22-00
Central Nervous System

22 Central Nervous System
Menu 1/2

22-00. Central Nervous System

22-001. Spinal Cord

22-01. Spinal cord, transverse section 1. Dog, H-E stain, x 5.0.

22-02. Spinal cord, transverse section 2. Dog, Weigert stain, x 4.5.

22-03. Spinal cord, transverse section 3. Dog, Nissl stain, x 5.0.

22-04. Spinal cord, transverse section 4. Dog, Bodian's silver impregnation, x 5.0.

22-002. Human Brain Stem

22-05. Section through the level of the first cervical segment (C1). x 2.0.

22-06. Section of the medulla oblongata 1. The level of the lower portion of the pyramidal decussation. x 2.0.

22-07. Section of the medulla oblongata 2. The level of the upper portion of the pyramidal decussation. x 2.0.

22-08. Section of the medulla oblongata 3. The level of the inferior end of the lem- niscus decussation. x 2.0.

22-09. Section of the medulla oblongata 4. The level of the upper portion of the lemnis- cus decussation. x 1.6.

22-10. Section of the medulla oblongata 5. The level of the middle portion of the principal olivary nucleus. x 1.6.

22-11. Medulla oblongata 6. The level of the upper portion of the hypoglossus nerve nucleus. x 1.6.

22-12. Boundary of medulla oblongata to the pons. The level of the lateral recessus of the fourth ventricle. x 1.6.

22-13. Pons 1. The level of the nucleus of facial nerve. x 1.6.

22-14. Pons 2. The level of the nucleus of abducens nerve. x 1.6.

22-15. Pons 3. The level of the motor nucleus of the trigeminal nerve. x 1.4.
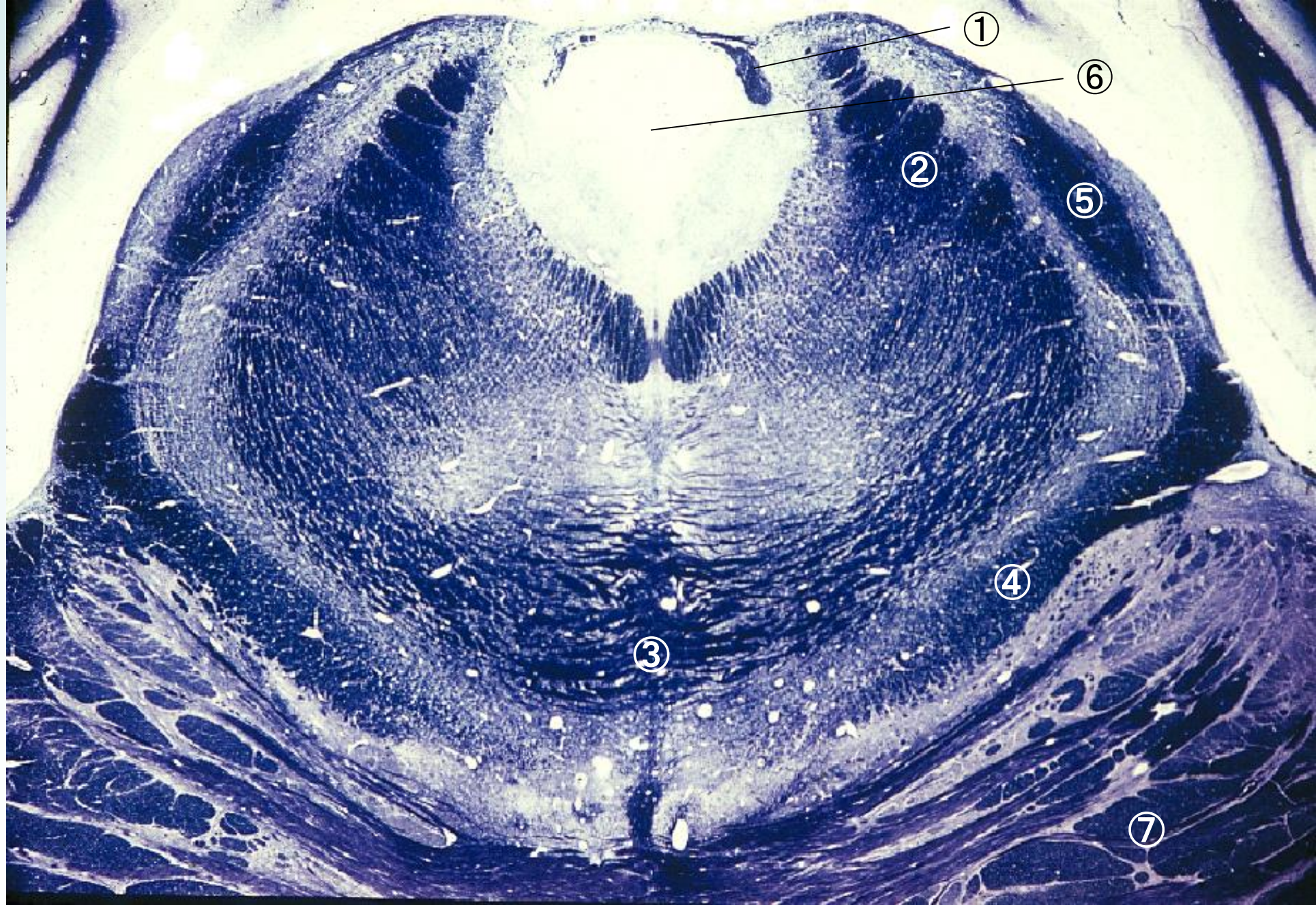
22-16. Isthmus rhombencephli. The caudal end of midbrain. x 1.4.
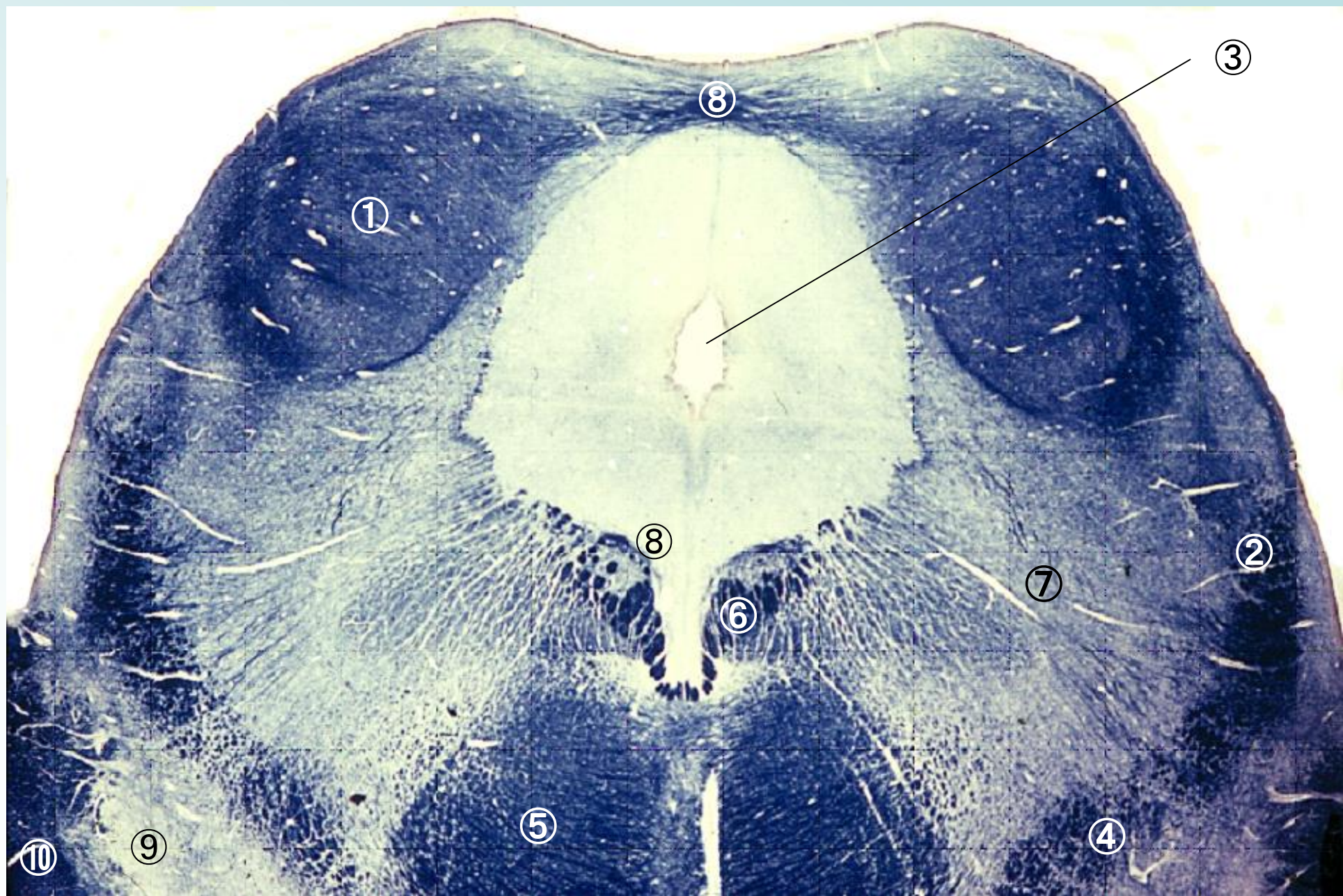
22-17. Mesencephalon 1. The level of the inferior colliculus. x 1.4.
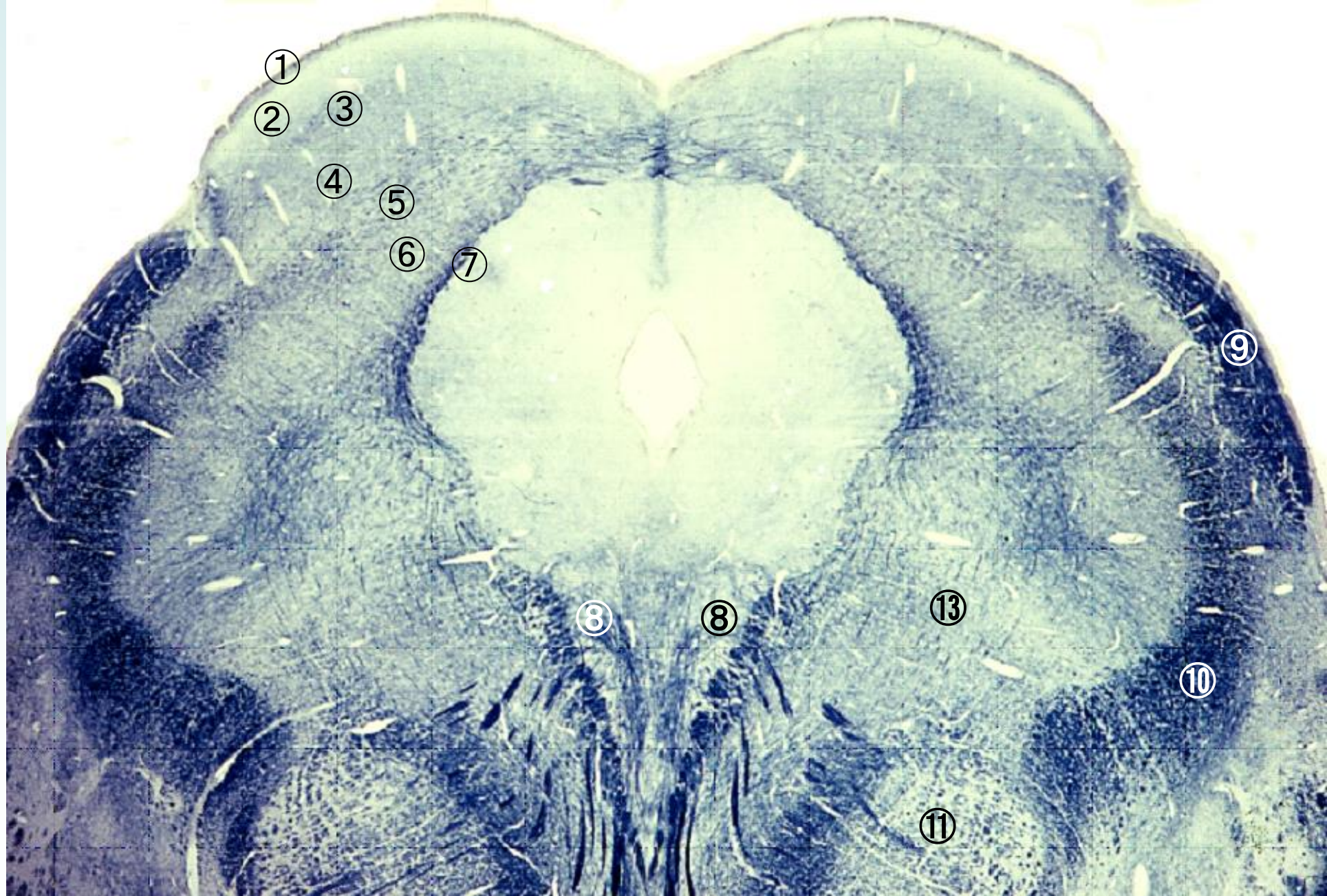
22-18. Mesencephalon 2. Dorsal half of the superior colliculus. x 1.4.

