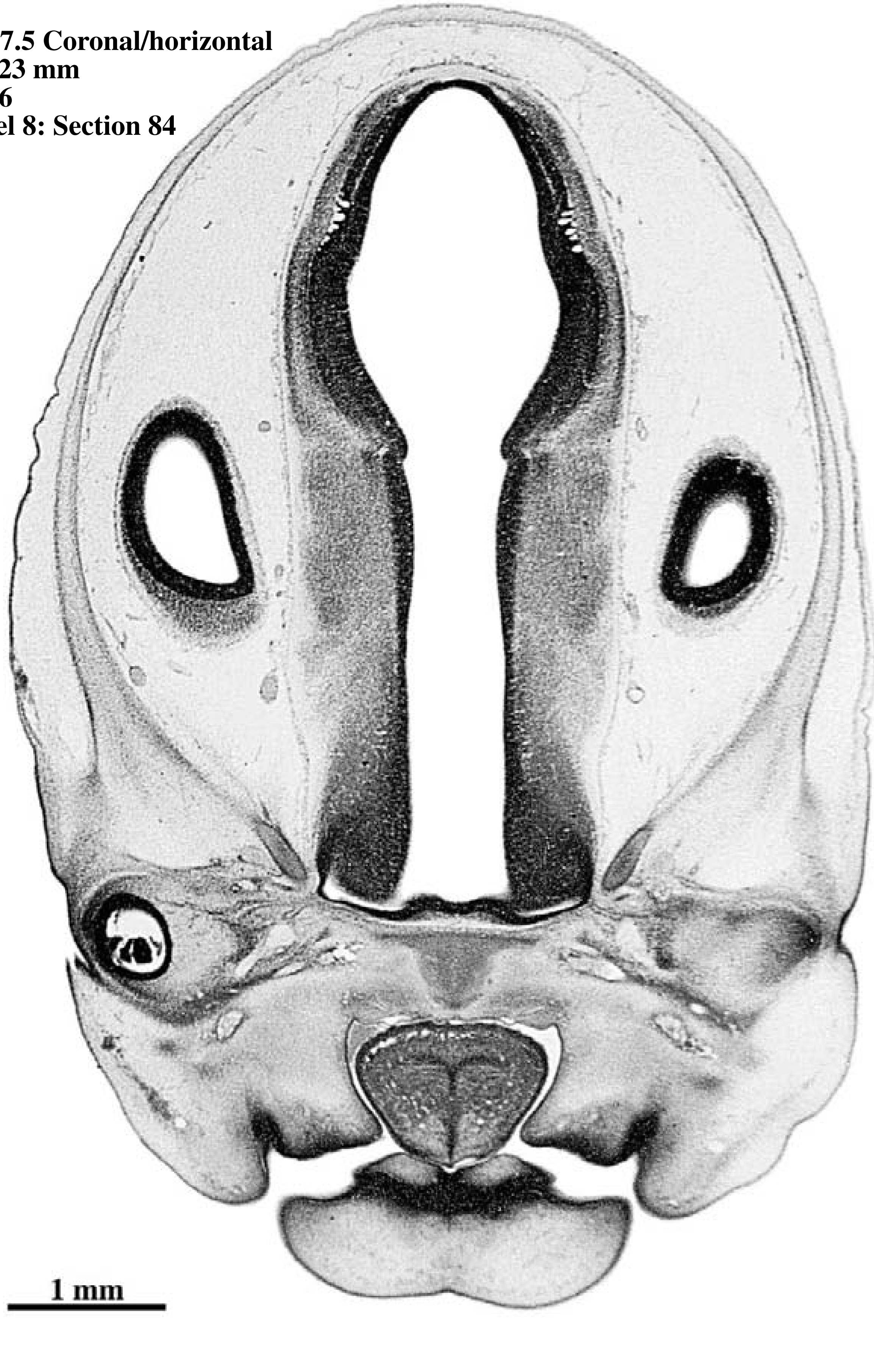


PLATE 193B

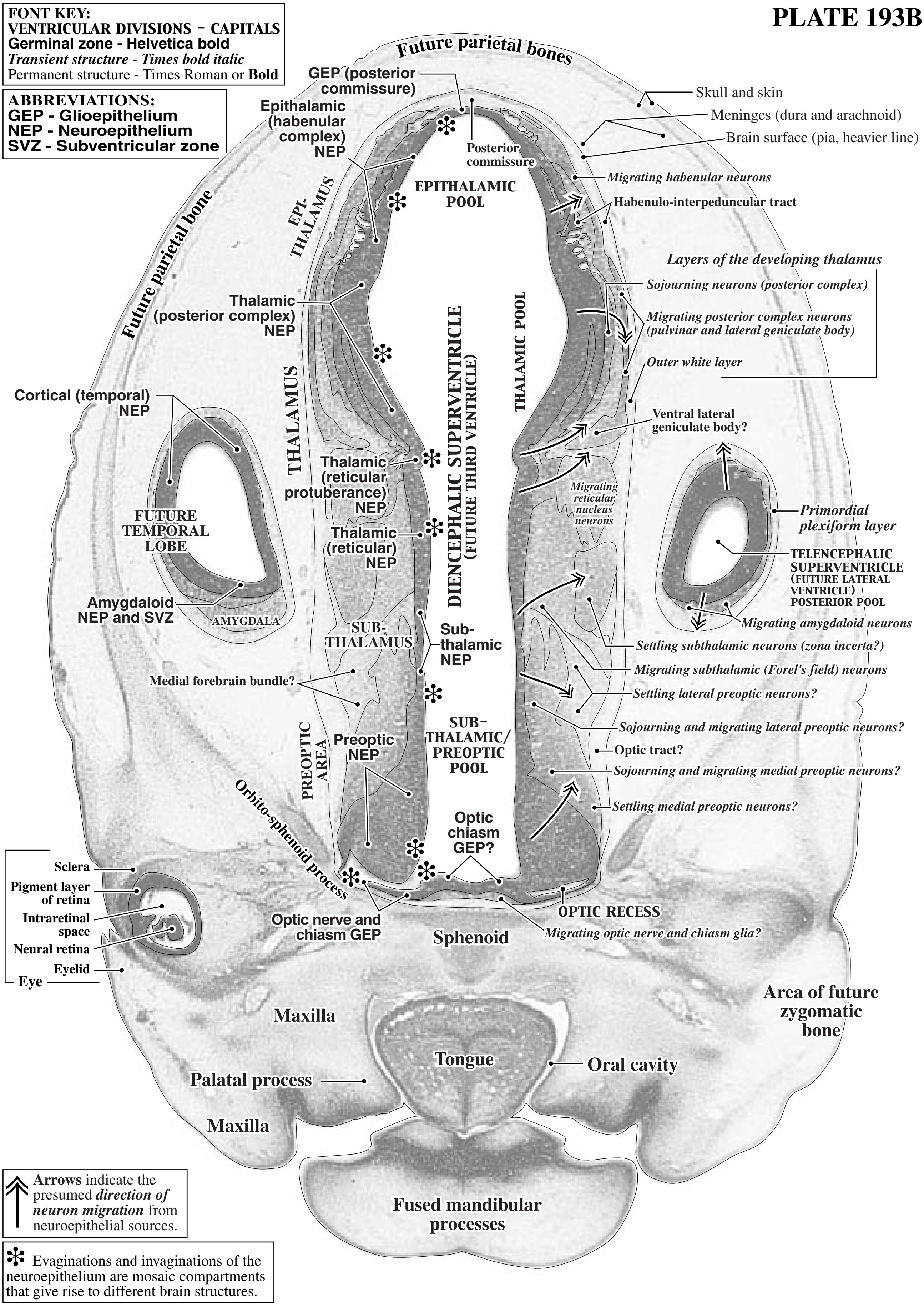

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
SVZ - Subventricular zone
Future parietal bones
GEP (posterior commissure)
Skull and skin
Meninges (dura and arachnoid)
Brain surface (pia, heavier line)
Epithalamic (habenular complex) NEP
Posterior commissure
Migrating habenular neurons
EPITHALAMIC POOL
Habenulo-interpeduncular tract
EPI-THALAMUS
Future parietal bone
Layers of the developing thalamus
Sojourning neurons (posterior complex)
Thalamic (posterior complex) NEP
Migrating posterior complex neurons (pulvinar and lateral geniculate body)
Outer white layer
THALAMIC POOL
DIENCEPHALIC SUPERVENTRICLE (FUTURE THIRD VENTRICLE)
Cortical (temporal) NEP
THALAMUS
Ventral lateral geniculate body?
Thalamic (reticular protuberance) NEP
Migrating reticular nucleus neurons
Primordial plexiform layer
FUTURE TEMPORAL LOBE
Thalamic (reticular) NEP
TELENCEPHALIC SUPERVENTRICLE (FUTURE LATERAL VENTRICLE) POSTERIOR POOL
Amygdaloid NEP and SVZ
AMYGDALA
Migrating amygdaloid neurons
SUB-THALAMUS
Sub-thalamic NEP
Settling subthalamic neurons (zona incerta?)
Medial forebrain bundle?
Migrating subthalamic (Forel's field) neurons
Settling lateral preoptic neurons?
SUB-THALAMIC/PREOPTIC POOL
Sojourning and migrating lateral preoptic neurons?
PREOPTIC AREA
Preoptic NEP
Optic tract?
Sojourning and migrating medial preoptic neurons?
Orbito-sphenoid process
Settling medial preoptic neurons?
Optic chiasm GEP?
Sclera
Pigment layer of retina
Intraretinal space
Neural retina
Eyelid
Eye
Optic nerve and chiasm GEP
OPTIC RECESS
Sphenoid
Migrating optic nerve and chiasm glia?
Maxilla
Area of future zygomatic bone
Tongue
Oral cavity
Palatal process
Maxilla
Fused mandibular processes
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

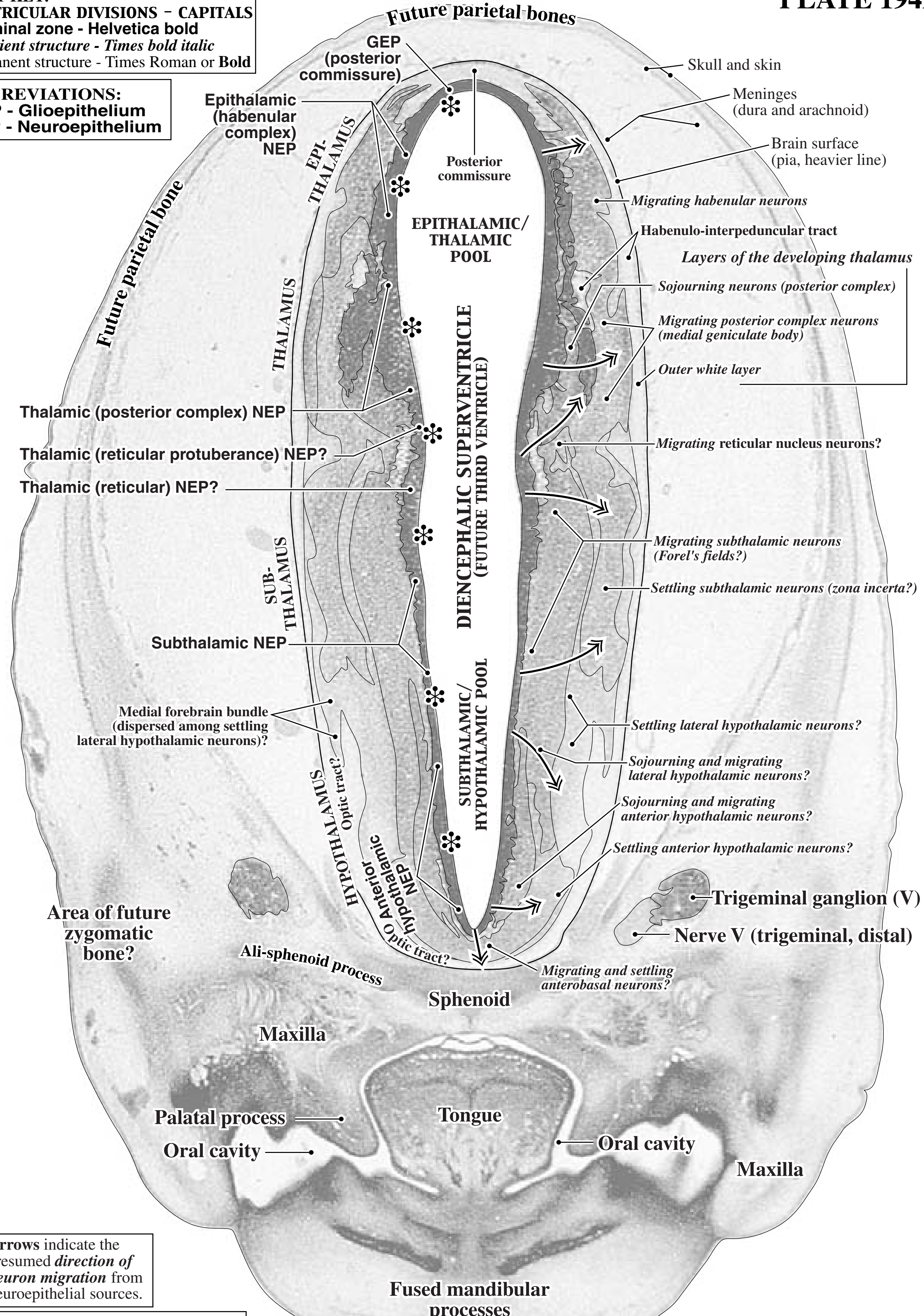
PLATE 194A

GW7.5
Coronal/horizontal
CR 23 mm
C966
Level 9:
Section 92

PLATE 194B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

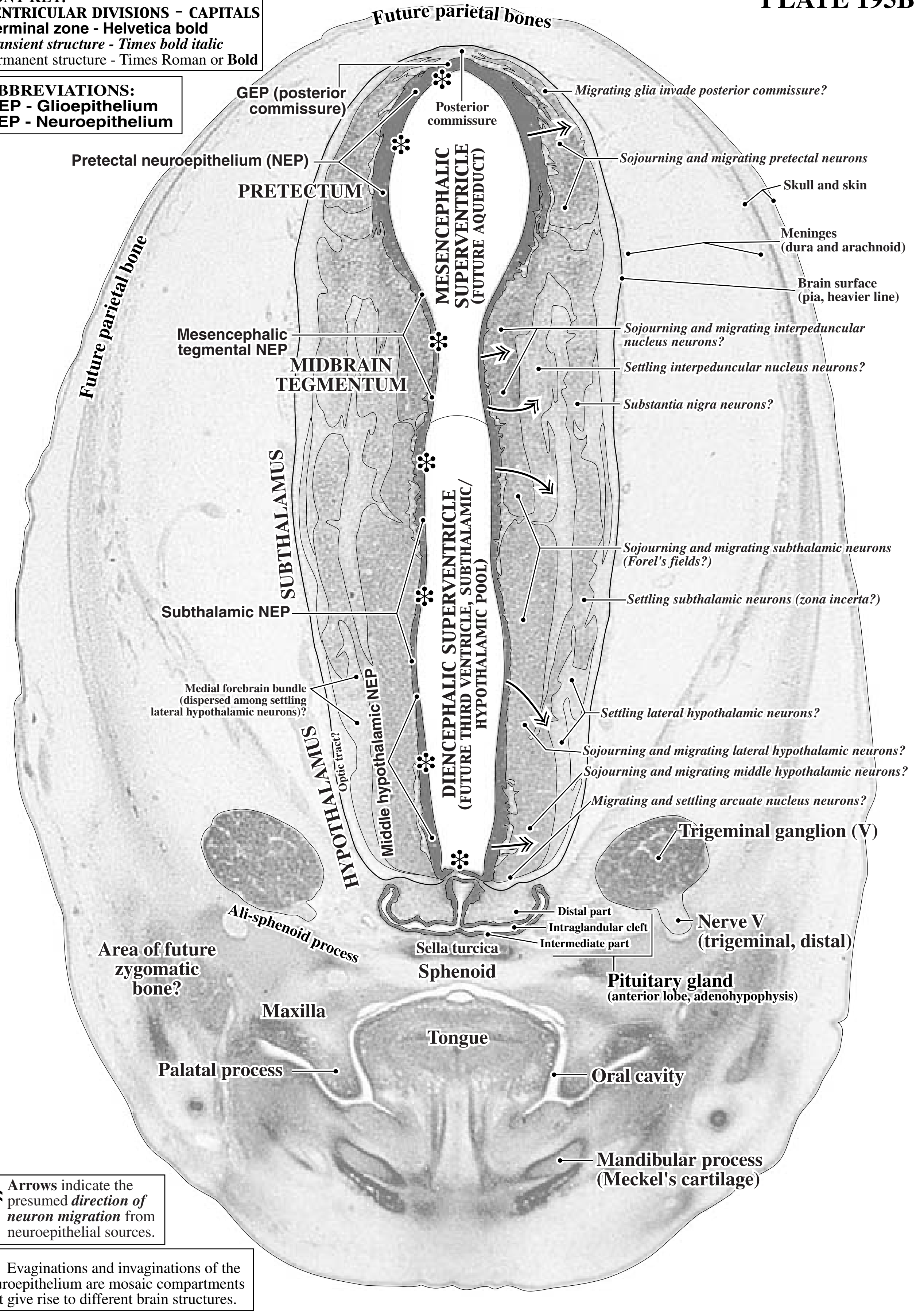
PLATE 195A

GW7.5
Coronal/horizontal
CR 23 mm, C966
Level 10:
Section 98

PLATE 195B

FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

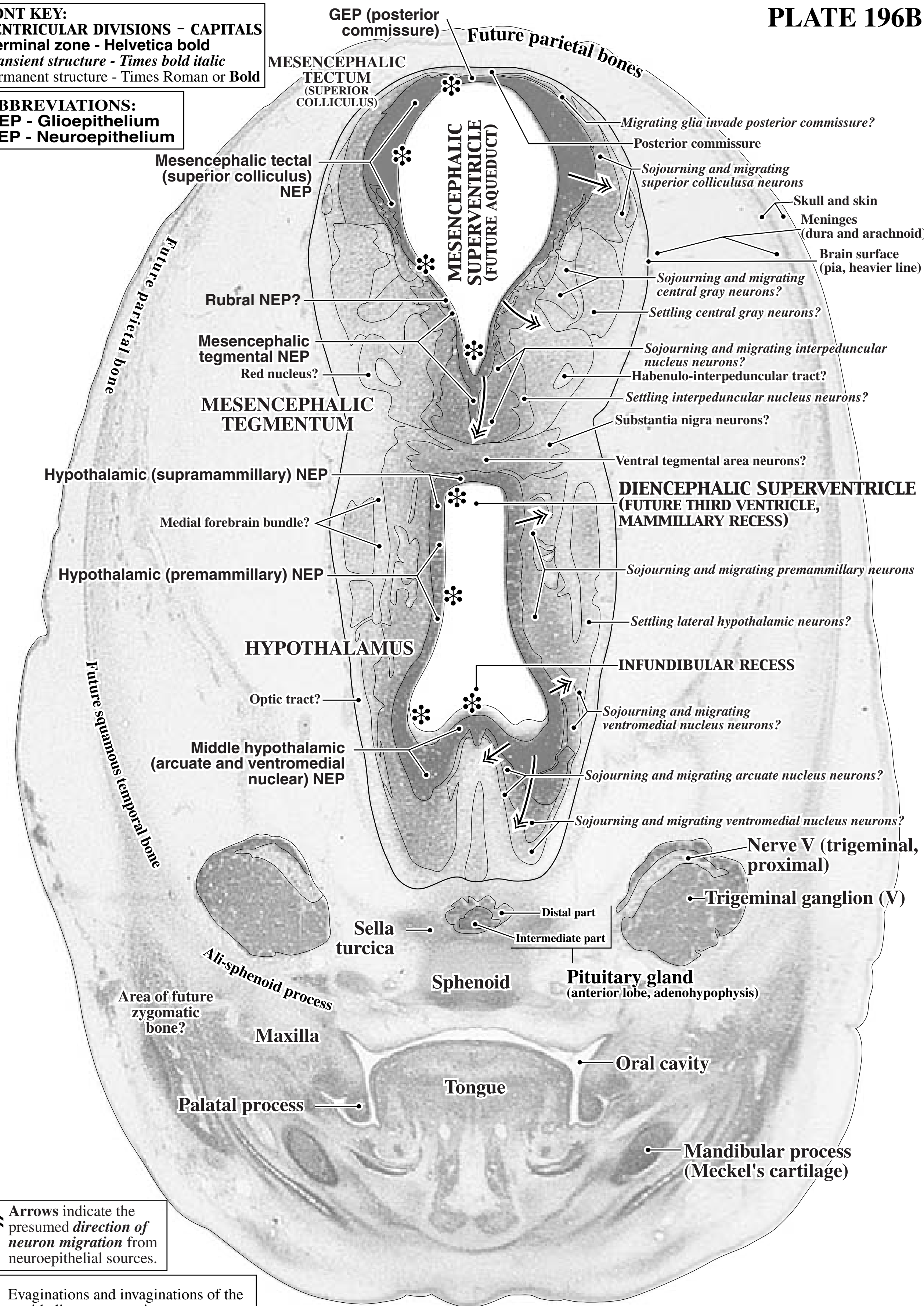
PLATE 196A

GW7.5
Coronal/horizontal
CR 23 mm, C966
Level 11:
Section 105

PLATE 196B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

PLATE 197A

GW7.5
Coronal/horizontal
CR 23 mm, C966
Level 12:
Section 112

PLATE 197B

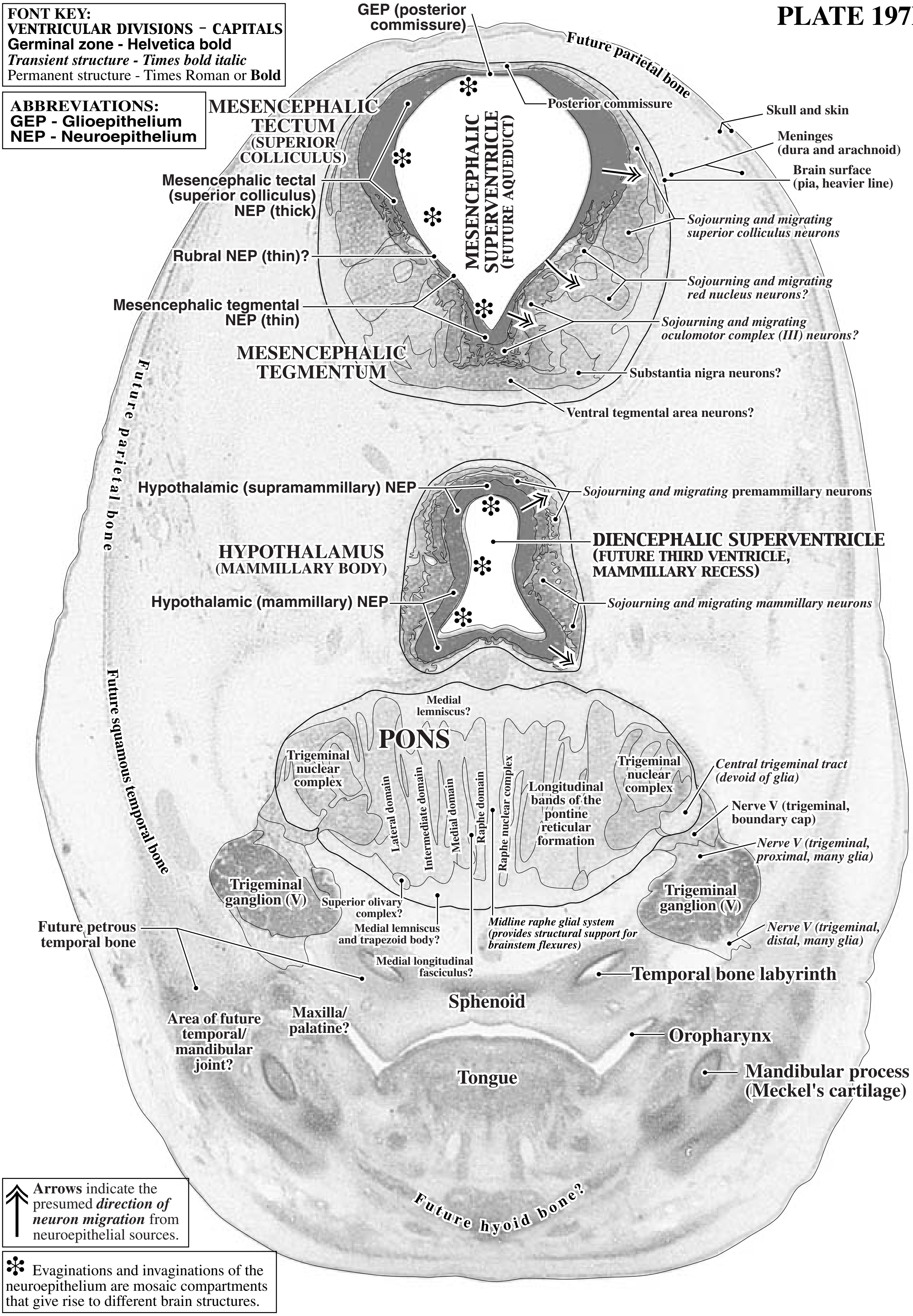

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
GEP (posterior commissure)
Future parietal bone
Posterior commissure
Skull and skin
Meninges (dura and arachnoid)
Brain surface (pia, heavier line)
MESENCEPHALIC TECTUM (SUPERIOR COLLICULUS)
MESENCEPHALIC SUPERVENTRICLE (FUTURE AQUEDUCT)
Mesencephalic tectal (superior colliculus) NEP (thick)
Sojourning and migrating superior colliculus neurons
Rubral NEP (thin)?
Sojourning and migrating red nucleus neurons?
Mesencephalic tegmental NEP (thin)
Sojourning and migrating oculomotor complex (III) neurons?
MESENCEPHALIC TEGMENTUM
Substantia nigra neurons?
Ventral tegmental area neurons?
Future parietal bone
Hypothalamic (supramammillary) NEP
Sojourning and migrating premammillary neurons
DIENCEPHALIC SUPERVENTRICLE (FUTURE THIRD VENTRICLE, MAMMILLARY RECESS)
HYPOTHALAMUS (MAMMILLARY BODY)
Hypothalamic (mammillary) NEP
Sojourning and migrating mammillary neurons
Future squamous temporal bone
Medial lemniscus?
PONS
Trigeminal nuclear complex
Lateral domain
Intermediate domain
Medial domain
Raphe domain
Raphe nuclear complex
Longitudinal bands of the pontine reticular formation
Trigeminal nuclear complex
Central trigeminal tract (devoid of glia)
Nerve V (trigeminal, boundary cap)
Nerve V (trigeminal, proximal, many glia)
Trigeminal ganglion (V)
Superior olivary complex?
Medial lemniscus and trapezoid body?
Midline raphe glial system (provides structural support for brainstem flexures)
Trigeminal ganglion (V)
Nerve V (trigeminal, distal, many glia)
Future petrous temporal bone
Medial longitudinal fasciculus?
Temporal bone labyrinth
Sphenoid
Area of future temporal/ mandibular joint?
Maxilla/ palatine?
Oropharynx
Tongue
Mandibular process (Meckel's cartilage)
Future hyoid bone?
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

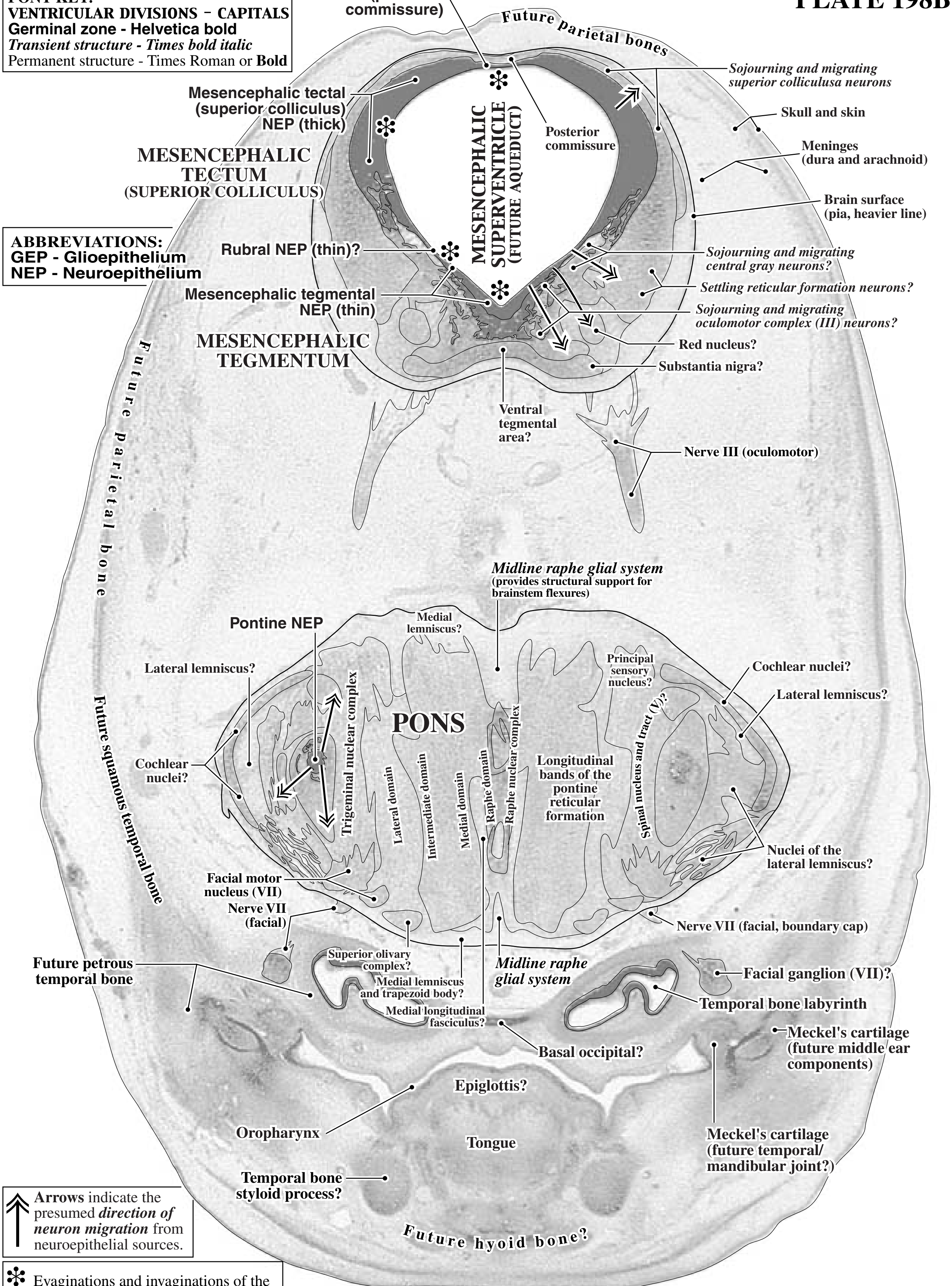
PLATE 198A

GW7.5
Coronal/horizontal
CR 23 mm, C966
Level 13:
Section 119

PLATE 198B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

PLATE 199A

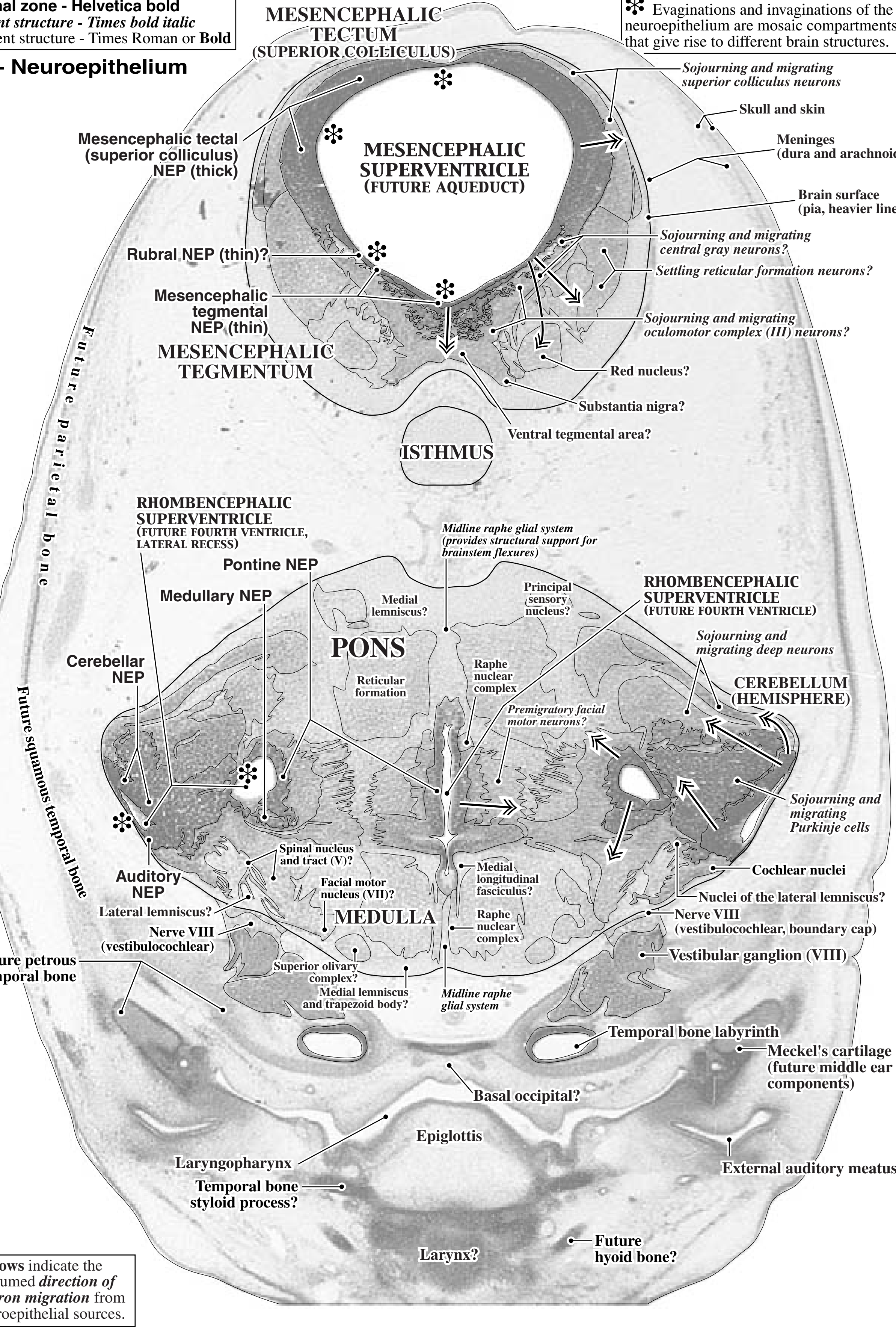
GW7.5 Coronal/horizontal
CR 23 mm, C966
Level 14:
Section 125

PLATE 199B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

NEP - Neuroepithelium

❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 200A

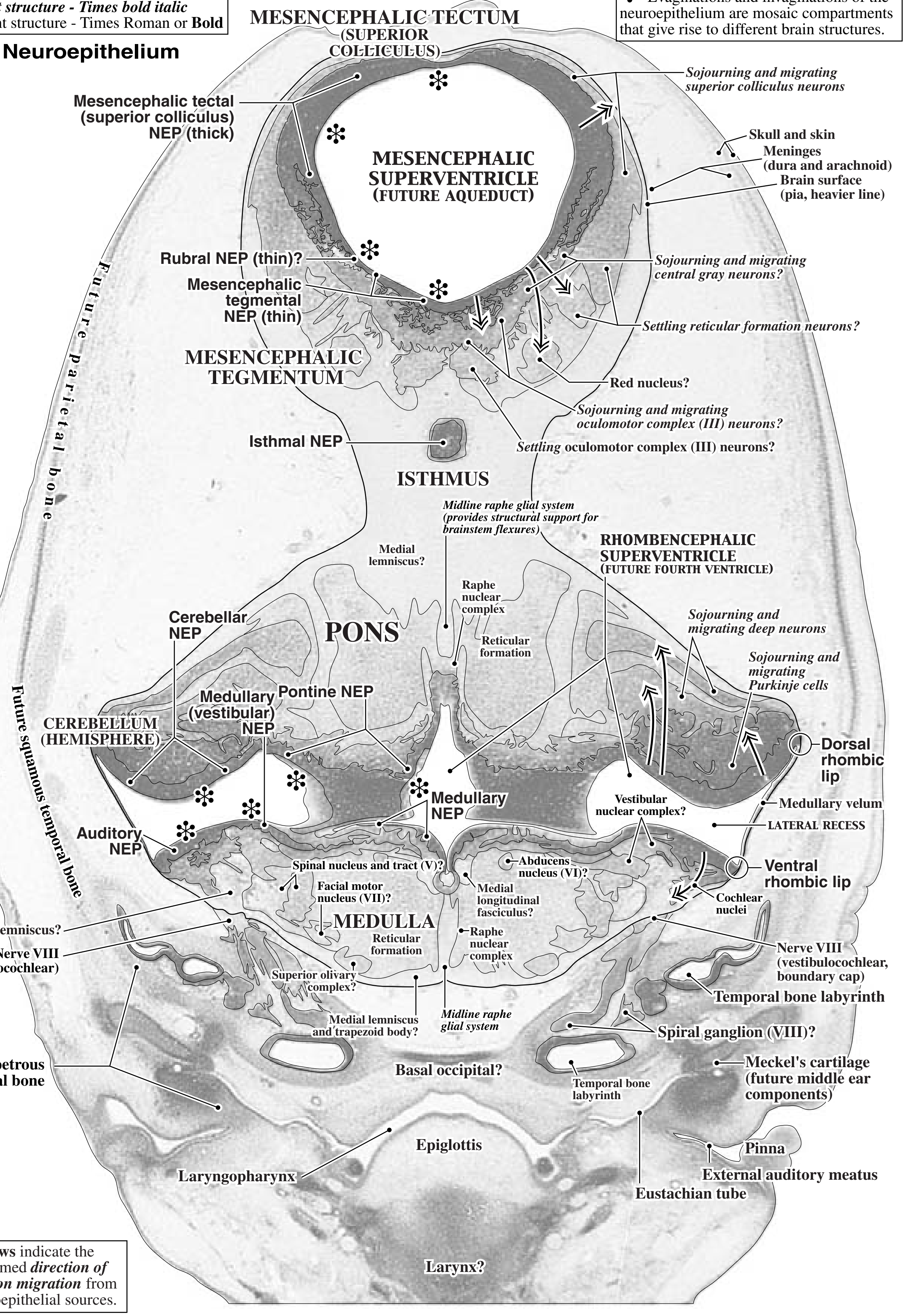
GW7.5 Coronal/horizontal
CR 23 mm, C966
Level 15:
Section 128

PLATE 200B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

NEP - Neuroepithelium

❈ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 201A

GW7.5 Coronal/horizontal
CR 23 mm, C966
Level 16:
Section 139

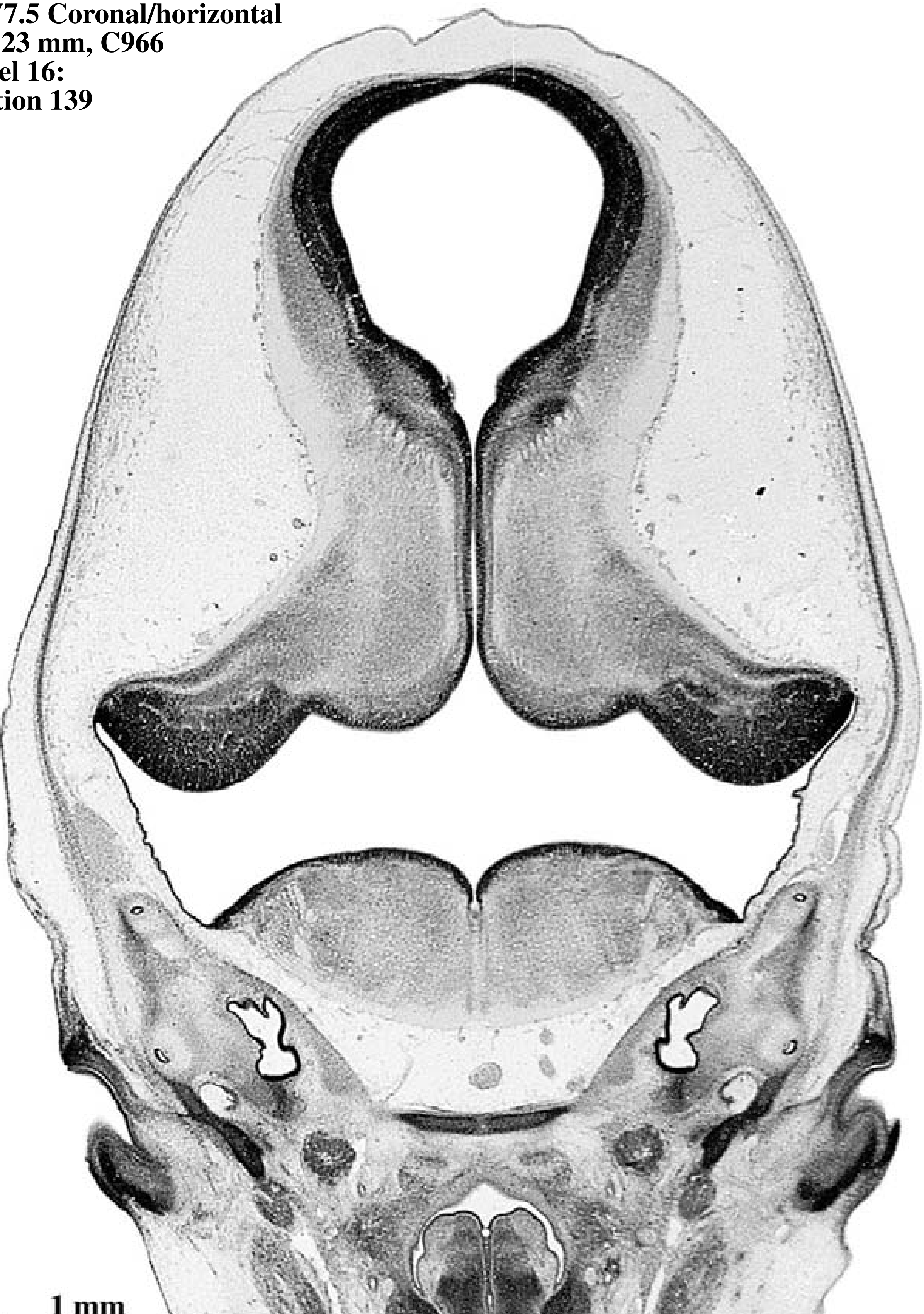
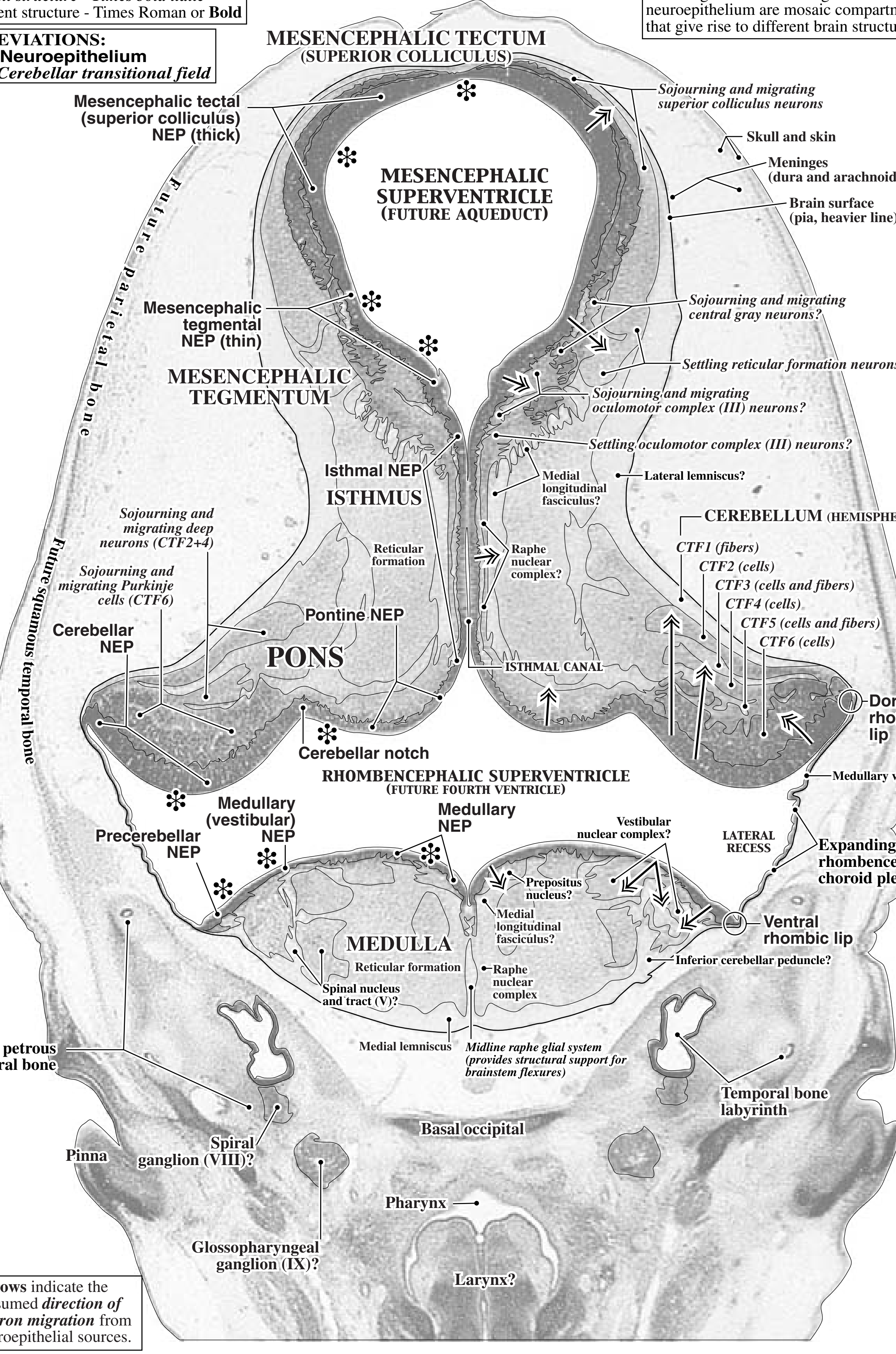