22-19. Mesencephalon 3. Ventral half of the superior colliculus. x 1.4.

22-003. Human Cerebrum(Frontal section)

22-20. Section passing through the anterior commisure.

22-21. Section passing through the infundibulum and hypophysis.

22-22. Section passing through the corpus mammillare.

22-23. Section passing through the anterior portion of the nucleus ruber.

22-24. Section passing through the lateral geniculate body.

22-004. Cerebellar Cortex

22-25. A cerebellar lobe. Human, Nissl stain, x 1.7.

22-26. Cerebellar cortex 1. Human, Nissl stain, x 40.

22-27. Cerebellar cortex 2. Human, Nissl stain, x 64.

22-28. Cerebellar cortex 3. Human, Nissl stain, x 160.

22-29. Cerebellar cortex 4. Dog, Bodian's silver impregnation, x 64.

22-30. Cerebellar cortex 5. Human, Suzuki's silver impregnation, x 160.
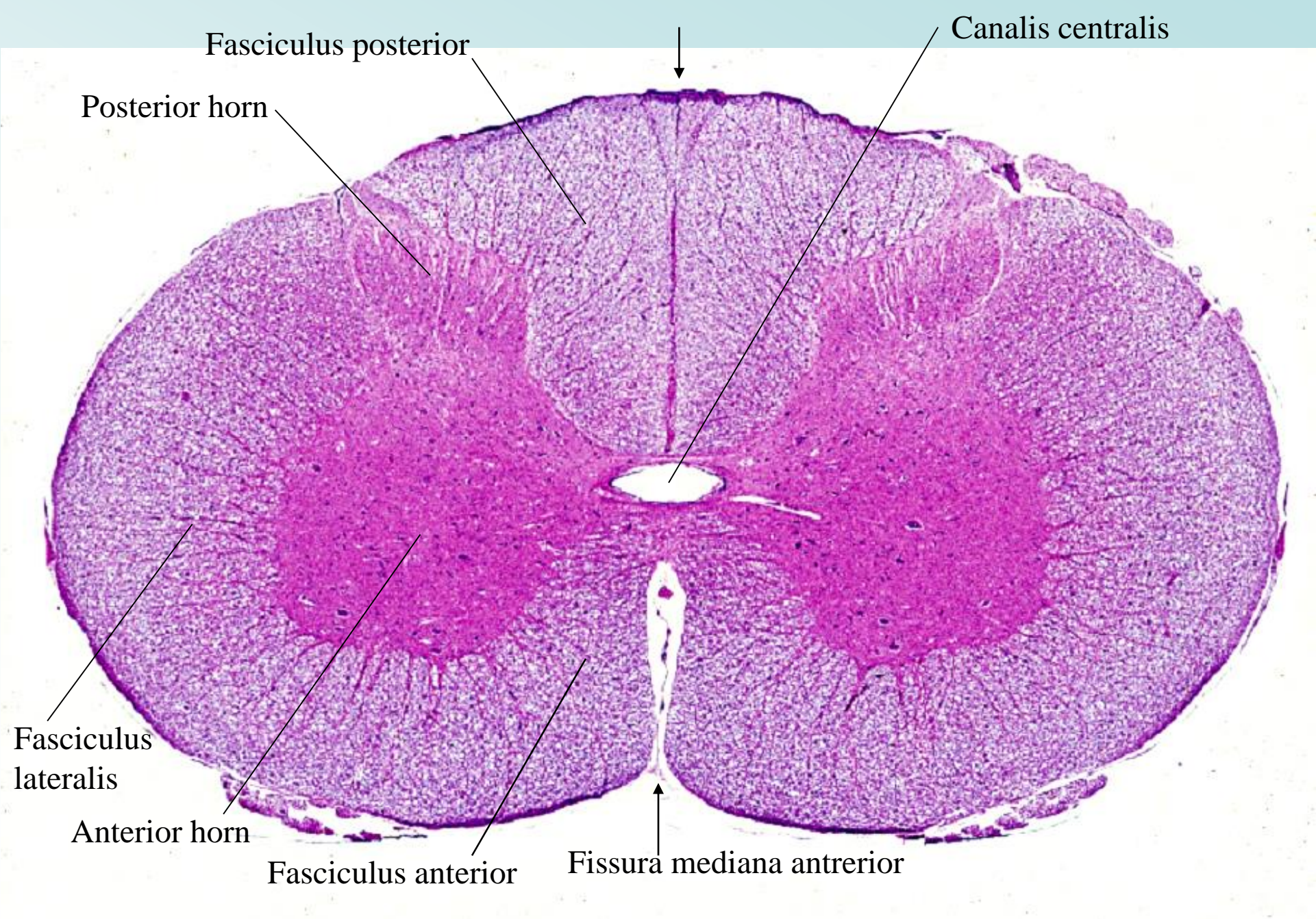
22 Central Nervous System
Menu 2/2

22-001
Spinal Cord

Fasciculus posterior

Canalis centralis

Posterior horn

Fasciculus lateralis

Anterior horn

Fasciculus anterior

Fissura mediana antrerior

22-01 Spinal cord, transverse section 1. Dog, H-E stain, x 5.0.

Fasciculus posterior

Radix posterior

Posterior horn

Fasciculus lateralis

Fasciculus anterior

Anterior horn

Radix anterior

22-02 Spinal cord, transverse section 2. Dog, Weigert stain, x 4.5.

Posterior horn

Anterior horn

Fissura mediana anterior

Canalis centralis

22-03 Spinal cord, transverse section 3. Dog, Nissl stain, x 5.0.

Canalis centralis

Posterior horn

Fasciculus posterior

Anterior horn

Radix anterior

Fissura mediana anterior

Fasciculus anterior

Fasciculus lateralis

22-04 Spinal cord, transverse section 4. Dog, Bodian's silver impregnation, x 5.0.

22-002
Human Brain Stem

Sulcus medianus posterior

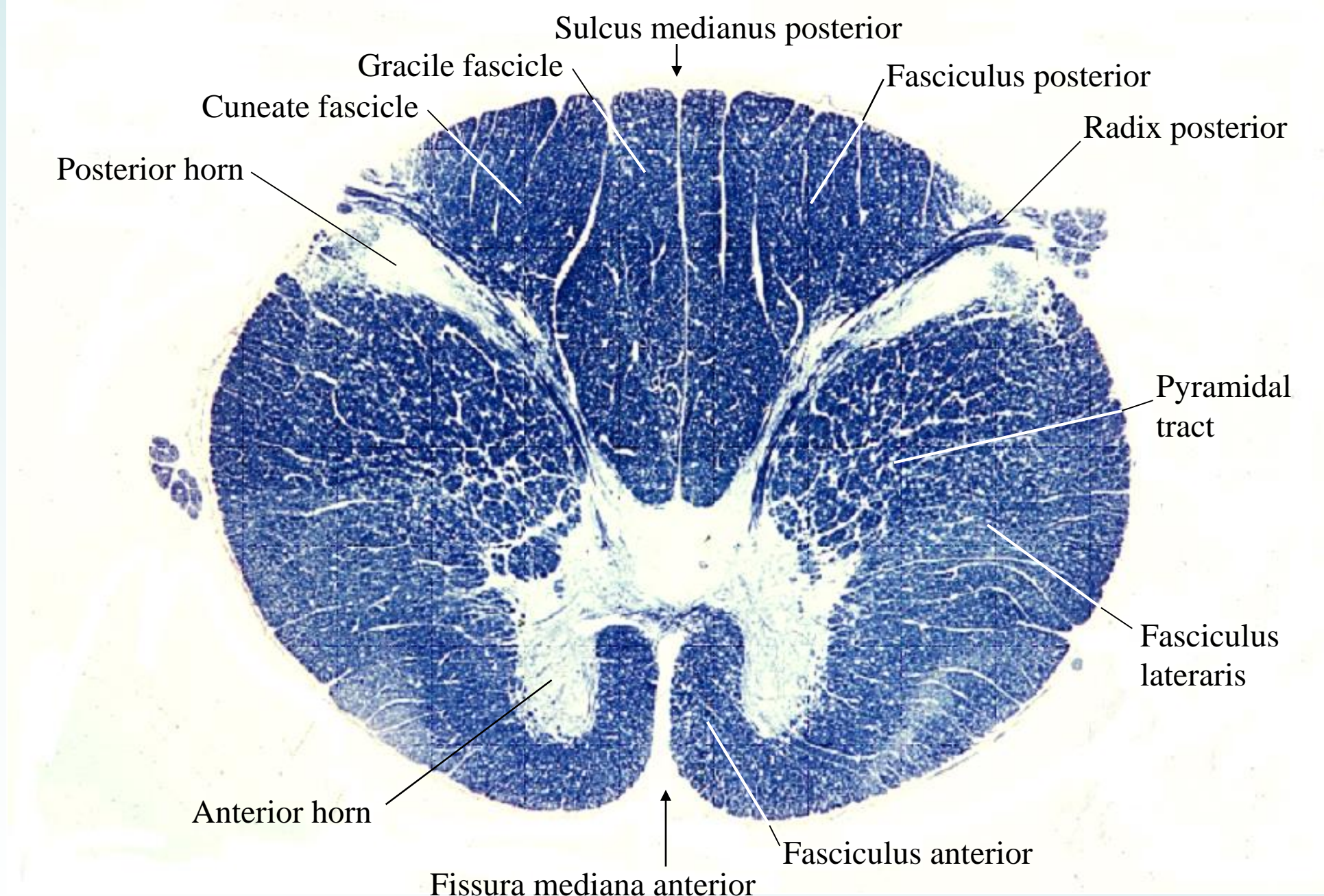Gracile fascicle

Cuneate fascicle

Fasciculus posterior

Posterior horn

Radix posterior

Pyramidal tract

Fasciculus lateraris

Anterior horn

Fasciculus anterior

Fissura mediana anterior

22-05 Section through the level of the first cervical segment（C1）. x 2.0.

Fasciculus gracilis

Fasciculus cuneatus

Spinal tract of V. nerve

Spinal nucleus of V. nerve

Pyramidal tract

Central gray matter

Anterior horn

Pyramidal decussation

Pyramidal tract

22-06 Section of the medulla oblongata 1. The level of the lower portion of the pyramidal decussation. x 2.0.

Gracile fascicle

Gracile nucleus

Cuneate fascicle

Cuneate nucleus

Spinal tract of V. nerve

Spinal nucleus of V. nerve

Central gray matter

Anterior horn

Pyramidal decussation

Pyramidal tract

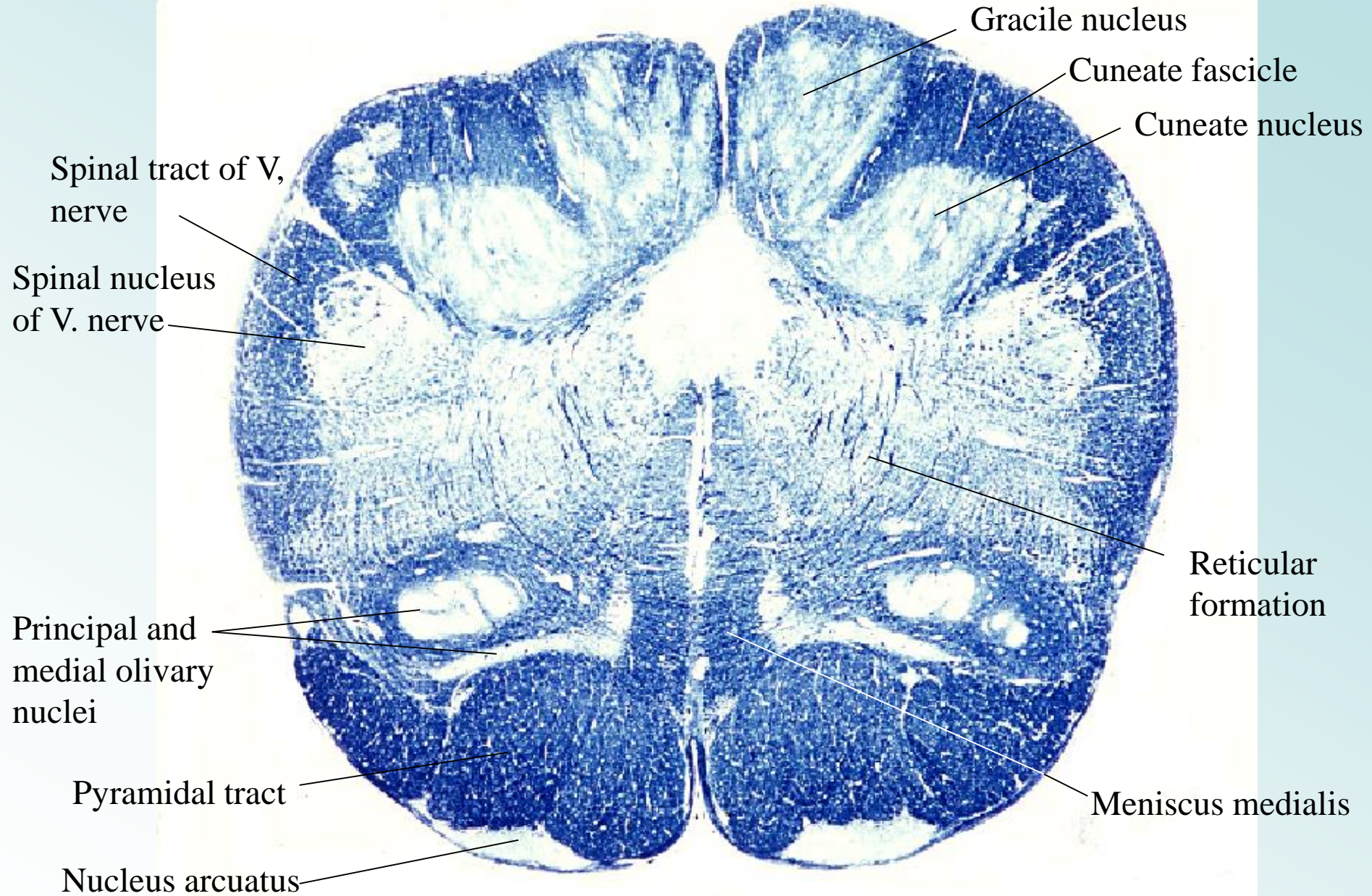22-07 Section of the medulla oblongata 2. The level of the upper portion of the pyramidal decussation. x 2.0.

Gracile fascicle

Gracile nucleus

Cuneate fascicle

Cuneate nucleus

Spinal tract of V. nerve

Spinal nucleus of V. nerve

Central gray matter

Reticular formation

Medial olivary nucleus

Lemniscus decussation

Lemniscus medialis

Pyramidal tract

22-08 Section of the medulla oblongata 3. The level of the inferior end of the lem-niscus decussation. x 2.0.

Gracile nucleus

Cuneate fascicle

Cuneate nucleus

Spinal tract of V, nerve

Spinal nucleus of V. nerve

Reticular formation

Principal and medial olivary nuclei

Pyramidal tract

Meniscus medialis

Nucleus arcuatus

22-09 Section of the medulla oblongata 4. The level of the upper portion of the lemniscus decussation. x 1.6.

Spinal tract & nucleus of V. nerve

IV ventricle

Corpus restiforme

① ②

Solitary fascicle

Reticular formation
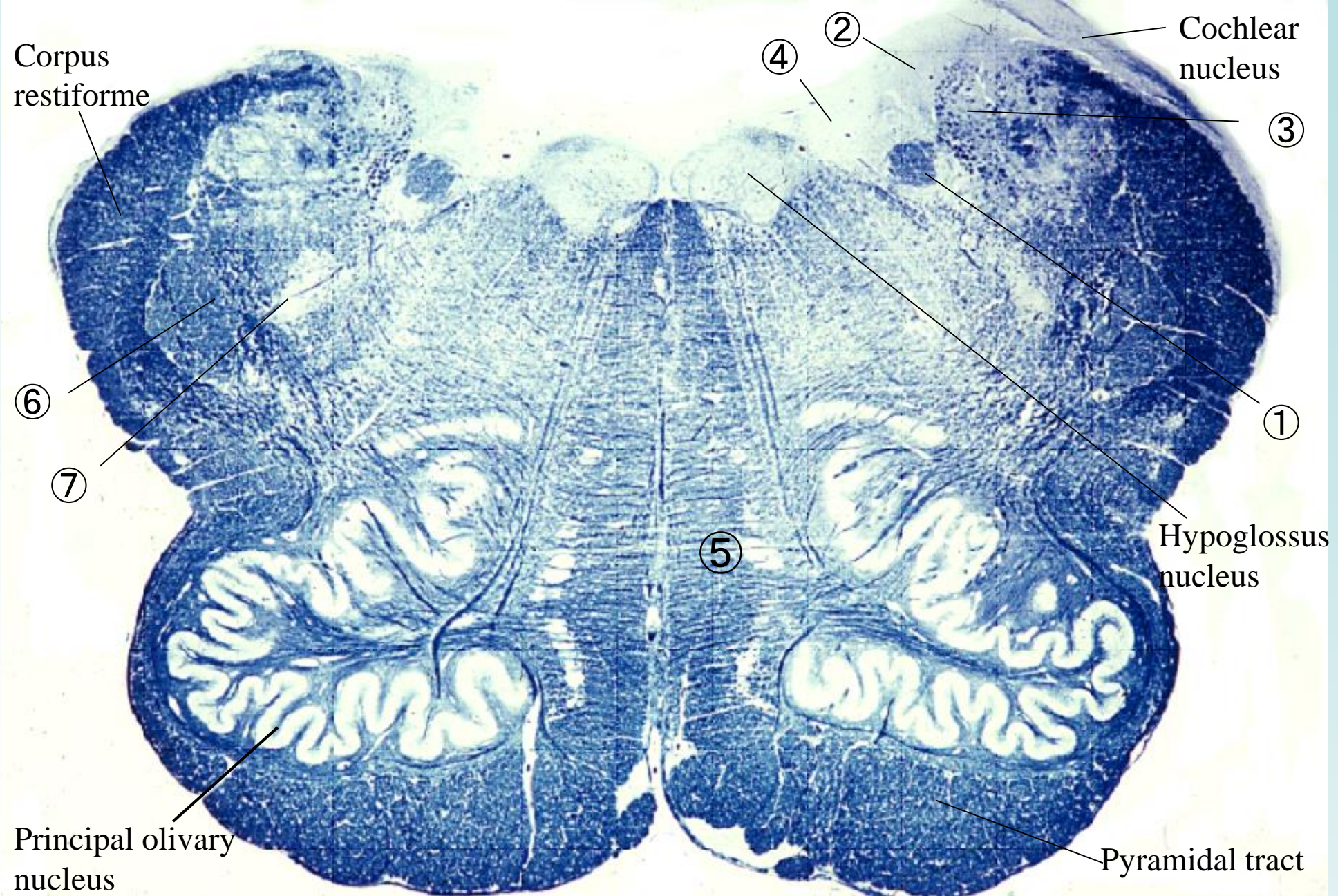
Hypoglossus nerve nucleus