PLATE 201B

FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
NEP - Neuroepithelium
CTF - Cerebellar transitional field

✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

PLATE 202A

GW7.5 Coronal/horizontal
CR 23 mm, C966
Level 17:
Section 147

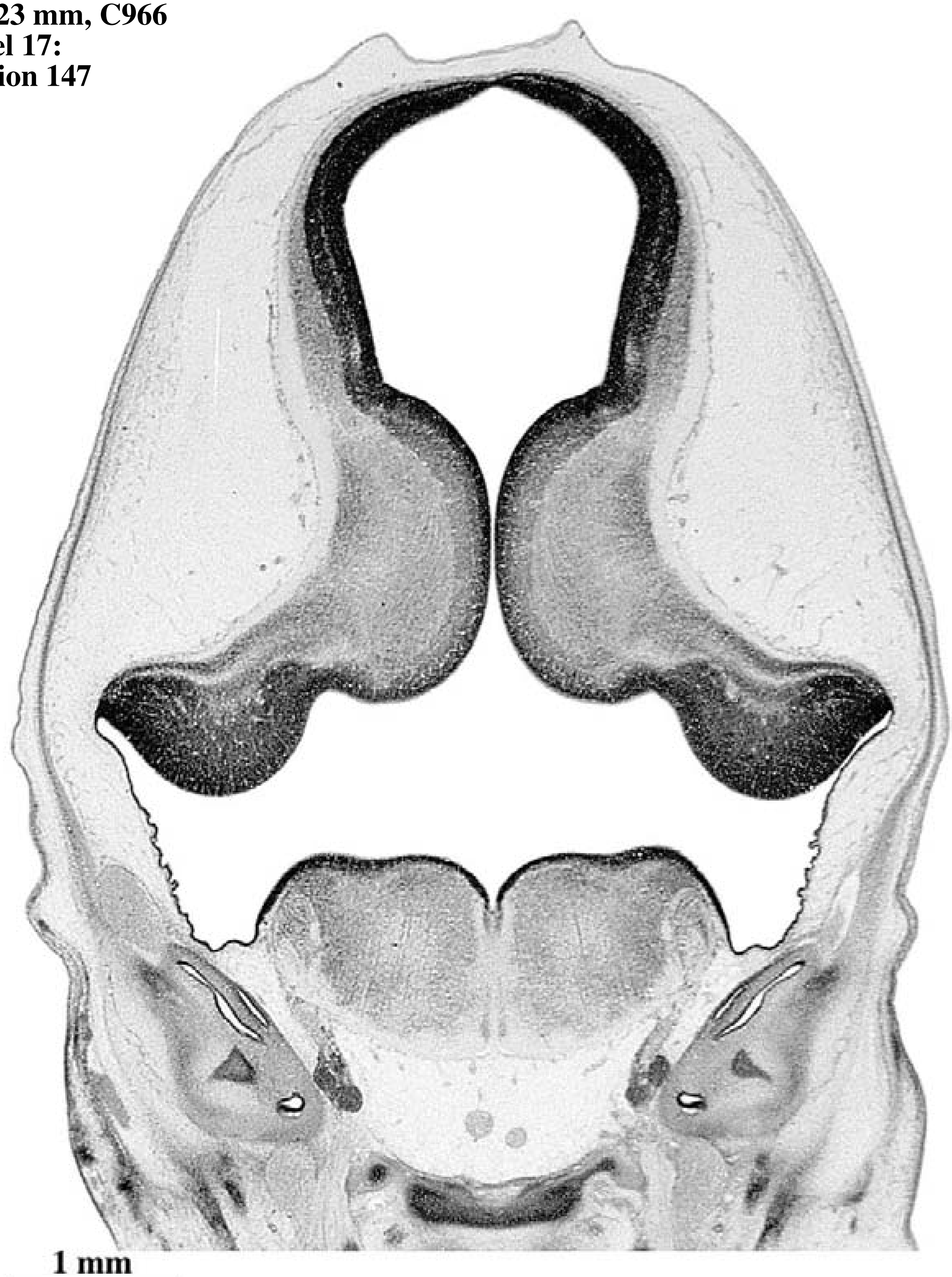
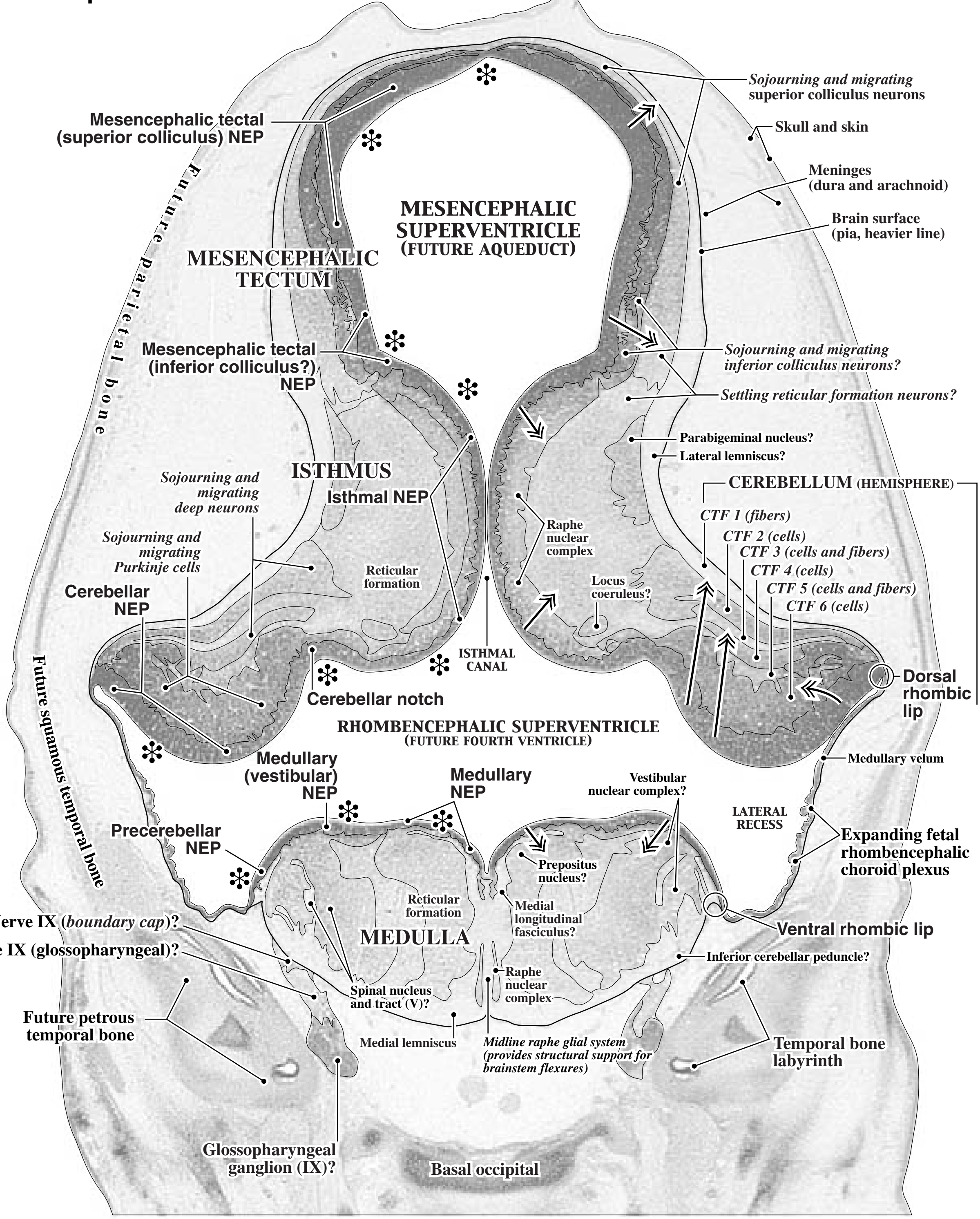


PLATE 202B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

NEP - Neuroepithelium



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

PLATE 203A

GW7.5 Coronal/horizontal
CR 23 mm, C966
Level 18:
Section 157

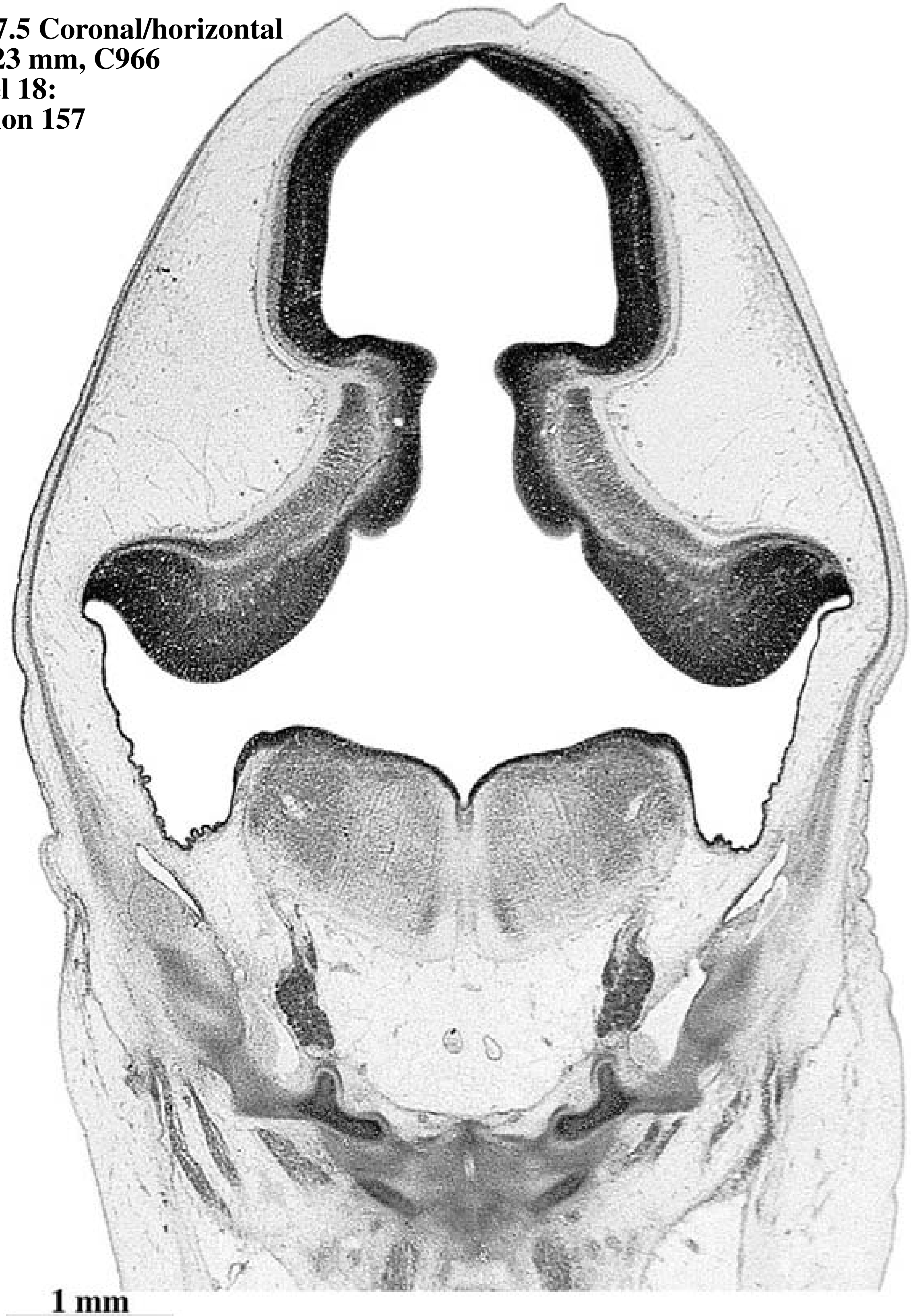
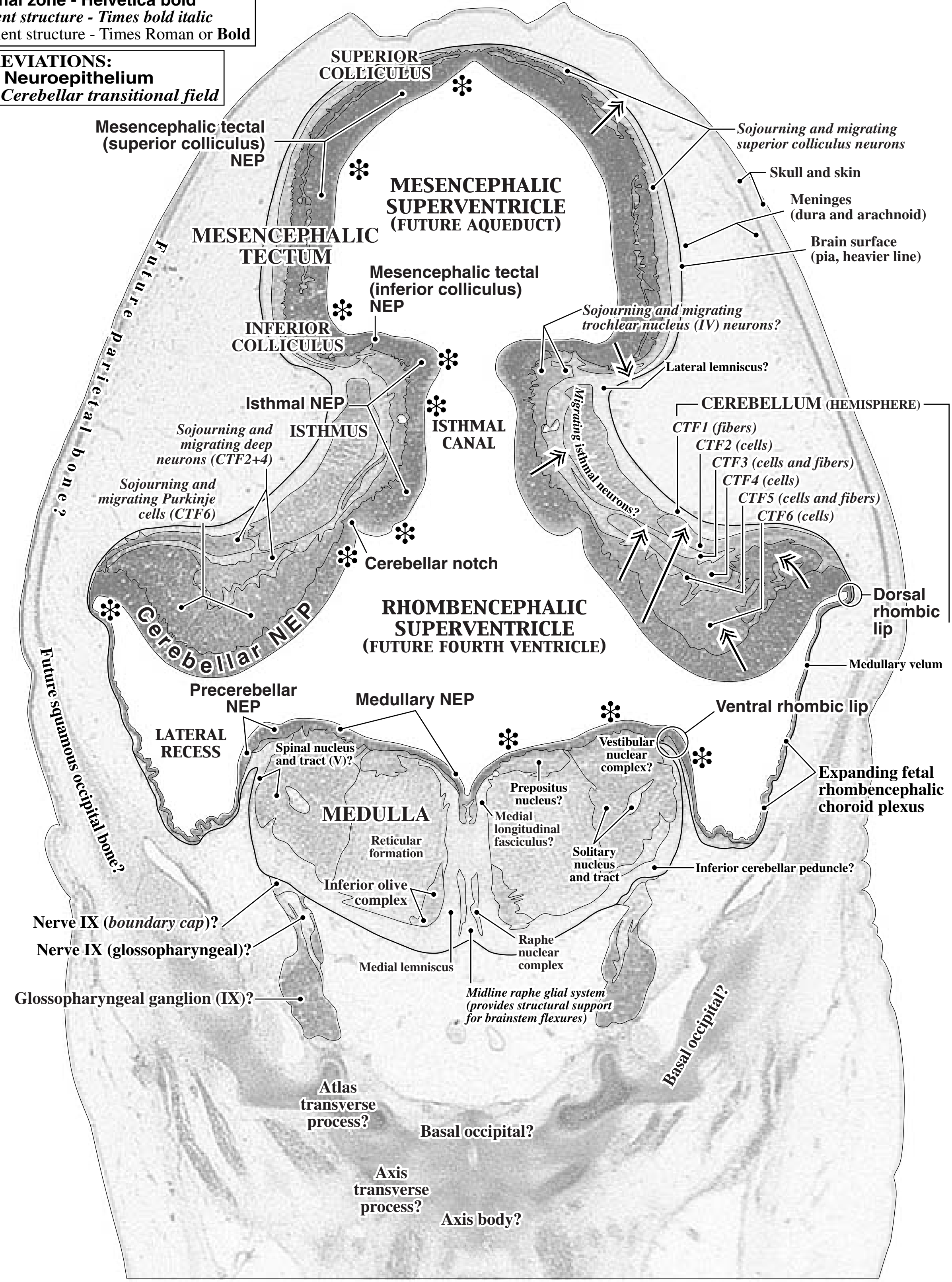


PLATE 203B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
NEP - Neuroepithelium
CTF - Cerebellar transitional field



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

❇ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

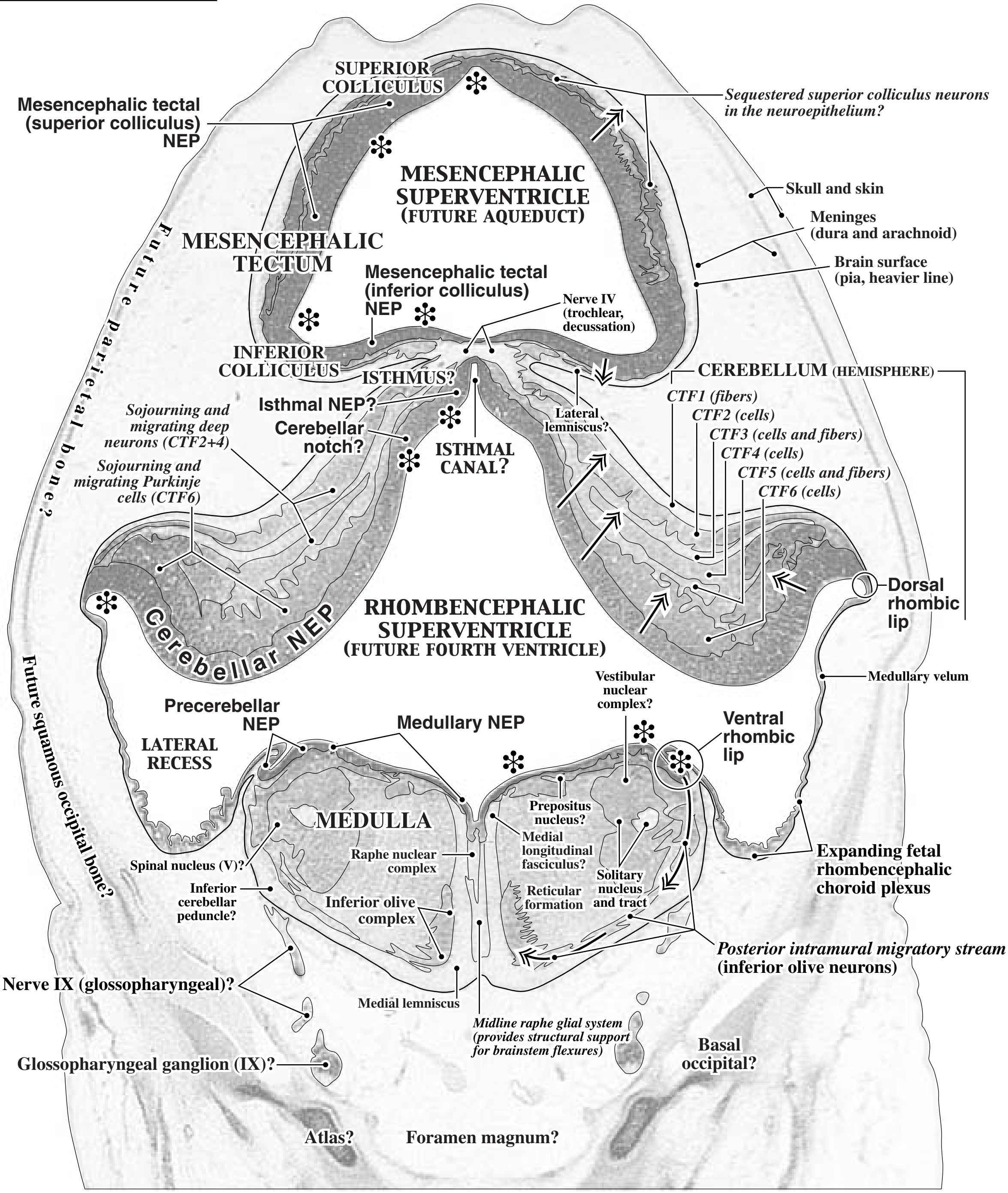
PLATE 204A

GW7.5 Coronal/horizontal
CR 23 mm, C966
Level 19:
Section 163

PLATE 204B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
NEP - Neuroepithelium
CTF - Cerebellar transitional field



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

PLATE 205A

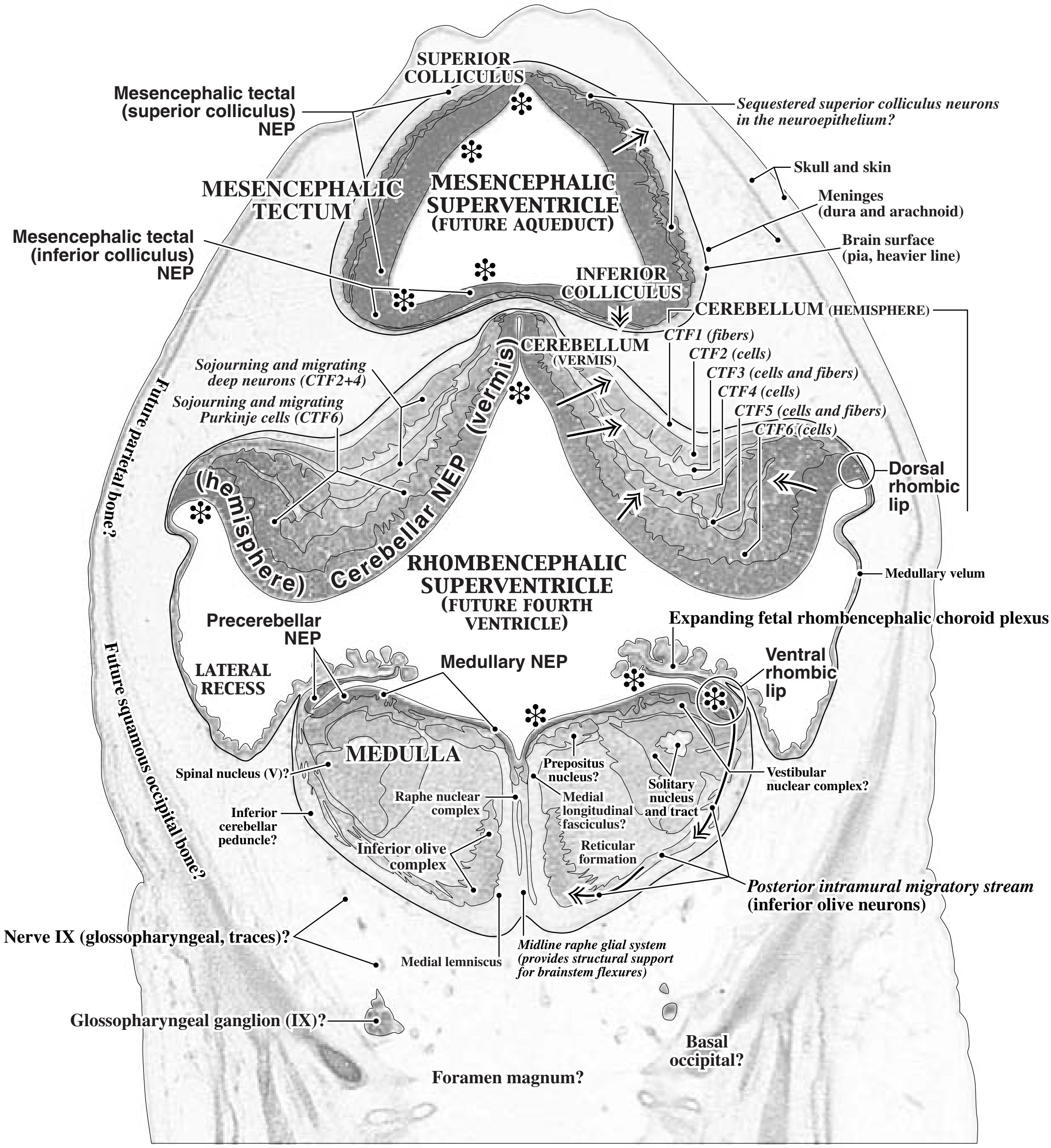
GW7.5 Coronal/horizontal
CR 23 mm, C966
Level 20:
Section 171

1 mm

PLATE 205B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

ABBREVIATIONS:
NEP - Neuroepithelium
CTF - Cerebellar transitional field



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

PLATE 206A

GW7.5 Coronal/horizontal
CR 23 mm, C966
Level 21:
Section 179

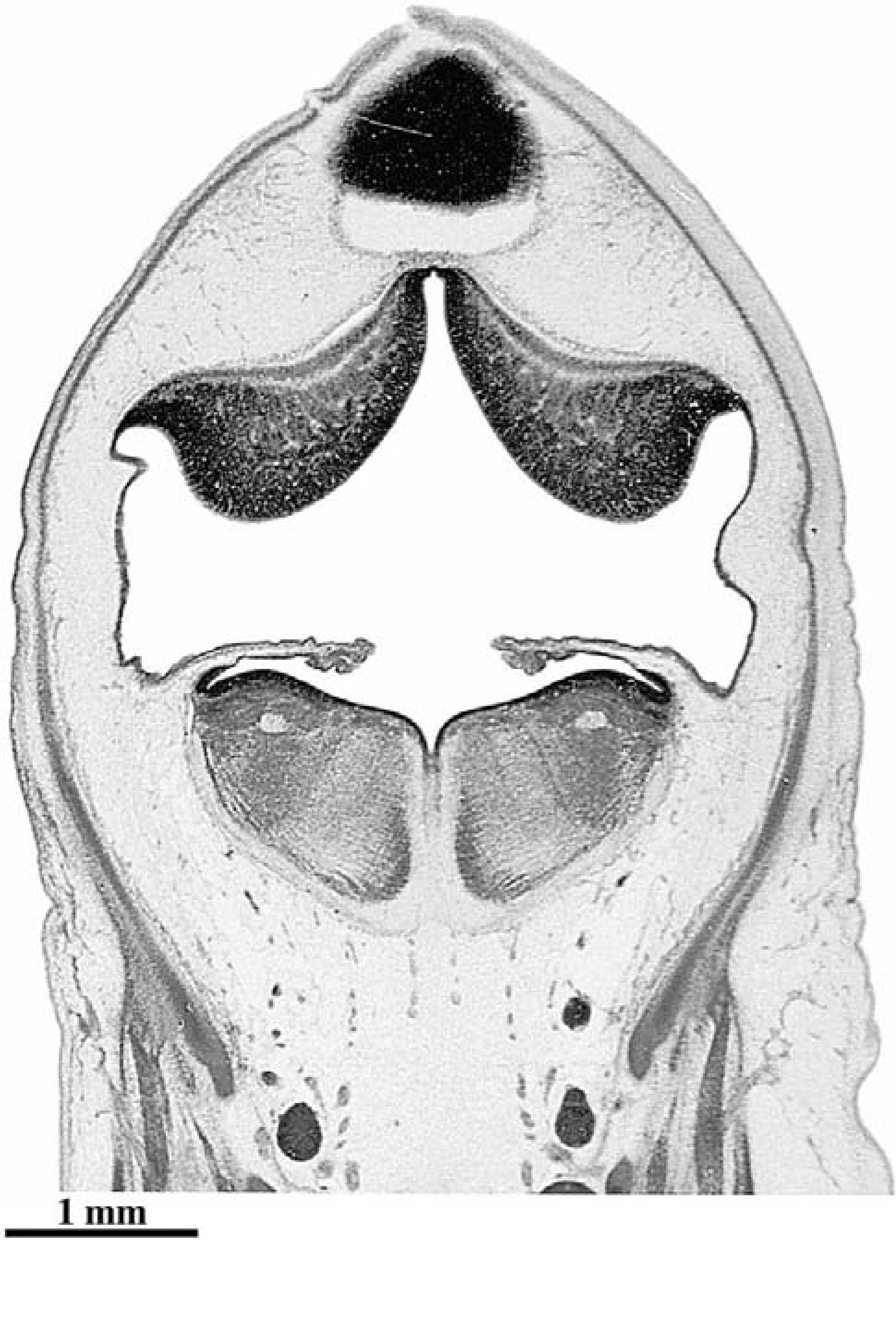
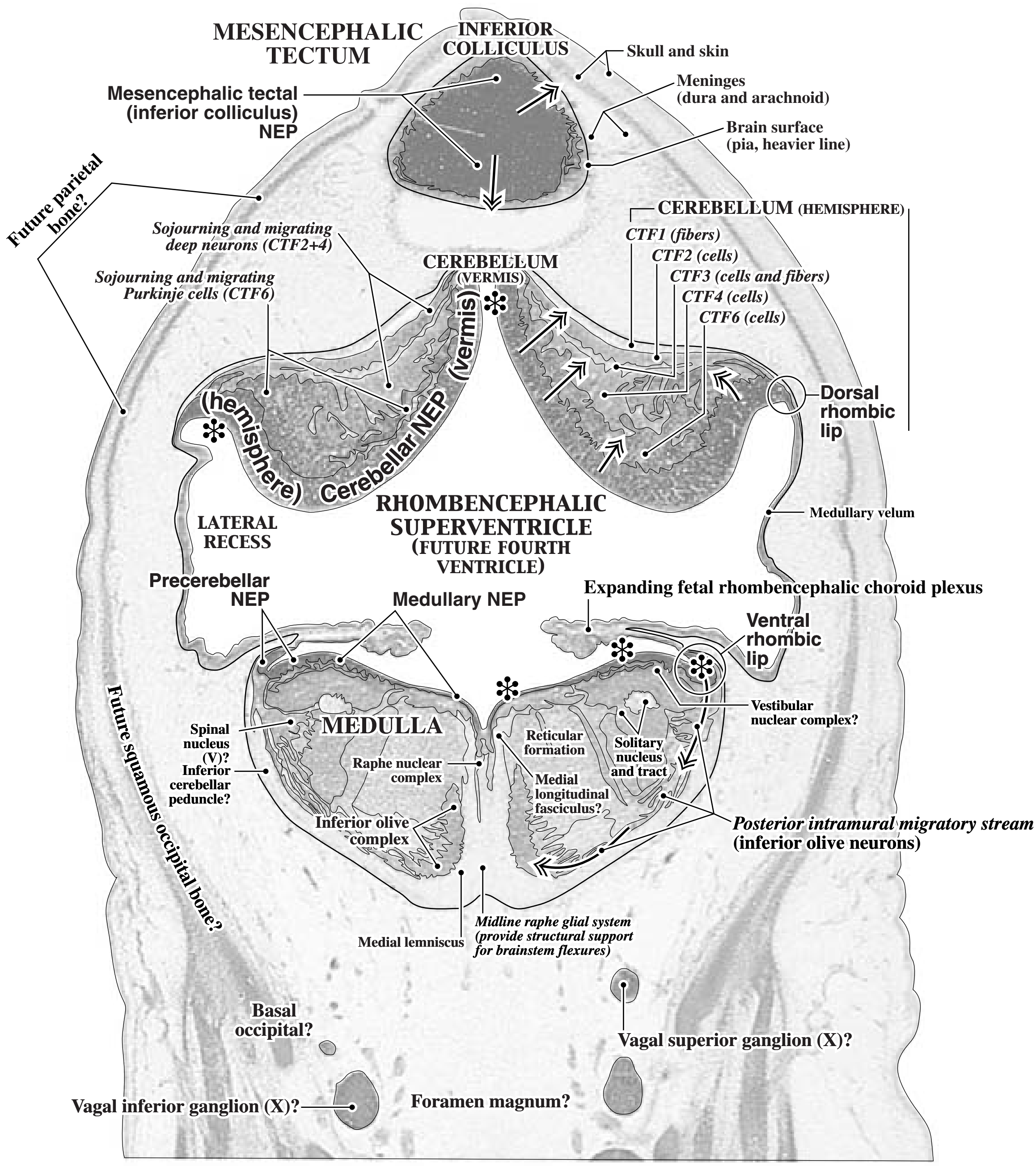


PLATE 206B

FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

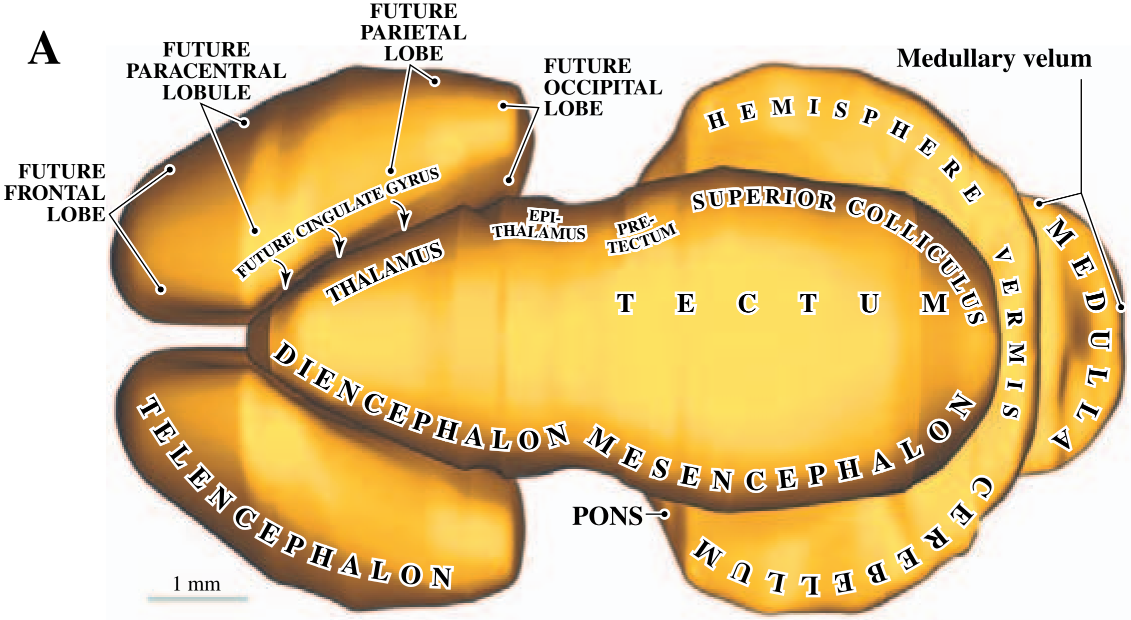
ABBREVIATIONS:
NEP - Neuroepithelium
CTF - Cerebellar transitional field



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

✻ Evaginations and invaginations of the neuroepithelium are mosaic compartments that give rise to different brain structures.

FIGURE 10 GW7.5, CR23 mm, C966, COMPUTER-AIDED 3-D RECONSTRUCTION

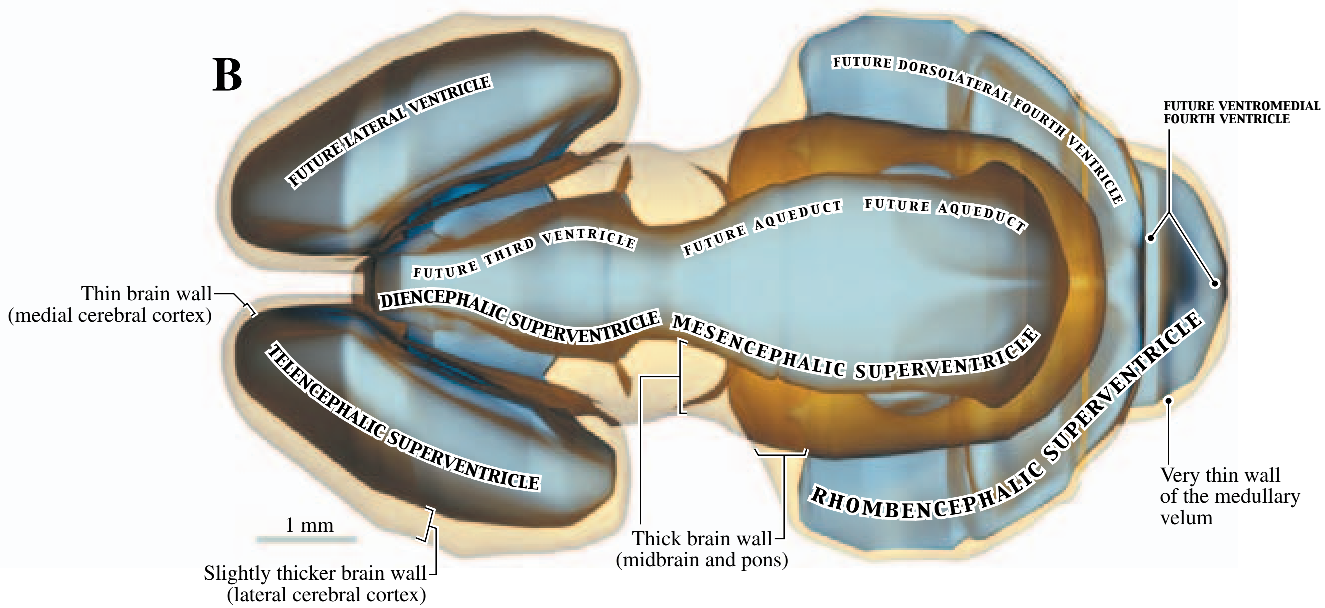


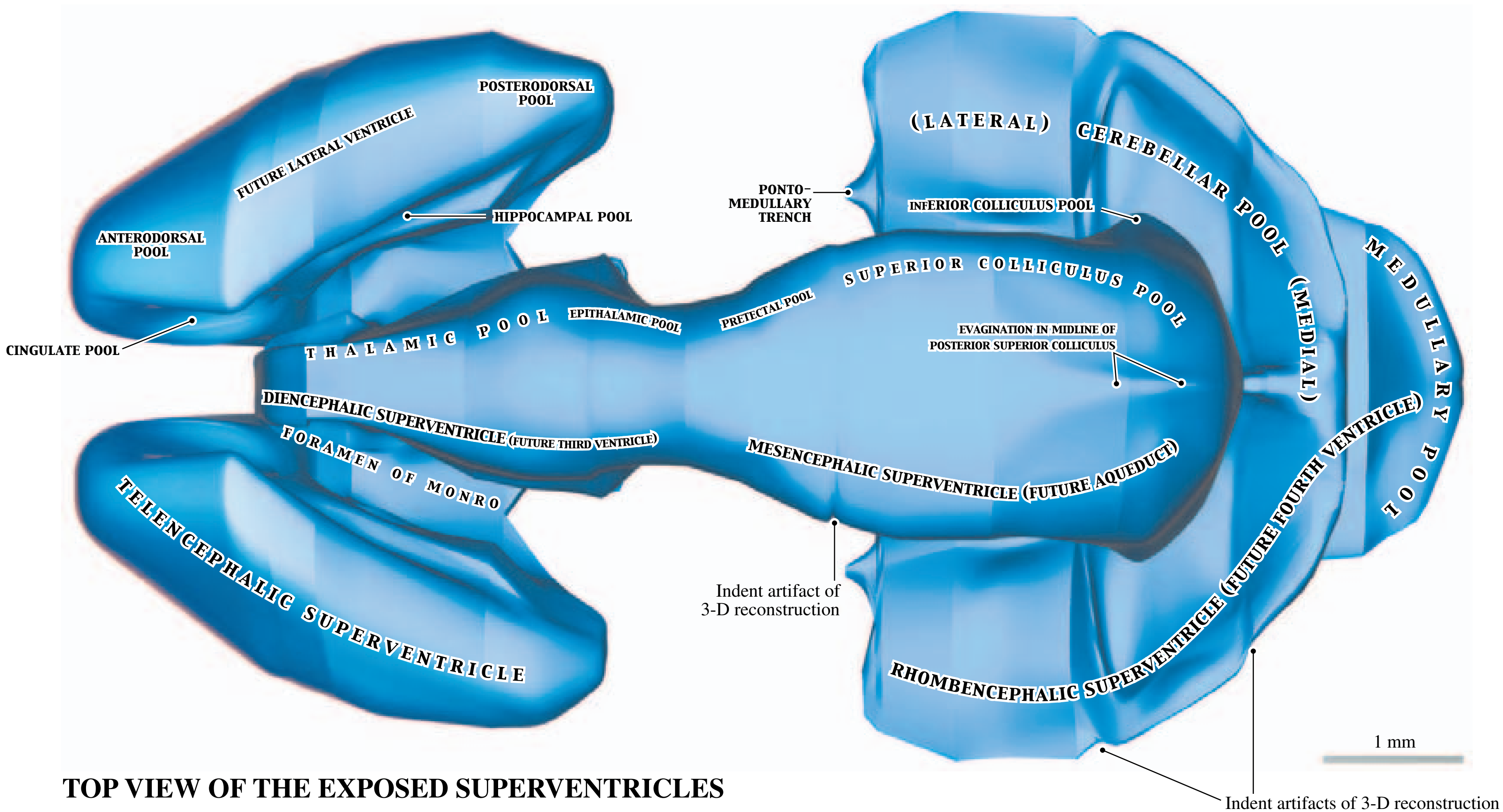
A. TOP VIEW OF THE BRAIN SURFACE

The observer is looking straight down on the top of the brain. Note the small size of the telencephalon. In a mature brain, the only structure visible from the top is the telencephalon. At GW 7.5, the telencephalon does not yet cover the dorsal surface of the diencephalon. All of the mesencephalic tectum is visible. The cerebellum appears as a wide ledge forming a horseshoe-shaped understory beneath the tectum. The pons is only partly visible connecting to the anteroventral edge of the cerebellum. The medullary velum is all that is visible of the medulla.

B. TOP VIEW SHOWING THE SUPERVENTRICLES

A substantial portion of the brain's volume is occupied by the ventricles. In a mature brain, the ventricles are small, central cavities. At GW 7.5, the diencephalic and mesencephalic superventricles are already narrowing to resemble their adult shapes, and the brain wall is thickest in that region. Most of the telencephalon is filled with the paired telencephalic superventricles, but note that the brain wall is thicker laterally than medially in accordance with the ventrolateral (earlier maturing) to dorsomedial (later maturing) developmental gradient. The dark areas within the brain wall are caused by looking through more than one thickness.

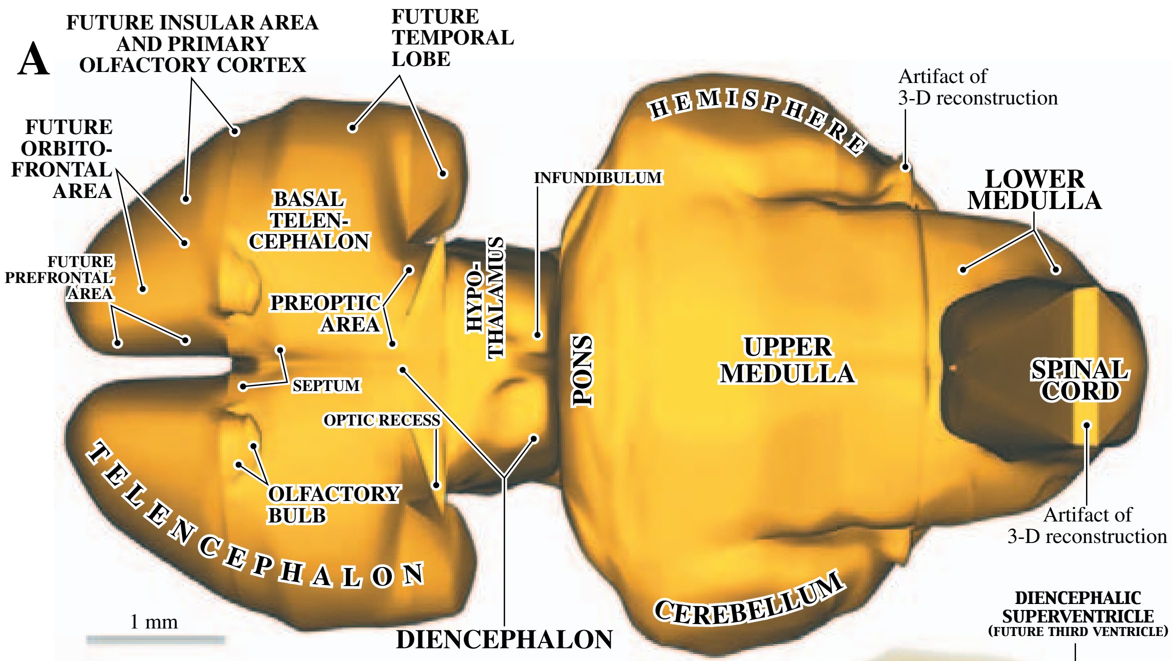




TOP VIEW OF THE EXPOSED SUPERVENTRICLES

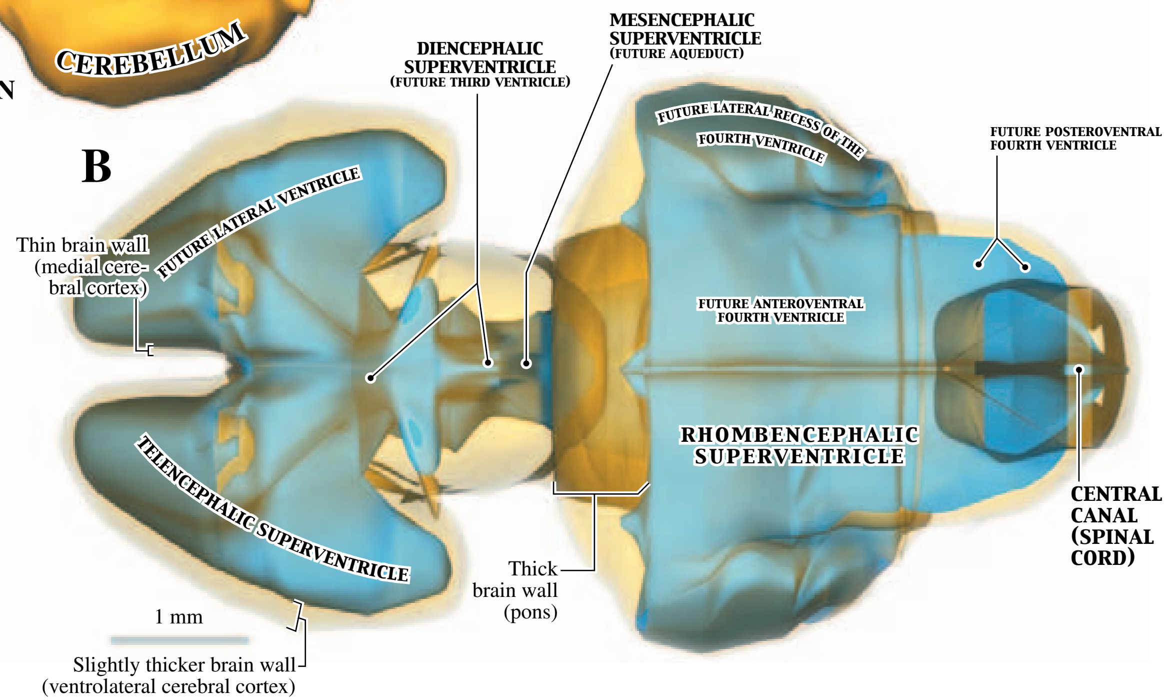
Enlarged view of **Figure 10B** showing only the ventricles. Because the ventricles contain fluid, subdivisions are called "pools." The various pools are named according to adjacent structures, which often produce evaginations into the ventricle (such as the cingulate and hippocampal pools). The complex shape of the brain ventricles is primarily a result of (1) localized differential proliferation in the adjacent neuroepithelium and (2) flexures in the diencephalon, midbrain, pons, and medulla during development.