Principal olivary nucleus

Lemniscus medialis

Nucleus arcuatus

Pyramidal tract

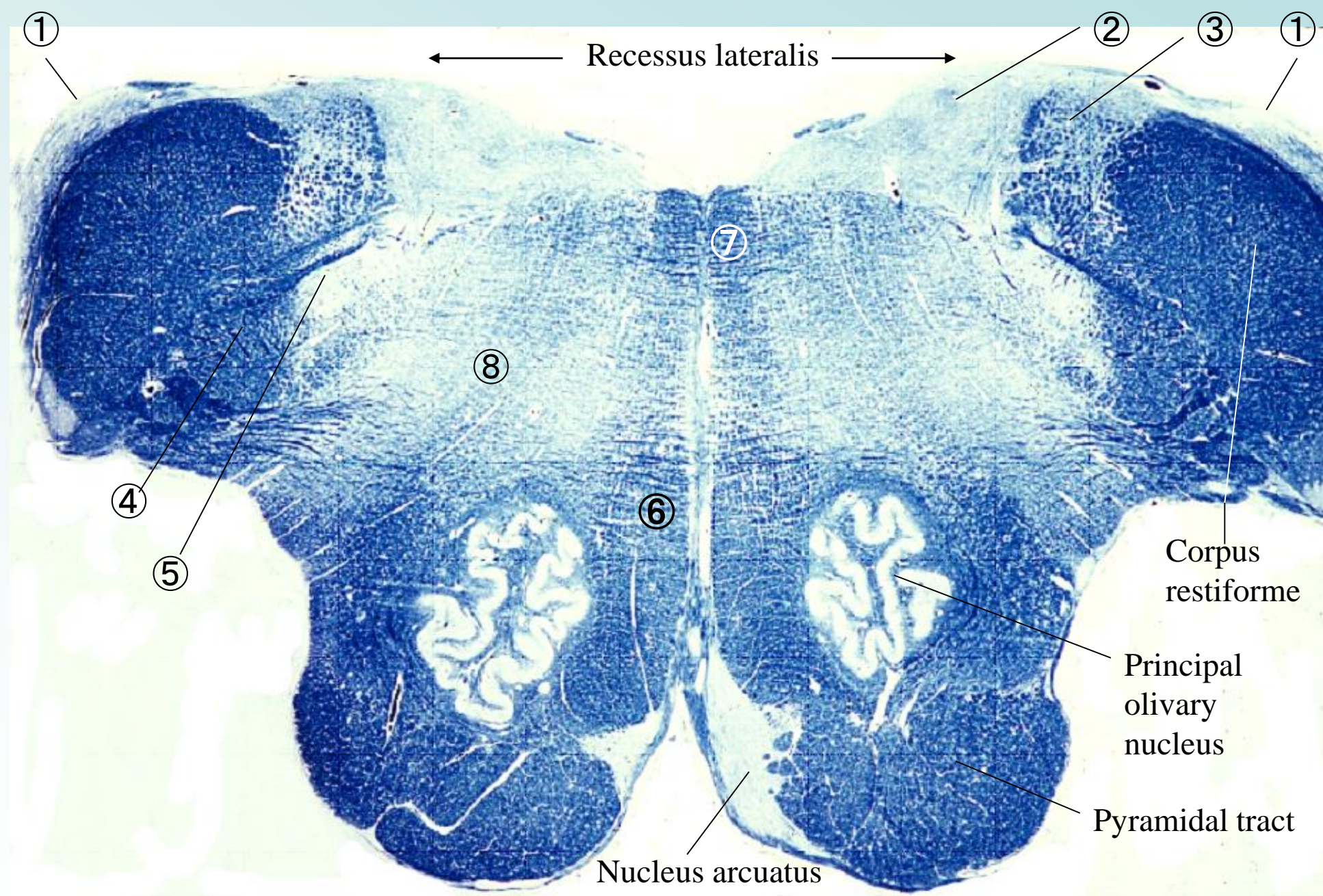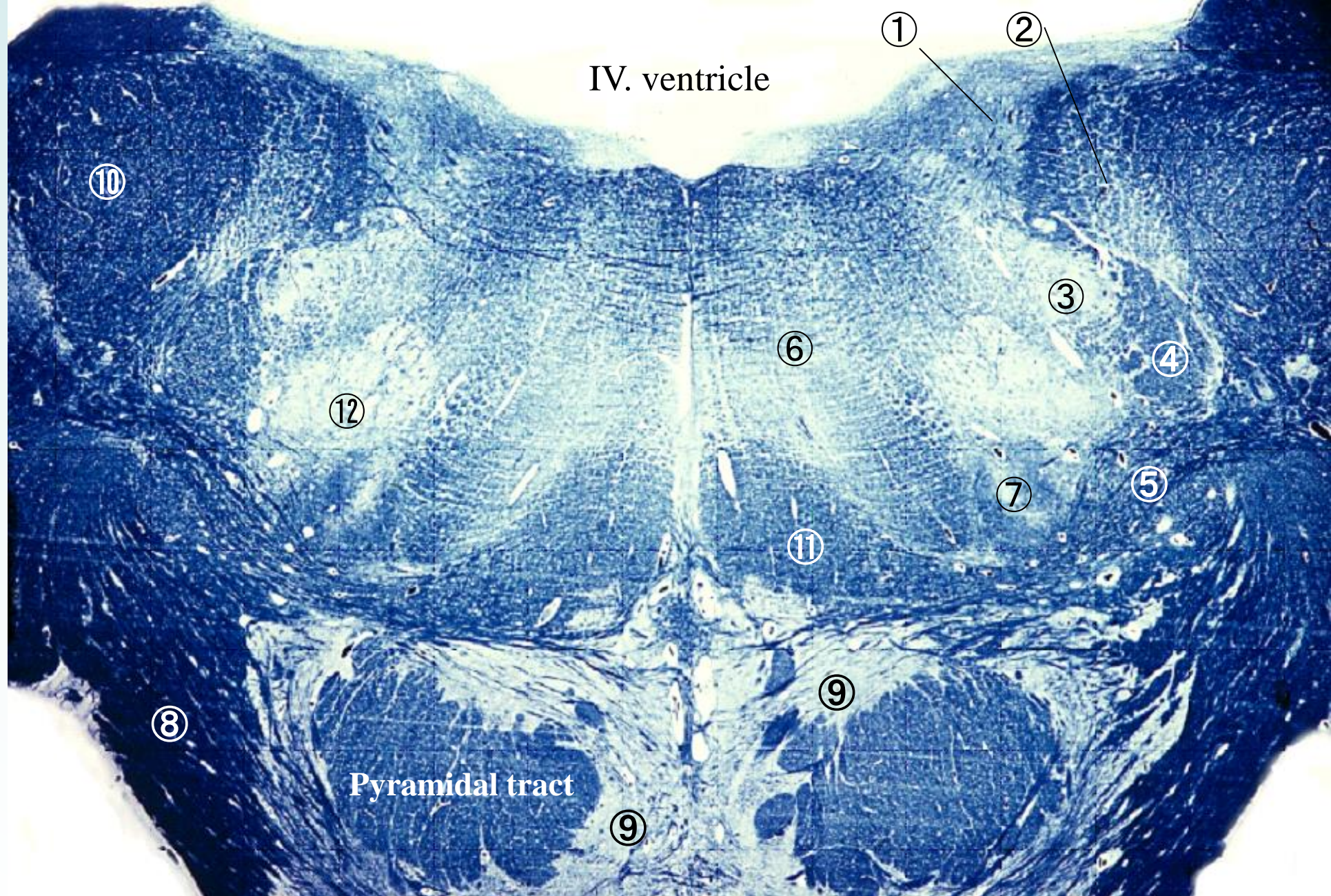22-10 Section of the medulla oblongata 5. The level of the middle portion of the principal olivary nucleus. x 1.6.

Corpus restiforme

② ④ Cochlear nucleus

③

①

⑥

⑦

Hypoglossus nucleus

⑤

Principal olivary nucleus

Pyramidal tract

22-11 Medulla oblongata 6. The level of the upper portion of the hypoglossus nerve nucleus. x 1.6.

① ② ③ ①

Recessus lateralis

⑦

⑧

④

⑤

⑥

Corpus
restiforme

Principal
olivary
nucleus

Pyramidal tract

Nucleus arcuatus

22-12 Boundary of medulla oblongata to the pons. The level of the lateral recessus of
the fourth ventricle. x 1.6.

IV. ventricle

① ②

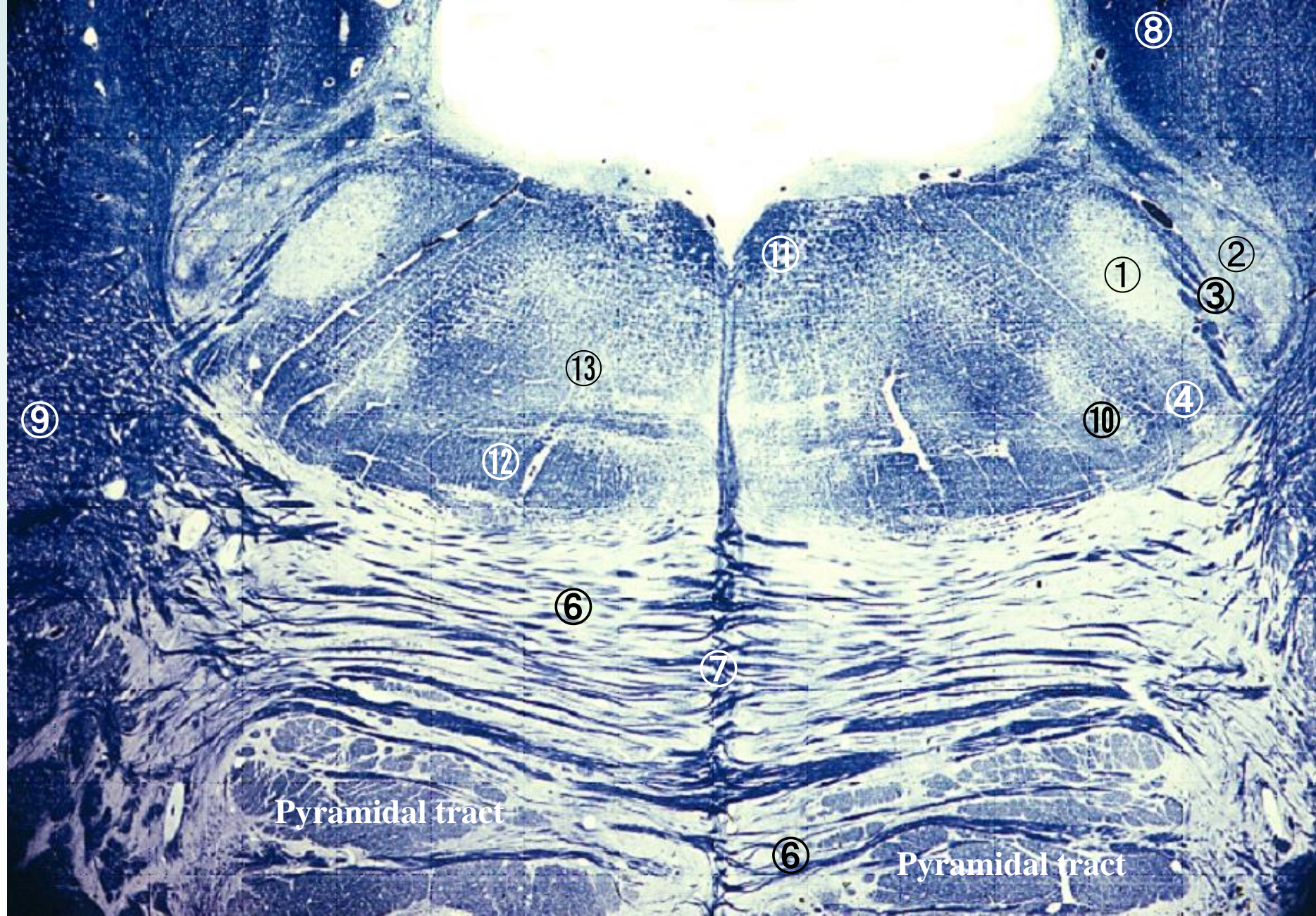⑩

③

⑥

④

⑫

⑤

⑦

⑪

⑨

⑧

Pyramidal tract

⑨

22-13 Pons 1. The level of the nucleus of facial nerve. x 1.6.

Pyramidal tract

22-14 Pons 2. The level of the nucleus of abducens nerve. x 1.6.

⑧ ⑪ ② ① ③ ⑬ ④ ⑨ ⑩ ⑫ ⑥ ⑦

Pyramidal tract

⑥

Pyramidal tract

22-15 Pons 3. The level of the motor nucleus of the trigeminal nerve. x 1.4.

22-16 Isthmus rhombencephli. The caudal end of midbrain. x 1.4.
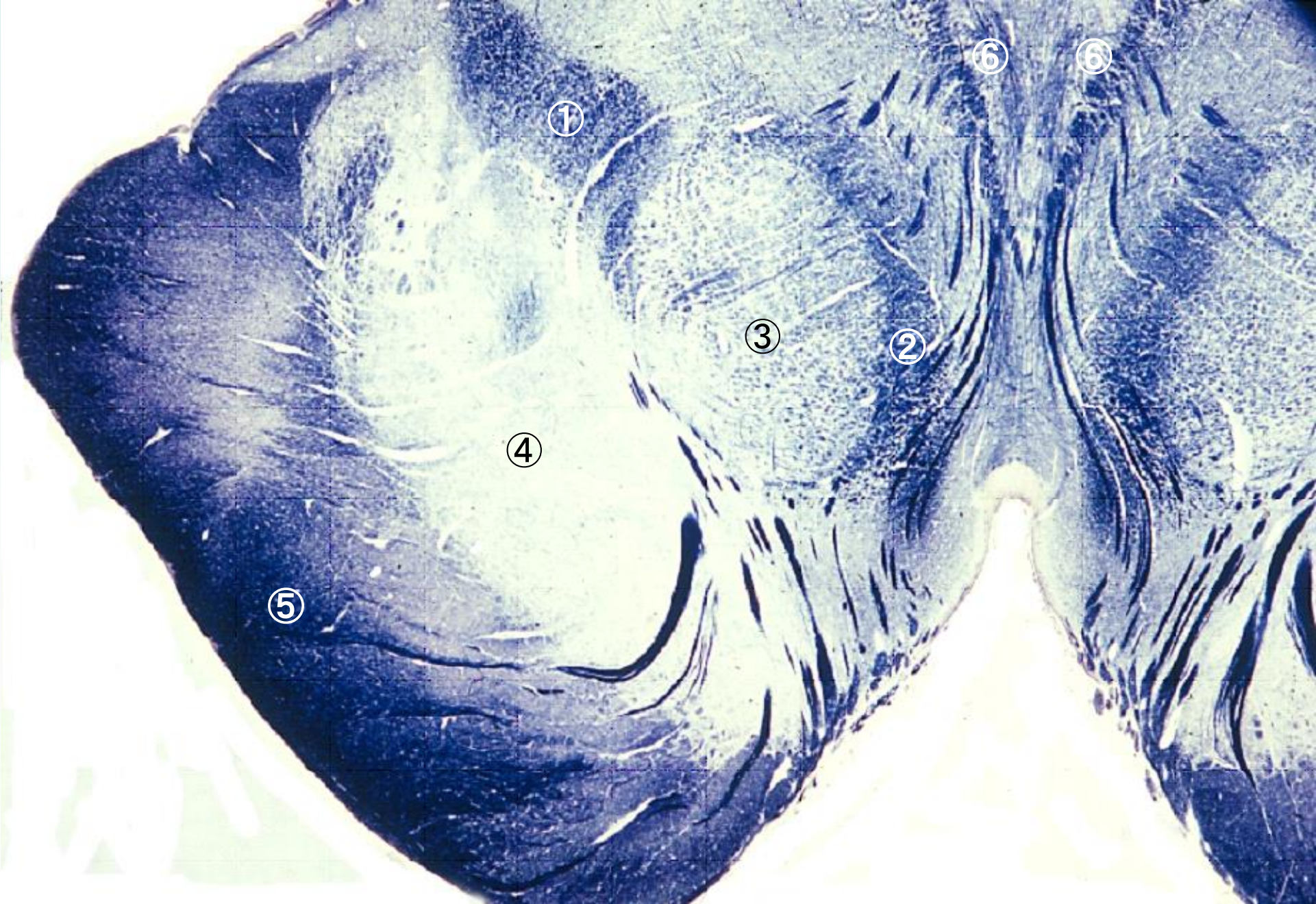
22-17 Mesencephalon 1. The level of the inferior colliculus. x 1.4.