FIGURE 12 GW7.5, CR23 mm, C966, COMPUTER-AIDED 3-D RECONSTRUCTION



A. BOTTOM VIEW OF THE BRAIN SURFACE

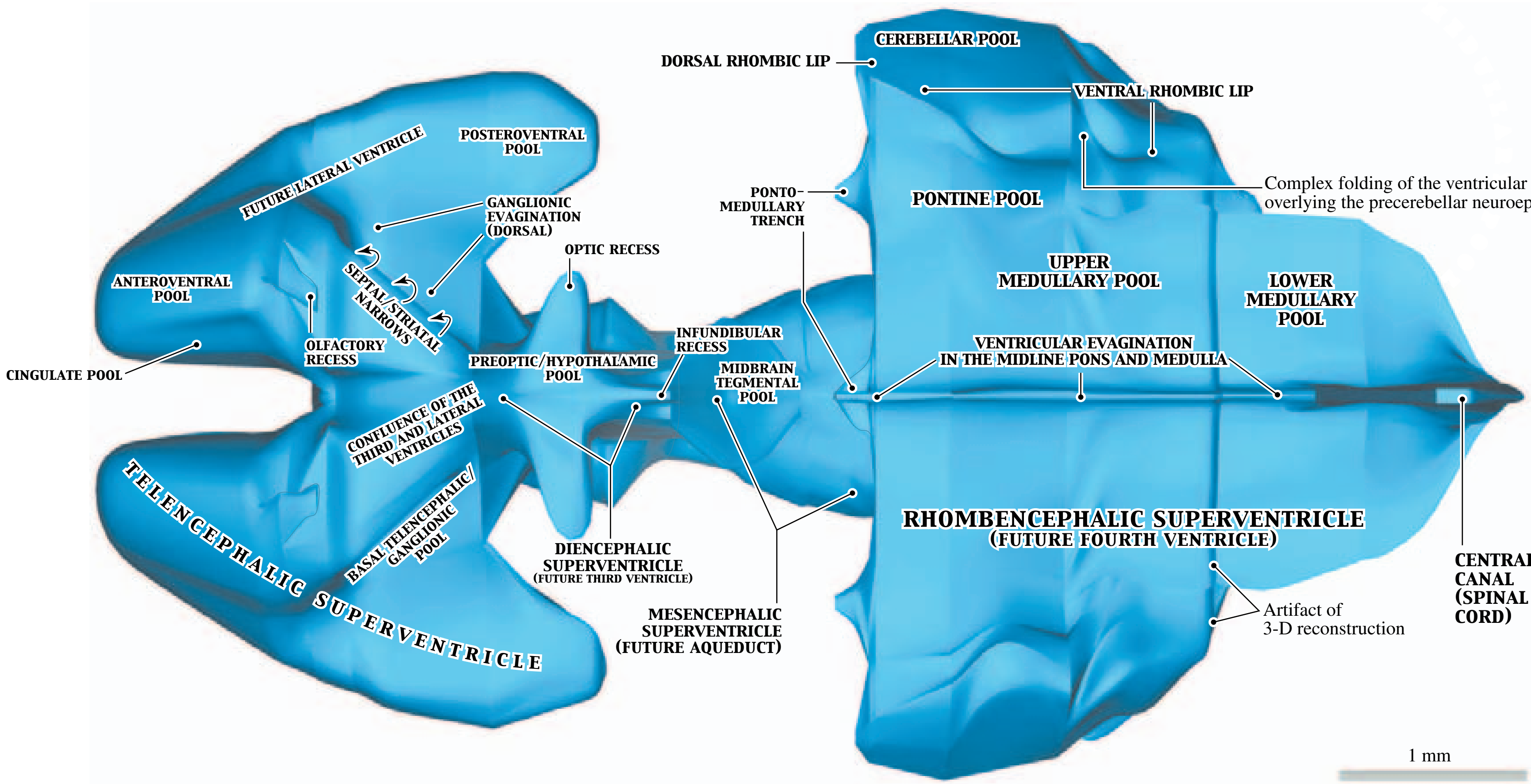
The observer is below, looking straight up at the bottom of the brain and spinal cord. Note the olfactory bulb is located behind the cortex and evaginates from the basal telencephalic area (just above the developing olfactory epithelium in the skull, see **Plates 188 and 189**). The enormous growth of the prefrontal area of the cortex eventually displaces the bulb to lie in a more anterior position. This ventral view shows little of the ventral mesencephalon, because the tegmentum is folded above the ventral diencephalon. The cerebellum still appears as a wide ledge on the lateral edge of the pons that arches over the upper and lower medulla. The spinal cord is coming straight down from the lower medulla.



B. BOTTOM VIEW SHOWING THE SUPERVENTRICLES

The brain wall is thickest in the pons from this viewpoint because the pontine parenchyma is in front of the anterior edge of the rhombencephalic superventricle. In the telencephalon, the lateral brain wall is thicker than the medial wall in accordance with the ventrolateral (earlier maturing) to dorsomedial (later maturing) developmental gradient. As in **Figure 10B**, the dark areas within the brain wall are caused by looking through more than one thickness.

FIGURE 13 GW7.5, CR23 mm, C966, COMPUTER-AIDED 3-D RECONSTRUCTION



BOTTOM VIEW OF THE EXPOSED SUPERVENTRICLES

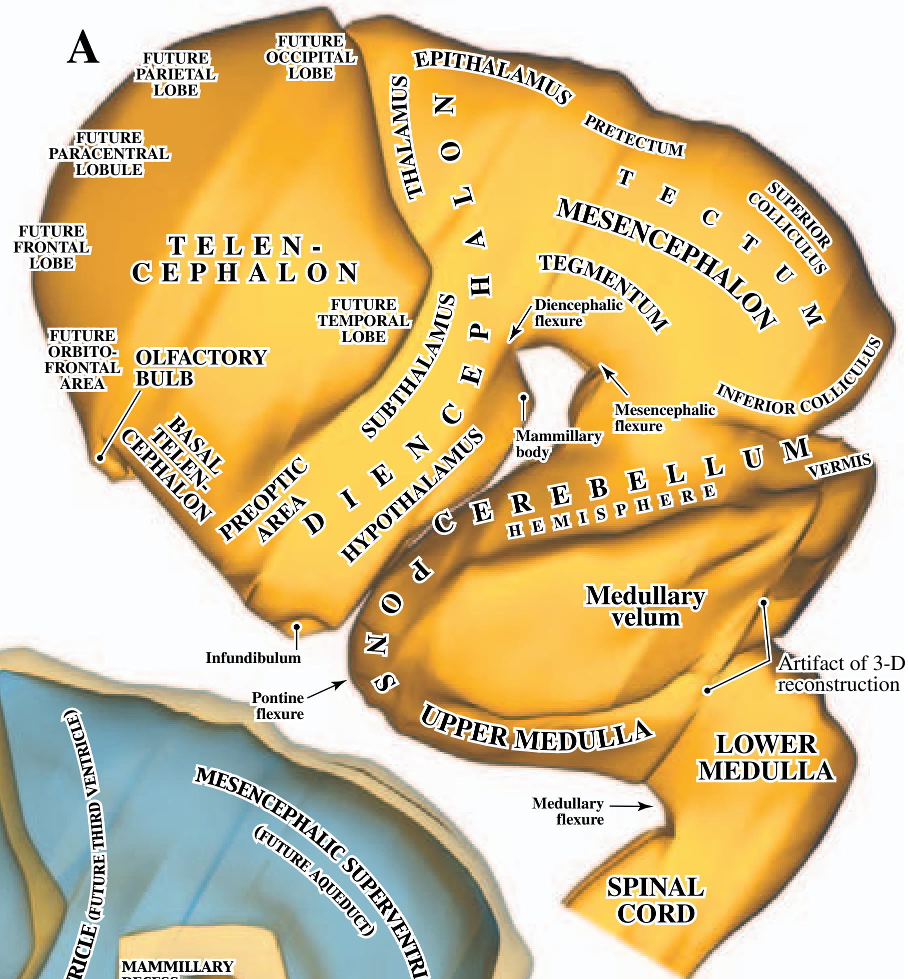
Enlarged view of **Figure 12B** showing only the ventricles. The complex evaginations of the ventricular surface indicate the heterogeneous nature of the neuroepithelium that lines different ventricular divisions.

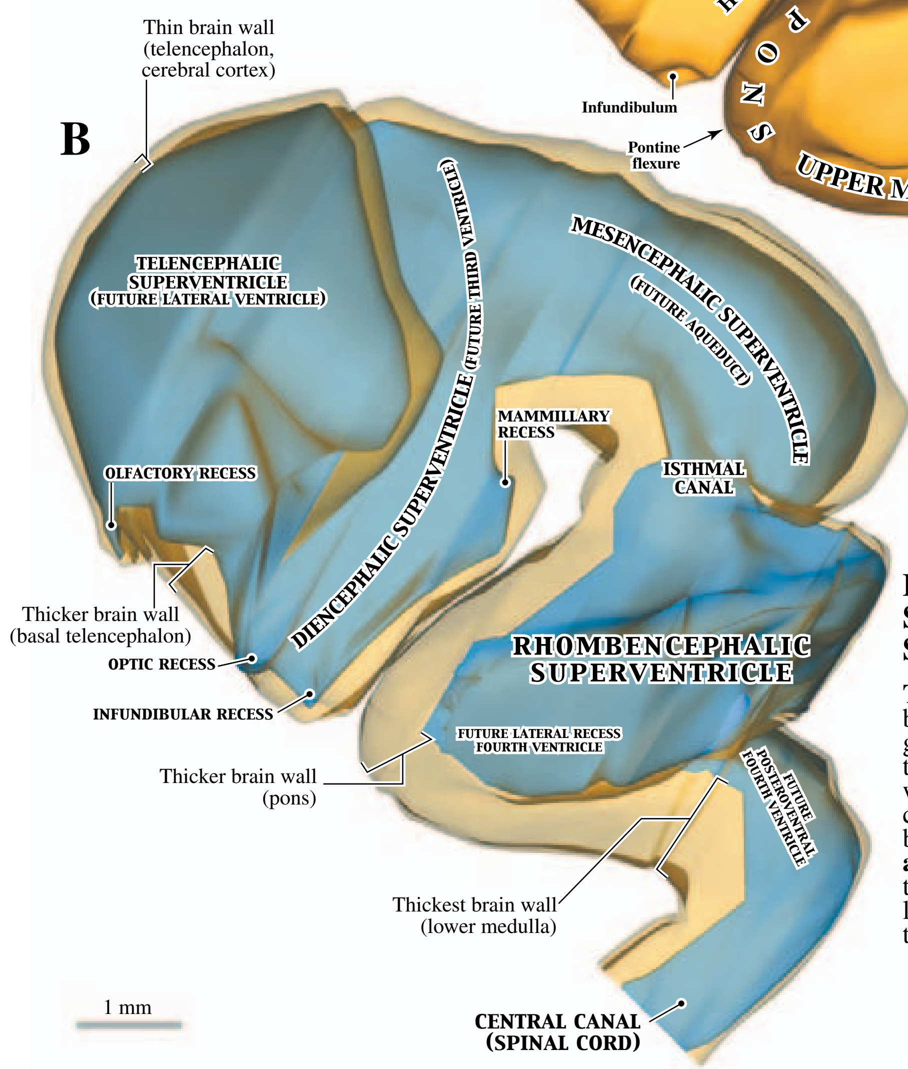
FIGURE 14

GW7.5, CR23 mm, C966, COMPUTER-AIDED 3-D RECONSTRUCTION

A. SIDE VIEW OF THE BRAIN SURFACE

The observer is beside the model, looking at the lateral surface of the brain and upper cervical spinal cord. Note the posterior-facing olfactory bulb beneath the basal telencephaon. This lateral view shows most clearly all of the flexures in the brainstem.



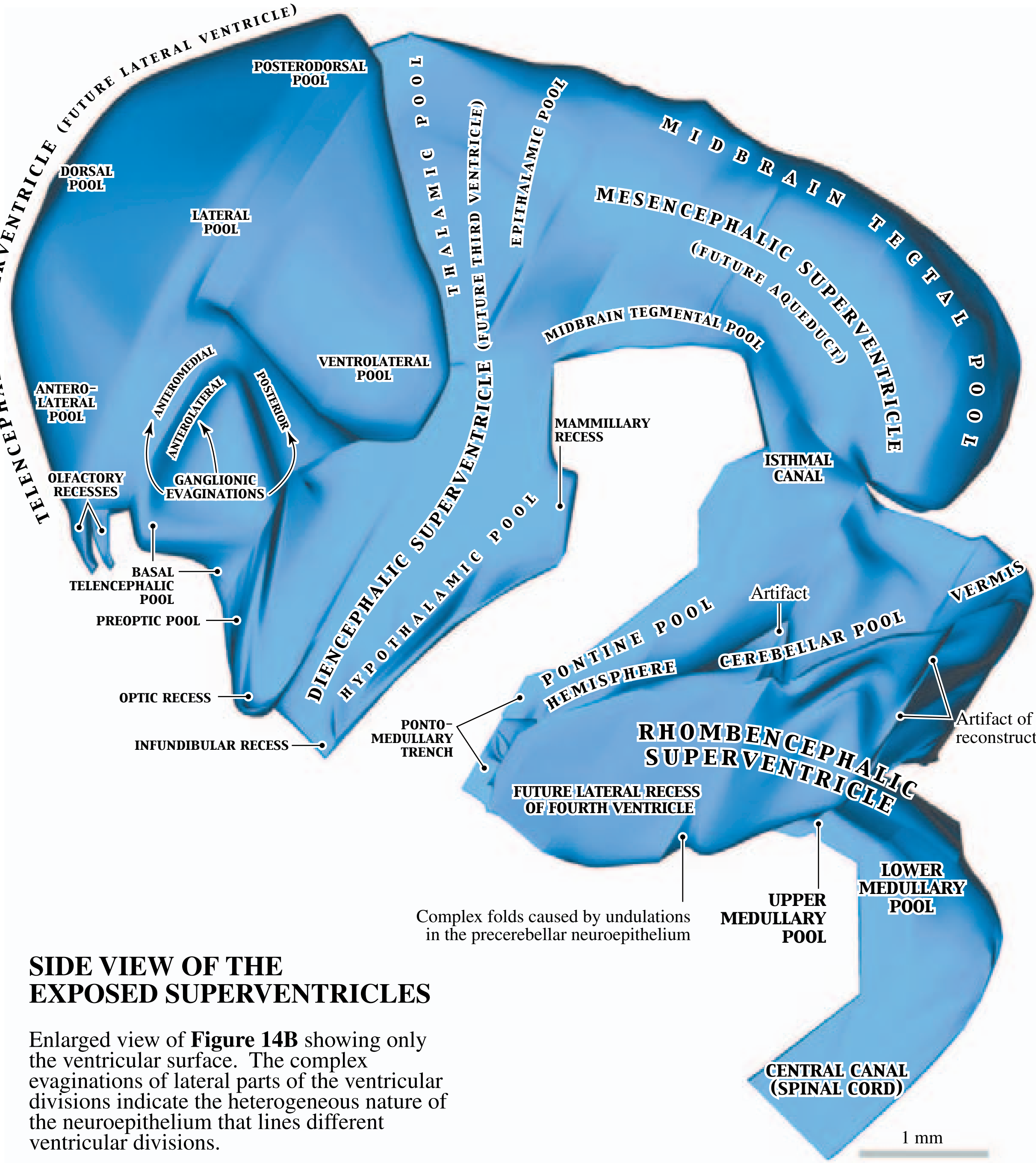


B. SIDE VIEW SHOWING THE SUPERVENTRICLES

The varying thicknesses of the brain wall mirror a maturation gradient: the medulla has the thickest wall and is most mature, while the thin wall of the cerebral cortex is one of the least mature brain areas. As in **Figures 10B and 12B**, the dark areas within the brain wall are caused by looking through more than one thickness.

GW7.5, CR23 mm, C966, COMPUTER-AIDED 3-D RECONSTRUCTION

FIGURE 15

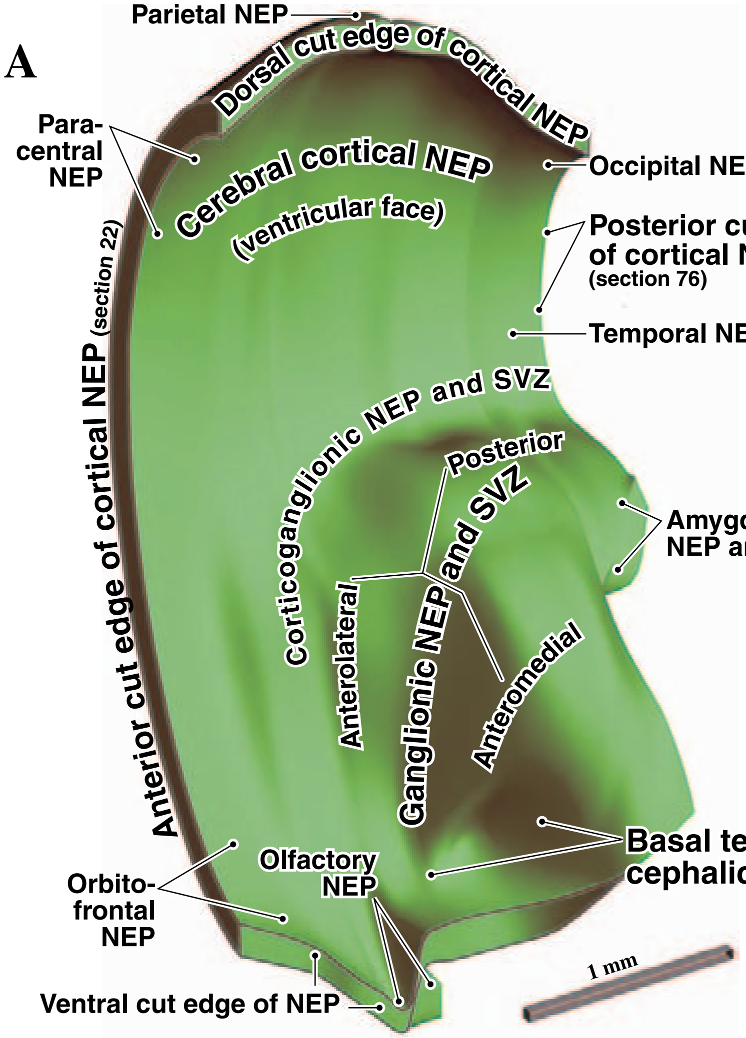


SIDE VIEW OF THE EXPOSED SUPERVENTRICLES

Enlarged view of **Figure 14B** showing only the ventricular surface. The complex evaginations of lateral parts of the ventricular divisions indicate the heterogeneous nature of the neuroepithelium that lines different ventricular divisions.

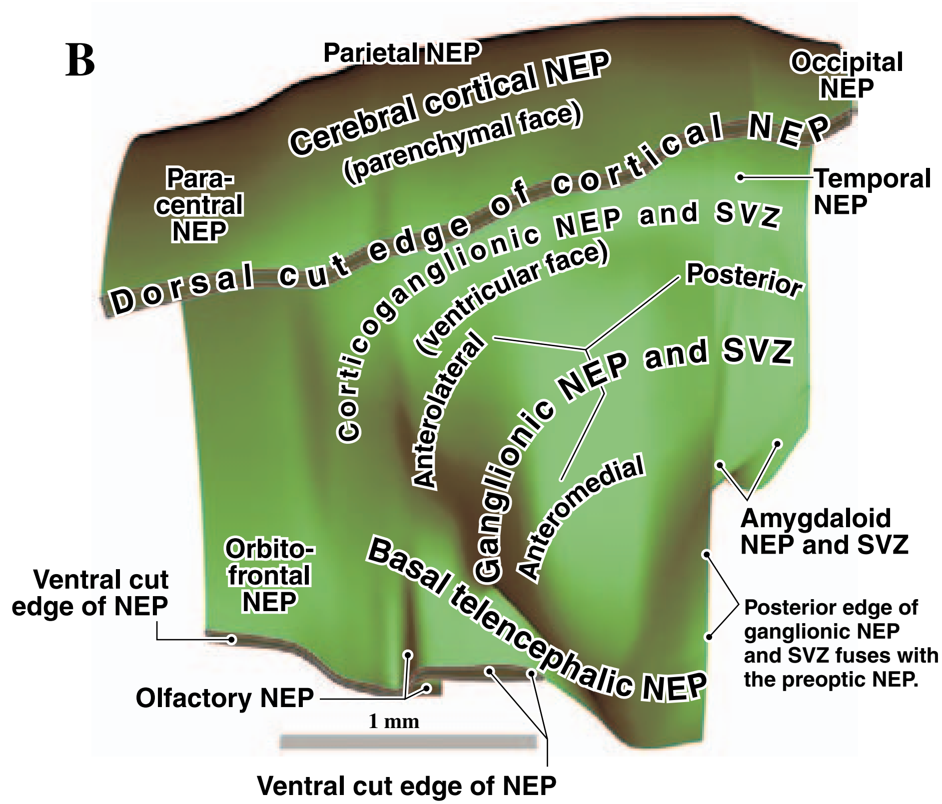
FIGURE 16 GW7.5, CR23 mm, C966, COMPUTER-AIDED 3-D RECONSTRUCTION OF THE LATERAL TELENCEPHALIC NEUROEPITHELIUM

A



A. is an inside "camera" view of the lateral half of the telencephalic neuroepithelium and subventricular zone; the medial half is not reconstructed so that the ganglionic and olfactory evaginations are visible. The reconstruction includes sections 22 (between **Levels 1 and 2, Plates 187 and 188**) through 76 (**Level 7, Plate 192**). The camera is looking straight (0° pitch) at the reconstruction with a +60° rotation (heading). The large ganglionic evagination is evident in the ventrolateral NEP and SVZ.

B

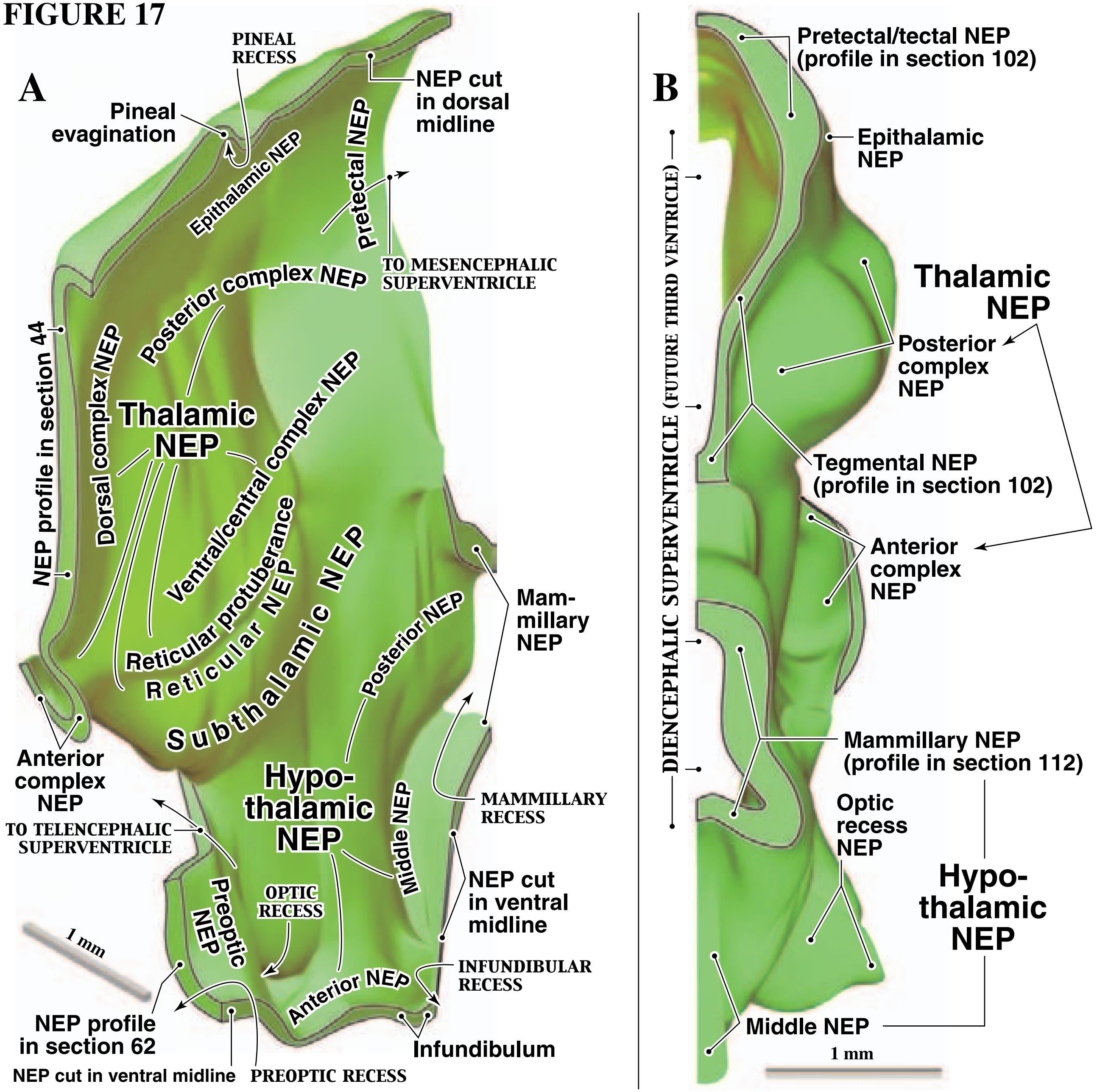


B. is another inside "camera" view of the same reconstruction in **A**. The camera is looking down (-70° pitch) at the reconstruction with a +90° rotation (heading). From that angle, the superficial face of the dorsal cortical NEP is visible, and the large ganglionic evagination rises up into the future lateral ventricle. The posterior edge of the ganglionic NEP and SVZ fuses with the preoptic NEP posterior to the foramen of Monro. See that transition between Level 5 (**Plate 190**) and Level 6 (**Plate 191**).

ABBREVIATIONS: NEP - Neuroepithelium SVZ - Subventricular zone	Neuroepithelial compartments labeled in Helvetica Bold.

FIGURE 17

GW7.5, CR23 mm, C966, COMPUTER-AIDED 3-D RECONSTRUCTION OF THE DIENCEPHALIC NEUROEPITHELIUM



Two inside "camera" views of the right half of the diencephalic neuroepithelium that includes section 44 (near **Level 3, Plate 188**) through section 112 (**Level 12, Plate 197**); the NEP in all sections has been cut where it bridges the midline dorsally and ventrally so that its folds and undulations can be observed.

A. The camera views the front of the reconstruction with +45˚heading and -25˚ pitch. From this angle, we see the ventricular face of the NEP.

B. The camera views the back of the reconstruction with 180˚ heading and -10˚ pitch. From this angle, we see some of the parenchymal face of the NEP. Note the prominent folding in the anterior complex NEP, the thick posterior complex NEP, and the back wall of the NEP lining the optic recess.

It is postulated that the multiple evaginations and invaginations of the diencephalic neuroepithelium are mosaic compartments that give rise to different thalamic, hypothalamic, and preoptic nuclei.

ABBREVIATION:
NEP - Neuroepithelium

Neuroepithelial compartments labeled in Helvetica Bold.
VENTRICULAR DIVISIONS LABELED IN CAPITALS.

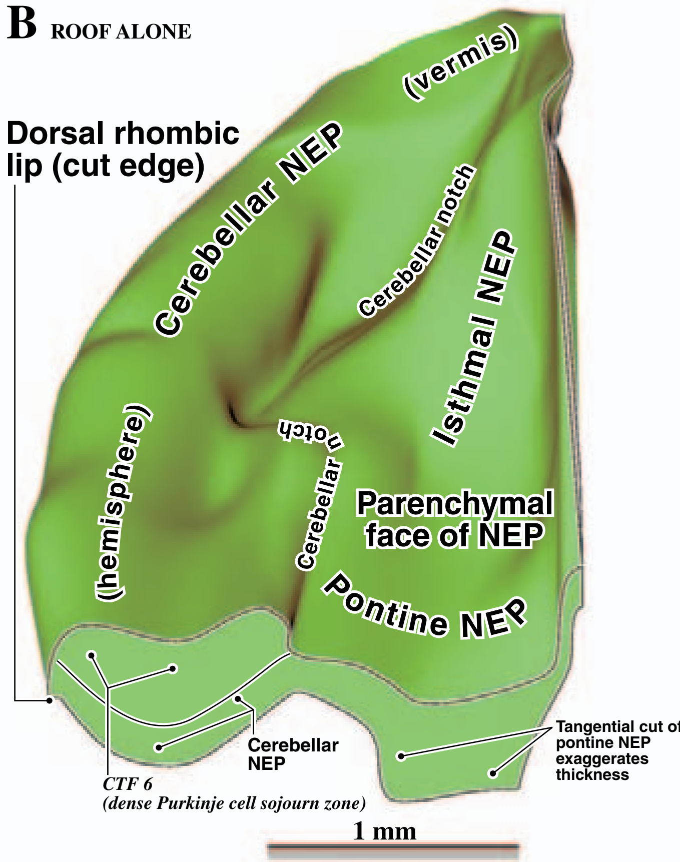
FIGURE 18
GW7.5, CR23 mm, C966, COMPUTER-AIDED 3-D RECONSTRUCTION OF THE RHOMBENCEPHALIC NEUROEPITHELIUM

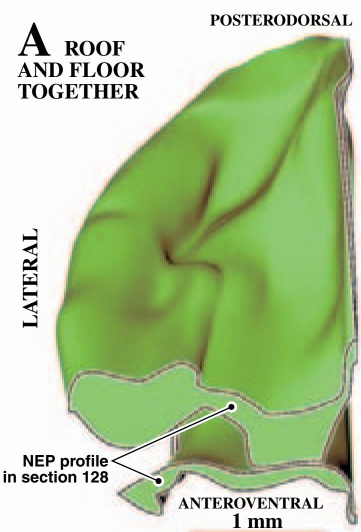
The reconstruction includes section 128 (**Level 15, Plate 200**) through section 193 (posterior to **Level 21, Plate 179**); the NEP in all sections has been cut where it bridges the midline dorsally and ventrally, and only the right half is shown. The camera is looking at the front of the NEP (0˚ heading, -10˚ pitch).

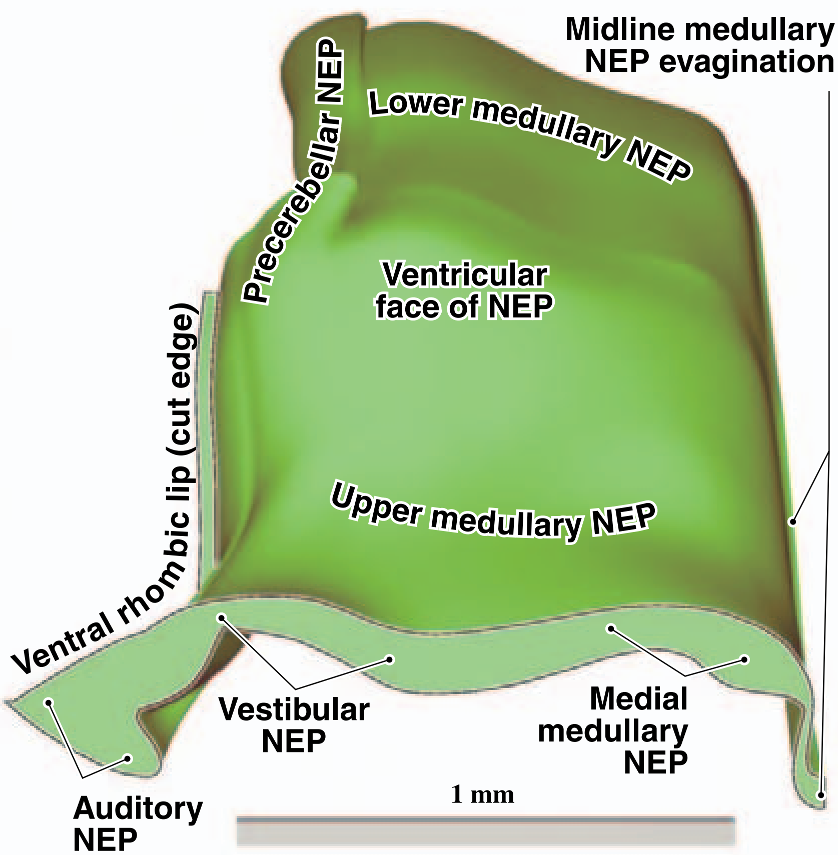
A. shows both the roof and floor plates of the rhombencephalic NEP with orientation labels.

B. shows the parenchymal face of the roof NEP bordering the differentiating zones of the pons, isthmus, and cerebellum. Since the edges between ***CTF6*** (Purkinje cell sojourn zone) and the **cerebellar NEP** are virtually indistinguishable, both are included in the reconstruction.

C. shows the ventricular face of the floor NEP overlying the upper (adjacent to pons) and lower medulla (adjacent to spinal cord).





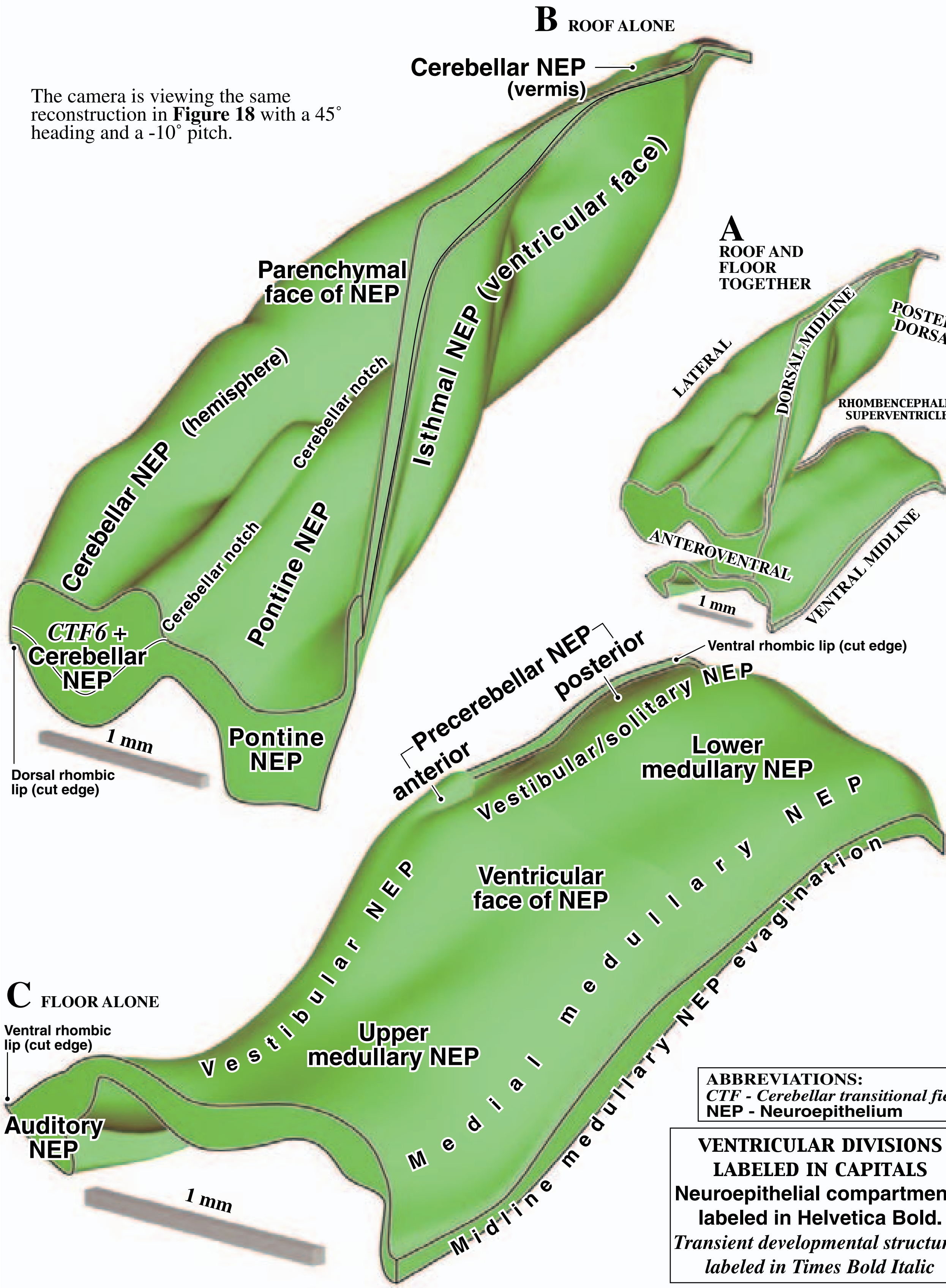


ABBREVIATIONS:
CTF - Cerebellar transitional field
NEP - Neuroepithelium

Neuroepithelial compartments labeled in Helvetica Bold.
Transient developmental structures labeled in Times Bold Italic

FIGURE 19
GW7.5, CR23 mm, C966, COMPUTER-AIDED 3-D RECONSTRUCTION OF THE RHOMBENCEPHALIC NEUROEPITHELIUM

The camera is viewing the same reconstruction in **Figure 18** with a 45° heading and a -10° pitch.



ABBREVIATIONS:
CTF - Cerebellar transitional field
NEP - Neuroepithelium

VENTRICULAR DIVISIONS LABELED IN CAPITALS
Neuroepithelial compartments labeled in Helvetica Bold.
Transient developmental structures labeled in Times Bold Italic

PART XI: GW7.5 SAGITTAL

PART XI: GW7.5 SAGITTAL

This specimen number 6202 in the Carnegie Collection, designated here as C6202, is a fetus of unknown sex with a crown-rump length (CR) of 21 mm estimated to be at gestational week (GW) 7.5. The entire fetus was cut in the sagittal plane in 20 µm sections and stained with hematoxylin and eosin. Information on the date of specimen collection, fixative, and embedding medium was not available to us. Since there is no photograph of this specimen before histological processing, a specimen from Hochstetter (1919) that is comparable in age to C6202 is used to show external brain features at GW7.5 (**A**, **Figure 20**). Like all other sagittal specimens in this Volume, C6202's sections are not cut parallel to the midline; **Figure 20** shows the approximate rotations in horizontal (**B**) and vertical (**C**) dimensions. Photographs of 7 sections (**Levels 1-7**) are illustrated at low magnification in four parts (**Plates 207A-D** through **213A-D**). The **A/B** parts show the brain in place in the skull; the **C/D** parts show only the brain (and some peripheral ganglia) at slightly higher magnification. **Plates 214-221** show high-magnification views of various parts of the brain at different levels from the cerebral cortex (**Plate 214**) to the midline raphe glial structure in the midbrain and cervical spinal cord (**Plate 221**). Most of the high-magnification plates are rotated 90˚ (landscape orientation) to more efficiently use page space.

C6202 is less mature than C966 even though it is only 2 mm shorter in CR length. The ***superventricles*** are large in the centers of all brain structures, especially in the telencephalon and rhombencephon, but the telencephalon is smaller than it is in C966. Sections near the midline show the enormous size of the diencephalic and mesencephalic superventricles. The respective thicknesses of the ***neuroepithelium*** (NEP) and parenchyma are keys to determining the degree of maturation of various brain structures.

The parenchyma is thick and bordered by a thin NEP in the medial medulla, indicating that many neurons have been generated here, but the production of late-generated neurons continues. The parenchyma is thinner and the NEP is thicker in the lateral medulla, entire pons, and entire midbrain tegmentum. There are layers of dense cells adjacent to the NEP where neurons are sojourning and the rest of the pontine and mesencephalic tegmental parenchyma is filled with migrating and settling neurons. The ***precerebellar neuroepithelium*** in the lateral medulla is thick and many neurons are entering the ***posterior intramural migratory stream***, but few have accumulated in the indistinct inferior olive in the medial medulla. The cerebellar parenchyma has only four layers in the ***cerebellar transitional field (CTF)***. The cells in ***CTF2***, ***3***, and ***4*** are probably deep neurons that will eventually settle in the dentate, interpositus, and fastigial nuclei. ***CTF5*** and **6** are present in C966 and presumably contain Purkinje cells, but these layers are absent in C6202. The cerebellar NEP is thicker than it is in C966 and is now producing the oldest Purkinje cells. The mesencephalic tectal NEP is very thick and lies adjacent to a thin parenchyma. The majority of neurons in both the superior and inferior colliculi have not yet been generated. The diencephalic NEP is thick and the adjacent parenchyma is filled with dense zones of sojourning and migrating neurons. The basal telencephalic NEP and the basal ganglionic NEP are thick, and the oldest neurons are settling in the adjacent parenchyma. Many neurons in the basal telencephalon have yet to be generated. In the cerebral cortex, the NEP is bordered by a thin primordial plexiform layer that contains the oldest cortical neurons (Cajal-Retzius cells) and subplate neurons. The cortical NEP is expanding and increasing its number of neural stem cells as the telencephalic superventricle grows; nearly all cortical neurons in layers II-VI have still to be generated.

GW7.5 SAGITTAL

A perfect sagittal cut through the brain bisects the cerebral cortex into two separate hemispheres by passing through the interhemispheric fissure, and does the same in the brainstem by passing through the midline of the ventricles.

Sections of C6202's brain rotate 10.5˚ counterclockwise from the horizontal midline running through the cerebral cortex and midbrain tectum (top view). C6202's sections are quite close to the vertical midline, rotating only 2.8˚ counterclockwise (back view). In the sections illustrated on the following pages, the telencephalon and diencephalon (top) are tilted away from the observer, while the medulla and upper spinal cord (bottom) are tilted toward the observer.