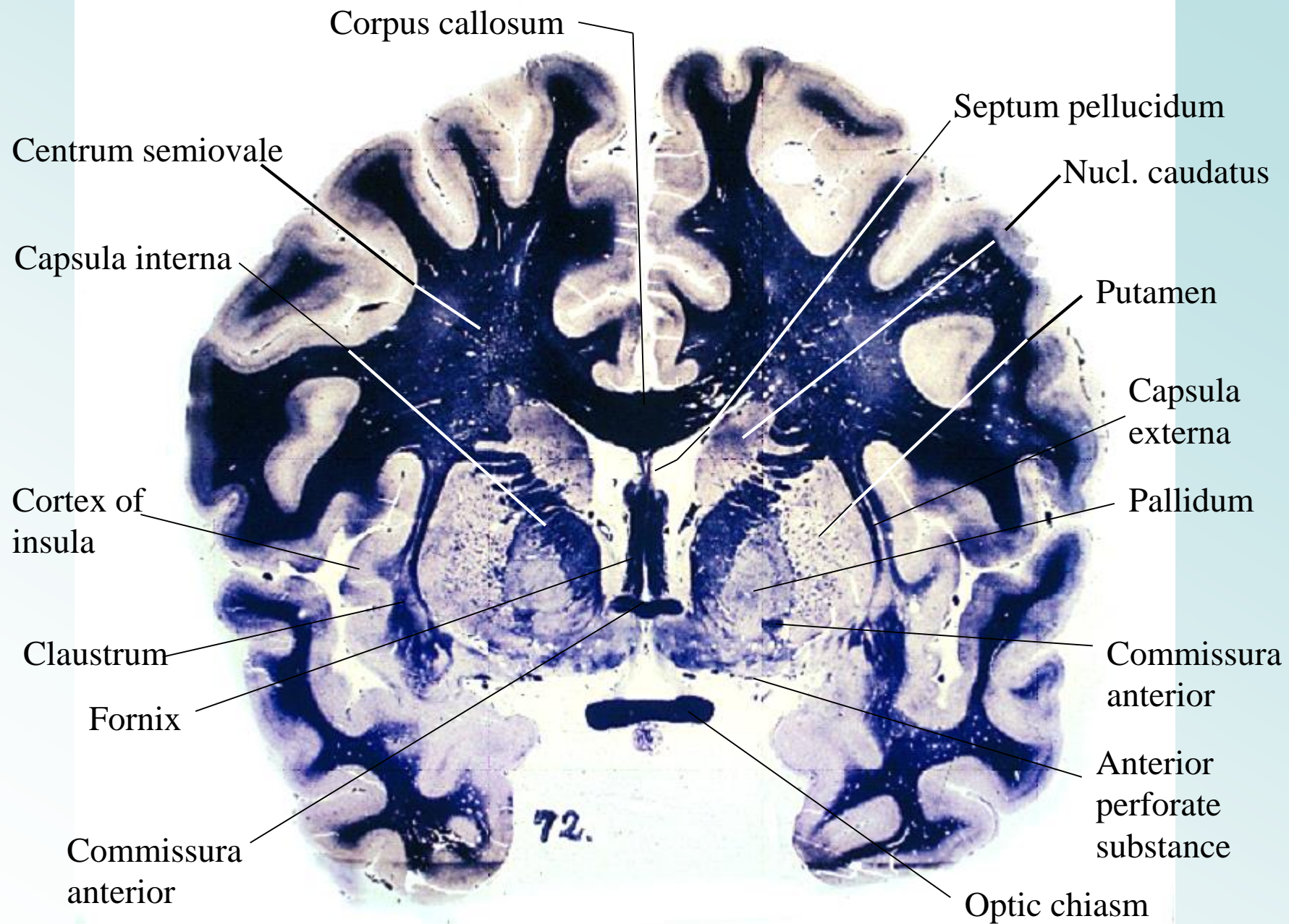**22-18 Mesencephalon 2. Dorsal half of the superior colliculus. x 1.4.**

22-19 Mesencephalon 3. Ventral half of the superior colliculus. x 1.4.

22-003
Human Cerebrum
(Frontal section)

Corpus callosum

Centrum semiovale

Septum pellucidum

Nucl. caudatus

Capsula interna

Putamen

Cortex of insula

Capsula externa

Pallidum

Claustrum

Commissura anterior

Fornix

Anterior perforate substance

Commissura anterior

Optic chiasm

72.

22-20 Section passing through the anterior commisure.

Corpus callosum

Ventriculus lateralis

Capsula interna

Capsula externa

Cortex of insula

Pallidum

Nucleus caudatus

Thalamus

Capsula extrema

Capsula externa

Claustrum

Putamen

Fornix

Hypophysis

Optic nerve

Amygdaloid body

22-21 Section passing through the infundibulum and hypophysis.

Nucleus caudatus

Capsula interna

Putamen

Claustrum

Pallidum

Amygdaloid body

Lateral ventricle

Thalamus

Capsula externa

Capsula exterema

Claustrum

Lateral ventricle

Crus cerebri

Corpus mammillare

22-22 Section passing through the corpus mammillare.

Corpus callosum

Fornix

Nucleus caudatus

Medial

Thalamus

Lateral

Putamen

Lateral ventricle

Gyrus dentatus

Crus cerebri

Pontine basis

Lateral ventricle

Capsula interna

Nucleus ruber

Substantia nigra

22-23 Section passing through the anterior portion of the nucleus ruber.

22-24 Section passing through the lateral geniculate body.

Fornix

Lateral ventricle

Nucleus caudatus

Medial

Thalamus

Lateral

Capsula interna

Centre median

Nucleus ruber

Gyrus dentatus

Corpus geniculatum laterale

Substantia nigra

Crus cerebri

Pontine basis

361

22-004
Cerebellar Cortex

↓ : Sulcus cerebelli

Medullary plate

22-25 A cerebellar lobe. Human, Nissl stain, x 1.7.

Molecular layer

Purkinje cell layer

Grnular layer

22-26 Cerebellar cortex 1. Human, Nissl stain, x 40.