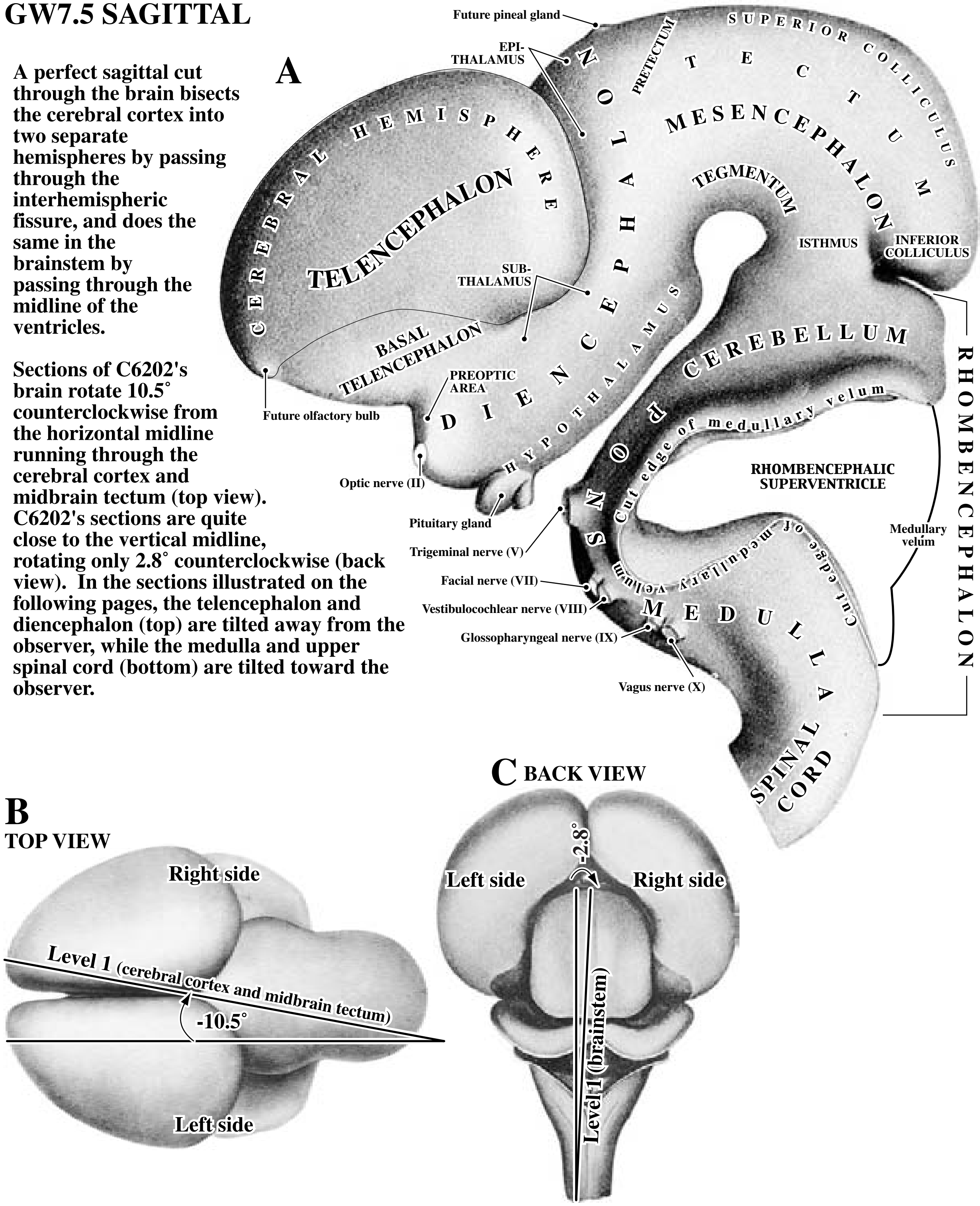


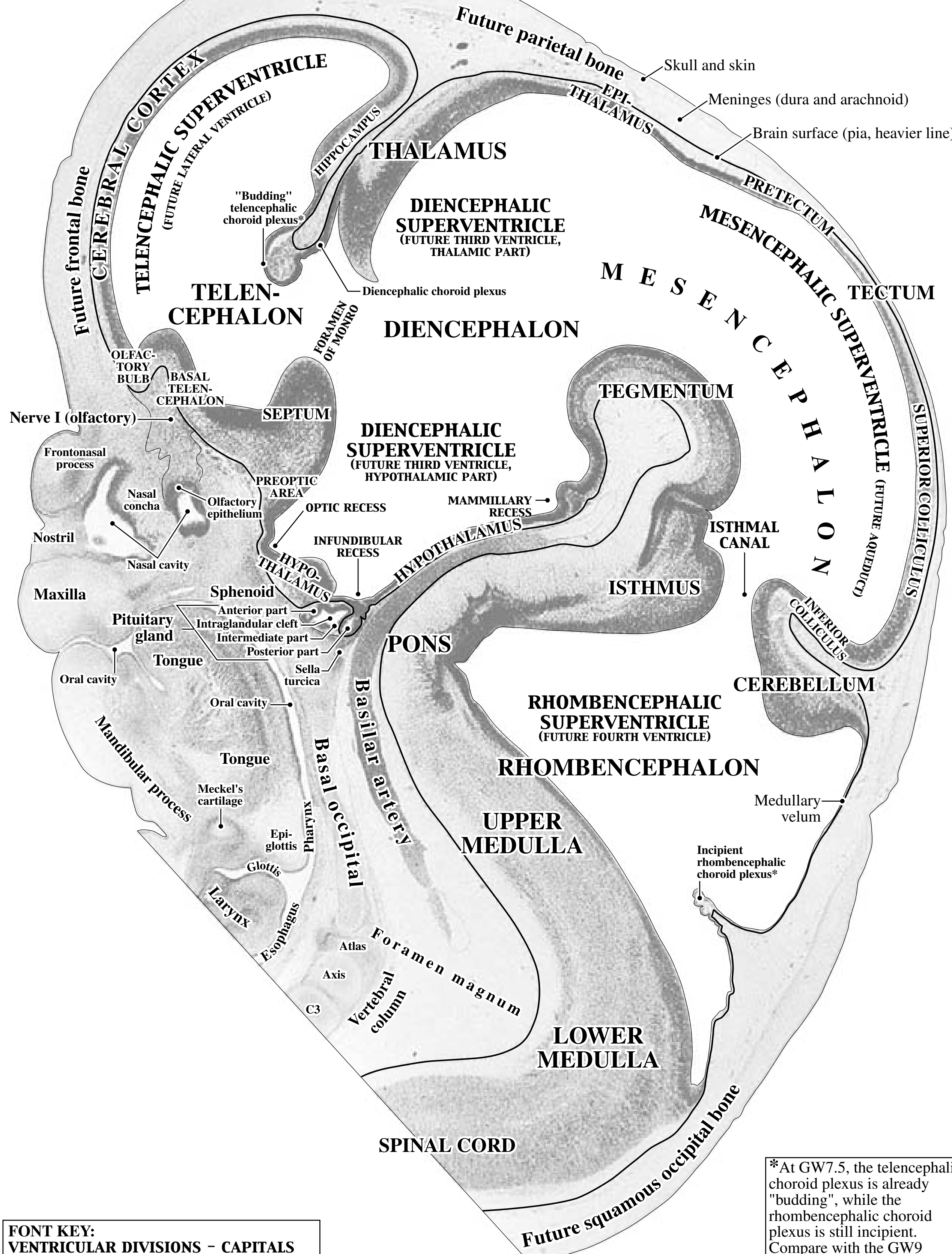
Figure 20. **A**, The lateral view of the brain and upper cervical spinal cord from a specimen with a crown-rump length of 19.4 mm (modified from Figure 35, Table VI, Hochstetter, 1919) identifies external features of a brain similar to C6202 (CR 21 mm). **B**, Top view of the brain in **A** (modified from Figure 37, Table VI, Hochstetter, 1919) shows how C6202's sections rotate from a line parallel to the horizontal midline in the interhemispheric fissure and midbrain tectum. **C**, Back view of the brain with a crown-rump length of 38 mm (modified from Figure 44, Table VIII, Hochstetter, 1919) shows how C6202's sections rotate from a line parallel to the vertical midline in the brainstem and upper cervical spinal cord.

PLATE 207A

GW7.5 Sagittal
CR 21 mm, C6202
Level 1: Slide 30, Section 2
SKULL, MAJOR BRAIN STRUCTURES, AND VENTRICULAR DIVISIONS

Neuroepithelial and parenchymal structures are labeled in Parts C and D of this plate on the following pages.

PLATE 207B

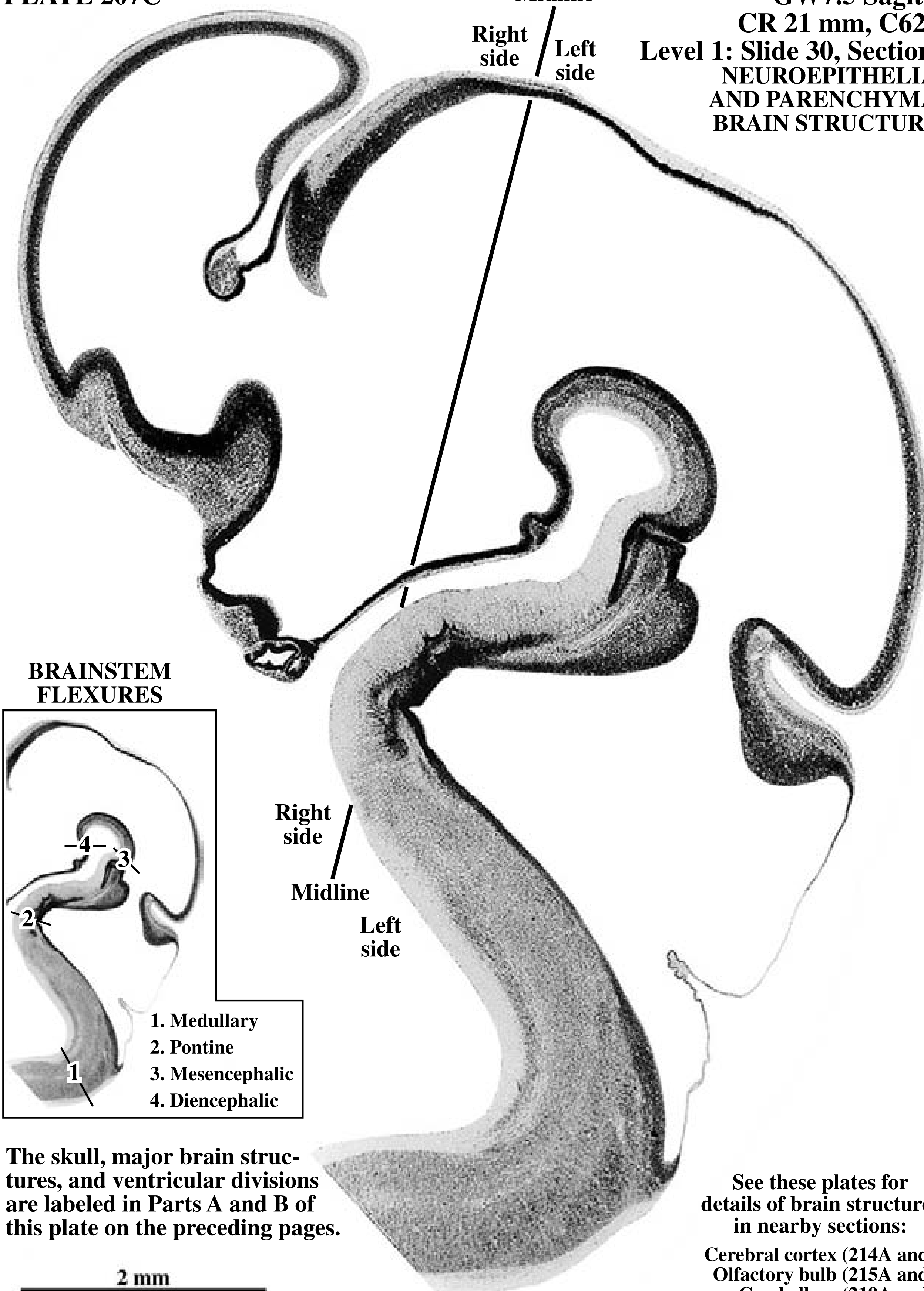


FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

*At GW7.5, the telencephalic choroid plexus is already "budding", while the rhombencephalic choroid plexus is still incipient. Compare with the GW9 specimen shown in **Plates 58A and B** on pages 137-138.

PLATE 207C

GW7.5 Sagittal
CR 21 mm, C6202
Level 1: Slide 30, Section 2
NEUROEPITHELIAL AND PARENCHYMAL BRAIN STRUCTURES



BRAINSTEM FLEXURES

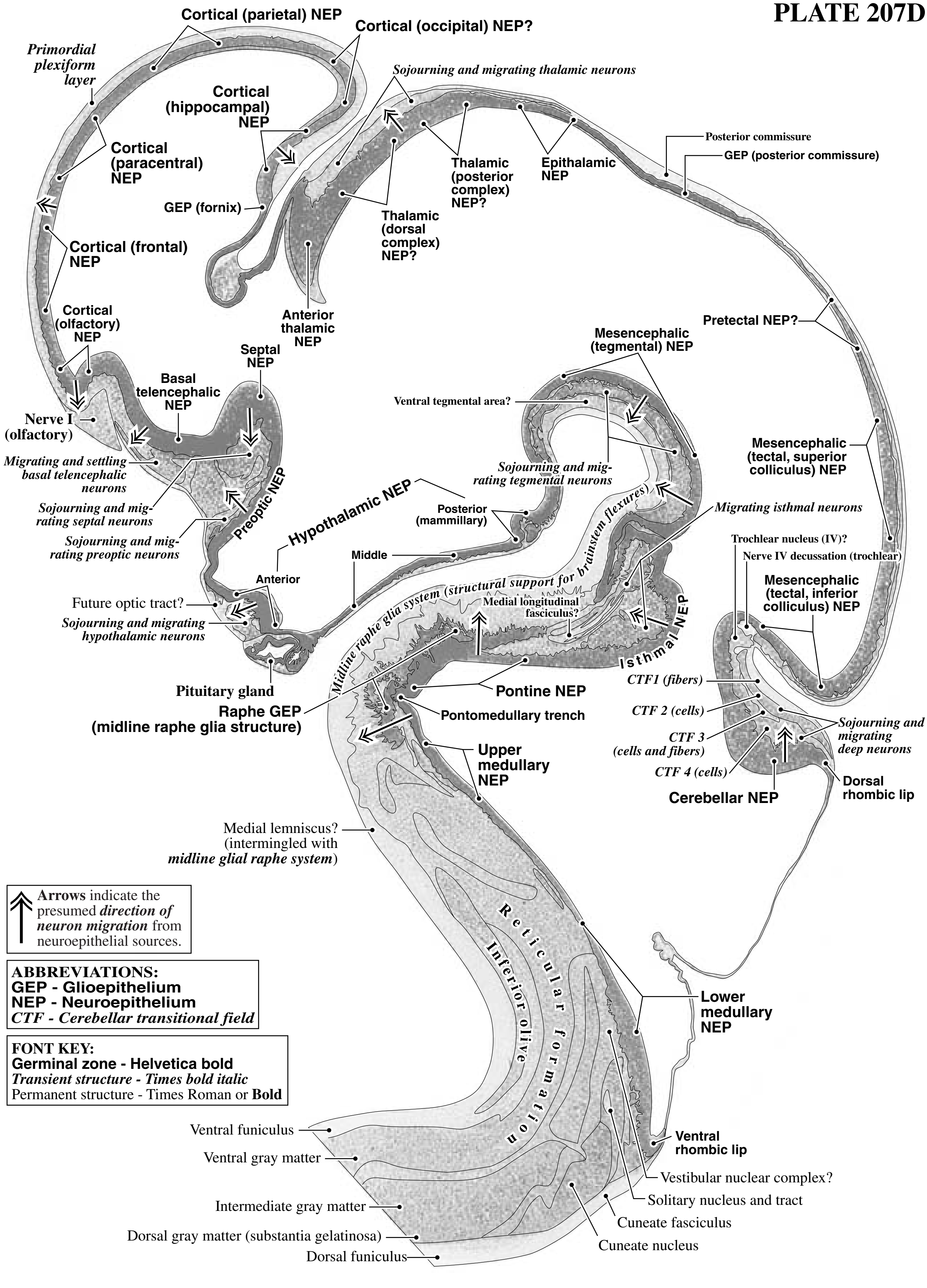
The skull, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

2 mm

See these plates for details of brain structures in nearby sections:

Cerebral cortex (214A and B)
Olfactory bulb (215A and B)
Cerebellum (219A and B)
Midline glial fibers (221A and B)

PLATE 207D



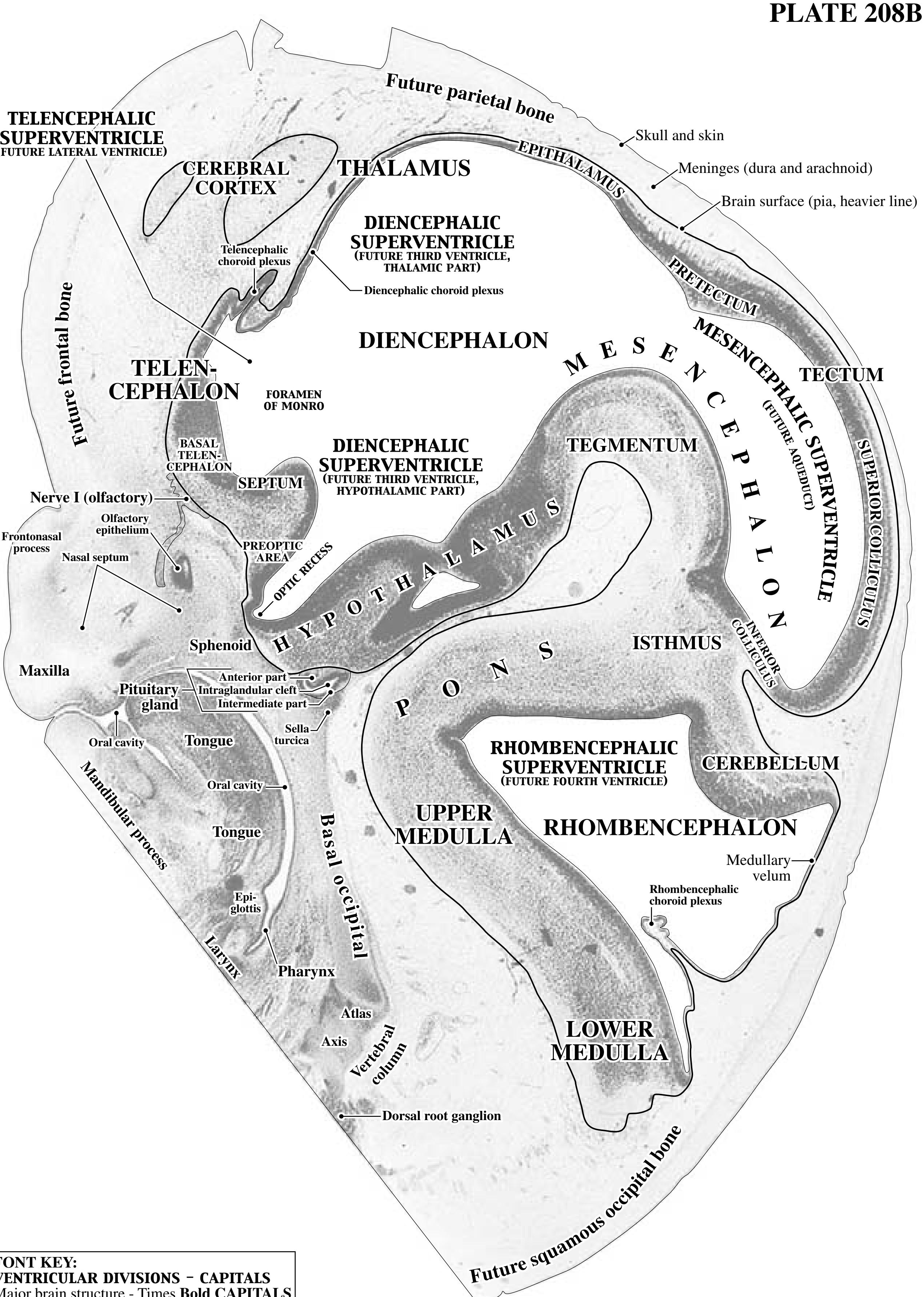
Cortical (parietal) NEP
Cortical (occipital) NEP?
Primordial plexiform layer
Sojourning and migrating thalamic neurons
Cortical (hippocampal) NEP
Cortical (paracentral) NEP
Posterior commissure
GEP (posterior commissure)
Thalamic (posterior complex) NEP?
Epithalamic NEP
GEP (fornix)
Thalamic (dorsal complex) NEP?
Cortical (frontal) NEP
Cortical (olfactory) NEP
Anterior thalamic NEP
Pretectal NEP?
Mesencephalic (tegmental) NEP
Septal NEP
Basal telencephalic NEP
Ventral tegmental area?
Nerve I (olfactory)
Mesencephalic (tectal, superior colliculus) NEP
Migrating and settling basal telencephalic neurons
Sojourning and migrating tegmental neurons
Preoptic NEP
Hypothalamic NEP
Posterior (mammillary)
Migrating isthmal neurons
Sojourning and migrating septal neurons
Sojourning and migrating preoptic neurons
Trochlear nucleus (IV)?
Nerve IV decussation (trochlear)
Middle
Mesencephalic (tectal, inferior colliculus) NEP
Anterior
Midline raphe glia system (structural support for brainstem flexures)
Medial longitudinal fasciculus?
Future optic tract?
Sojourning and migrating hypothalamic neurons
Isthmal NEP
CTF1 (fibers)
Pituitary gland
Pontine NEP
Raphe GEP (midline raphe glia structure)
Pontomedullary trench
CTF 2 (cells)
CTF 3 (cells and fibers)
Sojourning and migrating deep neurons
CTF 4 (cells)
Upper medullary NEP
Cerebellar NEP
Dorsal rhombic lip
Medial lemniscus? (intermingled with midline glial raphe system)
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Reticular formation
Inferior olive
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
CTF - Cerebellar transitional field
Lower medullary NEP
FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or Bold
Ventral funiculus
Ventral rhombic lip
Ventral gray matter
Vestibular nuclear complex?
Intermediate gray matter
Solitary nucleus and tract
Cuneate fasciculus
Dorsal gray matter (substantia gelatinosa)
Cuneate nucleus
Dorsal funiculus

PLATE 208A

GW7.5 Sagittal
CR 21 mm, C6202
Level 2: Slide 26, Section 2
SKULL, MAJOR BRAIN STRUCTURES, AND VENTRICULAR DIVISIONS

Neuroepithelial and parenchymal structures are labeled in Parts C and D of this plate on the following pages.

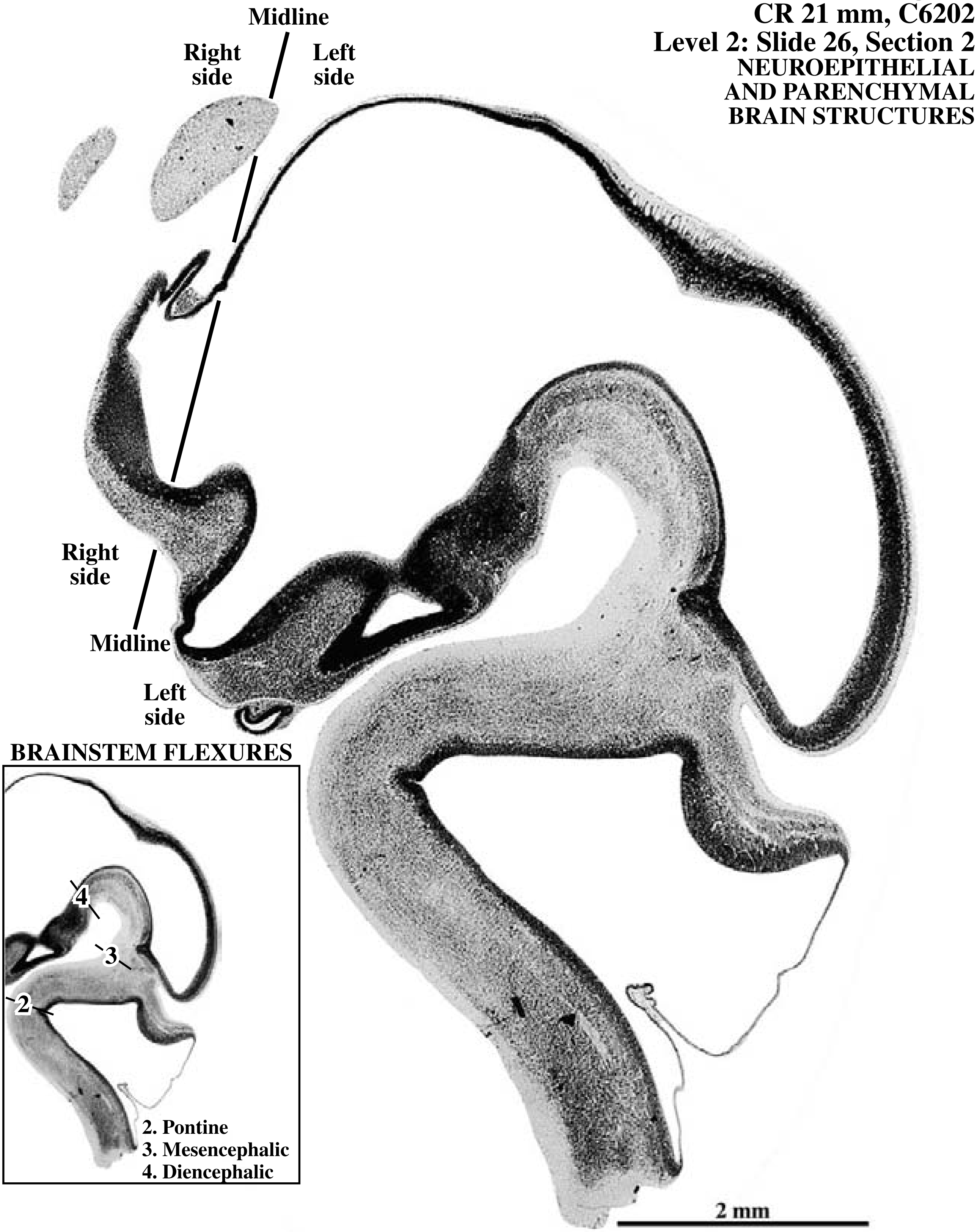
PLATE 208B



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 208C

GW7.5 Sagittal
CR 21 mm, C6202
Level 2: Slide 26, Section 2
NEUROEPITHELIAL AND PARENCHYMAL BRAIN STRUCTURES

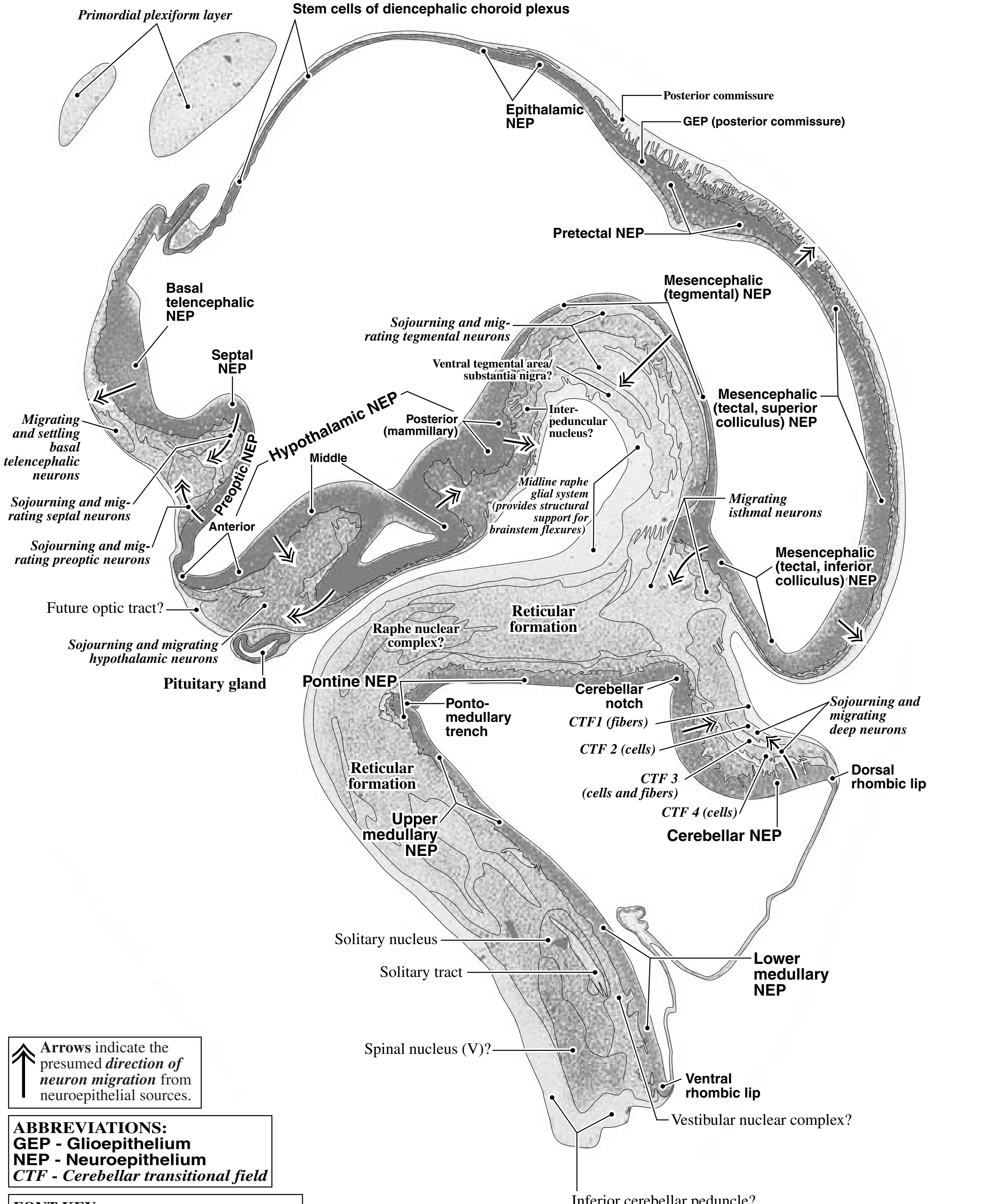


BRAINSTEM FLEXURES

The skull, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

See Plates 210A and B for details of the anterior and middle hypothalamus, Plates 218A and B for details of the midbrain tegmentum in nearby sections.

PLATE 208D



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
CTF - Cerebellar transitional field

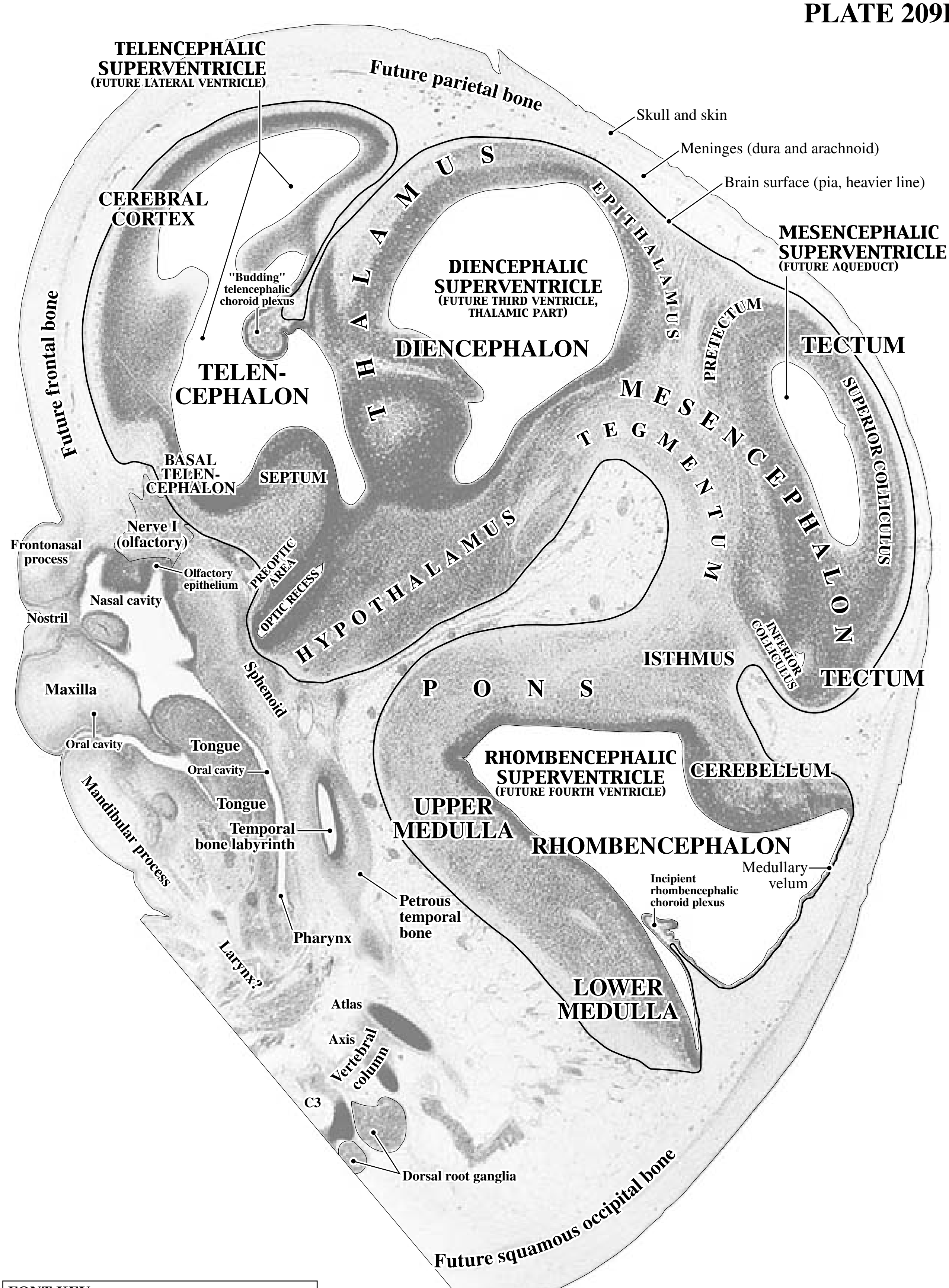
FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 209A

GW7.5 Sagittal
CR 21 mm, C6202
Level 3: Slide 24, Section 2
Left side of brain
SKULL, MAJOR BRAIN STRUCTURES, AND VENTRICULAR DIVISIONS

Neuroepithelial and parenchymal structures are labeled in Parts C and D of this plate on the following pages.

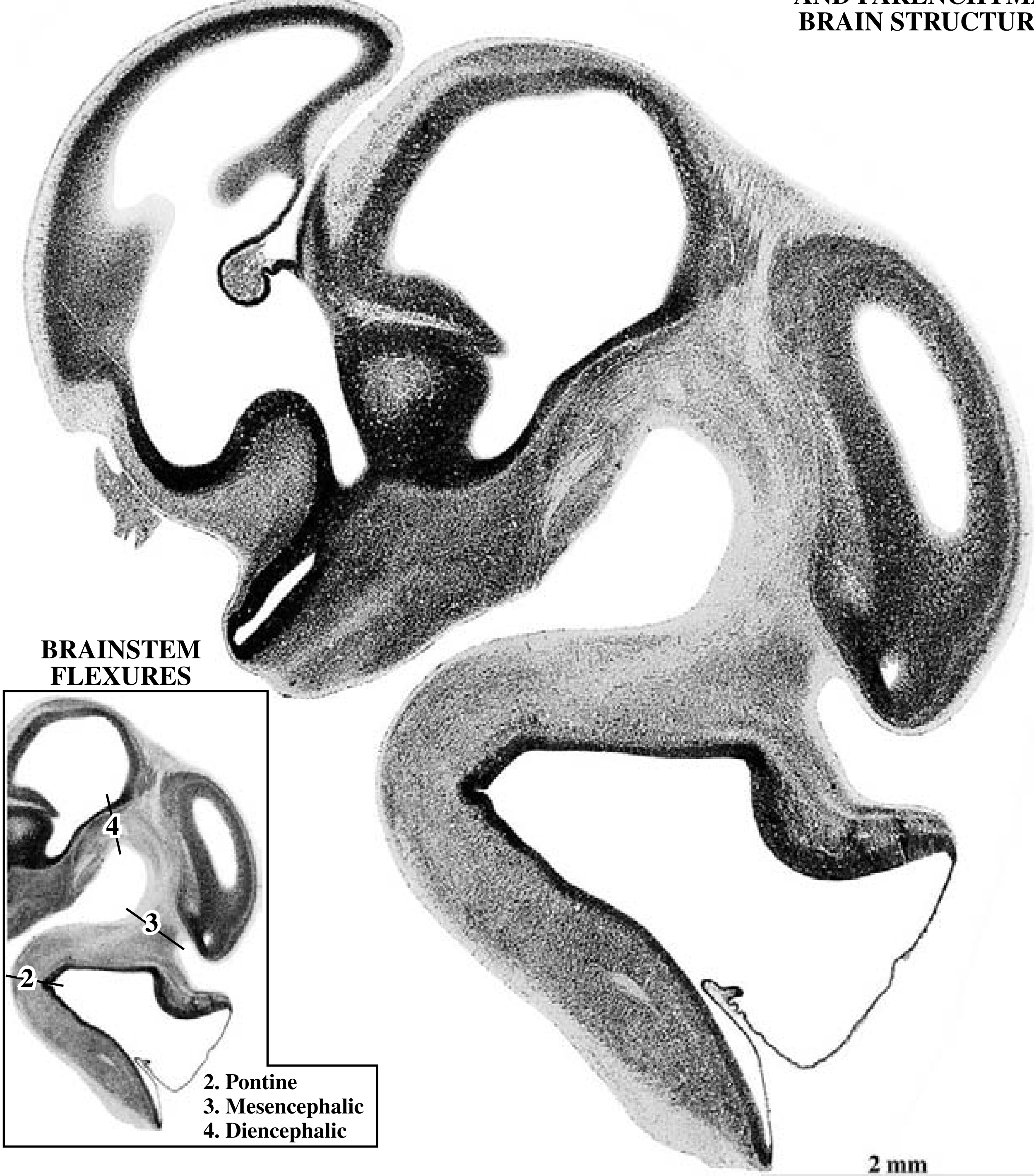
PLATE 209B



FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 209C

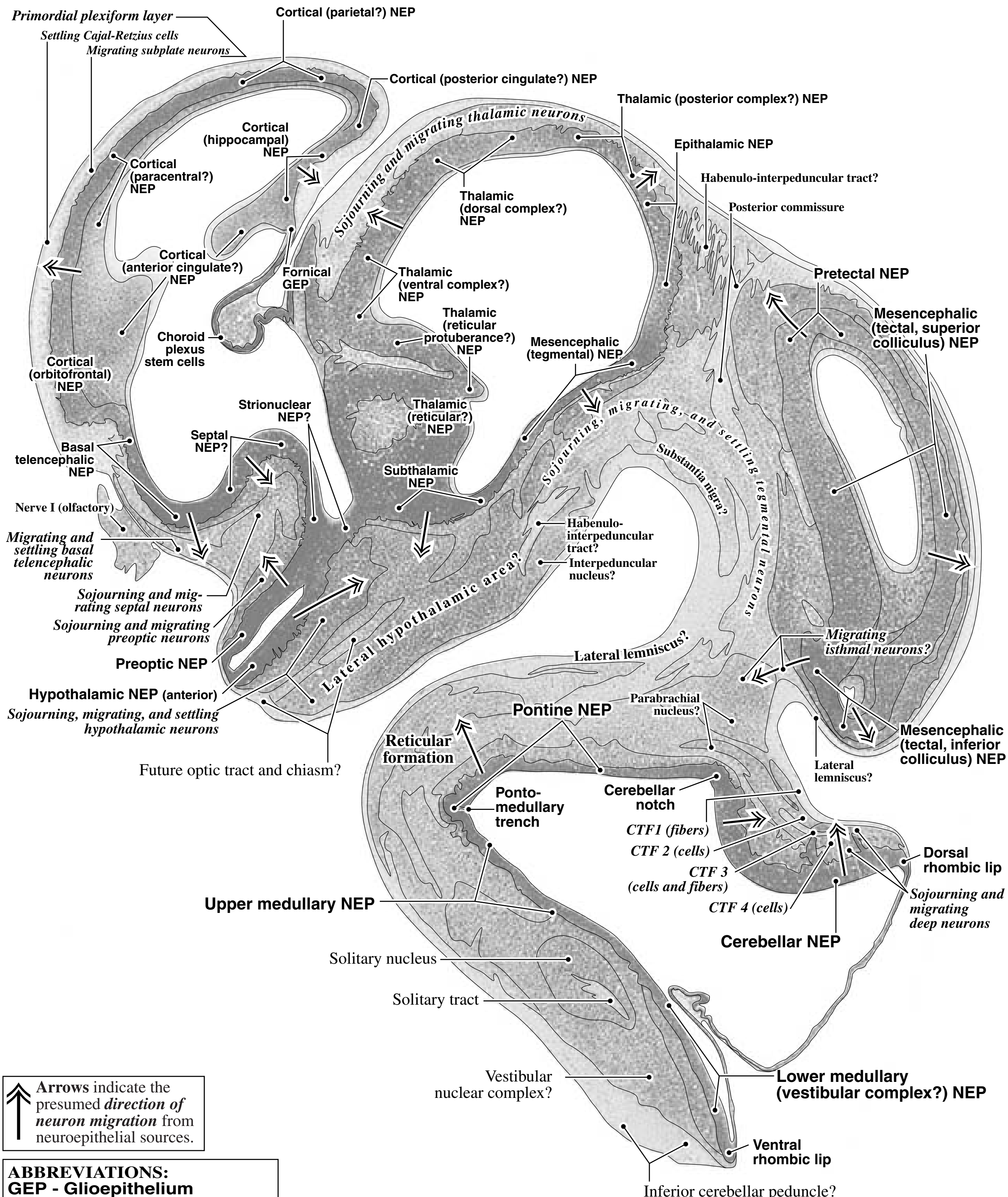
GW7.5 Sagittal
CR 21 mm, C6202
Level 3: Slide 24, Section 2
Left side of brain
NEUROEPITHELIAL AND PARENCHYMAL BRAIN STRUCTURES



BRAINSTEM FLEXURES

The skull, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 209D



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
CTF - Cerebellar transitional field

FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

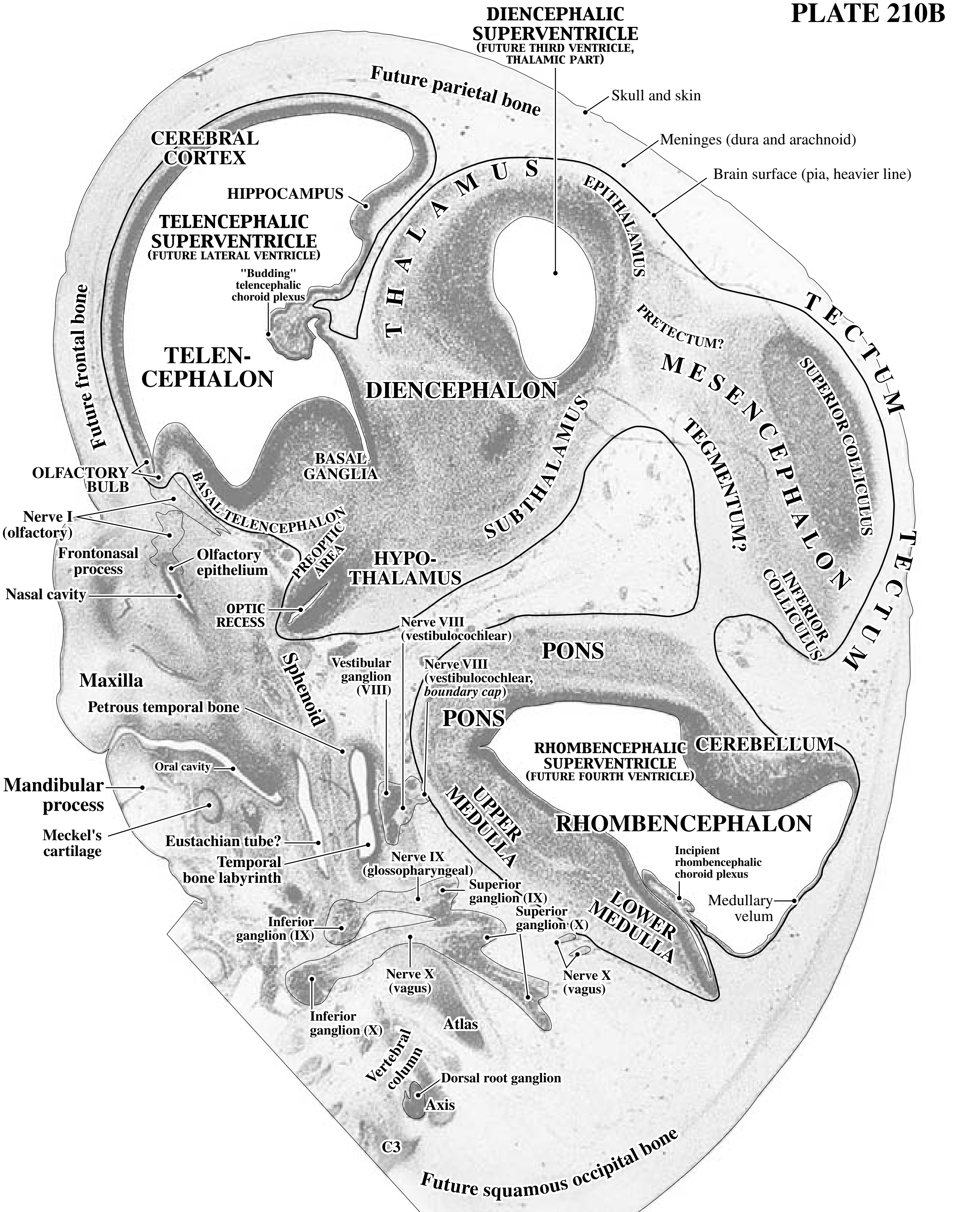
PLATE 210A

GW7.5 Sagittal
CR 21 mm, C6202
Level 4: Slide 22, Section 2
Left side of brain
SKULL, MAJOR BRAIN STRUCTURES, AND VENTRICULAR DIVISIONS

2 mm

Neuroepithelial and parenchymal structures are labeled in Parts C and D of this plate on the following pages.

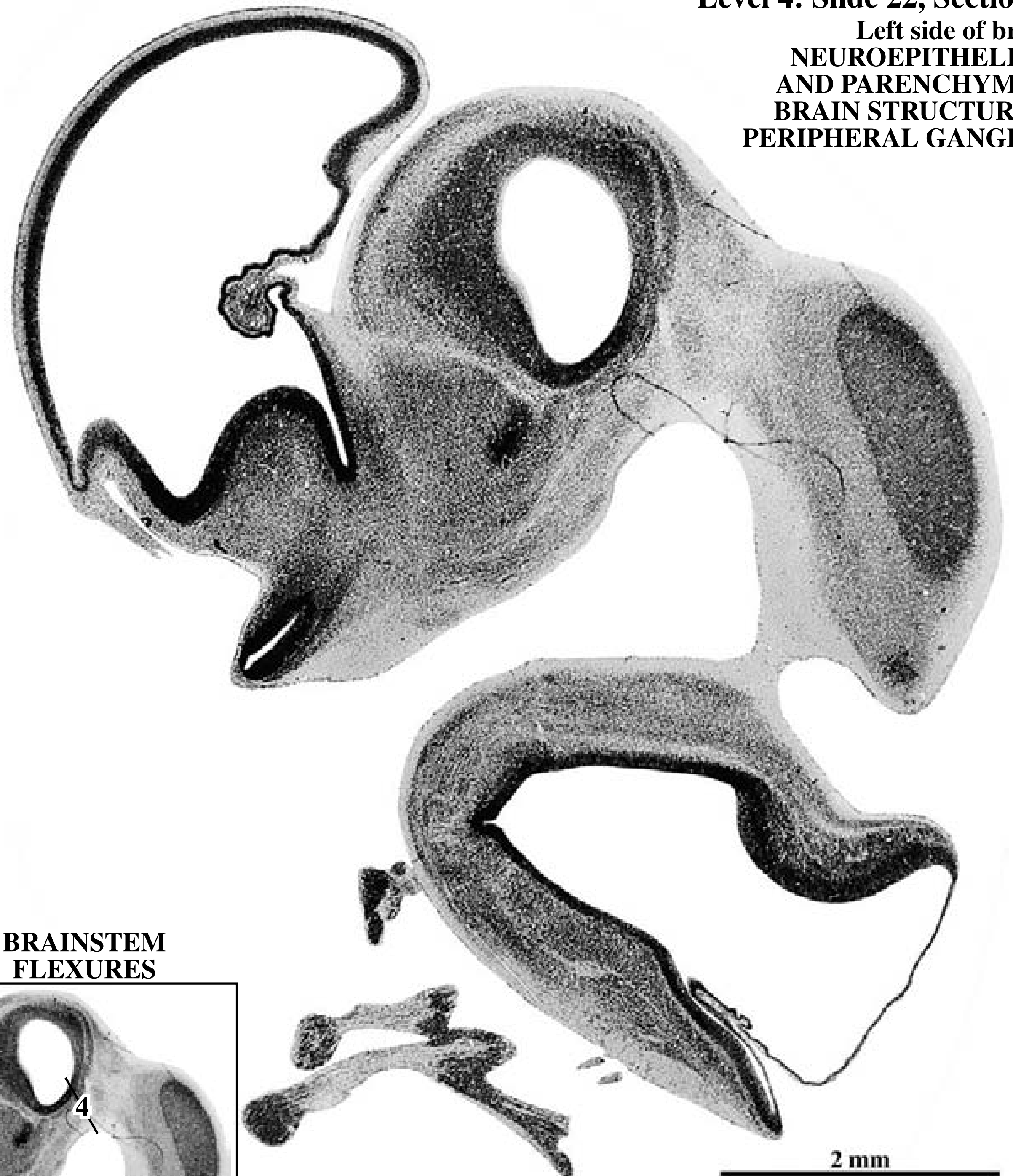
PLATE 210B



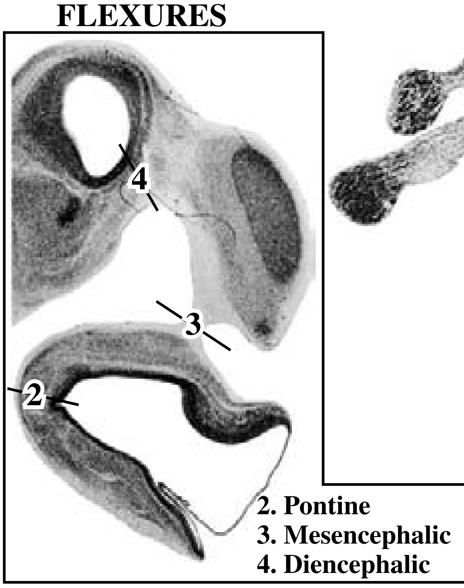
FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 210C

GW7.5 Sagittal
CR 21 mm, C6202
Level 4: Slide 22, Section 2
Left side of brain
NEUROEPITHELIAL AND PARENCHYMAL BRAIN STRUCTURES, PERIPHERAL GANGLIA

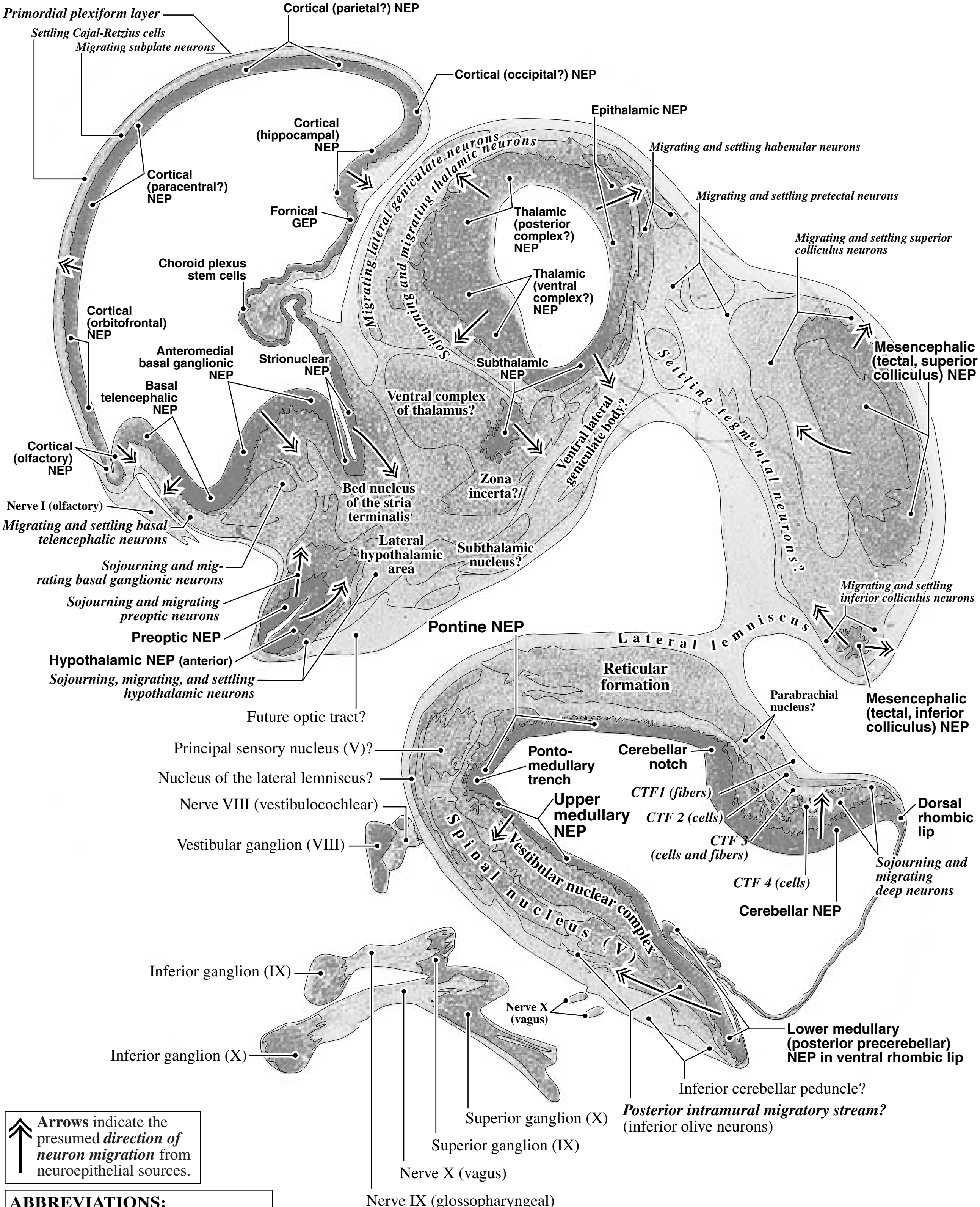


BRAINSTEM FLEXURES



The skull, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 210D



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
CTF - Cerebellar transitional field

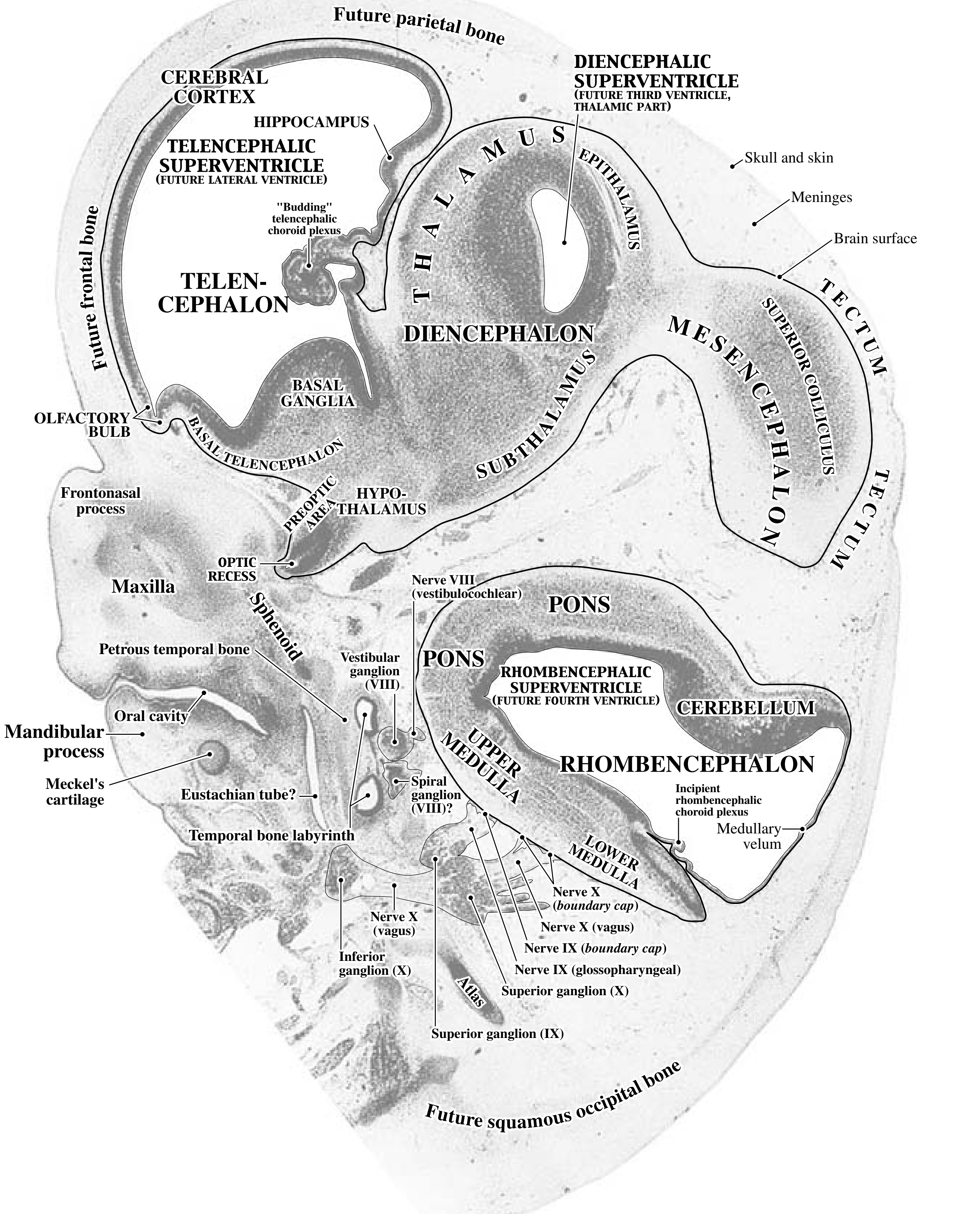
FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 211A

GW7.5 Sagittal
CR 21 mm, C6202
Level 5: Slide 21, Section 2
Left side of brain
SKULL, MAJOR BRAIN STRUCTURES, AND VENTRICULAR DIVISIONS

Neuroepithelial and parenchymal structures are labeled in Parts C and D of this plate on the following pages.

PLATE 211B



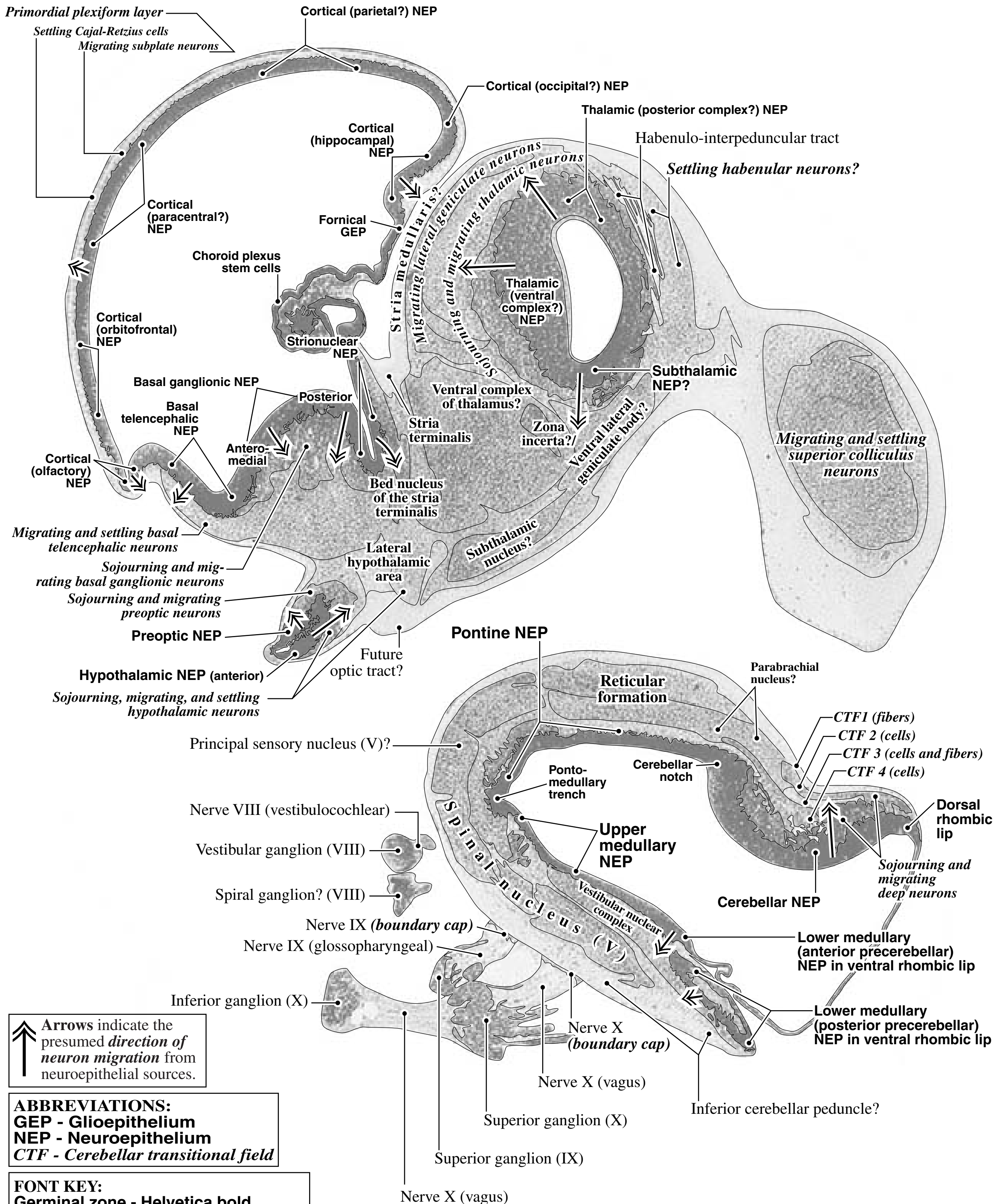
FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

PLATE 211C

GW7.5 Sagittal
CR 21 mm, C6202
Level 5: Slide 21, Section 2
Left side of brain
NEUROEPITHELIAL AND PARENCHYMAL BRAIN STRUCTURES, PERIPHERAL GANGLIA

The skull, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 211D



Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
CTF - Cerebellar transitional field

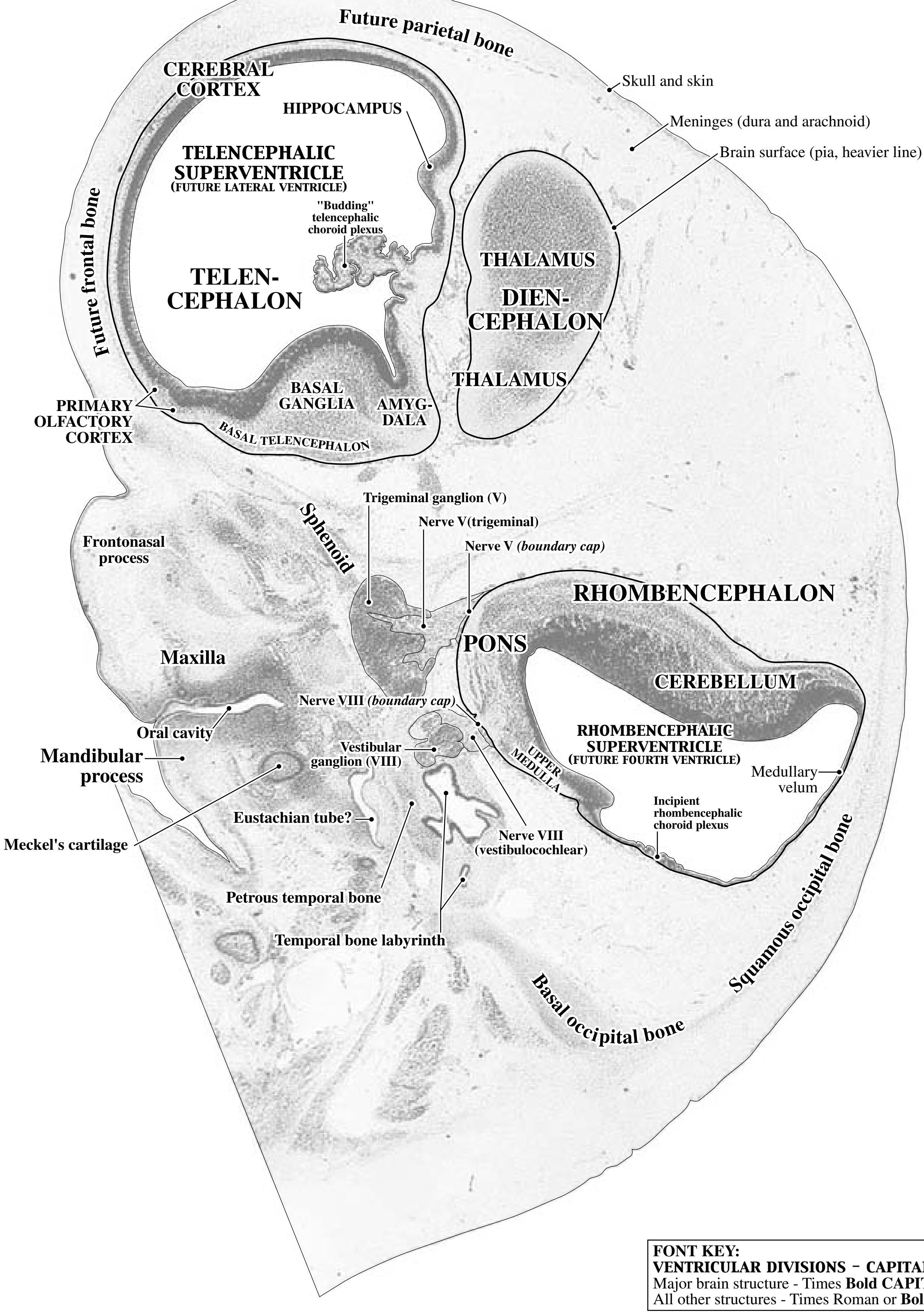
FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 212A

GW7.5 Sagittal
CR 21 mm, C6202
Level 6: Slide 18, Section 2
Left side of brain
SKULL, MAJOR BRAIN STRUCTURES, AND VENTRICULAR DIVISIONS

Neuroepithelial and parenchymal structures are labeled in Parts C and D of this plate on the following pages.

PLATE 212B



FONT KEY:
VENTRICULAR DIVISIONS - CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

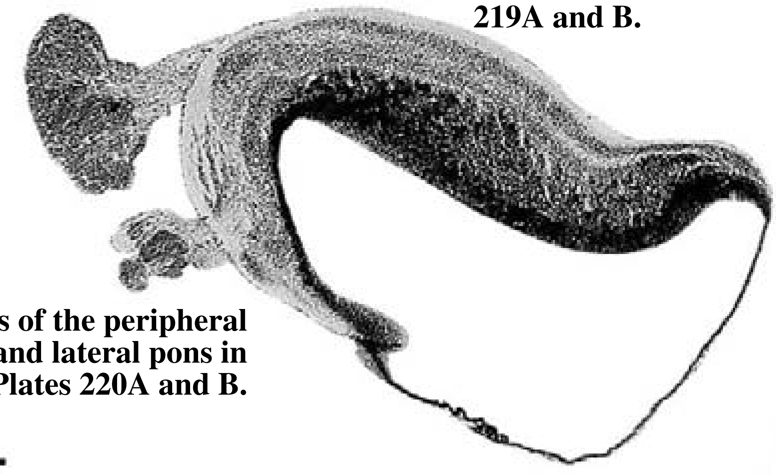
PLATE 212C

GW7.5 Sagittal
CR 21 mm, C6202
Level 6: Slide 18, Section 2
Left side of brain
NEUROEPITHELIAL AND PARENCHYMAL BRAIN STRUCTURES, PERIPHERAL GANGLIA

See details of the cerebral cortex in Plates 214A and B.

See details of the hippocampus, basal ganglia, and amygdala in Plates 216A and B.

See details of the cerebellum in Plates 219A and B.

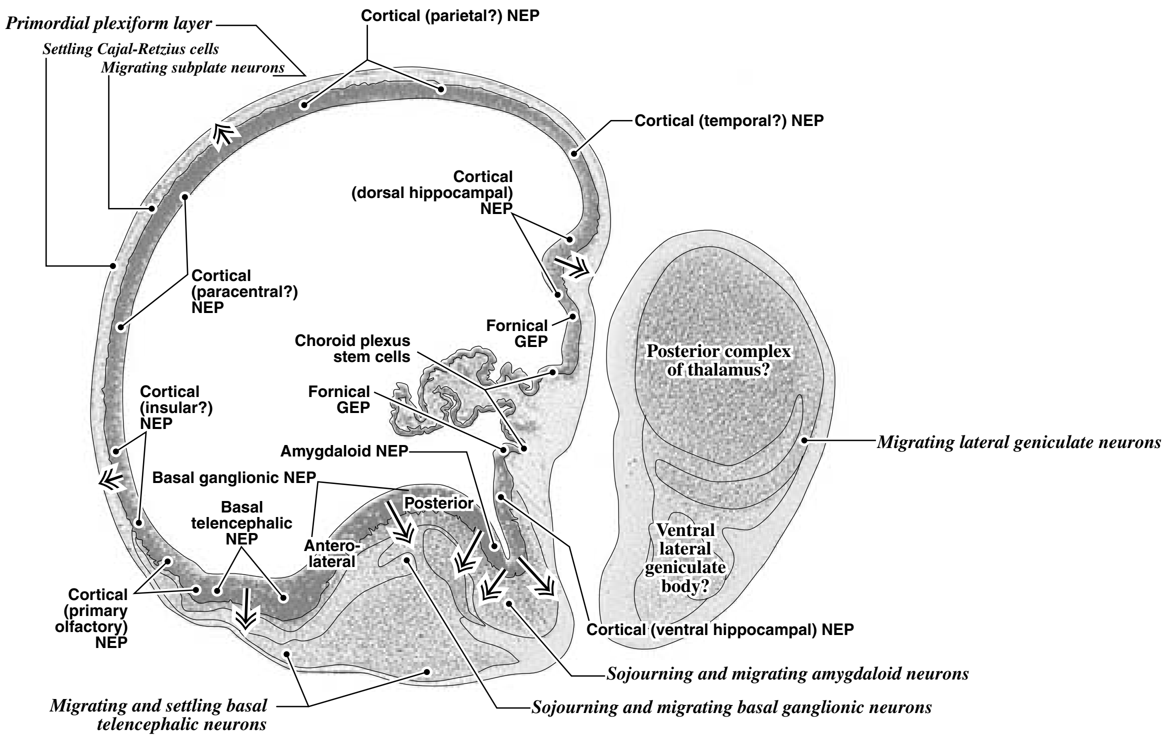


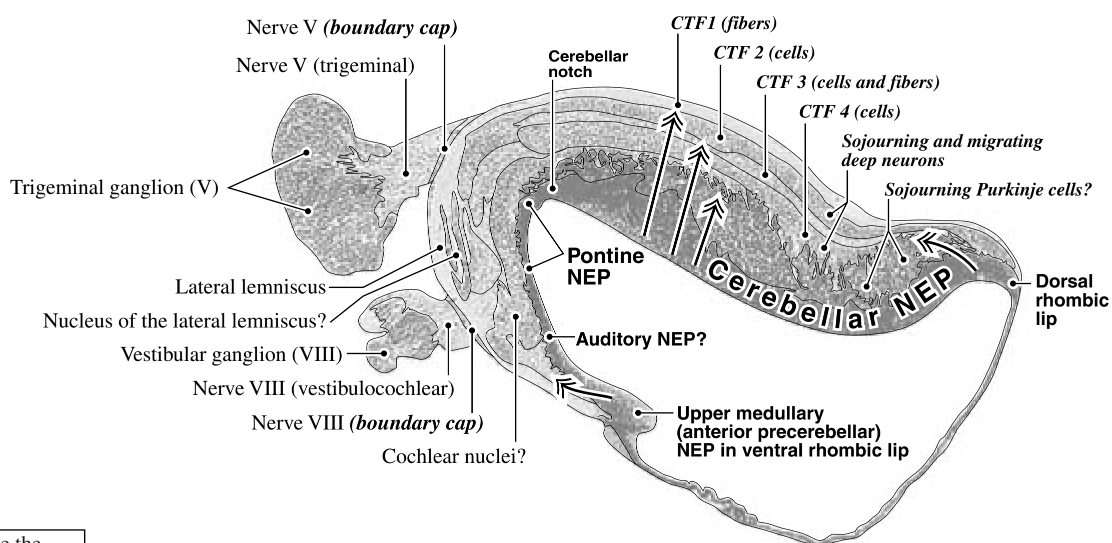
See details of the peripheral ganglia and lateral pons in Plates 220A and B.

2 mm

The skull, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 212D





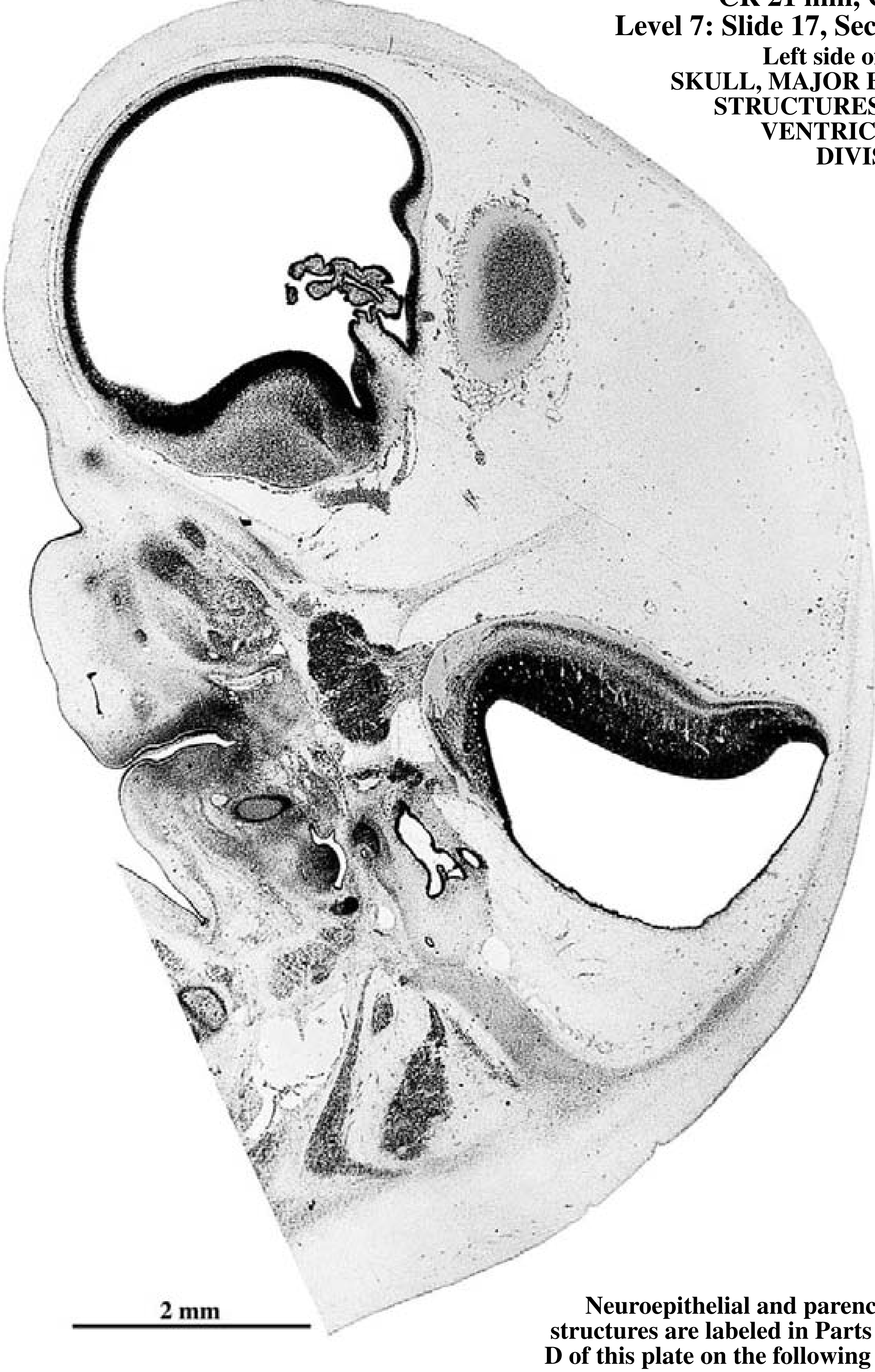
Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
CTF - Cerebellar transitional field

FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

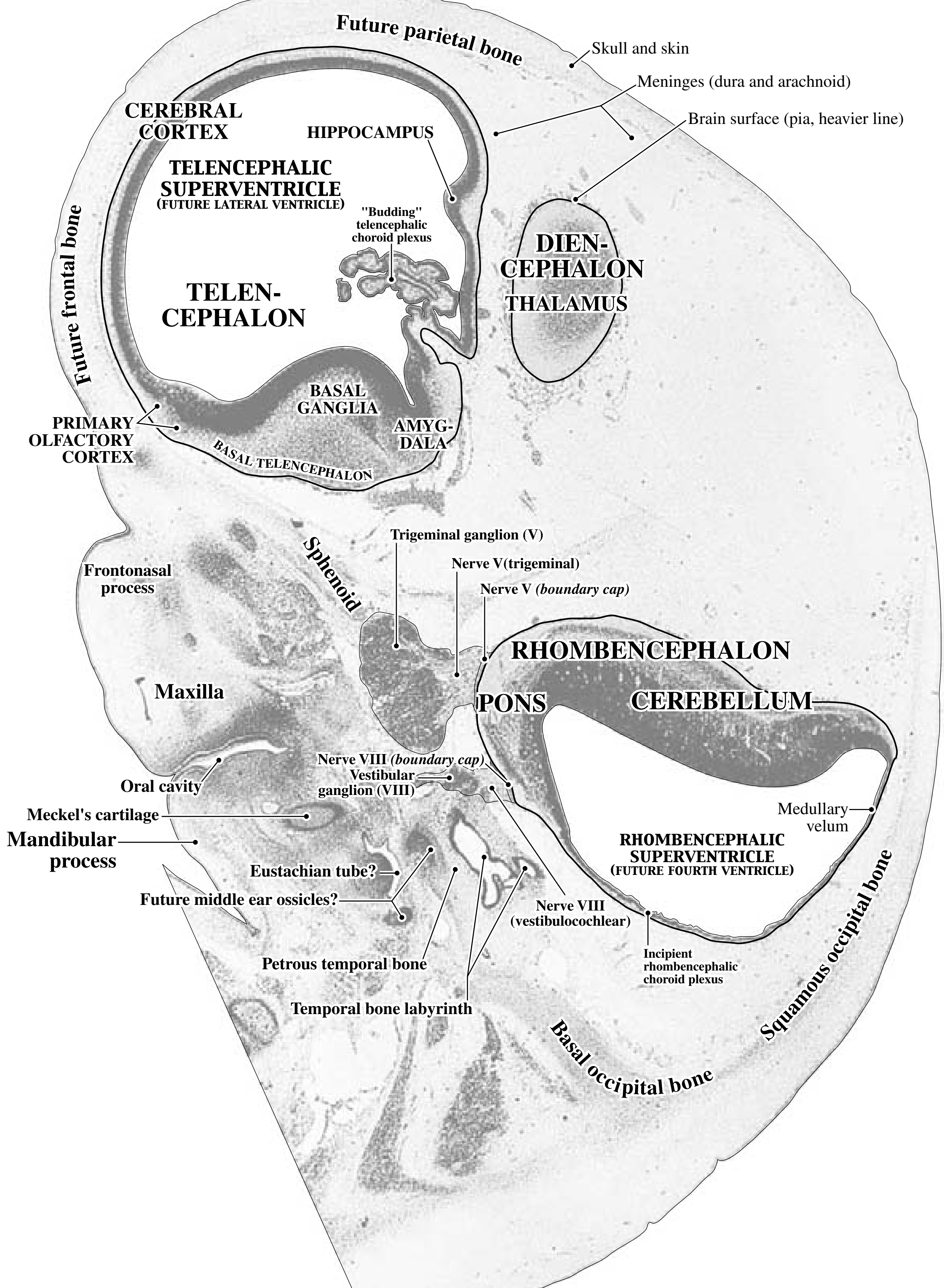
PLATE 213A

GW7.5 Sagittal
CR 21 mm, C6202
Level 7: Slide 17, Section 2
Left side of brain
SKULL, MAJOR BRAIN STRUCTURES, AND VENTRICULAR DIVISIONS



Neuroepithelial and parenchymal structures are labeled in Parts C and D of this plate on the following pages.

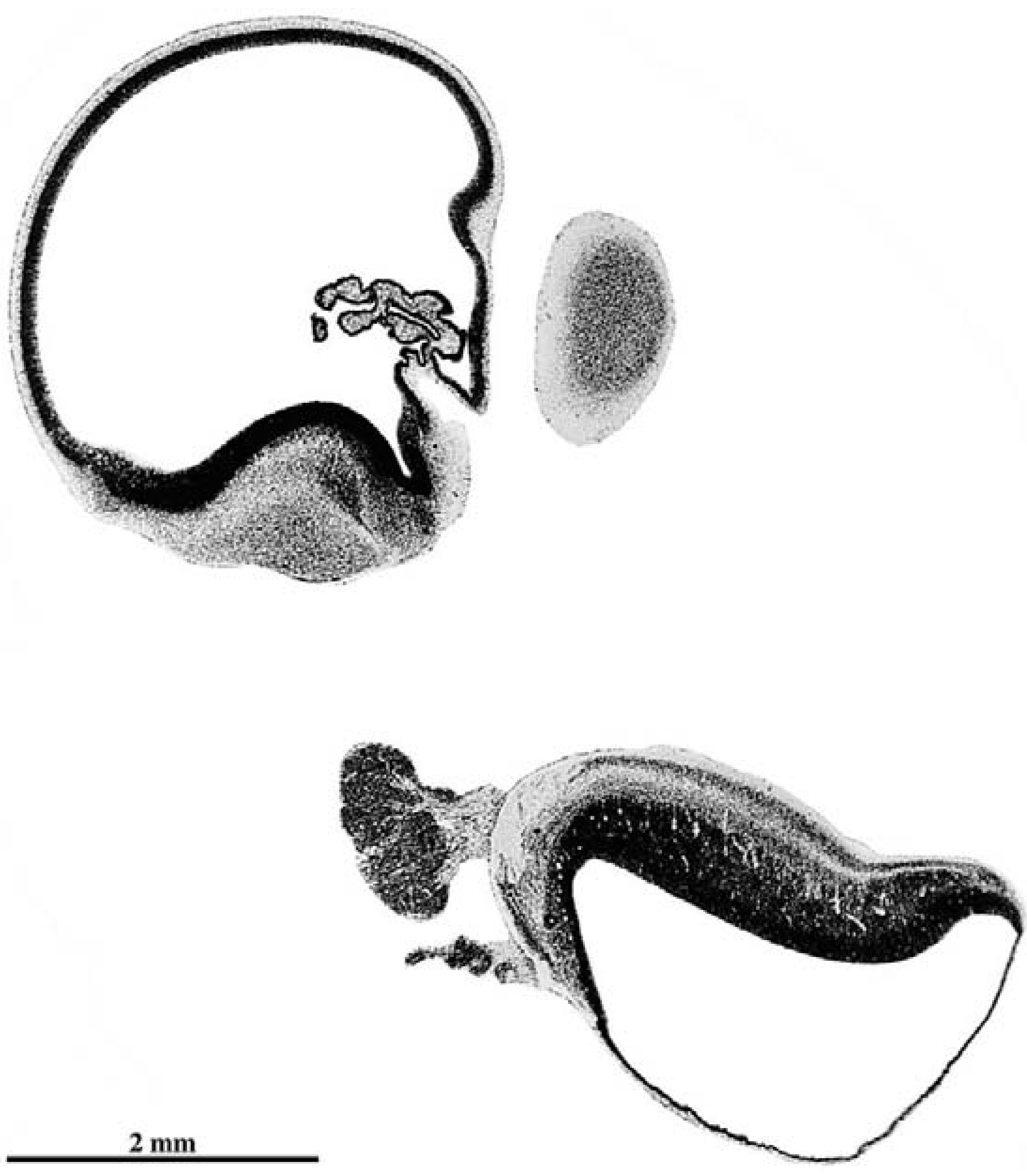
PLATE 213B



FONT KEY:
VENTRICULAR DIVISIONS – CAPITALS
Major brain structure - Times **Bold CAPITALS**
All other structures - Times Roman or **Bold**

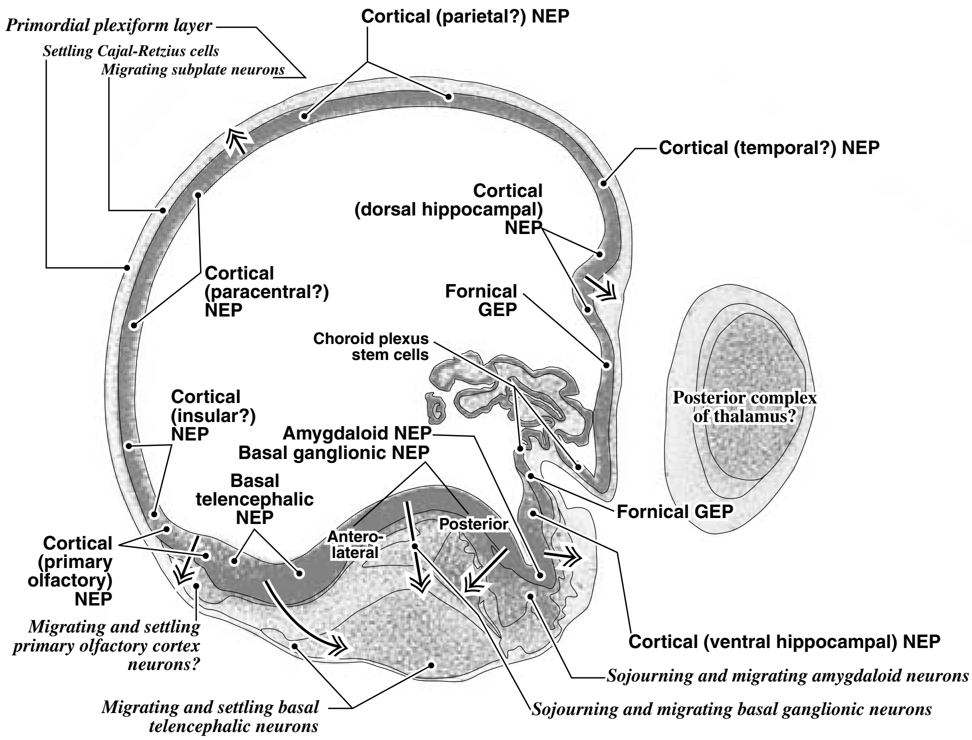
PLATE 213C

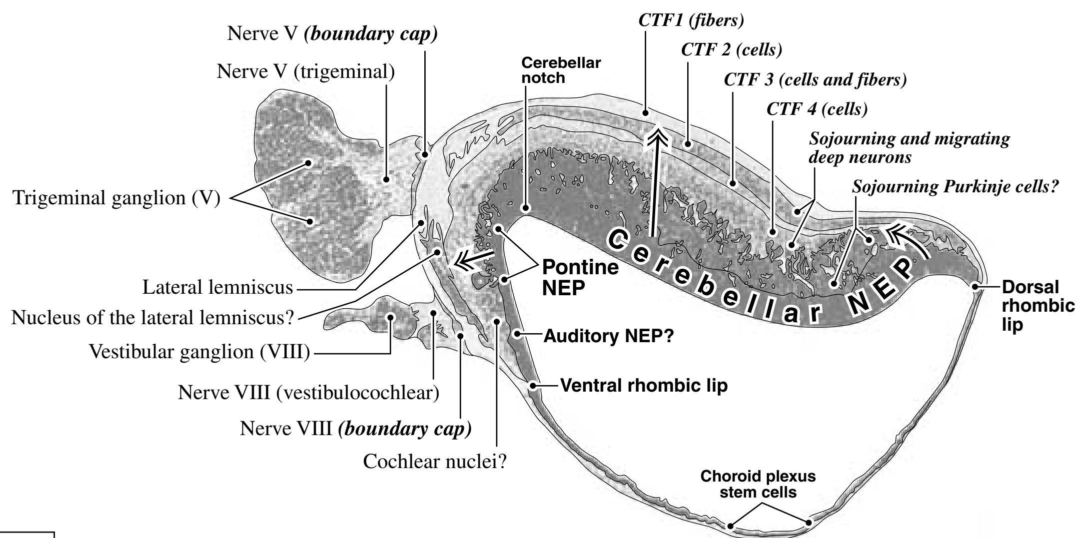
GW7.5 Sagittal
CR 21 mm, C6202
Level 7: Slide 17, Section 2
Left side of brain
NEUROEPITHELIAL AND PARENCHYMAL BRAIN STRUCTURES, PERIPHERAL GANGLIA



The skull, major brain structures, and ventricular divisions are labeled in Parts A and B of this plate on the preceding pages.

PLATE 213D





Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

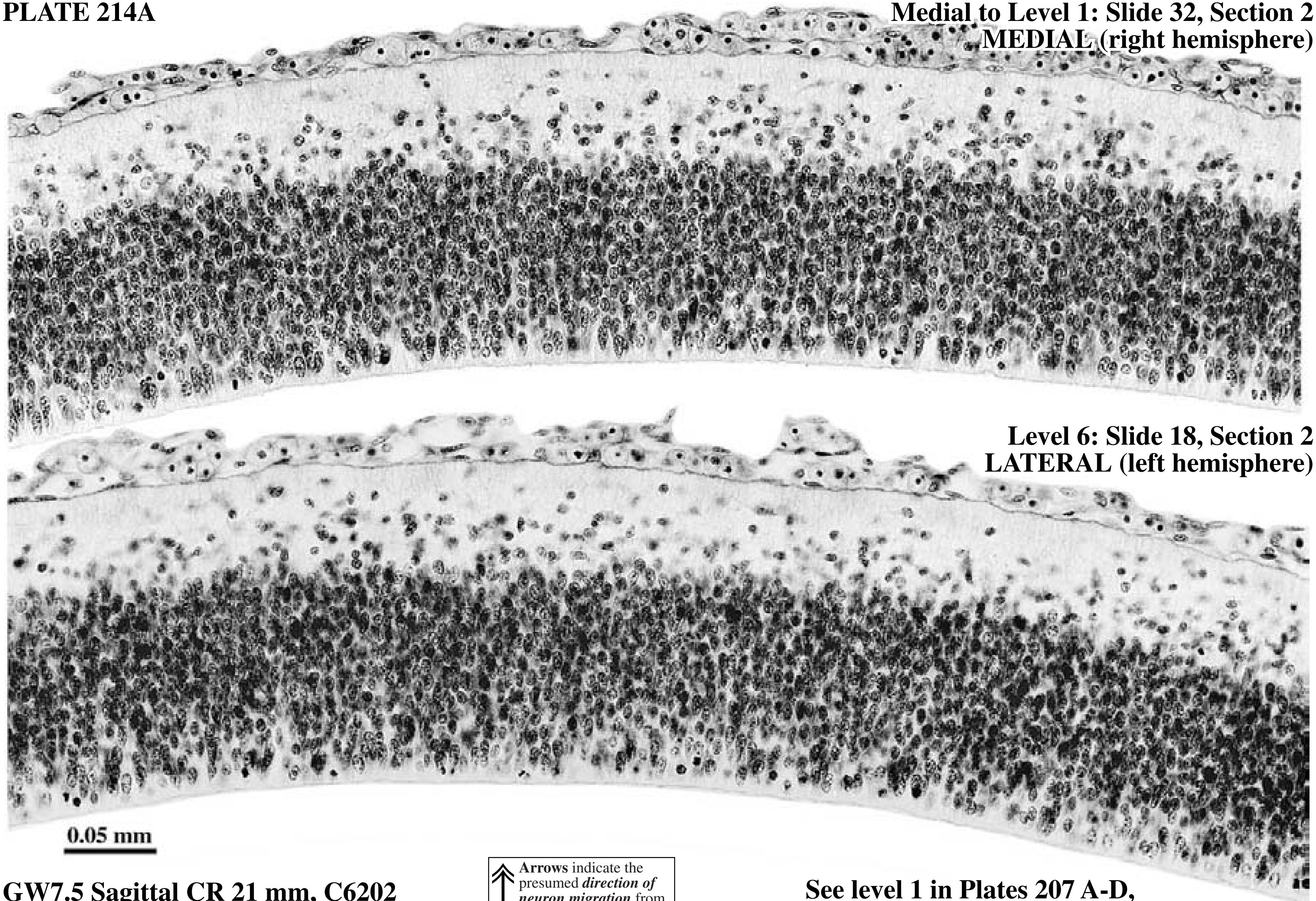
ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium
CTF - Cerebellar transitional field

FONT KEY:
Germinal zone - Helvetica bold
Transient structure - Times bold italic
Permanent structure - Times Roman or **Bold**

PLATE 214A

Medial to Level 1: Slide 32, Section 2
MEDIAL (right hemisphere)

Level 6: Slide 18, Section 2
LATERAL (left hemisphere)

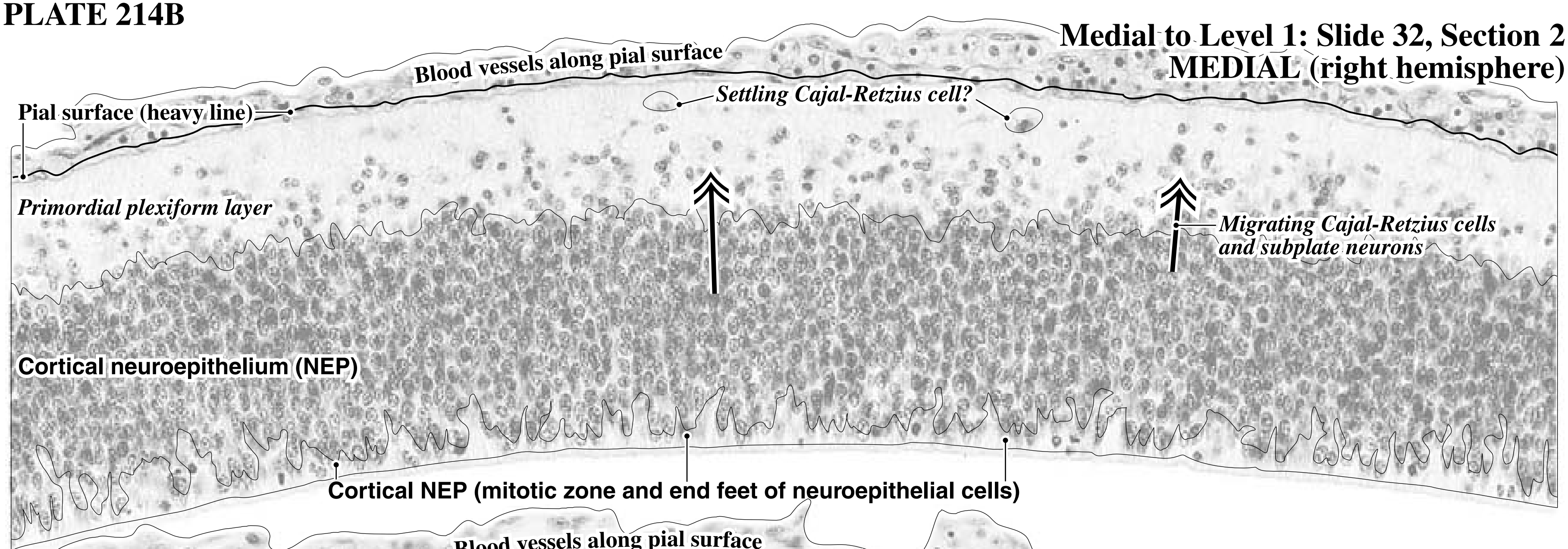


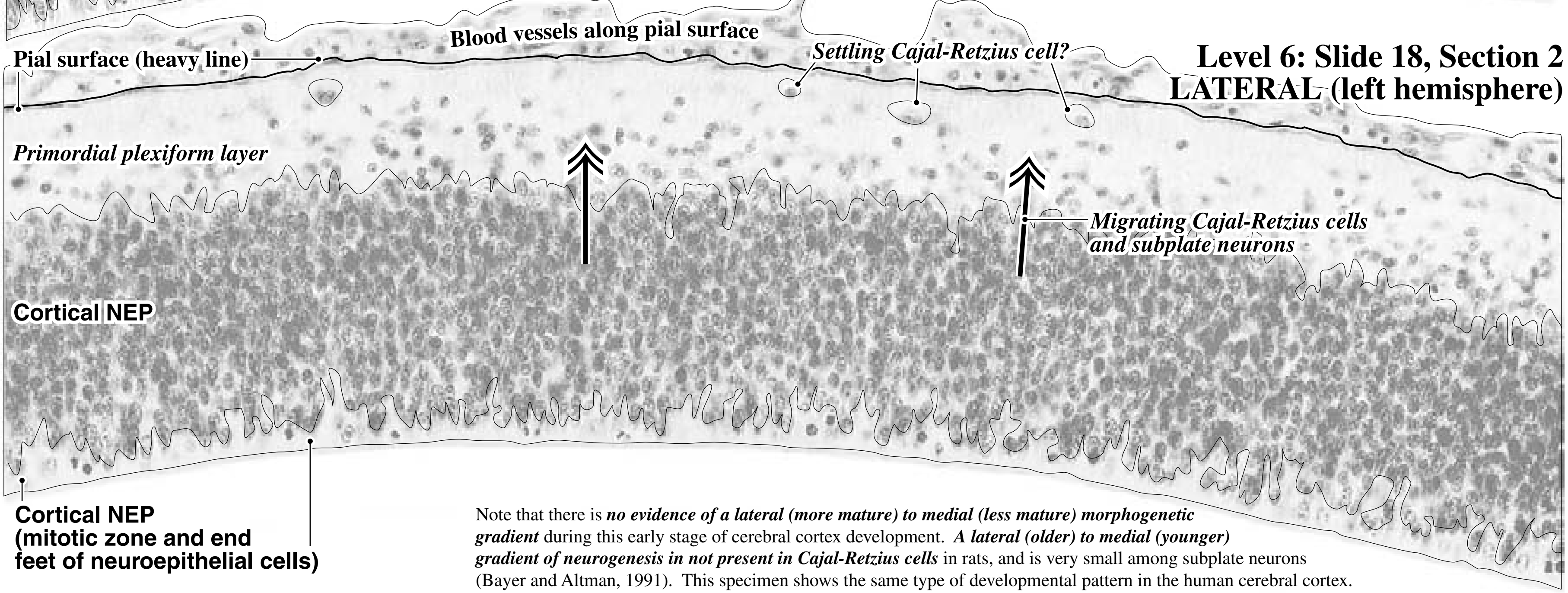
GW7.5 Sagittal CR 21 mm, C6202
DORSAL CEREBRAL CORTEX

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

See level 1 in Plates 207 A-D,
level 6 in Plates 212 A-D.

PLATE 214B

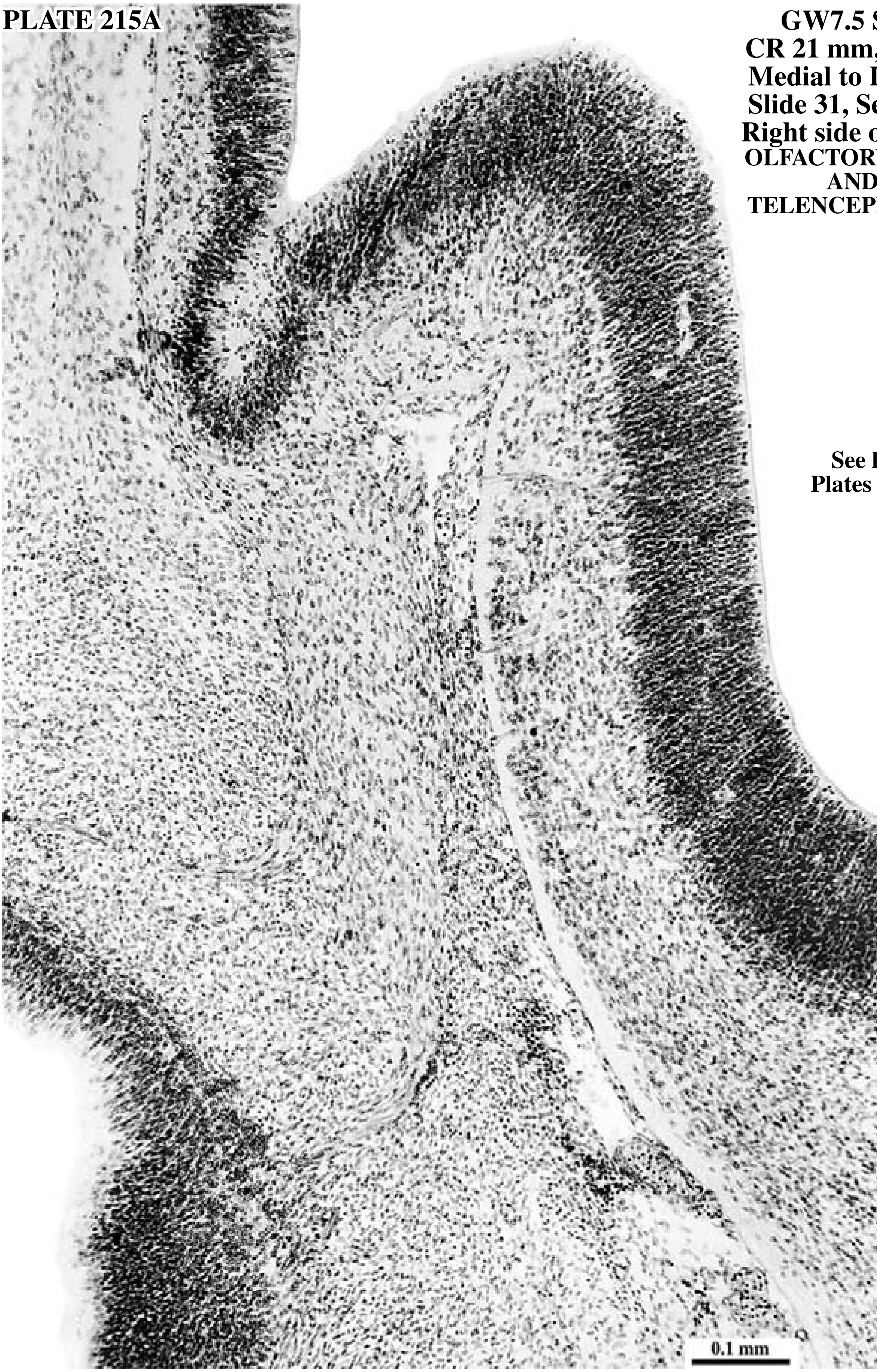




Note that there is ***no evidence of a lateral (more mature) to medial (less mature) morphogenetic gradient*** during this early stage of cerebral cortex development. ***A lateral (older) to medial (younger) gradient of neurogenesis in not present in Cajal-Retzius cells*** in rats, and is very small among subplate neurons (Bayer and Altman, 1991). This specimen shows the same type of developmental pattern in the human cerebral cortex.

PLATE 215A

GW7.5 Sagittal
CR 21 mm, C6202
Medial to Level 1:
Slide 31, Section 2
Right side of brain
OLFACTORY BULB
AND BASAL
TELENCEPHALON



See level 1 in
Plates 207A-D.

PLATE 215B

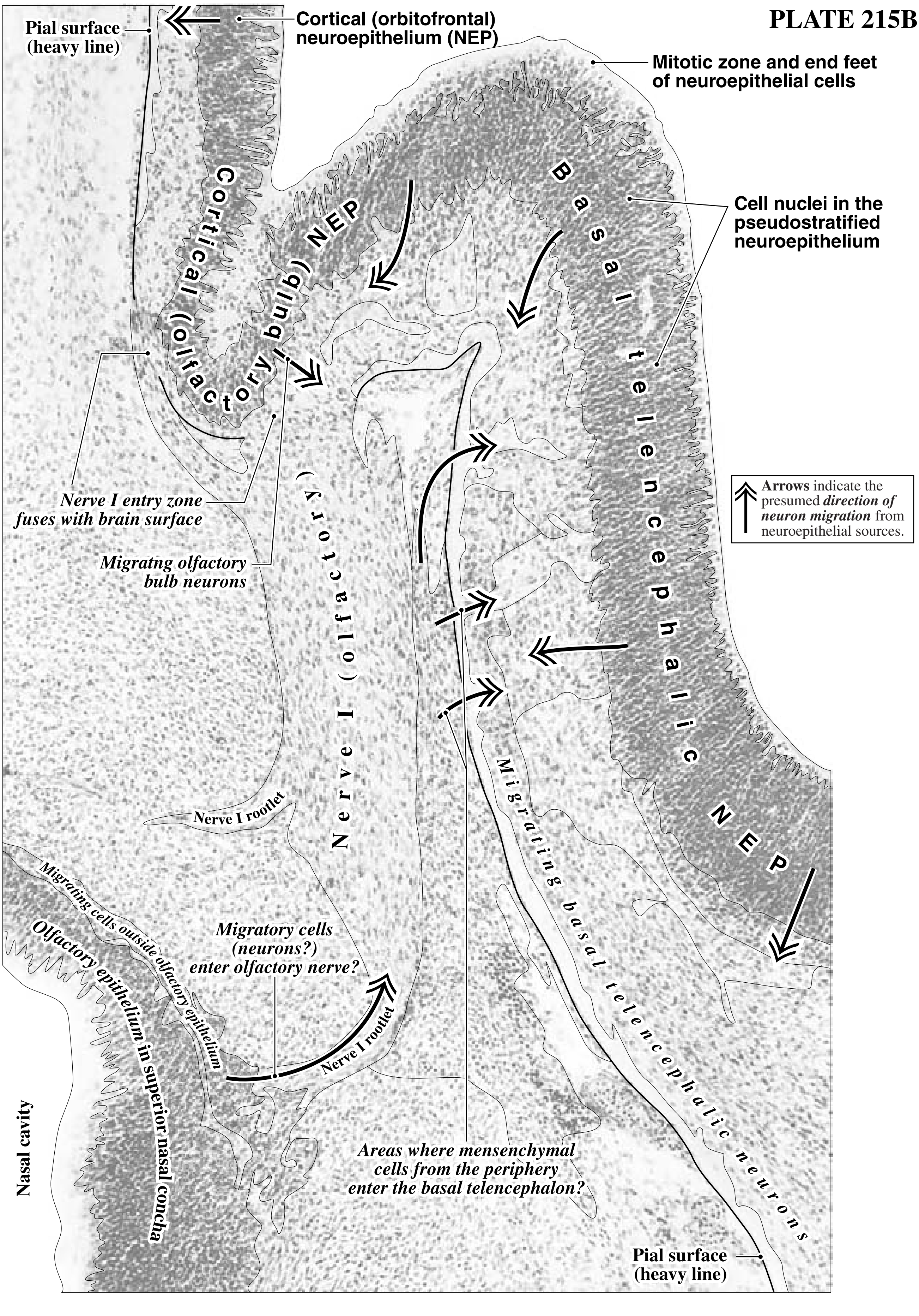
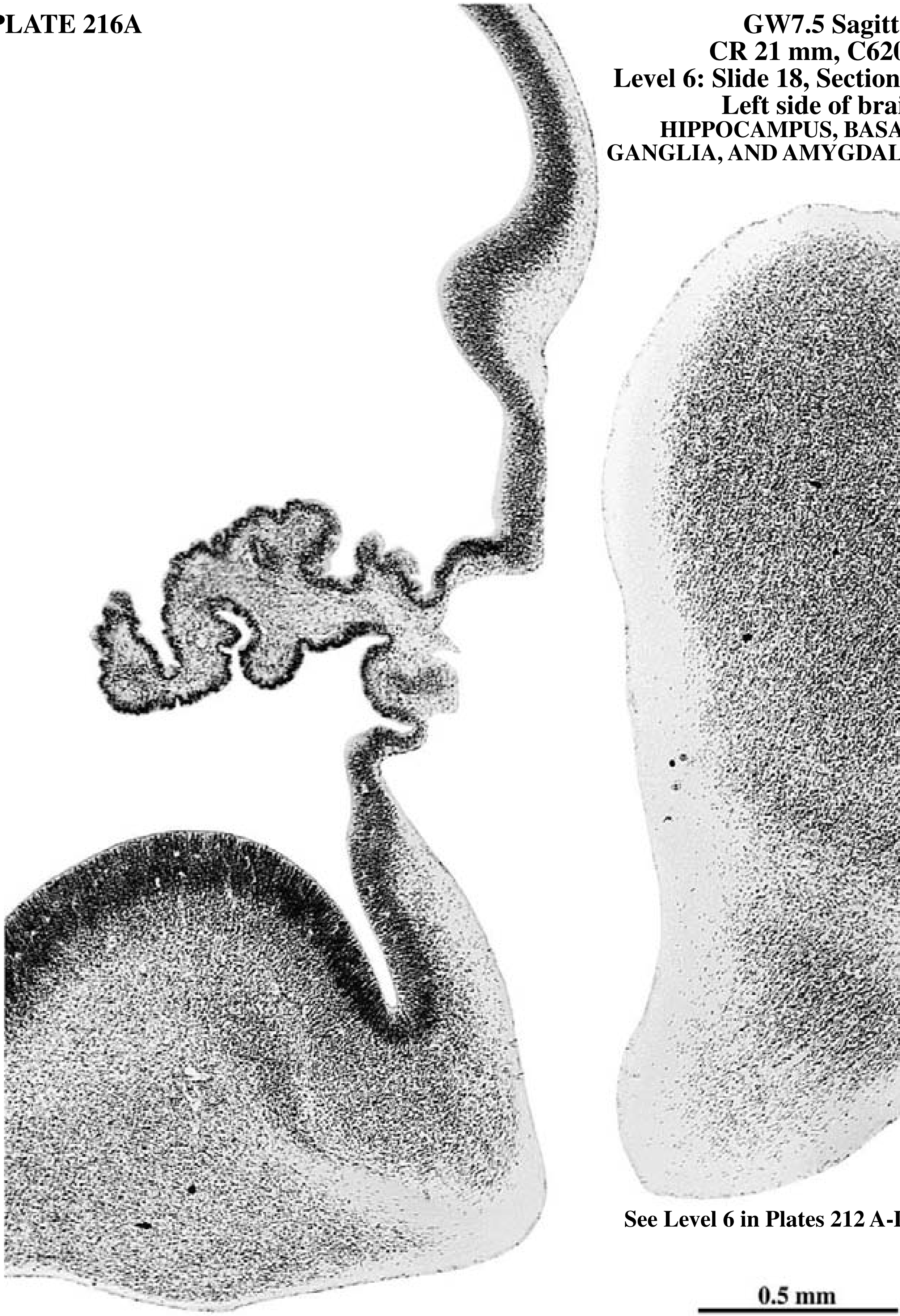

Pial surface
(heavy line)
Cortical (orbitofrontal)
neuroepithelium (NEP)
Mitotic zone and end feet
of neuroepithelial cells
Cortical (olfactory bulb) NEP
Basal telencephalic NEP
Cell nuclei in the
pseudostratified
neuroepithelium
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Nerve I entry zone
fuses with brain surface
Migratng olfactory
bulb neurons
Nerve I (olfactory)
Nerve I rootlet
Migrating basal telencephalic neurons
Migrating cells outside olfactory epithelium
Olfactory epithelium in superior nasal concha
Migratory cells
(neurons?)
enter olfactory nerve?
Nerve I rootlet
Nasal cavity
Areas where mensenchymal
cells from the periphery
enter the basal telencephalon?
Pial surface
(heavy line)

PLATE 216A

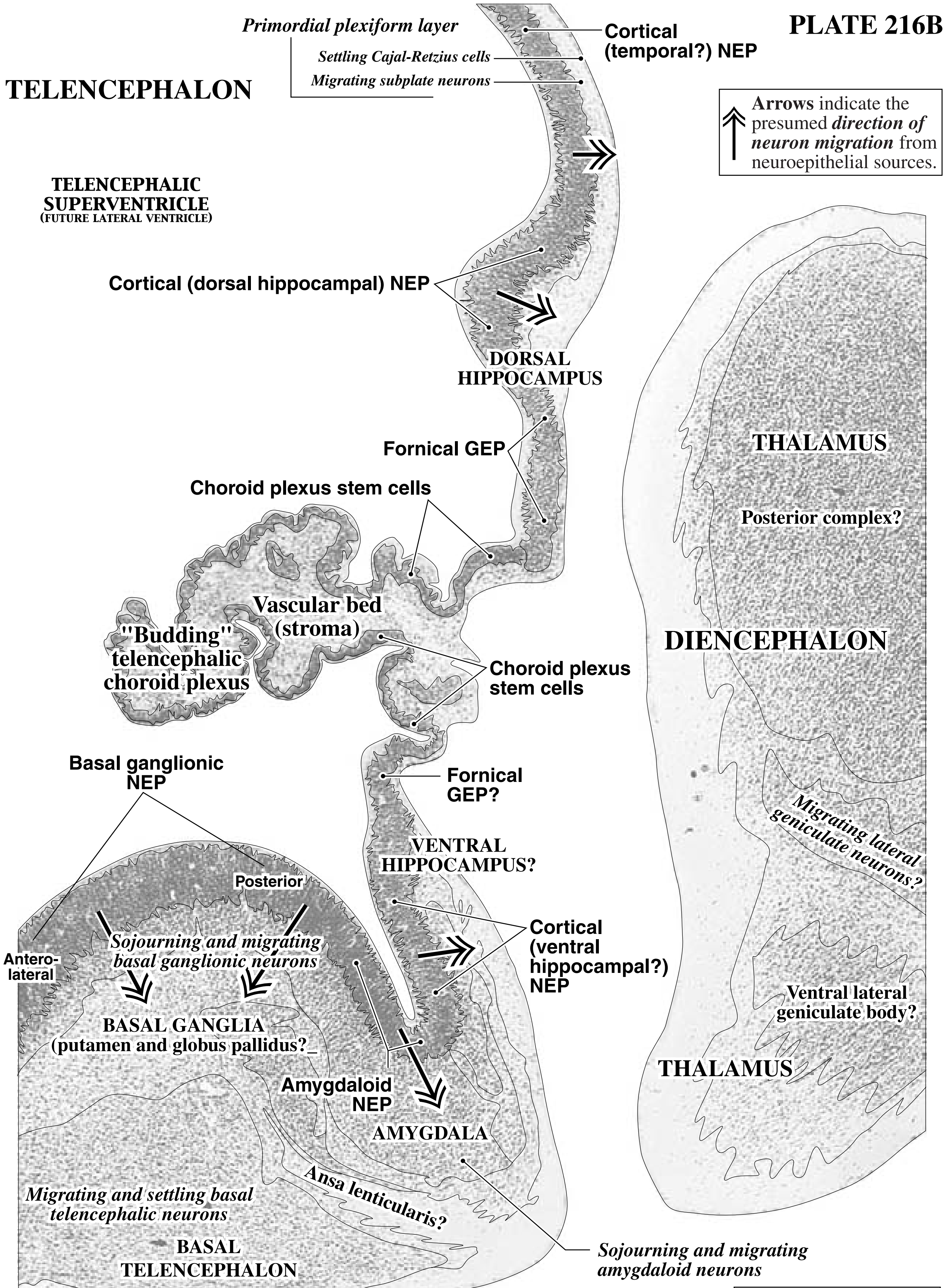
GW7.5 Sagittal
CR 21 mm, C6202
Level 6: Slide 18, Section 2
Left side of brain
HIPPOCAMPUS, BASAL GANGLIA, AND AMYGDALA



See Level 6 in Plates 212 A-D.

0.5 mm

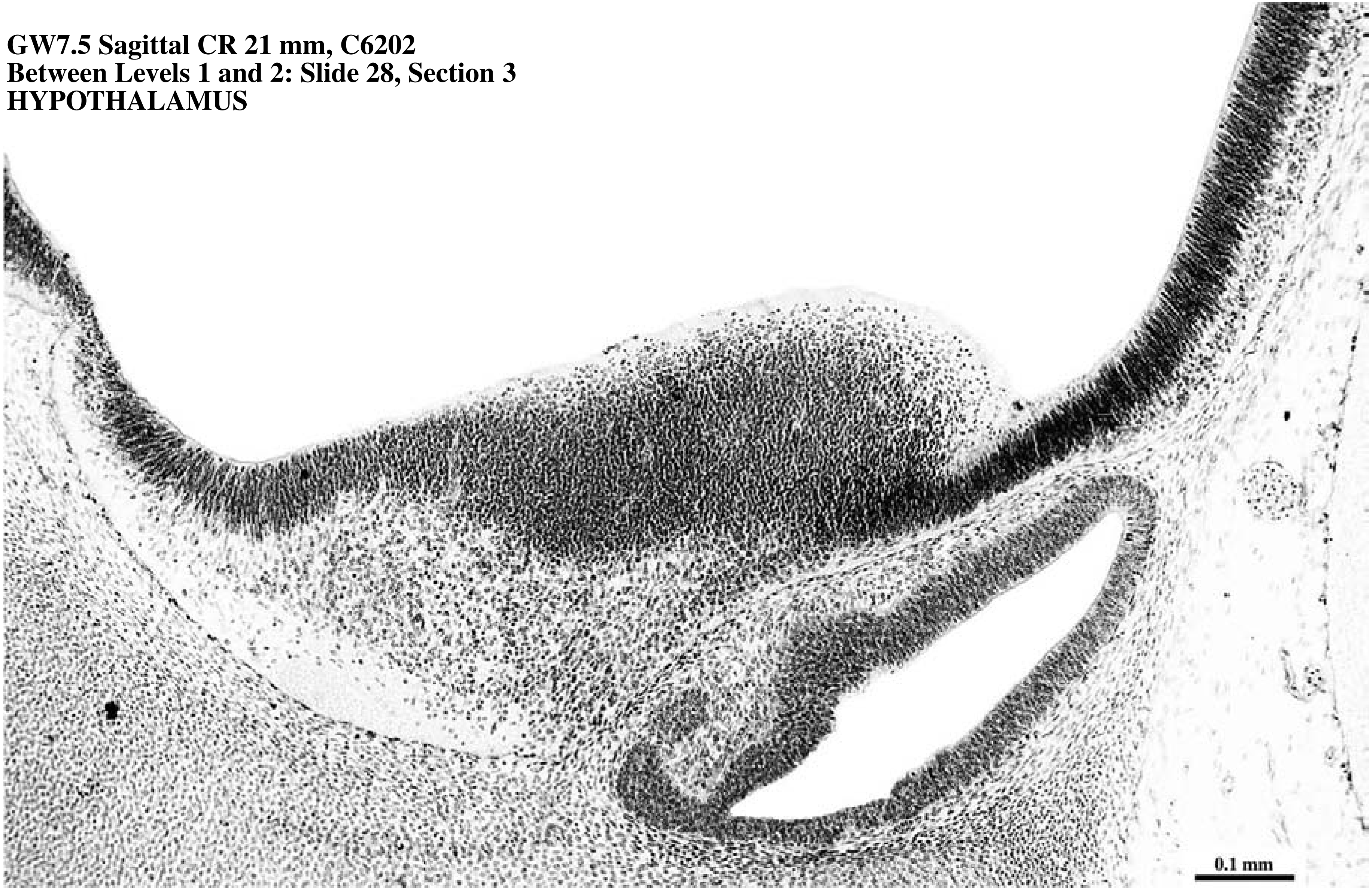
PLATE 216B



ABBREVIATIONS:
GEP - Glioepithelium
NEP - Neuroepithelium

PLATE 217A

GW7.5 Sagittal CR 21 mm, C6202
Between Levels 1 and 2: Slide 28, Section 3
HYPOTHALAMUS



See level 1 in Plates 207A-D, level 2 in Plates 208 A-D.

PLATE 217B

Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

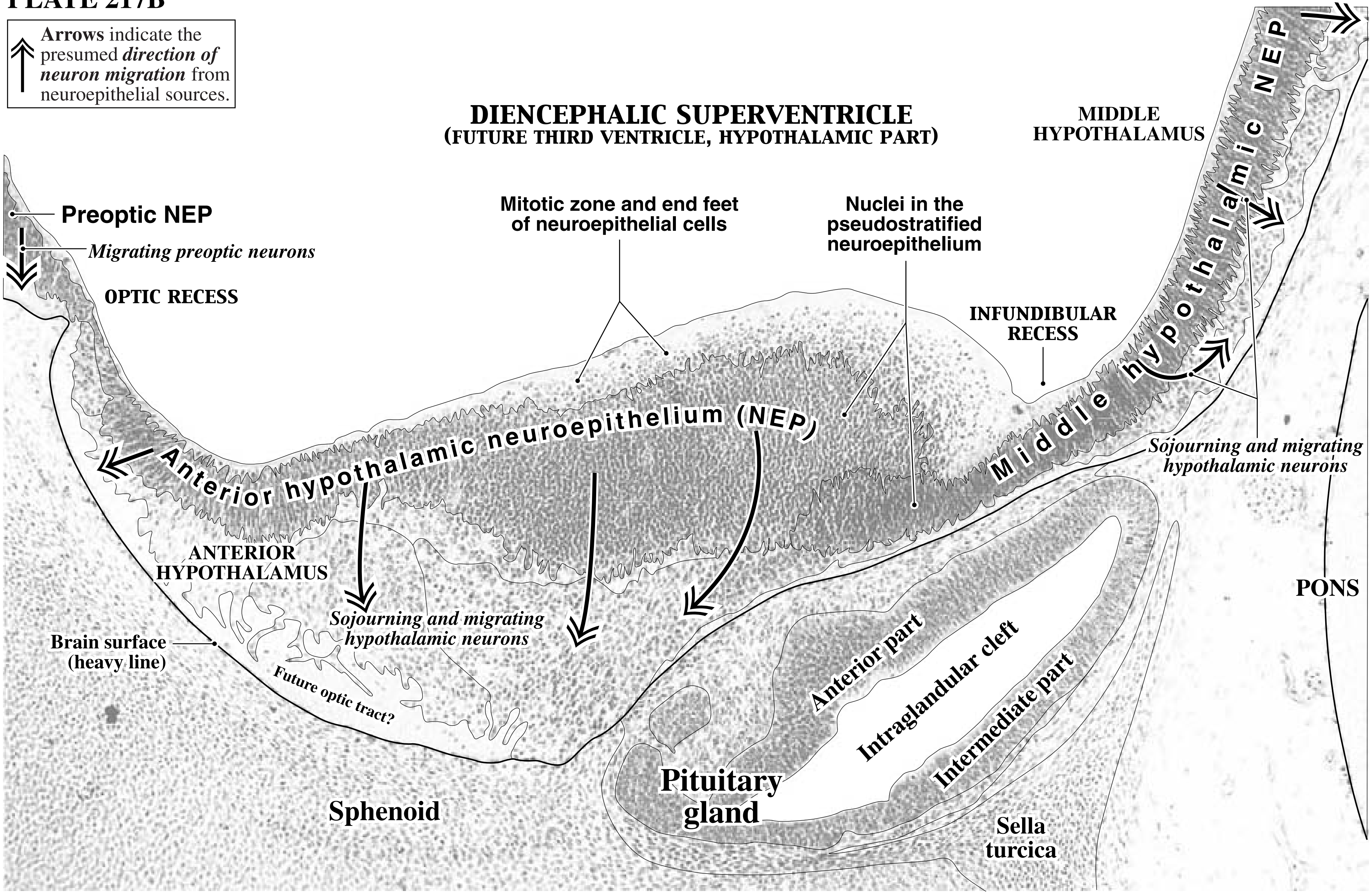
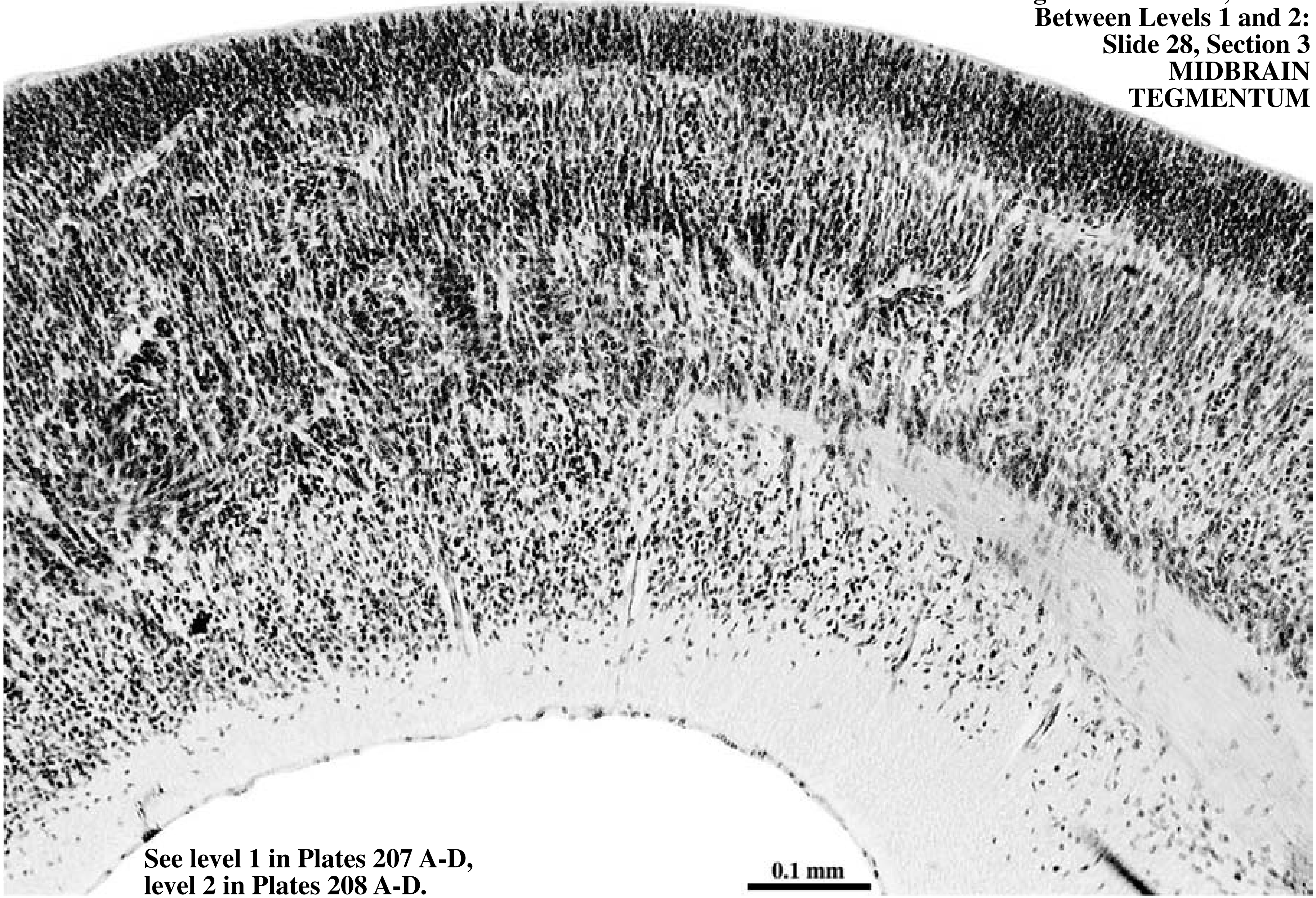


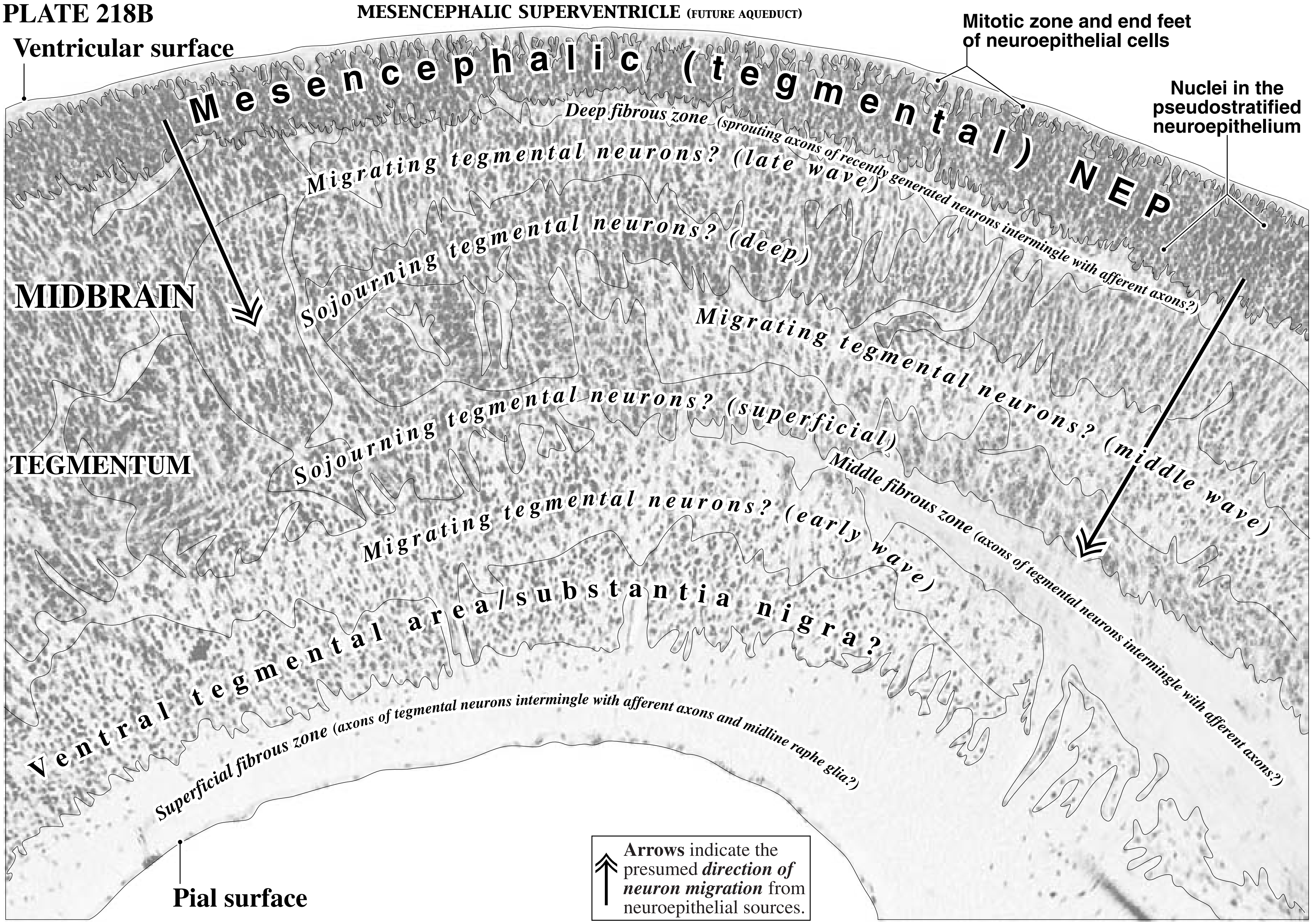
PLATE 218A

GW7.5 Sagittal CR 21 mm, C6202
Between Levels 1 and 2:
Slide 28, Section 3
MIDBRAIN
TEGMENTUM



See level 1 in Plates 207 A-D,
level 2 in Plates 208 A-D.

PLATE 218B



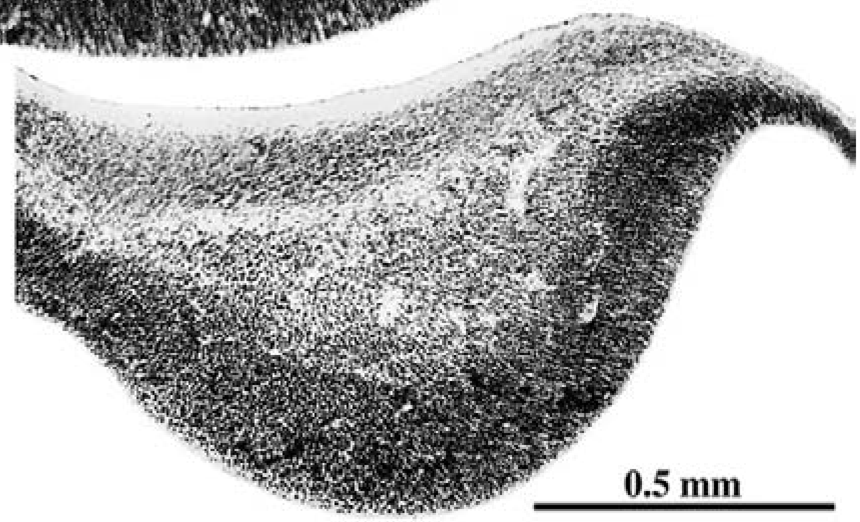
MESENCEPHALIC SUPERVENTRICLE (FUTURE AQUEDUCT)
Ventricular surface
Mitotic zone and end feet of neuroepithelial cells
Nuclei in the pseudostratified neuroepithelium
Mesencephalic (tegmental) NEP
Deep fibrous zone (sprouting axons of recently generated neurons intermingle with afferent axons?)
Migrating tegmental neurons? (late wave)
Sojourning tegmental neurons? (deep)
MIDBRAIN
Migrating tegmental neurons? (middle wave)
Sojourning tegmental neurons? (superficial)
TEGMENTUM
Middle fibrous zone (axons of tegmental neurons intermingle with afferent axons?)
Migrating tegmental neurons? (early wave)
Ventral tegmental area/substantia nigra?
Superficial fibrous zone (axons of tegmental neurons intermingle with afferent axons and midline raphe glia?)
Pial surface
Arrows indicate the presumed *direction of neuron migration* from neuroepithelial sources.

PLATE 219A

GW7.5 Sagittal CR 21 mm, C6202
CEREBELLUM

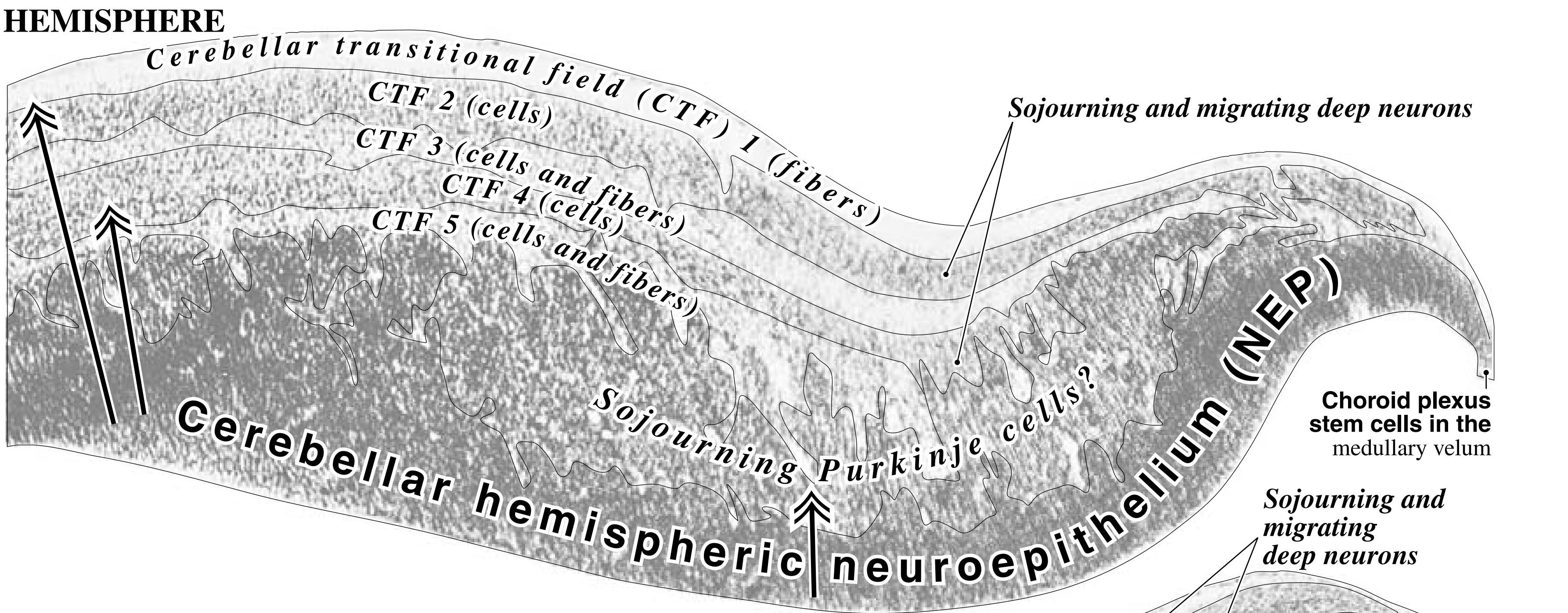
HEMISPHERE
Level 6: Slide 18, Section 2

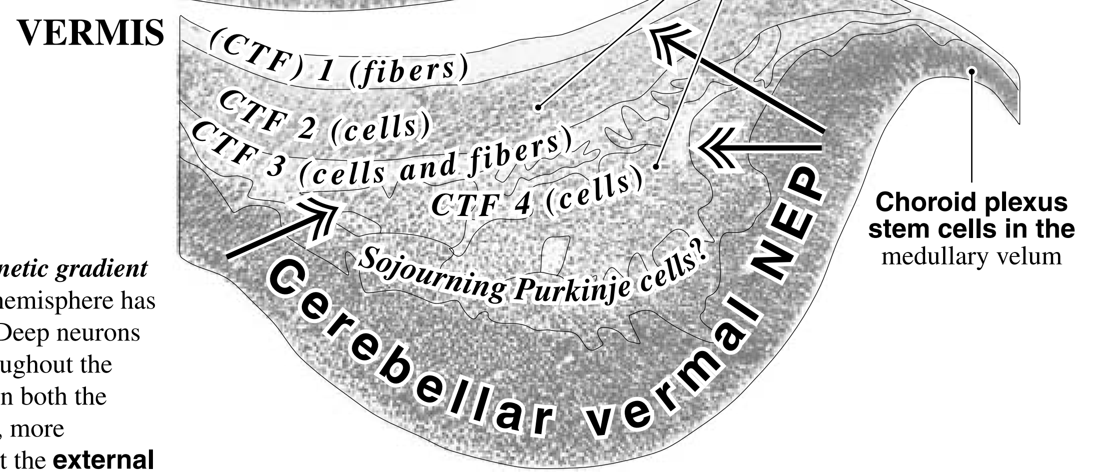
VERMIS
Between Levels 1 and 2:
Slide 29, Section 2



See level 1 in Plates 207 A-D, level 2 in Plates 208 A-D, and level 6 in Plates 212 A-D.

PLATE 219B





Arrows indicate the presumed ***direction of neuron migration*** from neuroepithelial sources.

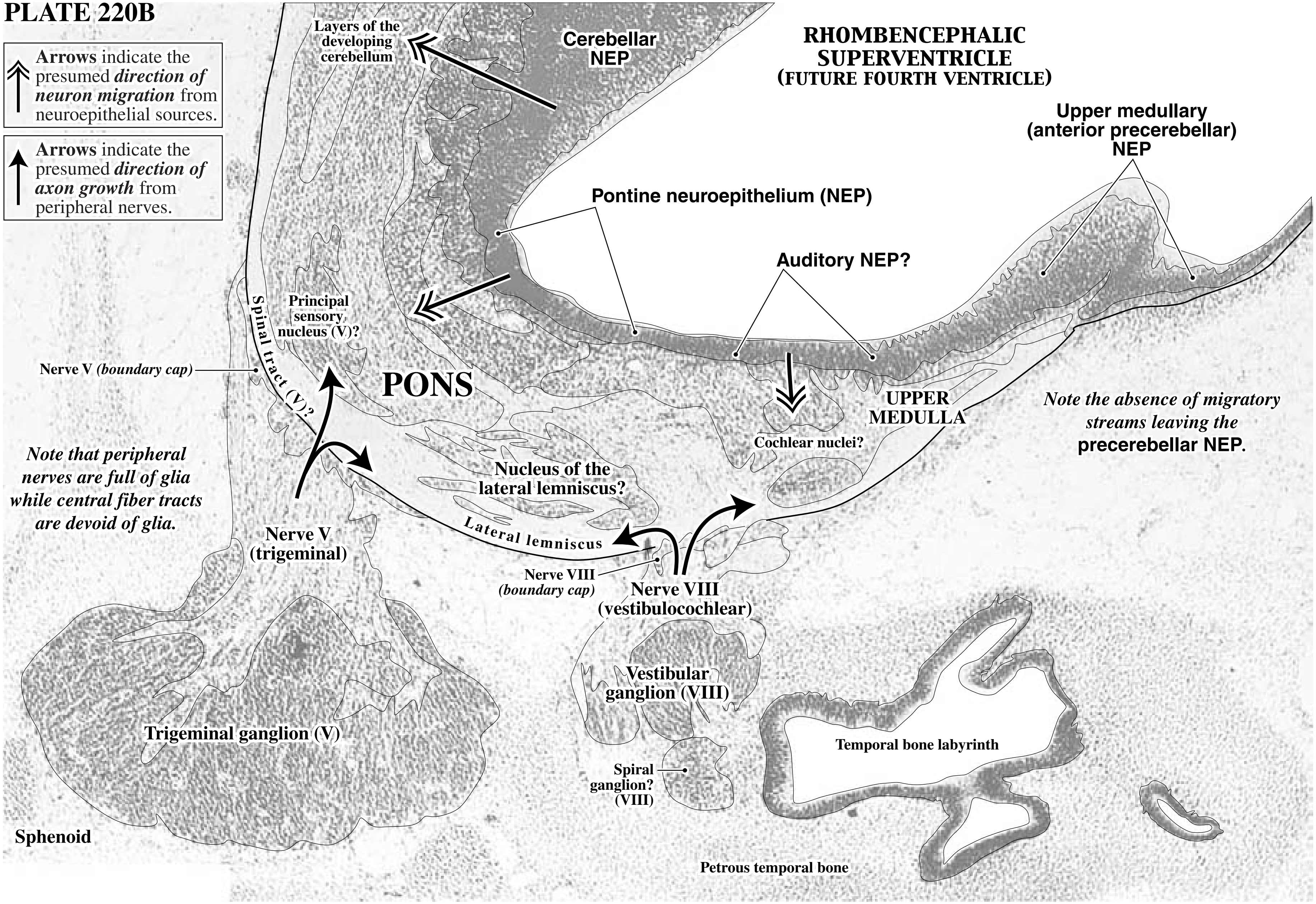
There is a lateral (more mature) to medial (less mature) morphogenetic gradient between the hemisphere and vermis of the cerebellum. The larger hemisphere has better defined and more transitional layers than the smaller vermis. Deep neurons predominate in the transitional field outside the germinal matrix throughout the cerebellum, indicating that they are earlier-generated neurons. Within both the hemispheric and vermal parts of the **cerebellar neuroepithelium**, more Purkinje cells and fewer deep neurons are being generated. Note that the **external germinal layer** is not present at this stage of cerebellar development.

PLATE 220A

GW7.5 Sagittal CR 21 mm, C6202
Level 6: Slide 18, Section 2
PONS AND PERIPHERAL GANGLIA

See level 6 in Plates 212 A-D.

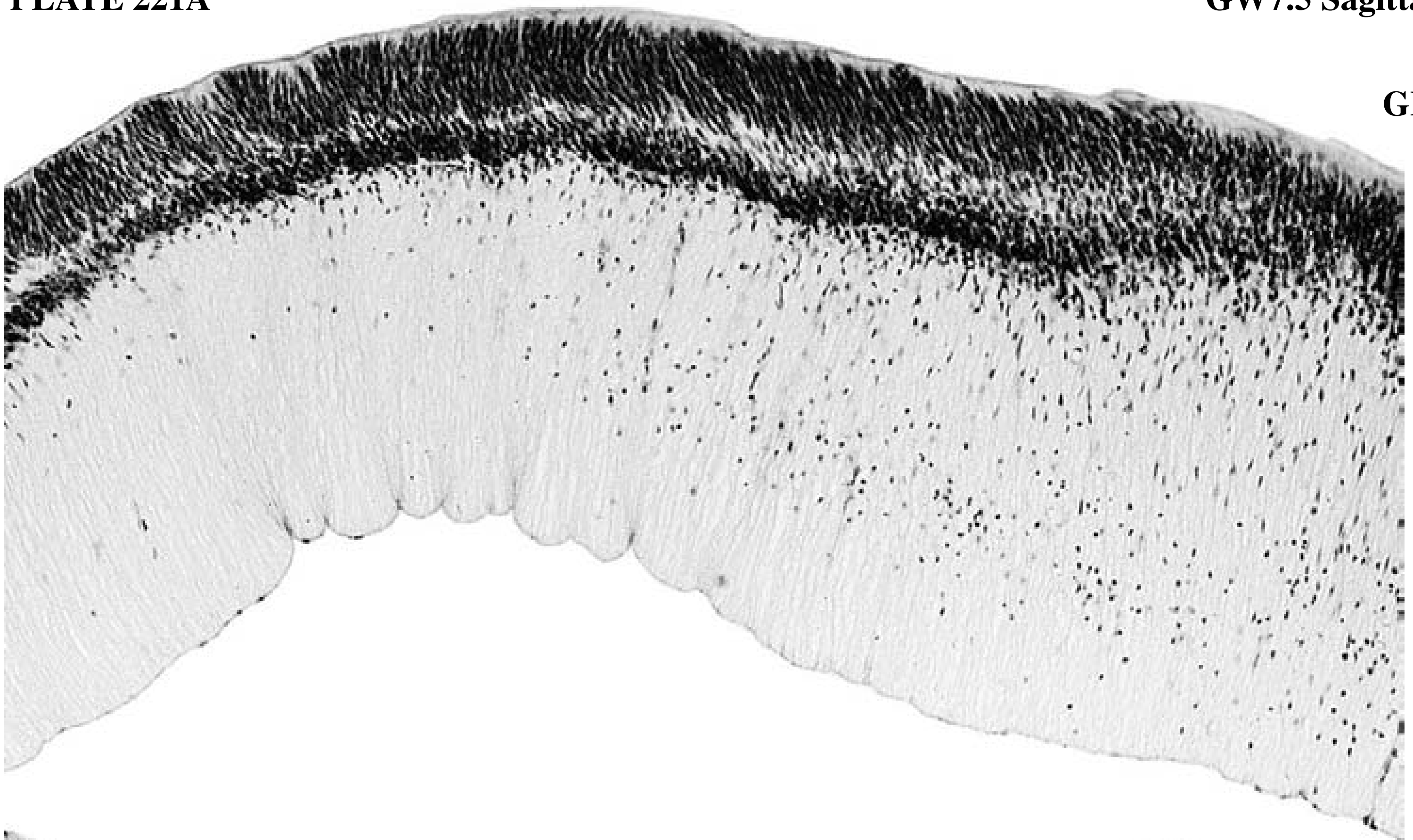
PLATE 220B



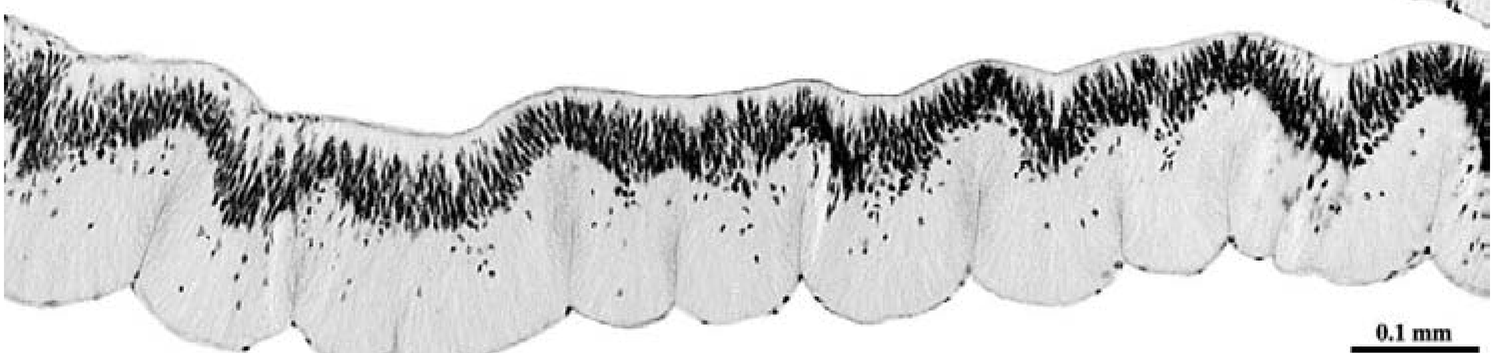
Arrows indicate the presumed direction of neuron migration from neuroepithelial sources.
Arrows indicate the presumed direction of axon growth from peripheral nerves.
Layers of the developing cerebellum
Cerebellar NEP
RHOMBENCEPHALIC SUPERVENTRICLE
(FUTURE FOURTH VENTRICLE)
Upper medullary (anterior precerebellar) NEP
Pontine neuroepithelium (NEP)
Auditory NEP?
Principal sensory nucleus (V)?
Spinal tract (V)?
Nerve V (boundary cap)
PONS
UPPER MEDULLA
Cochlear nuclei?
Note the absence of migratory streams leaving the precerebellar NEP.
Note that peripheral nerves are full of glia while central fiber tracts are devoid of glia.
Nucleus of the lateral lemniscus?
Lateral lemniscus
Nerve V (trigeminal)
Nerve VIII (boundary cap)
Nerve VIII (vestibulocochlear)
Vestibular ganglion (VIII)
Trigeminal ganglion (V)
Spiral ganglion? (VIII)
Temporal bone labyrinth
Sphenoid
Petrous temporal bone

PLATE 221A

GW7.5 Sagittal CR 21 mm, C6202
Medial to Level 1
MIDLINE RAPHE
GLIAL STRUCTURE



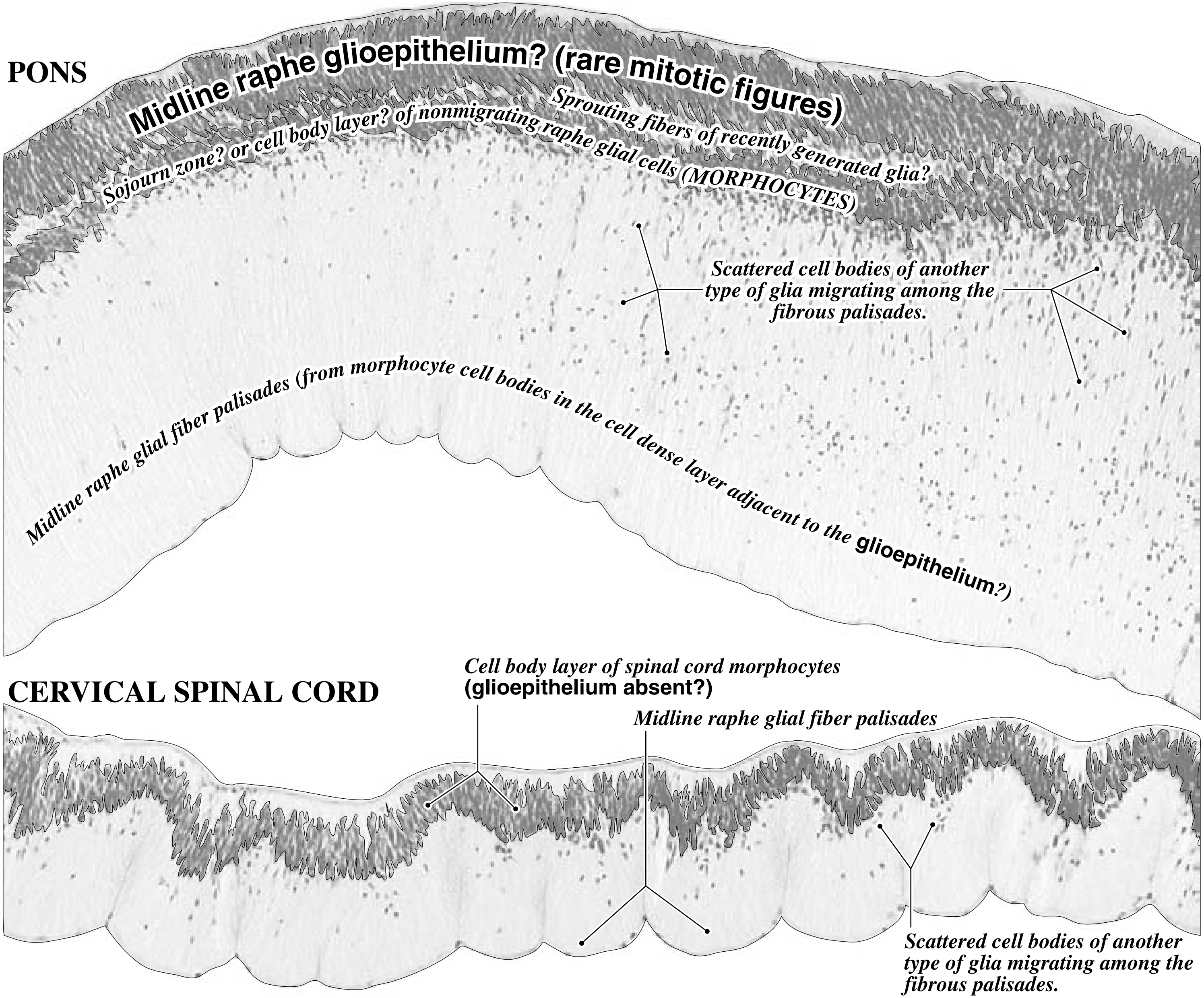
Pons adjacent to the pontine flexure in slide 31, section 2.



Cervical spinal cord adjacent to the medullary flexure in slide 32, section 2.

See level 1 in Plates 207A-D.

PLATE 221B



The **midline raphe glial system** is prominent in regions where the shape of the brain and spinal cord sharply change curvature. Van Hartesveldt et al. (1986) described this in rats, and it is virtually identical in man. The strong fibrous palisades may provide structural stability in the region of these curvatures. Consequently, we call the specialized glia MORPHOCYTES.

There is structural variability between the pons and spinal cord. In the PONS (top panel) there are two cell-dense layers near the ventricular surface. Since mitotic figures are rare in the layer adjacent to the ventricle, it may not be an active germinal zone generating glia. However, at earlier stages of development (to be described in Volume 5), this layer is full of stem cells generating midline raphe glia. The second layer is most likely the densely packed cell bodies that have long fibrous processes extending to the pial surface rather than a premigratory sojourn zone. Morphocytes may be predominantly nonmigratory cells that differentiate at the site of their generation (similar to the ependymal cells that eventually line the ventricular system).

In the SPINAL CORD (bottom panel) there is one cell-dense layer adjacent to the central canal. These are the cell bodies with relatively short (compared to the pons) fibrous processes that extend to the pial surface.

In both regions, there are widely scattered cells dispersed between the fibers. These are most likely other types of glial cells that do not play a structural role (nonmorphocytes) in the raphe system.

GLOSSARY

An asterisk in front of a term indicates that it is a separate entry in the Glossary with additional information. Terms referring to transient developmental structures are underlined.

A

Abducens nucleus (VI) – An aggregate of cranial nerve motor neurons situated beneath the fourth ventricle in the *pons. The nucleus receives input from the *vestibular nuclear complex and is the source of motor fibers of cranial *nerve VI that innervate the lateral rectus muscle of the eye.

Accessory nucleus (XI) – A column of motor neurons that extends from the region of the *nucleus ambiguus in the medulla to segments 5-6 of the cervical spinal cord. Its axons form *nerve XI that innervates the sternocleidomastoid and trapezius muscles.

Accumbent NEP – Neuroepithelial source of the neurons and neuroglia of the *nucleus accumbens. After cessation of neurogenesis, this germinal matrix is transformed into a *glioepithelium.

Alisphenoid process – A cartilaginous structure in the developing skull that surrounds part of the trigeminal nerve and the facial nerve; eventually it becomes the posterior wing of the *sphenoid bone.

Allocortex (embryonic) – Portion of the cerebral hemispheres that, in contrast to the *neocortex, develops into a "three-layered" (oligolaminar) cortex. Among prominent allocortical regions are the *hippocampus, the *primary olfactory cortex, and the *entorhinal cortex.

Ammon's horn (hippocampus) – Part of the *hippocampus that contains a prominent layer of large pyramidal cells.

Ammonic migration and sojourn zone – Migrating pyramidal cells originating in the *ammonic NEP that settle in *Ammon's horn.

Ammonic NEP – Neuroepithelial patch of the *hippocampal NEP, the putative source of the pyramidal cells of Ammon's horn.

Amygdala – A large subcortical structure with several subdivisions in the temporal lobe, implicated in adults in behavioral aggression.

Amygdaloid NEP – Neuroepithelial lining of the anterior wall of the posteroventral *telencephalic superventricle, the presumptive site of origin of neurons and glia of the *amygdala. It is continuous rostrally with the posterior *striatal NEP and caudally with the ventral *hippocampal NEP.

Amygdalohippocampal area – Also called the cortical amygdaloid transition area, connected in the mature brain with the *bed nucleus of the stria terminalis and the *ventromedial hypothalamic nucleus.

Ansa lenticularis – Fiber tract that originates in the internal (medial) segment of the *globus pallidus, courses dorsal to the *zona incerta, and terminates in the *thalamus, in particular the *ventral complex and the *centromedian nucleus.

Anterior amygdaloid area – A region of small to medium-sized cells in the mature *amygdala that represents a transition zone between the *substantia innominata and the amygdaloid complex proper.

Anterior commissure (embryonic) – Large fiber bundle that crosses in the ventral telencephalon and interconnects in the mature brain several forebrain structures on the right and left sides, including the *primary olfactory cortex, the *entorhinal cortex, the *amygdala, and some components of the *temporal lobe. Some of its fibers have crossed the midline by GW9.

Anterior complex (thalamus) – A group of anterior thalamic nuclei with related connections. Components of the anterior thalamic complex are the anterodorsal nucleus, the anteromedial nucleus, and the anteroventral nucleus. In he mature brain, the afferents of the anterior complex come principally from the *hippocampal region and the *mammillary body. The ascending efferents terminate in the *cingulate gyrus, while the descending efferents terminate in the *mammillary body. The anterior thalamic complex is a component of the "limbic system."

Anterior extramural migratory stream – Large stream of young neurons migrating anteroventrally from the *anterior precerebellar NEP to the *pontine gray and the *reticular tegmental nucleus. The stream forms during the latter part of the late first trimester.

<u>Anterior pituitary gland (embryonic)</u> – The anterior lobe of the pituitary gland, also known as the adenohypophysis. It is derived from Rathke's pouch during embryonic development.

<u>Anterior precerebellar NEP</u> – Neuroepithelial source of neurons of the *pontine gray and *reticular tegmental nucleus. It lines the *rhombencephalic superventricle dorsally and the young neurons migrate to their target structures by way of the *anterior extramural migratory stream.

<u>Aqueduct (embryonic)</u> – *See* **<u>Mesencephalic superventricle</u>**

Arcuate nucleus (hypothalamus) – A small-celled nucleus that surrounds the base of the third ventricle posteriorly. It contains releasing hormones and is involved in the central nervous regulation of the anterior pituitary gland.

Atlas – The first cervical vertebra.

<u>Auditory germinal trigone</u> – Proliferative site in the *rhombencephalon that contains the NEP and the external germinal layer of the *cochlear nuclei and contributes stem cells to the rhombencephalic *choroid plexus.

Axis – The second cervical vertebra.

B

Basal ganglia – A broad term that includes three large ganglionic (subcortical) components of the telencephalon, the *caudate nucleus, the *putamen, and the *globus pallidus. The latter two are also referred to as the *striatum. Basal ganglia pathologies have been linked to Parkinsonism, Huntington's disease, and other motor abnormalities.

<u>Basal ganglionic NEP and SVZ</u> – Composed of three large hillocks or eminences protruding into the *telencephalic superventricle – the anterolateral, the anteromedial, and the posterior – and contain the neuroepithelial and subventricular stem cells that furnish neurons and neuroglia to the *basal ganglia. A fourth component is the cortico-ganglionic NEP/SVZ. The SVZ is far more prominent in the basal ganglia than in the developing *cerebral cortex.

Basal nucleus (amygdala) – The largest nucleus in the amygdala that forms a major part of the *basolateral complex. It is separated from the *lateral nucleus by a thin fibrous band.

Basal nucleus of Meynert – Large-celled component of the *substantia innominata that provides in the mature brain cholinergic input to the *cerebral cortex.

Basal occipital – The occipital bone surrounding the *foramen magnum.

<u>Basal telencephalic NEP and SVZ</u> – Putative source of neurons and neuroglia of the *basal nucleus of Meynert and the *substantia innominata.

Basolateral complex (amygdala) – The largest and best differentiated part of the amygdala in humans. Its principal components are the *basal nucleus and the *lateral nucleus.

Bed nucleus of the stria terminalis – A large subcortical telencephalic field with indistinct boundaries. It is situated medial to the *globus pallidus, lateral to the *septum, and is transected by the *anterior commissure; a thin portion extends back to the *amygdala adjacent to the *stria terminalis. It has its own germinal source, the *strionuclear NEP and GEP.

<u>Boundary cap</u> – A thin ring of proliferative cells surrounding the spinal and cranial nerves at the site they enter the central nervous system.

Brachium of the inferior colliculus – A fiber tract situated superficially in the fibrous layer covering of the *inferior colliculus. It is composed of ascending auditory fibers from the inferior colliculus and auditory nuclei in the *pons to the *medial geniculate body.

C

<u>Calcarine sulcus (embryonic)</u> – Cortical fissure in the occipital lobe; its wall is the target of the visual fibers from the *lateral geniculate body. It is recognizable in incipient form by the end of the first trimester.

Caudate nucleus – Elongated and arched component of the *basal ganglia beneath the *cerebral cortex. It abuts the lateral ventricle and extends from anterodorsal (its "head") to posteroventral (its "tail").

Cajal-Retzius cells – The earliest-generated *cerebral cortex neurons. Their perikarya are oriented parallel to the pial surface in *layer I.

Central autonomic area (spinal cord) – Region of the spinal cord that surrounds the *central canal and is implicated in nociceptive and autonomic functions. It may be continuous rostrally with the periaqueductal *central gray.

<u>Central canal (embryonic)</u> – Portion of the ventricular system that extends caudally from the cervical to the sacral segments of the *spinal cord. During embryonic development, the proliferative *neuroepithelium lining this canal is the source of neurons and neuroglia of the spinal cord. After the cessation of neurogenesis, the shrunken central canal is lined by the *ependyma.

Central complex (thalamus) – A group of contiguous central thalamic nuclei, including the *centromedian, central lateral, and paracentral nuclei.

Central gray (periaqueductal) – Oval shaped region in the core of the mesencephalon that surrounds the *aqueduct and is capped by the *superior colliculus and the *inferior colliculus.

Central nucleus (amygdala) – Part of the *corticomedial complex that is sometimes put in a class by itself. A large nucleus situated lateral to the medial nucleus that extends from the *anterior amygdaloid area to the caudal pole of the amygdala where it blends with the *putamen and the tail of the *caudate nucleus.

Central nucleus (inferior colliculus) – Laminated core of the *inferior colliculus where auditory fibers of the *lateral lemniscus terminate in a tonotopic order.

<u>Centromedian nucleus (thalamus, embryonic)</u> – Large spherical structure surrounded by fibers of the internal medullary lamina, classified with the *central complex of the thalamus. It is a paleothalamic structure that has extensive connections with the *striatum and the *reticular formation of the midbrain and is prominent by the end of the first trimester.

<u>Cerebellar NEP</u> – An extensive neuroepithelial matrix that lines the *rhombencephalic superventricle lateral to the *dorsal rhombic lip. It is the direct source of the neurons of the *cerebellar deep nuclei and the *Purkinje cells, and an indirect source of its basket, stellate and granule cells, by way of its secondary proliferative matrix, the *external germinal layer.

<u>Cerebellar transitional field (CTF)</u> – Transient cellular and fibrous layers, composed of migrating deep neurons and Purkinje cells, and of exiting and entering fiber tracts, prior to the formation of the cerebellar cortex during the second trimester.

Cerebellum (deep nuclei) – Three pairs of ganglionic structures in the depth of the cerebellum: the medial *fastigial nucleus; the intermediate *interpositus nucleus, and the lateral *dentate nucleus. The efferent fibers of cerebellar *Purkinje cells synapse with the neurons of the cerebellar deep nuclei which, in turn, are the source of cerebellofugal fibers that terminate in structures outside the cerebellum. The early-generated deep nuclei neurons are mostly situated superficially (above the later generated Purkinje cells) during the late first trimester.

Cerebellum (hemisphere) – Portion of the cerebellum situated on either side of the midline *vermis. It is prominent in the cerebellum in higher mammals and man.

Cerebellum (vermis) – Midline portion of the cerebellar cortex. It is a relatively small part of the cerebellum in higher mammals and man.

<u>Cerebral cortex (embryonic)</u> – The expanding and differentiating bilateral brain tissue covering the lateral, dorsal and medial aspects of the telencephalic superventricles. It has two major components, the *neocortex and the *allocortex. The *stratified transitional field and the *cortical plate begin to form during the late first trimester.

<u>Cerebral peduncle (embryonic)</u> – Fibrous region along the ventrolateral aspect of the diencephalon and mesencephalon, containing fibers of the *corticofugal tract. It begins to form by the end of the first trimester and some of its fibers reach the formative *pontine gray.

<u>Choroid plexus (embryonic)</u> – Glycogen-rich epithelial tissue that forms and begins to expand during the later first trimester in the *rhombencephalic and *telencephalic superventricles. It is formed by proliferative stem cells associated with the cerebellar *germinal trigone and an analogous germinal site in the *hippocampus. The fetal choroid plexus may play a role in the anaerobic metabolism of the early developing brain. During late-fetal development, it becomes gradually transformed into the mature choroid plexus of the shrunken fourth ventricle, with a different cellular composition and perhaps a different function.

Cingulate cortex – A rostrocaudally extending medial region of the cerebral cortex with an *allocortical organization. By virtue of its structure and principal connections, it is considered a component of the "limbic system."

<u>Cingulate NEP</u> – Long neuroepithelial stretch along the medial bank of the *telencephalic superventricle that generates the neurons and glia of the *cingulate cortex.

<u>Claustrum (embryonic)</u> – Subcortical gray matter adjacent to the *insula. During embryonic development, it is in the path of the *lateral migratory stream.

__Cochlear NEP__ – Neuroepithelial patch in the vicinity of the *ventral rhombic lip, the putative source of neurons and glia of the ventral and dorsal *cochlear nuclei.

Cochlear nuclei – The dorsal and ventral auditory nuclei are targets of *nerve VIII auditory fibers. Both nuclei contribute axons to the *lateral lemniscus that terminate in the *nuclei of the lateral lemniscus, the *inferior colliculus, and the *medial geniculate body.

__Cortical NEP__ – Extensive and continuous neuroepithelial lining of the lateral, dorsal and medial banks of the *telencephalic superventricle. It is the sole constituent of the *cerebral cortex during the early embryonic period but, following a strict timetable and spatial gradient, it expands and then shrinks as a class of differentiating neurons and glia leave it to enter the *stratified transitional field and migrate to the *cortical plate. The cortical NEP is also the source of a secondary proliferative matrix, the *subventricular zone, and of a fate-restricted *glioepithelium and the cells that line the enduring *ependyma.

Cortical nucleus (amygdala) – Also called the periamygdaloid cortex, part of the *corticomedial complex in the superficial amygdala.

__Cortical plate__ – The densely packed cellular band in the embryonic and fetal *cerebral cortex that later becomes the laminated *gray matter. It is situated between the future molecular layer, or *layer I and the subplate (the future layer VII).

__Corticofugal fibers (embryonic)__ – Collective term for the efferent fiber system (the traditional pyramidal tract) that originates in the cerebral cortex and terminates in subcortical structures. It is known by different names along its path from rostral to caudal: *internal capsule, *cerebral peduncle, *transpontine corticofugal tract, and corticospinal tract. The corticofugal tract begins to form during the end of the late first trimester but its fibers do not reach the spinal cord before the end of the second trimester.

__Corticoganglionic NEP__ – A transitional neuroepithelium at the junction between the *cortical NEP and the *basal ganglionic NEP and SVZ.

Corticomedial complex (amygdala) – Portion of the *amygdala that includes the *anterior amygdaloid area, the *central nucleus, and the *cortical nucleus.

Cricoid cartilage – A ring-shaped cartilage that forms the base of the larynx.

Cuneate fasciculus – A large fiber tract in the dorsolateral *spinal cord. It is composed of the ascending branch of the primary sensory axons of dorsal root ganglion cells that terminate topographically in the *cuneate nucleus.

__Cuneate nucleus (embryonic)__ – The target of the *cuneate fasciculus in the lower *medulla and the source of second-order somatosensory fibers that cross the midline and enter the contralateral *medial lemniscus. It is recognizable by GW8.

D

Dentate gyrus – Curved small-celled component of the *hippocampus, interlocked with the large-celled *Ammon's horn. Although the *dentate migration is recognizable by the end of the first trimester, the blades of the dentate gyrus do not form until the second trimester.

__Dentate migration__ – Precursors of granule cells of the *dentate gyrus that migrate from a patch of the *hippocampal NEP to form what will later become the secondary germinal matrix of the hippocampus, the *subgranular zone.

__Dentate nucleus (embryonic)__ – Lobulated and largest of the *cerebellar deep nuclei in the core of the cerebellar hemispheres, it is the principal source of efferent fibers of the *superior cerebellar peduncle. In the embryonic cerebellum, the early-generated neurons of the dentate nucleus are situated superficially and do not descend until after the late-generated *Purkinje cells migrate toward the surface to form the cerebellar cortex toward the early fetal period.

Diagonal band of Broca – Oblique nucleus situated ventral to the medial *septum. It is subdivided into a vertical limb dorsally and a horizontal limb ventrally.

__Diencephalic NEP__ – The extensive neuroepithelial lining of the *diencephalic superventricle. Its different mosaic components, distinguished by their bilaterally symmetrical variable thicknesses and evaginations or invaginations into the ventricle, are the source of neurons and glia of the different nuclei of the *diencephalon.

__Diencephalic superventricle__ – Large midline component of the embryonic ventricular system that is later reduced to the small and narrow third ventricle. It is confluent laterally, by way of the foramen of Monro, with the *telencephalic superventricle, and caudally with the *mesencephalic superventricle. Its lining, the *diencephalic NEP, is the source of all the neurons and glia of the *diencephalon.

<u>Diencephalon (embryonic)</u> – Extensive forebrain region flanked laterally by the telencephalon and continuous caudally with the mesencephalon. Among its larger components are the *epithalamus and the *thalamus dorsally; the *preoptic area, *hypothalamus, and *subthalamus ventrally; and the *pretectum caudally. Its development precedes that of dorsal *telencephalon.

Dorsal complex (thalamus) – Collective term for two structurally and functionally related dorsally situated thalamic regions, the *dorsomedial nucleus and the dorsolateral nucleus.

Dorsal funiculus – *See* **Dorsal white matter**

Dorsal gray matter (spinal cord) – Wing-shaped region of the spinal gray matter, the target of the local collaterals dorsal root afferent fibers. Its principal component is the small-celled substantia gelatinosa. The neurons of the dorsal gray matter originate in the *neuroepithelium flanking the transient dorsal spinal canal.

<u>Dorsal hippocampus (embryonic)</u> – The portion of the *hippocampus located above the thalamus during the early stages of embryonic development. In the late second trimester, this region is displaced by the expanding *cerebral cortex laterally and then ventrally.

<u>Dorsal motor nucleus (X) (embryonic)</u> – An early-forming column of parasympathetic preganglionic motor neurons dorsolateral to the *hypoglossal nucleus. Their axons leave the brain in cranial *nerve X and terminate in the parasympathetic ganglia supplying the viscera of the thoracic, pericardial, and abdominal cavities. *See also* **Nerve X**.

<u>Dorsal rhombic lip</u> – The dorsolateral anchoring point of the *medullary velum that covers the expanding *rhombencephalic superventricle. Following the formation of the cerebellar *external germinal layer by the end of the first trimester, it is recognized as the *germinal trigone. The *ventral rhombic lip forms the ventrolateral anchoring point of the medullary velum.

<u>Dorsal sensory nucleus (X) (embryonic)</u> – A medial nucleus in the early-forming *solitary nuclear complex of the *medulla that lies dorsolateral to the *dorsal motor nucleus (X). *See also* **Nerve X**.

Dorsal tegmental nucleus – Situated in the central gray dorsal to the *trochlear nucleus and extending caudally into the pons. It is targeted by fibers of the *mammillotegmental tract.

Dorsal white matter (spinal cord) – Medial fibrous component of the white matter situated between the wings of the *dorsal gray matter; also known as the dorsal column or the dorsal funiculus. It contains ascending somatosensory and proprioceptive fibers that terminate in the dorsal column nuclei of the medulla. In the upper spinal cord it has two distinguishable parts, the *gracile fasciculus medially, and the *cuneate fasciculus laterally.

Dorsomedial nucleus (hypothalamus) – Area situated above the more distinct *ventromedial nucleus of the hypothalamus. Its principal connections are with the *bed nucleus of the stria terminalis and the *septum.

Dorsomedial nucleus (thalamus) – Also known as the medial dorsal nucleus, this component of the *dorsal complex is situated between the internal medullary lamina and the periventricular gray. Its principal connections are with the *amygdala, the *hypothalamus, the *olfactory tubercle, and the *orbital gyrus. It is considered a paleothalamic component of the limbic system rather than as a neothalamic relay nucleus to the neocortex.

E

<u>Endopiriform nucleus (embryonic)</u> – Small telencephalic nucleus deep to the *primary olfactory cortex and ventral to the *claustrum. The *lateral migratory stream percolates through this nucleus during development.

Entorhinal cortex – Allocortical component of the *parahippocampal gyrus. It is bordered internally by the *subicular complex and is separated from the *neocortex in the maturing brain by the rhinal sulcus. It is the source of the perforant pathway to the *hippocampus.

Ependyma – Layer of cuboidal cells that line the lumen of the permanent brain *ventricles and *central canal after dissolution of the proliferative *neuroepithelium.

<u>Epithalamic NEP</u> – Neuroepithelial patch of the *diencephalic NEP, the putative source of neurons and glia of the *epithalamus.

Epithalamus – Collective term for the region of the dorsal diencephalon consisting of the *habenular nuclei, the stria medullaris, and the *habenulo-interpeduncular tract.

Ethmoid – A cranial bone that lies beneath the olfactory bult and forms part of the nasal septum.

Eustachian tube – A canal between the oral cavity and the middle ear.

External capsule – Slender fiber band situated between the *claustrum and the *putamen.

External cuneate nucleus – Situated lateral to the *cuneate nucleus in the *medulla, also known as the accessory cuneate nucleus, it is the source of the cuneocerebellar tract. The nucleus relays somesthetic and proprioceptive information from anterior regions of the body to the *cerebellum.

External germinal layer (cerebellum) – Subpial, secondary germinal matrix of the cerebellar cortex, the source of its late-differentiating granule, stellate, and basket cells. It begins to form at the end of the first trimester and persists as a source of neurons over the surface of the human cerebellar cortex until the end of the second year of postnatal life.

F

Facial motor nucleus – A large aggregate of somatic motor neurons in the ventrolateral pons dorsal to the *superior olive complex. It is the source of the motor fibers of *nerve VII that innervate the facial mimetic muscles. Subdivisions of this nucleus innervate different facial muscles.

Fastigial nucleus (cerebellum) – A deep nucleus of the *cerebellum, also known as the medial cerebellar nucleus. It is the target of Purkinje cell axons that originate in the *vermis. Its axons contribute to the large efferent system that leaves the cerebellum.

Foramen magnum – The large opening in the occipital bone that surrounds the spinal cord.

Foramen of Monro (embryonic) – Large bilateral channels that connect the paired *telencephalic superventricles with the midline *diencephalic superventricle.

Forel's fields (embryonic) – Early differentiating subthalamic tegmental field (H1and H2) traversed by fibers of the *ansa lenticularis, lenticular fasciculus, and subthalamic fasciculus.

Fornical GEP – Fate-restricted germinal extension of the hippocampal NEP, the glioepithelium that surrounds the fornix. It may be the germinal source of the oligodendrocytes of the fornix.

Fornix – An early forming fiber tract of the *hippocampus that distributes fibers in the mature brain to the *septum and the thalamic *anterior complex, and terminates in the *mammillary body.

Fourth ventricle (embryonic) – *See* **Rhombencephalic superventricle**

Frontal bone – Part of the skull that lies over the frontal lobes of the cerebral cortex.

Frontal lobe or **cortex (embryonic)** – Region of the developing *cerebral cortex that will grow into the large frontal lobe anterior to the central sulcus. The *orbital cortex is sometimes distinguished as a separate component.

Frontal NEP – Long stretch of the cortical neuroepithelium that is presumed to generate the cells of the *frontal lobe. Before settling in the *cortical plate, the migrating and sojourning neurons form a site-specific *stratified transitional field.

Frontal nasal process – A primordium in the immature skull of the future frontal and nasal bones.

G

Ganglionic narrows – Ventricular region where the *basal ganglionic eminences protrude into the lumen of the *telencephalic superventricle.

Germinal trigone (cerebellum) – Proliferative germinal matrix of the *dorsal rhombic lip with three prongs: the *cerebellar NEP, the *external germinal layer, and the stem cells of the rhombencephalic *choroid plexus.

Glioepithelium (GEP) – Fate-restricted transient germinal matrix in the developing brain, the presumed source of neuroglia (astrocytes and oligodendroglia) precursors. There are two types of glioepithelia, the *perifascicular GEP that surround fiber tracts, such as the *fornical GEP, and another that covers the surface of the brain, the *subpial granular layer. Glioepithelia are easiest to recognize without special glial markers at sites of considerable distance from neuronal aggregates or their migratory routes.

Glioepithelium/Ependyma (G/EP) – Transient proliferative linings of the ventricle that endure into adulthood and give rise to both glia and cells of the *ependyma.

Globus pallidus – Component of the *striatum, situated medial to the *putamen, with an external (lateral) and internal (medial) segment. Pallidal fibers are the principal efferents from the striatum to the *thalamus, the *subthalamus, and the *tegmentum.

Gracile fasciculus – A large fiber tract in the dorsomedial *spinal cord. It is composed of the branch of axons of dorsal root ganglia that convey somatosensory input from lower parts of the body. The fibers terminate topographically in the *gracile nucleus.

Gracile nucleus (embryonic) – Gray mass in the core of the *gracile fasciculus that receives input from that fiber tract. Axons of these neurons cross the midline in the *medulla, enter the contralateral *medial lemniscus. It is recognizable by GW8.

Gray matter (embryonic) – General term for the laminated component of the mature cerebral cortex with a high concentration of neuronal cell bodies and nerve processes but few myelinated fibers. In the embryonic cerebral cortex, the unlaminated cortical gray matter is known as the *cortical plate.

H

Habenular nuclei (complex) – Mediodorsally situated nuclei in the posterodorsal *thalamus; sometimes distinguished from the thalamus proper as the *epithalamus. Its two distinct components are the medial and the lateral habenular nuclei. Habenular afferents come principally from the *septum and the *hypothalamus, and its efferents form the *habenulo-interpeduncular tract.

Habenulo-interpeduncular tract (embryonic) – An early forming fiber bundle, also known as the fasciculus retroflexus, that originates in the *habenular nuclei. It courses through the posterior *thalamus and terminates in the *interpeduncular nucleus of the midbrain.

Hippocampal NEP – Long medial stretch of the *cortical NEP, the putative neuroepithelial source of neurons and glia of the hippocampus. It has three distinctive parts, the *ammonic NEP, the *dentate migration, and the *fornical GEP.

Hippocampal region – An inclusive term (also called the hippocampal formation) that includes not only the *hippocampus proper but also the *subicular complex and other components of the *parahippocampal cortex.

Hippocampus – A distinctive allocortical (three-layered or oligolaminar) region formed by the interlocking *dentate gyrus and *Ammon's horn. The hippocampus is continuous with the *subicular complex. The principal afferents of the hippocampus travel in the alveolar and perforant paths; its efferents leave by way of the *fimbria that join the *fornix.

Honeycomb matrix – Strands of radially oriented fibers surrounded by migrating cells that may be present by the end of the first trimester in the *superior colliculus and forms during the second trimester in the *stratified transitional field of the sensory areas of the developing *cerebral cortex.

Hook bundle (embryonic) – Intracerebellar decussating fiber tract that originates in the deep nuclei of the cerebellum and presumed to leave it contralaterally as the uncinate fasciculus. A prominent fibrous region identified at the base of the cerebellum in GW8-GW9 specimens may be the sprouting fibers of this tract.

Hypoglossal nucleus (XII) – A column of somatic motor neurons near the floor of the *fourth ventricle in the caudal medulla. Their axons form cranial *nerve XII that innervate the intrinsic and extrinsic muscles of the tongue.

Hyoid bone – A small bone embedded in the throat muscles that lies below the tongue and above the larynx.

Hypothalamic NEP – Stretch of the *diencephalic NEP, situated posterior to the preoptic NEP and ventral to the subthalamic NEP. It is the source of neurons and glia of the nuclei of the *hypothalamus.

Hypothalamus (embryonic) – Early differentiating large diencephalic region that surrounds the ventral (or hypothalamic) portion of *diencephalic superventricle. It is continuous anteriorly with the *preoptic area and merges caudally with the midbrain *tegmentum. The hypothalamus contains a large number of discrete nuclei, among them the *suprachiasmatic nucleus, the *supraoptic nucleus, the *paraventricular nucleus, the *arcuate nucleus, the *ventromedial nucleus, the *dorsomedial nucleus, the *lateral tuberal nucleus, and the *mammillary body.

I

Inferior cerebellar peduncle – Large fiber tract, also known as the restiform body. It contains ascending afferents to the cerebellum from the *spinal cord, the *external cuneate nucleus, the *inferior olive, and the *lateral reticular nucleus.

Inferior collicular NEP – Distinctive neuroepithelial component of the *tectal NEP surrounding the posterior pool of the mesencephalic syperventricle and the source of neurons of the *inferior colliculus.

Inferior colliculus – Paired inferior hillocks of the midbrain *tectum that receive primary, secondary, and higher order auditory afferents. The output of the inferior colliculus is mainly to the *medial geniculate body in the thalamus, but some axons extend to the primary auditory cortex in the *temporal lobe.

Inferior olive – A distinctive convoluted region in the ventrolateral *medulla, with the large principal nucleus and the smaller accessory nuclei. Its axons join the contralateral *inferior cerebellar peduncle and terminate in the *cerebellar cortex as climbing fibers.

Inferior olive (embryonic) – A compact cell aggregate in the lower *medulla, formed by neurons of the *posterior intramural migratory stream during the late first trimester. Its lamination does not begin until the end of the second trimester.

Inferior vestibular nucleus – This nucleus begins caudally in the *medulla near the *external cuneate nucleus and extends rostrally along the medial border of the *inferior cerebellar peduncle.

Infundibular recess – Small recess of the third ventricle that evaginates into the *infundibulum.

Infundibulum – Stalk extending from the ventral *hypothalamus that forms a link with the pituitary gland.

Insula (insular cortex) – Large buried neocortical region that is continuous internally with the *frontal, *parietal and *temporal lobes.

Interhemispheric fissure – Longitudinal cleft that separates the two cerebral hemispheres. The corpus callosum that traversed it in the maturing brain has not yet started to form in the first trimester.

Internal capsule (embryonic) – Massive fiber tract between the *thalamus and *striatum, composed of *thalamocortical and *corticofugal fibers. It is continuous with the incipient *cerebral peduncle caudally.

Interpeduncular nucleus – Midline mesencephalic structure above the interpeduncular fossa and between the *cerebral peduncles. It is the target of fibers of the *habenulo-interpeduncular tract.

Interpositus nucleus (cerebellum) – A deep cerebellar nucleus located between the *dentate nucleus and the *fastigial nucleus. It contains a lateral and a medial group of neurons, the emboliform near the *dentate nucleus, and the globosus near the *fastigial nucleus.

Isthmal canal – Channel that interconnects the *mesencephalic and *rhombencephalic superventricles.

Isthmal NEP – The putative source of neurons and glia of the *isthmus.

Isthmus – Transitional brain region between the *midbrain tectum, the *pons, and the *cerebellum.

L

Lateral geniculate body – Large posteroventral thalamic region, composed in the maturing brain of the laminated dorsal lateral geniculate nucleus and its capsule of ipsi- and contralateral *optic tract fibers. Its axons project, by way of the *visual radiation, to the ipsilateral *occipital lobe.

Lateral geniculate nucleus (embryonic) – The neurons of this prominent thalamic nucleus appear to be generated dorsally in a distinct neuroepithelial locus and migrate ventrolaterally where they meet the incoming *optic tract fibers.

Lateral hypothalamic area – An ill-defined fibrous region of the *hypothalamus with scattered neurons medial to the cerebral peduncle. It is traversed by many fiber tracts, including the *medial forebrain bundle.

Lateral lemniscus – The fiber tract on the lateral surface of the *pons that contains secondary auditory fibers from the dorsal and ventral *cochlear nuclei and higher-order auditory fibers from the *superior olivary complex. The dorsal and ventral *nuclei of the lateral lemniscus are embedded within the fiber tract.

Lateral migratory stream (cortical) – Tangentially migrating neurons and glia in the developing *cerebral cortex that leave dorsal *cortical NEP and migrate laterally and ventrally to the *insula, the *temporal lobe, and other telencephalic structures that lack a nearby germinal matrix. The bulk of the lateral migratory stream follows a trajectory outlined by the receding *subventricular zone between the *basal ganglia and the lateral cortex.

Lateral nucleus (amygdala) – The most lateral nucleus in the *basolateral complex of the *amygdala. Cells from the *lateral migratory stream appear to enter the nucleus at the distinctive saw-toothed lateral edge.

Lateral olfactory tract – *See* **Olfactory tract**

Lateral preoptic area – An anterior continuation of the *lateral hypothalamic area in the *preoptic area.

Lateral reticular nucleus – A relatively discrete group of neurons in the caudal medulla, dorsolateral to the *inferior olive. The neurons of this precerebellar relay nucleus receive topographic exteroceptive and proprioceptive afferents from the *spinal cord and project ipsilaterally to the *cerebellum via the *inferior cerebellar peduncle.

Lateral septal nucleus – An indistinct gray mass in the lateral *septum that is closely associated with the *fornix, which provides input to these neurons.

Lateral tuberal nucleus (hypothalamus) – Two or three distinct spherical masses near the inferior surface of the *lateral hypothalamic area.

Lateral ventricles – *See* **Telencephalic superventricle**

Lateral vestibular nucleus – Also called Deiter's nucleus. A collection of large neurons lying dorsolaterally along the wall of the *fourth ventricle. It receives primary sensory input from the vestibular ganglion via cranial *nerve VIII and its large neurons are the source of the vestibulospinal tract.

Layer I (embryonic) – Cell sparse layer beneath the pia throughout the *cerebral cortex. This is the first cortical layer to develop and contains the earliest generated cortical neurons, including the *Cajal-Retzius cells.

Locus coeruleus – Aggregate of large pigmented cells in the *pons. It is the major source of ascending and descending noradrenergic fibers that are widely distributed throughout the central nervous system.

Luysian NEP – Putative source of neurons of the so-called *subthalamic nucleus (corpus Luysi) in the *hypothalamic NEP. The intramural migration of these neurons has been traced from the region of the formative *mammillary body to the level of the subthalamus dorsolaterally.

M

Mammillary body – Distinctive region in the posteroventral hypothalamus, composed of the medial and lateral mammillary nuclei. Its principal afferents are from the *septum and *subiculum that course in the *fornix; its efferents form the *mammillothalamic and *mammillotegmental tracts.

Mammillotegmental tract – Descending fiber bundle containing *mammillary body efferents to the brain stem, including the *dorsal tegmental nucleus.

Mammillothalamic tract – Ascending fiber bundle containing efferents of the *mammillary body that terminate in the thalamic *anterior complex.

Mandible – The lower jaw bone.

Maxilla – The upper jaw bone.

Meckel's cartilage – Cartilage of the first pharyngeal arch that is associated with the formation of the mandible (lower jaw bone) and the ossicles of the middle ear.

Medial accessory olive – A small nucleus in the *inferior olive complex that contains densely packed neurons along the lateral border of the medial lemniscus. It receives proprioceptive input from the spinal cord and its efferents reach the contralateral cerebellum (mainly the vermis) by way of the *inferior cerebellar peduncle.

Medial forebrain bundle – A diffuse fiber tract that extends from the *olfactory tubercle, through the *lateral hypothalamic area, to the *substantia nigra in the midbrain *tegmentum.

Medial geniculate body – Principal thalamic relay station in the auditory pathway to the *cerebral cortex. Its afferents originate in the *trapezoid body, the *superior olivary complex, the * nuclei of the lateral lemniscus, and the *inferior colliculus. Its efferents form the auditory radiation that terminates in the *temporal lobe.

Medial lemniscus – Large fiber bundle conveying tactile and other somatosensory input to the thalamus. It originates in the *gracile and *cuneate nuclei in the *medulla, crosses to the opposite side, ascends through the *pons and *midbrain, and terminates in the *ventral posterolateral and *ventral posteromedial nuclei of the thalamus.

Medial lemniscus (decussation) – Also known as the sensory decussation, it is composed of ascending fibers of the medial lemniscus that cross to the opposite side in the medulla.

Medial longitudinal fasciculus – A dorsomedial tract in the *midbrain, *pons, and *medulla that contains ascending and descending vestibular fibers coursing beneath the *oculomotor nuclear complex, the *trochlear nucleus, the *abducens nucleus, and the *hypoglossal nucleus. It turns ventrally in the posterior medulla and extends into the ventral funiculus of the cervical spinal cord.

Medial preoptic area – A rounded mass of neurons implicated in reproductive functions.

Medial septal nucleus – An indistinct nucleus in the midline septum that is continuous with the vertical limb of the *diagonal band of Broca.

Medial vestibular nucleus – Component of the *vestibular nuclear complex situated underneath the *fourth ventricle medial to the other vestibular nuclei. Its neurons receive primary sensory input from the vestibular ganglion via cranial *nerve VIII and project to the cerebellum.

Median preoptic nucleus – A small nucleus in the *preoptic area that forms a narrow cap around the *anterior commissure in the midline.

Medulla (embryonic) – Region of the neuraxis, also known as the medulla oblongata, surrounding the posterior *rhombencephalic superventricle and bounded by the *pons rostrally and the *spinal cord caudally. An extremely heterogeneous region containing sensory, somatic motor, and visceral motor nuclei as well as several ascending, descending, and decussating fiber tracts.

Medullary NEP – Extensive neuroepithelial site that lines the variegated caudal bank of the *rhombencephalic superventricle. Its several subdivisions are the source of neurons and glia of the different sensory, relay and motor nuclei of the medulla.

Medullary velum – Membranous roof of the expanding *rhombencephalic superventricle. Its lateral anchor to the *rhombencephalon is known as the *dorsal rhombic lip and the *ventral rhombic lip, and its inner surface serves as a substratum for the expanding rhombencephalic choroid plexus.

Mesencephalic NEP – The extensive neuroepithelium that lines the large *mesencephalic superventricle. Its major divisions are the anterior *pretectal NEP, the dorsal *tectal NEP, the ventral *tegmental NEP, and the posterior *isthmal NEP. Subdivisions are the source, among others, of neurons and glia of the *superior colliculus and *inferior colliculus dorsally, and of the *red nucleus, the *oculomotor nuclear complex, and several tegmental nuclei ventrally.

Mesencephalic nucleus (V) – Large neurons scattered along the lateral border of the *central gray of the midbrain and pons. They are primary sensory neurons that enter the brain from the periphery early in development relaying proprioceptive information from the muscles of mastication.

Mesencephalic superventricle – Greatly inflated lumen of the embryonic *mesencephalon, situated between the *diencephalic superventricle rostrally and the *rhombencephalic superventricle caudally. The connection with the latter is by way of the *isthmal canal. It shrinks in the maturing brain into the narrow aqueduct.

Mesencephalon (embryonic) – Anterior part of the developing brainstem surrounding the *mesencephalic superventricle consisting of the *pretectum and *tectum dorsally, and of the *tegmentum ventrally. Among the intermediate components of the mesencephalon are the *central gray, the *oculomotor nuclear complex, the *red nucleus and the *reticular formation.

Meyer's loop – Part of the *visual radiation that takes a sharp curve in the *temporal lobe as it proceeds to the *occipital lobe.

Midbrain – *See* **Mesencephalon**

Middle cerebellar peduncle – Massive tract of *pontocerebellar fibers that originate in the *pontine gray and enter the cerebellum posterolateral to the *inferior cerebellar peduncle. The earliest fibers of this system emerge at the end of the first trimester.

Motor nucleus, V – *See* **Trigeminal, motor nucleus**

Motor nucleus, VII – *See* **Facial, motor nucleus**

N

Nasal conchae – Scroll-like processes of the *ethmoid and *maxilla that project into the lateral nasal cavity.

Neocortex (embryonic) – Portion of the cerebral hemispheres that develops a "six-layered" (multilaminar) cortical *gray matter. Neocortical development begins with the expansion of the primordial *cortical NEP devoid of differentiated neurons. It is followed by the formation of the *cortical plate, the *subventricular zone, and the different layers of the *stratified transitional field, in association with the ingrowth of *thalamocortical fibers, the outgrowth of *corticofugal fibers and the onset of the formation of intracortical connections. The principal divisions of the neocortex are the *frontal lobe, the *paracentral lobule, the *parietal lobe, the *temporal lobe, and the *occipital lobe.

Neocortical NEP – Extensive *neuroepithelium that lines the lateral and dorsal aspects the *telencephalic superventricles. The proliferating neocortical NEP cells are the source of neurons and glia that migrate to the nearby *cortical plate by way of the *stratified transitional field. Some of its cells may move to more distant sites by way of the *lateral migratory stream.

Nerve I – *See* **Olfactory nerve**

Nerve II – *See* **Optic nerve**

Nerve III (oculomotor) – Cranial motor nerve originating in the *oculomotor nuclear complex. It innervates all the extraocular muscles – except the lateral rectus and superior oblique – and the skeletal muscles of the eyelid, the smooth sphincter muscles of the iris, and the ciliary muscles of the lens.

Nerve IV (trochlear) – Cranial motor nerve composed of axons of the *trochlear nucleus that innervates the superior oblique muscle of the eye. This nerve is unique because it exits from the dorsal surface of the *midbrain behind the *inferior colliculus.

Nerve V and ganglia (trigeminal)– A mixed sensory and motor cranial nerve that has three peripheral branches, the ophthalmic, the maxillary, and the mandibular. All three branches contain peripheral sensory fibers from the trigeminal ganglion that terminate in the *trigeminal principal sensory nucleus, the *trigeminal spinal nucleus, and the substantia gelatinosa in upper cervical segments of the *spinal cord. A bundle of fibers in the mandibular branch, originating in the *trigeminal motor nucleus, innervates the muscles of mastication.

Nerve VI (abducens) – A motor cranial nerve that originates in the *abducens nucleus and emerges near the midline at the caudal border of the *pons. The fibers innervate the lateral rectus muscle of the eye.

Nerve VII and ganglion (facial) – A mixed sensory and motor nerve, the facial nerve has three components. Primary sensory gustatory fibers from the geniculate ganglion enter the *solitary tract and nucleus. Somatic motor fibers from the *facial motor nucleus innervate the mimetic muscles. Visceral motor (parasympathetic) fibers from preganglionic neurons of the indistinct salivatory nucleus target the pterygopalatine and submandibular ganglia.

Nerve VIII and ganglia (cochlear, vestibular) – A sensory cranial nerve that contains primary auditory afferents from the spiral ganglion in the cochlea and primary vestibular afferents from the vestibular (Scarpa's) ganglion. The auditory afferents terminate in the dorsal and ventral *cochlear nuclei; the vestibular afferents terminate in the nuclei of the *vestibular nuclear complex and some reach the *cerebellum.

Nerve IX and ganglia (glossopharyngeal) – A mixed sensory and motor cranial nerve. The sensory part of nerve IX originates in the superior and inferior ganglia, and relays gustatory input from the posterior third of the tongue and visceral sensory input from the tonsils, the Eustachian tube, and the carotid sinus. These fibers enter the solitary tract and terminate in the *solitary nucleus. The somatic motor part of nerve IX originates in the *nucleus ambiguus and innervates the pharyngeal and laryngeal muscles. The visceral motor fibers from parasympathetic preganglionic neurons in the salivatory nucleus terminate in the otic ganglion.

Nerve X and ganglia (vagus) – A mixed sensory and motor nerve, with some somatic and many visceral afferents and efferents associated with the craniosacral parasympathetic ganglia. The sensory fibers originate peripherally in the superior and inferior ganglia and are widely distributed throughout the body, including the pharynx, larynx, trachea, esophagus, and all the thoracic and abdominal viscera. They terminate centrally in the *solitary nucleus and at other medullary sites. Most of its preganglionic motor neurons are located in the *dorsal motor nucleus (X).

Nerve XI (accessory) – This motor nerve has a cranial and a spinal component. The cranial fibers originate in the *nucleus ambiguus and innervate the muscles of the larynx and pharynx. The spinal motor fibers originate in a motor column of the cervical *spinal cord and innervate the sternocleidomastoid and upper trapezius muscles.

Nerve XII (hypoglossal) – A somatic motor cranial nerve that originates in the *hypoglossal nucleus and innervates the intrinsic and extrinsic muscles of the tongue.

<u>Neuroepithelium</u> (NEP) – Pluripotential pseudostratified tissue of neural stem cells that extends from the frontal pole rostrally to the last segment of the spinal cord caudally and is the source of all neurons and neuroglia of the developing central nervous system. The NEP cells initially form the neural plate, then fold dorsally and fuse to form the neural tube (future spinal cord) caudally and the variegated cephalic vesicles (the future brain) rostrally. After that closure, the lumen of the cephalic vesicles expands enormously to form the *rhombencephalic, *mesencephalic, *diencephalic, and *telencephalic superventricles. This expansion provides the space for the mitotic division of NEP cell nuclei that have to shuttle to the fluid-filled lumen to undergo mitosis. The continuous but variegated cephalic NEP lining the ventricles has a mosaic organization, being composed of bilaterally symmetrical long and intermediate stretches, and short patches that give rise to neurons and glia of different brain regions, distinct structures, and specific cell types. Examples of long stretches are the *cortical NEP and the *cerebellar NEP; of intermediate stretches, the *thalamic NEP and the *hypothalamic NEP of the inclusive *diencephalic NEP; and of short patches, the *ammonic NEP and *dentate NEP of the inclusive *hippocampal NEP. The primary NEP is also the source of several *secondary germinal matrices that generate microneurons with locally arborizing axons. Finally, as neurogenesis winds down the pluripotential NEP is transformed at many sites into a *glioepithelium, such as the *fornical GEP, or into the *ependyma that lines the enduring ventricles.

Nuclei of the lateral lemniscus – Both components of this system, the dorsal nucleus and the ventral nucleus, receive their major input from the *cochlear nuclei and the *superior olivary complex by way of the *lateral lemniscus. Both nuclei are connected with the *inferior colliculus and the *medial geniculate body.

Nucleus accumbens – Ganglionic component of the ventral telencephalon ventromedial to the *striatum. It is distinguished from the striatum by its cellular organization, molecular composition, and intimate connections with the *hypothalamus, *amygdala, and other regions of the limbic system.

Nucleus ambiguus – Aggregate of **s**omatic motor neurons that form a thin column in the ventrolateral medulla. Its axons innervate the muscles of the larynx and pharynx via *nerve IX.

O

Occipital lobe or **cortex (embryonic)** – Posterior region of the developing cerebral cortex that will be the target of *visual radiation fibers from the *lateral geniculate body and the *pulvinar.

Occipital NEP – Putative neuroepithelial source of the neurons and glia of the occipital lobe. It is flanked in the fetal neocortex by the occipital *subventricular zone and the *stratified transitional field.

Oculomotor nerve – *See* **Nerve III**

Oculomotor nuclear complex – Situated at the base of the periaqueductal *central gray, the cell columns of this complex extend from the anterior pole of the *superior colliculus rostrally to the *trochlear nucleus caudally. Its somatic motor nuclei innervate the medial rectus, inferior rectus, superior rectus and inferior oblique muscles of the eye, and are associated with the fibers of the *medial longitudinal fasciculus. Most prominent of its autonomic (preganglionic) components is the dorsally located Edinger-Westphal nucleus.

Odontoid process – A tooth-like projection on the superior surface of the *axis that articulates with the *atlas.

Olfactory bulb – Laminated brain structure where the first-order fibers of the *olfactory nerve terminate and the second-order fibers of the *olfactory tract originate. It is composed of three classes of neurons: large mitral cells, the intermediate tufted cells, and the small granule cells.

Olfactory NEP – Putative source of the earlier-generated mitral and tufted cells of the olfactory bulb that lines the olfactory recess of the *telencephalic superventricle. The later-generated granule cells are supplied by the *rostral migratory stream.

Olfactory nerve (embryonic) – Composed of the fine axons of bipolar cells in the olfactory epithelium that terminate in the *olfactory bulb. The nerve is recognizable in GW7.5 specimens.

Olfactory tract – Large fiber bundle of second-order fibers that originate in the *olfactory bulb with two parts, the larger lateral olfactory stria and the smaller medial stria. The fibers of the lateral stria terminate in the *olfactory tubercle, the *primary olfactory cortex, and *corticomedial complex of the amygdala.

Olfactory tubercle – Allocortical area in the ventral telencephalon between the *diagonal band of Broca and the *nucleus accumbens. Its input comes mainly from the lateral *olfactory tract.

Optic chiasm (embryonic) – Site of crossing of fibers of the *optic nerve. Fibers from the nasal half of each retina cross here to the opposite side while those from temporal half proceed uncrossed. The earliest crossing fibers appear in GW7.5 specimens.

Optic nerve – This large fiber tract contains the axons of retinal ganglion cells. Beyond the *optic chiasm it is called the *optic tract.

Optic tract – Large bundle of crossed and uncrossed retinal afferent fibers. In the human brain the majority of the fibers terminate in the *lateral geniculate body; others proceed to the *superior colliculus, the *suprachiasmatic nucleus, the *pretectum, and some other structures.

Orbital cortex – Ventromedial region of the *frontal lobe with afferents from the thalamic dorsomedial nucleus and efferents to the *preoptic area and the *hypothalamus.

Orbitofrontal NEP – Putative source of neurons and glia of the orbitofrontal cortex.

Orbitosphenoid – A cartilaginous structure in the developing skull that surrounds the *optic nerve and eventually becomes the lesser wing of the sphenoid bone.

P

Palatal process – Part of the *maxilla that forms the hard palate in the roof of the mouth.

Pallidum – *See* **Globus pallidus**

Parabrachial nucleus – Dorsolateral pontine structure with indistinct boundaries that surrounds the *superior cerebellar peduncle. Its principal input comes from the *solitary nucleus and its efferents target the *ventral posteromedial nucleus of the thalamus, the *amygdala, and the *insular cortex.

Paracentral lobule (embryonic) – Incipient cortical region that becomes later divided by the central sulcus into the precentral gyrus and the postcentral gyrus. The term is used to distinguish this site of the presumptive motor and sensory projection areas from the *frontal lobe anteriorly and the *parietal lobe posteriorly.

Paracentral NEP – Putative neuroepithelium of the *paracentral lobule in the developing neocortex. It is flanked by the paracentral *subventricular zone and the paracentral *stratified transitional field.

Parahippocampal cortex (embryonic) – Allocortical and neocortical region between the *hippocampus and the *temporal lobe that will become the parahippocampal gyrus. Its subdivisions are the *subicular complex and the *entorhinal cortex.

Parahippocampal NEP – Putative source of the neurons and glia of the parahippocampal gyrus. It is flanked by the parahippocampal *subventricular zone and the parahippocampal *stratified transitional field.

Paraventricular nucleus (hypothalamus) – Prominent neuroendocrine structure abutting the third ventricle with a magnocellular and a parvocellular division. The large neurons of the paraventricular nucleus are the source of oxytocin and vasopressin that reach the posterior pituitary gland by axoplasmic flow. The small neurons of the nucleus are the source of releasing hormones conveyed to the portal vessels of the median eminence.

Parietal bone – A cranial bone in the skull that eventually lies over the parietal lobe of the cerebral cortex.

Parietal lobe of cortex (embryonic) – Region of the developing neocortex bounded anteriorly by the *paracentral lobule and posteriorly by the *occipital lobe.

Parietal NEP – Long stretch of the cortical neuroepithelium containing the neural stem cells of the *parietal lobe. It is flanked by the parietal *subventricular zone and *stratified transitional field.

Perifascicular GEP – Fate-restricted glioepithelium, the presumed source of oligodendrocytes that surround a fiber tract, such as the *fornical GEP.

Periventricular complex (thalamus) – The thalamic region surrounding the *mesencephalic superventricle that will become partitioned as the paracentral, parafascicular, paratenial, paraventricular, and reuniens nuclei. Its principal connections are with limbic system; connections with the *neocortex are sparse.

Petrous temporal bone – Part of the temporal bone that contains the internal ear and semicircular canals.

Pineal gland – Midline endocrine gland connected by its stalk to the pineal recess of the dorsal *mesencephalic superventricle. It secretes melatonin and other indoleamines. It is believed to receive indirect visual input from the retina.

Piriform cortex – *See* **Primary olfactory cortex**

Pituitary gland – *See* **Anterior pituitary gland**; **Posterior pituitary gland**

Pons (embryonic) – Developing brainstem region, situated between the *isthmus and the *medulla, that surrounds the anterior part of the *rhombencephalic superventricle. It contains some early ascending, descending and decussating fiber tracts, the sensory and motor nuclei of some of the cranial nerves, and the *reticular formation.

Pontine gray (embryonic) – This massive basal region of the *pons is just beginning to form as neurons of the *anterior extramural migratory stream start to settle and the earliest descending *corticofugal fibers reach the site. Corticofugal axons that collateralize here are the principal afferents of the pontine gray neurons that are, in turn, the source of the pontocerebellar fibers of the *middle cerebellar peduncle.

Posterior commissure (embryonic) – Early forming decussating fiber tract in the dorsal *mesencephalon that interconnects several nuclei in the *pretectum and *tectum.

Posterior complex (thalamus) – Division of the thalamus that includes the *lateral geniculate body, the *pulvinar, and the *medial geniculate body. The neurons of the lateral geniculate body and pulvinar appear to originate in a distant source and migrate from dorsal to ventral over an extended period.

Posterior intramural migratory stream – Stream of young neurons that migrate inside the parenchyma from their source in the posterior *precerebellar NEP dorsally, to form the *inferior olive in the ventral medulla.

Posterior extramural migratory stream – Stream of young neurons that originate in the posterior *precerebellar NEP, migrate outside the parenchyma, cross the midline ventrally, and settle on the opposite side to form the contralateral *external cuneate nucleus and *lateral reticular nucleus.

Posterior pituitary gland – The posterior lobe of the pituitary gland, also known as the neurohypophysis, is the terminal and storage site of hypothalamic neurosecretory cells.

Precerebellar NEP – Dorsally situated neuroepithelium that lines the *rhombencephalic superventricle in the vicinity of the ventral rhombic lip and is the source of neurons of the *precerebellar nuclei. Neurons of its rostral division migrate in the *anterior extramural migratory stream and settle in the *pontine gray and the *reticular tegmental nucleus. Neurons of its posterior division form two migratory streams, the *posterior intramural migratory stream that forms the *inferior olive, and the *posterior extramural migratory stream that crosses to the opposite side and forms the *lateral reticular nucleus and the *external cuneate nucleus.

Precerebellar nuclei – A series of nuclei in the *medulla and *pons that provide massive higher-order input to the *cerebellum, including the *inferior olive, the *external cuneate nucleus, the *lateral reticular nucleus, and the *pontine gray.

Premammillary area – Region with ill-defined boundaries anterior to the *mammillary body in the *hypothalamus.

Preoptic area (embryonic) – Early developing midline region surrounding the preoptic recess of the *diencephalic superventricle. It is contiguous anteriorly with the ventral telencephalon and blends posteriorly with the anterior *hypothalamus. It is implicated in the regulation of sexual behavior and reproductive functions.

Prepositus nucleus – Situated in the dorsomedial *medulla, it extends from the anterior part of the *hypoglossal nucleus to the posterior part of the *abducens nucleus.

Presubiculum – *Allocortical component of the *parahippocampal gyrus between the *subiculum and the *parasubiculum.

Pretectum – Dorsal area between the posterior *thalamus and the *superior colliculus with an early forming fiber system, the *posterior commissure.

Primary olfactory cortex – Allocortical region, also called the piriform lobe, where fibers of the lateral olfactory tract terminate. It is situated rostral to the *entorhinal cortex and includes the prepiriform area along the rhinal fissure and the periamygdaloid area.

Primordial plexiform layer (cortical) – The first transitional layer to appear outside of the *cerebral cortical NEP that contains *Cajal-Retzius cells and *subplate neurons. The *cortical plate forms within its boundaries later on in development.

Principal sensory nucleus (V) – *See* **Trigeminal, principal sensory nucleus**

Pulvinar (thalamus) – Large nucleus of the thalamic *posterior complex. Its subdivisions send fibers to various regions of the *parietal lobe, *occipital lobe, *temporal lobe, and frontal lobe It has been implicated in multisensory integration.

Purkinje cells (embryonic) – These neurons, which form a monolayer in the maturing cerebellar cortex, are generated in the *cerebellar NEP towards the end of the first trimester, subsequent to the production of the *cerebellar deep nuclei neurons. Hence they are initially situated beneath the layer of deep neurons adjacent to the cerebellar NEP. Later they migrate toward the surface of the formative cerebellar cortex as the *external germinal layer forms there.

Putamen – Lateral component of the *striatum. It lies between the *external capsule and the *globus pallidus. It is the major source of striatal efferents to the *thalamus, *subthalamic nucleus, *substantia nigra, and *tegmentum.

R

Raphe migration – Streams of cells that originate in the dorsal *medullary NEP and are later distributed in the midline of the ventral medulla.

Raphe nuclear complex – Several smaller and some larger cell aggregates that extend in and near the midline from the *midbrain rostrally to the *medulla caudally. The raphe cells are the principal source of serotonin-containing fibers distributed along the entire neuraxis from the forebrain to the *spinal cord. They are involved, as neuromodulators, in the regulation of sleep, wakefulness and emotional arousal.

Red nucleus (embryonic) – A prominent nucleus in the maturing brain with a small-celled (parvocellular) and a large-celled (magnocellular) division. It is recognizable during the first trimester in the vicinity of a germinal patch, identified as the *rubral NEP. The associated fibers may be early elements of the *superior cerebellar peduncle.

Reticular belt (thalamus) – Distinctive component of the thalamus; it is coextensive with the thalamic *reticular nucleus.

Reticular formation – A large collection of scattered neurons, enmeshed in a complex network of fibers, in the core of the *medulla, *pons, and *mesencephalon.

Reticular tegmental nucleus (embryonic) – Situated dorsal to the *pontine gray, this *precerebellar nucleus, also known as the nucleus reticularis tegmenti pontis, begins to form toward the end of the first trimester ahead of the pontine gray.

Reticular nucleus (thalamus, embryonic) – An early formong thin belt of cells and fibers between the wall of the *thalamus and the *internal capsule. Virtually all fibers that interconnect the thalamus and the cerebral cortex traverse the thalamic reticular nucleus.

Rhombencephalic superventricle – The greatly inflated NEP-lined lumen of the *rhombencephalon, situated between the *isthmal canal of the *mesencephalic superventricle rostrally and the central canal of the *spinal cord caudally.

Rhombencephalon (embryonic) – An extremely heterogeneous hindbrain region lining the *rhombencephalic superventricle, that includes the developing *cerebellum, *pons, and *medulla.

Rostral migratory stream – A large stream of mitotic and postmitotic cells in the forebrain extending from the cerebral *subventricular zone to the *olfactory bulb. It is a source of late generated neurons and persists after the NEP has receded or disappeared.

Rubral NEP – A distinctive neuroepithelial patch lining the *mesencephalic superventricle and situated between the *tectal NEP and the *tegmental NEP. It is the putative source of neurons of the early generated neurons of the *red nucleus.

S

Secondary germinal matrix – Layer or field of proliferative precursors of neurons and glia abutting or some distance from the primary *neuroepithelium. These fate-restricted stem cells are progeny of the NEP and persist for varying periods postnatally (some into adulthood). Examples of secondary germinal matrices are the *external germinal layer of the cerebellum, the *subventricular zone of the neocortex, the *subgranular zone of the dentate gyrus, and the *striatal subventricular zone. Typically, the secondary germinal matrices are the source of late-generated short-axoned interneurons, or microneurons.

Sella turcica – Part of the *sphenoid bone that surrounds the pituitary gland.

Septum – Midline telencephalic structure with two components, the *medial and *lateral nuclei. Its principal connections are with the *hippocampus and the *hypothalamus by way of the *fornix. The septum is a focal component of the limbic system.

Sojourn zone – Transient cellular layers formed by neurons that halt their migration for varying periods before they proceed to their final destination. They have been recognized at various sites, among them the *stratified transitional field of the cerebral cortex and the *cerebellar transitional field. It is hypothesized that the sojourn zones are sites where transient or enduring connections are made as the coarse circuitry of a brain region is established.

Solitary tract and nucleus (embryonic) – The solitary tract is an early forming medullary fiber system that may contain the primary sensory fibers of cranial *nerves VII, IX, and X that convey gustatory (VII and IX) and visceral-sensory information (IX and X) to the solitary nucleus. The *dorsal sensory nucleus of nerve X and the *commissural nucleus of nerve X are part of this nuclear complex.

Sphenoid – The skull bone that lies mainly beneath the hypothalamus, basal telencephalon, and mesencephalon. It contains the *alisphenoid and *orbitosphenoid processes and the *sella turcica around the *pituitary gland.

Spinal cord – Caudal tubular component of the central nervous system that surrounds the *central canal. Its core of gray matter (the dorsal horn, intermediate gray and ventral horn) and surrounding white matter (the dorsal, lateral and ventral funiculi) blend rostrally with the lower medulla.

Spinal nucleus (V) – *See* **Trigeminal, spinal nucleus**

Spinal tract (V) – *See* **Trigeminal, spinal tract**

Squamous temporal bone – The flat part of the *temporal bone that covers the *temporal lobe of the cerebral cortex.

Stratified transitional field (STF) – Transient component of the fetal *cerebral cortex, sandwiched between the *neuroepithelium and the *cortical plate. By the second trimester (GW13), illustrated in Volume 3, it has six layers of alternating cells and fibers (STF1 to STF6) that vary in their configuration in different lobes of the cerebral cortex. In the oldest specimens illustrated in this Volume (GW11), the STF has only two layers (STF1, 4/5) or at most three layers (STF1, 4, 5). The cell-rich STF4/5 is composed of sojourning neurons, and the cell-sparse STF1 of incoming *thalamocortical fibers with possibly some outgoing *corticofugal fibers.

Stria medullaris (thalamus) – Mediodorsal fiber bundle in the diencephalon coursing in an anteroposterior direction and terminating in the *habenular nuclei.

Stria terminalis – Arched fiber bundle that originates in the *amygdala, courses along the medial surface of the *caudate nucleus, and terminates in the *bed nucleus of the stria terminalis, the anterior *hypothalamus, and the *preoptic area.

Striatal NEP – Primary germinal source of neurons of the *caudate nucleus, *putamen, and *globus pallidus. It has a large anterolateral and anteromedial division, also known as the lateral and medial eminences, and a small posterior division that generates the neurons of the tail of the caudate nucleus. The posterior striatal NEP is continuous with the *amygdaloid NEP

Striatal subventricular zone (SVZ) – A massive *secondary germinal matrix flanking the striatal NEP. It generates the bulk of the neurons of *caudate nucleus, *putamen and *globus pallidus. It may also be the source of some cortical neurons.

Striatum – Term used for two components of the *basal ganglia: the *caudate nucleus and the *putamen.

Strionuclear GEP – Fate-restricted glioepithelium, the putative source of the glia of the stria terminalis, stria medullaris, and possibly other nearby fiber tracts.

Strionuclear NEP – Putative neuroepithelial source of the neurons and glia of the *bed nucleus of the stria terminalis. It is situated beneath the *striatal NEP in a notch of the *lateral ventricle near the *foramen of Monro.

Subcommissural organ – A highly vascularized circumventricular neuroendocrine organ located beneath the *posterior commissure in the roof of the *mesencephalon.

Subgranular zone (hippocampus) – A long-persisting secondary germinal matrix beneath the *granular layer of the dentate gyrus, the source of late generated dentate granule cells. It is recognizable in incipient form by the end of the first trimester.

Subicular complex – Collective term for the *parasubiculum, the *presubiculum, and the *subiculum in the *parahippocampal cortex.

Subpial granular layer – Transient cellular layer between *layer I and the pia in some regions of the developing *cerebral cortex. It may be a source of cortical astrocytes.

Subplate – A poorly-defined layer beneath the *cortical plate. It contains neurons that are the transient pioneer residents of the cortical plate.

Substantia innominata – Extensive telencephalic area with indistinct boundaries beneath the *globus pallidus. A prominent component of the substantia innominata is the *basal nucleus of Meynert.

Substantia nigra (embryonic) – A pigmented *midbrain tegmental structure in the maturing brain at the base of the *cerebral peduncle. It has two components, the dopaminergic pars compacta, and the GABAergic pars reticulata.

Subthalamic NEP – Neuroepithelial patch between the *thalamic NEP and the *hypothalamic NEP. It is also identified as the Forelian NEP to distinguish it from the *Luysian NEP.

Subthalamic nucleus – Biconvex diencephalic structure, also known as corpus Luysii, situated above the substantia nigra between the *zona incerta and the base of the *internal capsule. It has extensive reciprocal connections with the *globus pallidus, hence it is considered a component of the *basal ganglia circuitry. Subthalamic lesions produce persistent choroid movements (hemiballism) in the arms, legs and face.

Subthalamus (embryonic) – Diencephalic region situated between the *thalamus dorsally and the *hypothalamus ventrally. Its major components, *Forel's fields and the *zona incerta are recognizable in late first trimester fetuses.

Subthalamic nucleus NEP – *See* **Luysian NEP**

Subventricular zone (SVZ) – Secondary germinal matrix, derived from the primary *neuroepithelium. The SVZ flanks the NEP during early development and then abuts the ependyma when the NEP dissolves. The nuclei of proliferative SVZ cells, unlike the nuclei of NEP cells, do not shuttle to the lumen of the ventricle during mitosis. Prominent SVZs in the telencephalon are found in the *cerebral cortex and the *striatum.

Superior cerebellar peduncle (embryonic) –A large fiber tract that originates mainly in the *dentate nucleus and *interpositus nucleus. It is present by the end of the first trimester in the formative cerebellum and appears to reach the level of the *red nucleus.

Superior colliculus (embryonic) – Anterior component of the *tectum (known in lower vertebrates as the optic lobe) is a direct target of a small complement of optic nerve fibers. Several waves of migrating cells suggest its imminent lamination by the end of the first trimester. There are indications that the entering optic fibers form a *honeycomb matrix superficially.

Superior olivary complex – A group of neurons in the ventrolateral posterior *pons that receive auditory input from the dorsal and ventral *cochlear nuclei. Ipsilateral and contralateral fibers of the complex join the *lateral lemniscus and terminate in the *inferior colliculus and in the *medial geniculate body.

Superventricles – The small ventricles of the mature central nervous system – known as the lateral and third ventricles in the forebrain, the aqueduct in the midbrain, the fourth ventricle in the pons and medulla, and the central canal in the spinal cord – are a continuous system of narrow channels lined by an enduring *ependyma and filled with cerebrospinal fluid. In contrast, the ventricles of the embryonic and early fetal brain are greatly inflated, balloon-like cisterns, hence the term superventricles, lined by a continuously changing germinal matrix, the *neuroepithelium and a fetal *choroid plexus that differs from its mature counterpart. Its large and variegated components are distinguished as the *telencephalic, the *diencephalic, the *mesencephalic, and the *rhombencephalic superventricles.

Suprachiasmatic nucleus (hypothalamus) – Small, paired midline structure above the *optic chiasm. It is implicated in the photic entrainment of the circadian rhythm.

Supramammillary area (hypothalamus) – Hypothalamic region that caps the *mammillary body. Experimental studies in animals indicate that its cells project to the *dentate gyrus of the hippocampus.

Supraoptic nucleus (hypothalamus) – Located above the optic tract lateral to the optic chiasm. The large secretory neurons of this nucleus produce arginine vasopressin and oxytocin that are conveyed by axoplasmic flow to the posterior lobe of the pituitary gland.

T

Tectal NEP – Extensive mesencephalic, smooth-surfaced NEP that lines the dorsal bank of the *mesencephalic superventricle. Its larger anterior part generates the neurons and glia of the *superior colliculus, its smaller posterior part that of the *inferior colliculus.

Tectum (embryonic) – Dorsal region of the *mesencephalon, consisting of the earlier developing *superior colliculus anteriorly and the later developing *inferior colliculus posteriorly.

Tegmental NEP – The variegated ventral stretch of the *mesencephalic NEP that contains shorter patches that produce neurons and glia for various tegmental nuclei, such as the *substantia nigra and the *ventral tegmental area.

Tegmentum (embryonic) – Ventral and ventrolateral region of the *mesencephalon and *rhombencephalon with indistinct boundaries. In addition to several brainstem nuclei, it contains many early-forming ascending, decussating, and descending fiber tracts. Some tegmental nuclei have been implicated in somatomotor and visceromotor functions. The onset of development of some components of the tegmentum appear to antedate that of the *tectum.

Telencephalic superventricle – The largest component of the superventricles that begins to expand during the early first trimester and shrinks during the third trimester. It is bounded laterally, dorsally and dorsomedially by the long stretch of the *cortical NEP, and ventromedially and ventrally by the shorter *olfactory, *septal, *striatal, *hippocampal and *amygdaloid NEPs. A large portion of its lumen is occupied by the fetal telencephalic *choroid plexus.

Telencephalon (embryonic) – Extensive forebrain region consisting of both cortical and subcortical components whose neurons and glia are produced by NEP stretches and patches lining the *telencephalic superventricle.

Temporal bone – A cranial bone in the skull that covers the *temporal lobe of the cerebral cortex and contains the internal ear and semicircular canals.

Temporal lobe or **cortex (embryonic)** – Lateral and ventral portion of the developing cerebral cortex that will later become separated from much of the rest of the cerebral hemisphere by the lateral fissure.

Temporal NEP – Putative source of neurons and glia of the *temporal lobe. It is flanked during fetal development by the temporal *subventricular zone and the temporal *stratified transitional field.

Tenia tecta – Components of the *cerebral cortex that extend into the dorsomedial *septum (dorsal tenia tecta) and medial olfactory peduncle (ventral tenia tecta).

Thalamic NEP – Stretch of the *diencephalic NEP between the *epithalamic and the *hypothalamic NEPs. Its mosaic divisions are the putative source of neurons and glia of the diverse nuclei of the *thalamus.

Thalamocortical fibers (embryonic) – Collective term for the large afferent tracts that proceed from relay nuclei in the thalamus, by way of the *internal capsule, to the *cerebral cortex. These nuclei include the *ventral posterolateral and *ventral posteromedial nuclei, and the *lateral geniculate and *medial geniculate bodies.

Thalamus – Massive dorsal diencephalic structure with several distinct and some indistinct nuclei. As a convenience, the thalamus is divided into the following nuclear regions: the *anterior complex, the *central complex, the *dorsal complex, the *periventricular complex, the *posterior complex, the *ventral complex, and the *reticular belt.

Third ventricle – *See* **Diencephalic superventricle**

Thyroid cartilage – A shield-shaped cartilage in the larynx.

Transpontine corticofugal tract (embryonic) – Portion of the large descending fiber tract in the maturing brain that traverses the *pontine gray and gives off collaterals there. Pioneering fibers of this tract are present by the end of the first trimester.

Trapezoid body – A fiber tract extending from the ventral *cochlear nucleus to the contralateral *superior olivary complex. It contains second- and higher-order auditory fibers.

Trigeminal, motor nucleus (embryonic) – Aggregate of trigeminal somatic motor neurons situated medial to the *trigeminal principal sensory nucleus. It is recognizable in late first trimester embryos.

Trigeminal, principal sensory nucleus (embryonic) – The second-order sensory neurons in the trigeminal system located dorsal and lateral to the incoming sensory root of cranial *nerve V. It receives topographic somatosensory input from the face and mouth, and its efferents cross the midline in the pons and proceed to the thalamic *ventral complex in close association with the *medial lemniscus. The nucleus is prominent by the late first trimester.

Trigeminal, spinal nucleus (embryonic) – A continuation of the *trigeminal principal sensory nucleus that extends caudally through the *medulla to the second cervical level of the *spinal cord. It is prominent by the late first trimester.

Trigeminal, spinal tract – Primary sensory fibers of the trigeminal ganglion that convey touch and pressure information from the face. The axons enter the brain in the pons and proceed caudally, forming a lateral cap around the *trigeminal spinal nucleus where they terminate in a topographic order.

Trochlear nucleus – Aggregate of somatic motor neurons located posterior to the *oculomotor nuclear complex that innervate the superior oblique muscle of the eye by way of cranial *nerve IV.

V

Ventral anterior nucleus (thalamus, embryonic) – The ventral anterior nucleus, to be distinguished from the *anteroventral nucleus (which is part of the *anterior complex of the thalamus) is the most rostral component of the thalamic *ventral complex. Its afferents come mostly from the *globus pallidus and the *substantia nigra, and its efferents terminate in the *paracentral lobule of the neocortex. The nucleus is recognizable during the late first trimester as a developing structure with putative migrating and sojourning neurons and sprouting fiber bundles.

Ventral complex (thalamus, embryonic) – A group of structurally and functionally related ventrolateral and ventral nuclei of the thalamus, including the *ventral anterior, *ventral lateral, *ventral posterolateral, and *ventral posteromedial nuclei. The ventral thalamic complex is the principal topographically organized relay system of the direct (lemniscal) and indirect (cerebellar and striatal) somatosensory and proprioceptive input system to the sensory and motor areas of the *neocortex. Its components are recognizable during the late first trimester as formative structures with putative migrating and sojourning neurons and sprouting fiber bundles.

Ventral lateral nucleus (thalamus, embryonic) – Situated caudal to the *ventral anterior nucleus, this component of the thalamic *ventral complex is the target of input from the *superior cerebellar peduncle and the *red nucleus. Its somatotopically organized fibers terminate in the motor cortex and adjacent areas. The ventral lateral nucleus may be the principal relay from the *cerebellum to the *neocortex. The nucleus is recognizable during the late first trimester as a developing structure with putative migrating and sojourning neurons and sprouting fiber bundles.

Ventral posterolateral nucleus (thalamus, embryonic) – Situated caudal to the *ventral lateral nucleus, this region of the thalamic *ventral complex is the target of fibers of the *medial lemniscus that originate in the *cuneate nucleus and the *gracile nucleus and convey somatosensory information from the trunk and the extremities. Its efferents form the somesthetic radiation that terminates in a precise topographic order in the medial part of the *postcentral gyrus. The ventral posterolateral nucleus is the principal thalamic relay of somesthetic input from the trunk and limbs to the *neocortex. The nucleus is recognizable during the late first trimester as a developing structure with putative migrating and sojourning neurons and sprouting fiber bundles.

Ventral posteromedial nucleus (thalamus, embryonic) – Situated between the *ventral posterolateral nucleus and the *centromedian nucleus, this nucleus receives afferents from the *trigeminal sensory nuclei and the *parabrachial nucleus that convey sensory information from the face, the tongue, the oral cavity, and the neck. The efferents of this nucleus terminate in a precise topographic order in the lateral part of the *postcentral gyrus. The ventral posteromedial nucleus is the principal thalamic relay of somatosensory and gustatory input from the neck, head, and mouth to the *neocortex. The nucleus is recognizable during the late first trimester as a developing structure with putative migrating and sojourning neurons and sprouting fiber bundles.

Ventral rhombic lip – *see* **Precerebellar NEP**

Ventral tegmental area (embryonic) – Medial area flanking the *substantia nigra and containing a high concentration of dopaminergic neurons, much like the substantia nigra, pars compacta. It is present as a compact cell mass in the mesencephalon of late first trimester fetuses.

Ventricles – *See* **Superventricles**

Ventromedial nucleus (hypothalamus) – Large spherical nucleus that flanks the third ventricle and is surrounded by a fibrous shell. It has reciprocal connections with the *amygdala, the *bed nucleus of the stria terminalis, the *septum, and the *subiculum. It has been implicated in motivational functions related to feeding and sexual behavior.

Vermis – *See* **Cerebellum (vermis)**

Vestibular nuclear complex – A large area in the dorsal medulla, composed of the *medial, the *lateral, the *superior, and the *inferior vestibular nuclei. These nuclei get primary sensory input from the vestibular ganglion; their efferents join the *medial longitudinal fasciculus and form the vestibulospinal tract.

Visual radiation (embryonic) – Thalamocortical fibers that originate in the *lateral geniculate body and terminate in the striate cortex of the *occipital lobe. The identification of *Meyer's loop at GW11 suggests that this tract may reach the occipital lobe by the end of the first trimester.

W

White matter – General term for extensive regions in the brain and spinal cord composed of myelinated fiber tracts but few or no neuronal cell bodies. In histological preparations with myelin stains, the white matter appears black. In laminated brain regions, as in the *cerebral cortex, the white matter is called the medullary layer.

Z

Zygomatic bone – A facial bone in the cheek bone.

Zona incerta (embryonic) – Region in the *subthalamus with uncertain boundaries with *Forel's fields. It is a prominent area in the late first trimester *diencephalon.

An asterisk in front of a term indicates that it is a separate entry in the Glossary with additional information. Terms referring to transient developmental structures are underlined.