Molecular layer

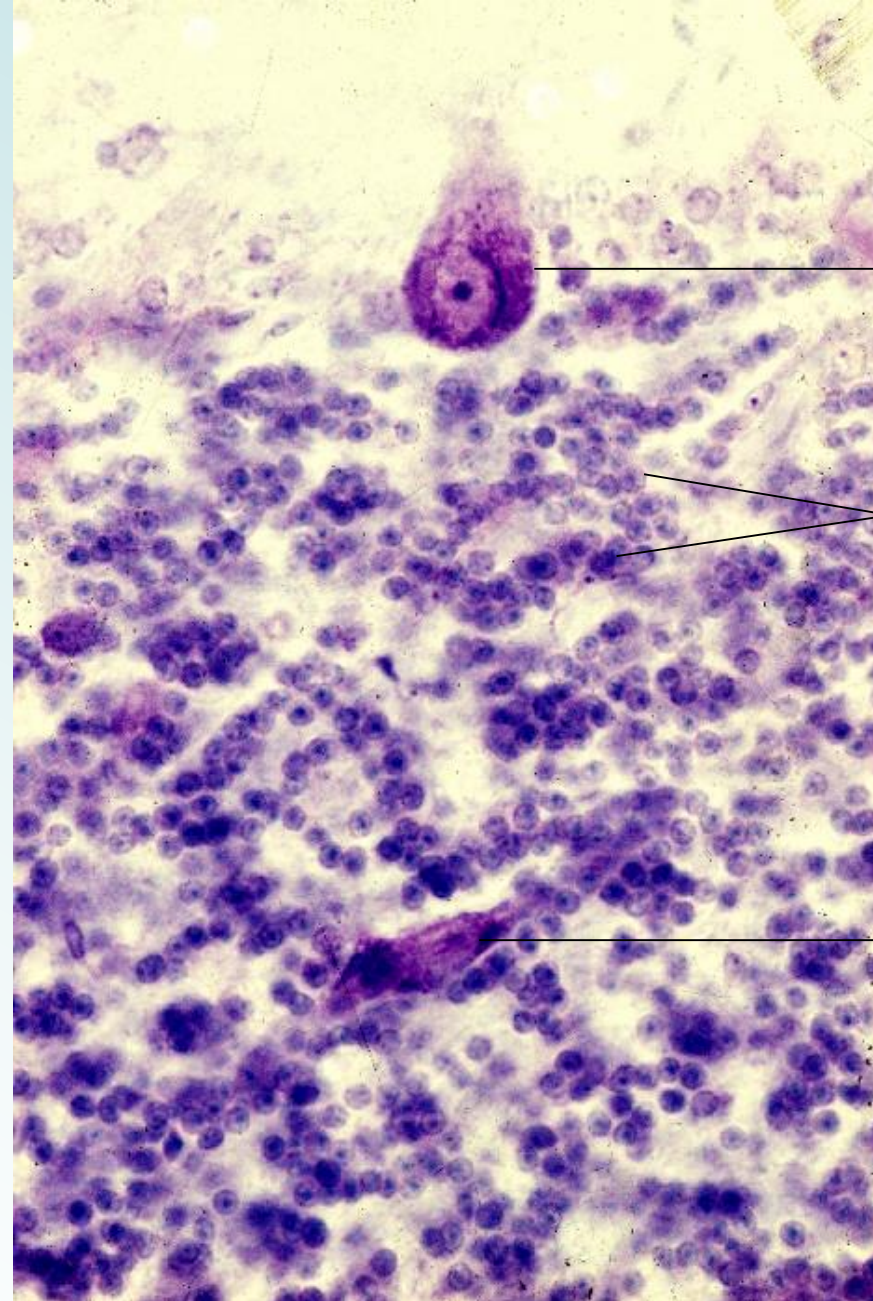Purkinje cell layer

Granular layer

22-27 Cerebellar cortex 2. Human, Nissl stain, x 64.

Purkinje cell

Granule cells

Nerve cell

22-28 Cerebellar cortex 3. Human, Nissl stain, x 160.
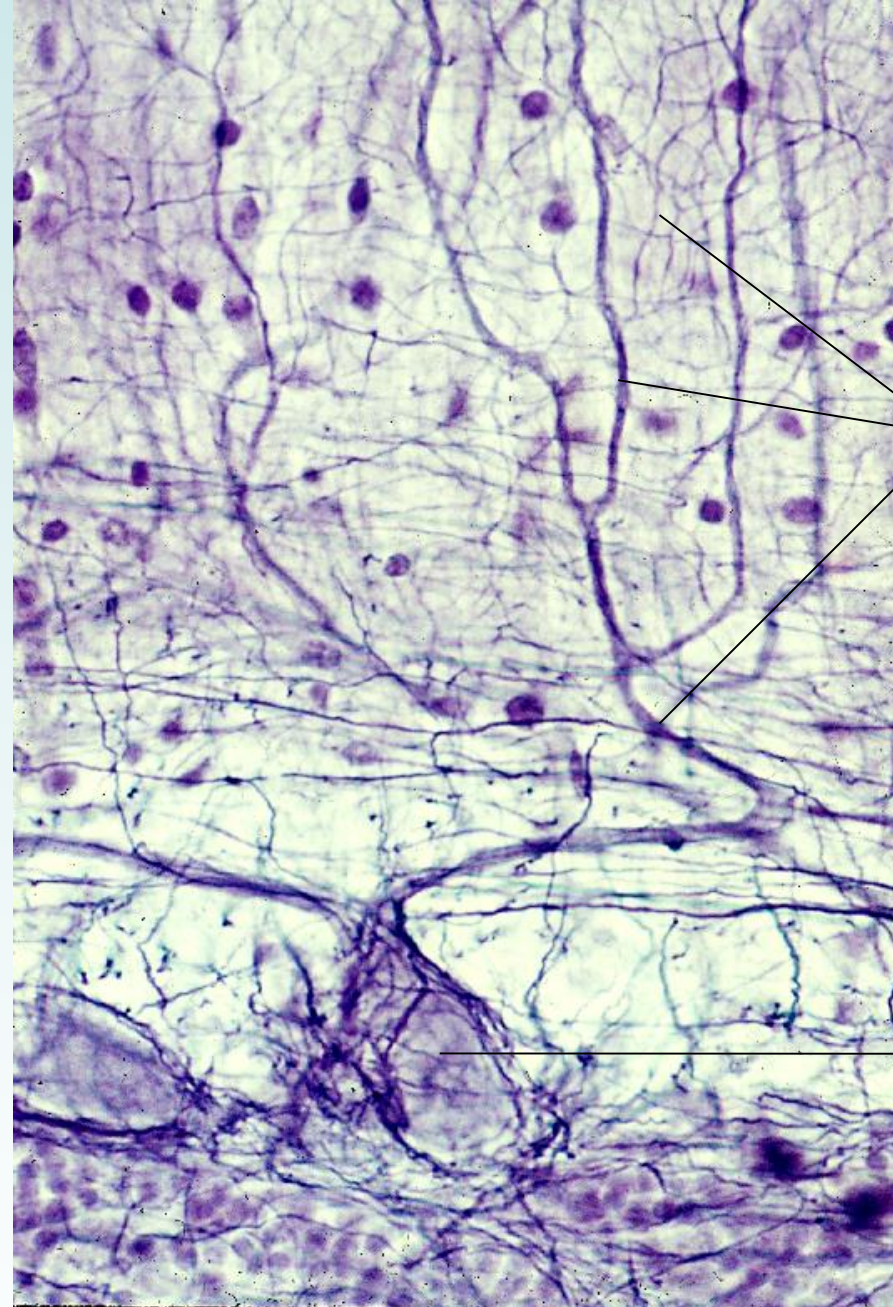
Molecular layer

Purkinje cell layer

Granular layer

22-29 Cerebellar cortex 4. Dog, Bodian's silver impregnation, x 64.

Dendrites

Purkinje cell

22-30　Cerebellar cortex 5. Human, Suzuki's silver impregnation, x 160.
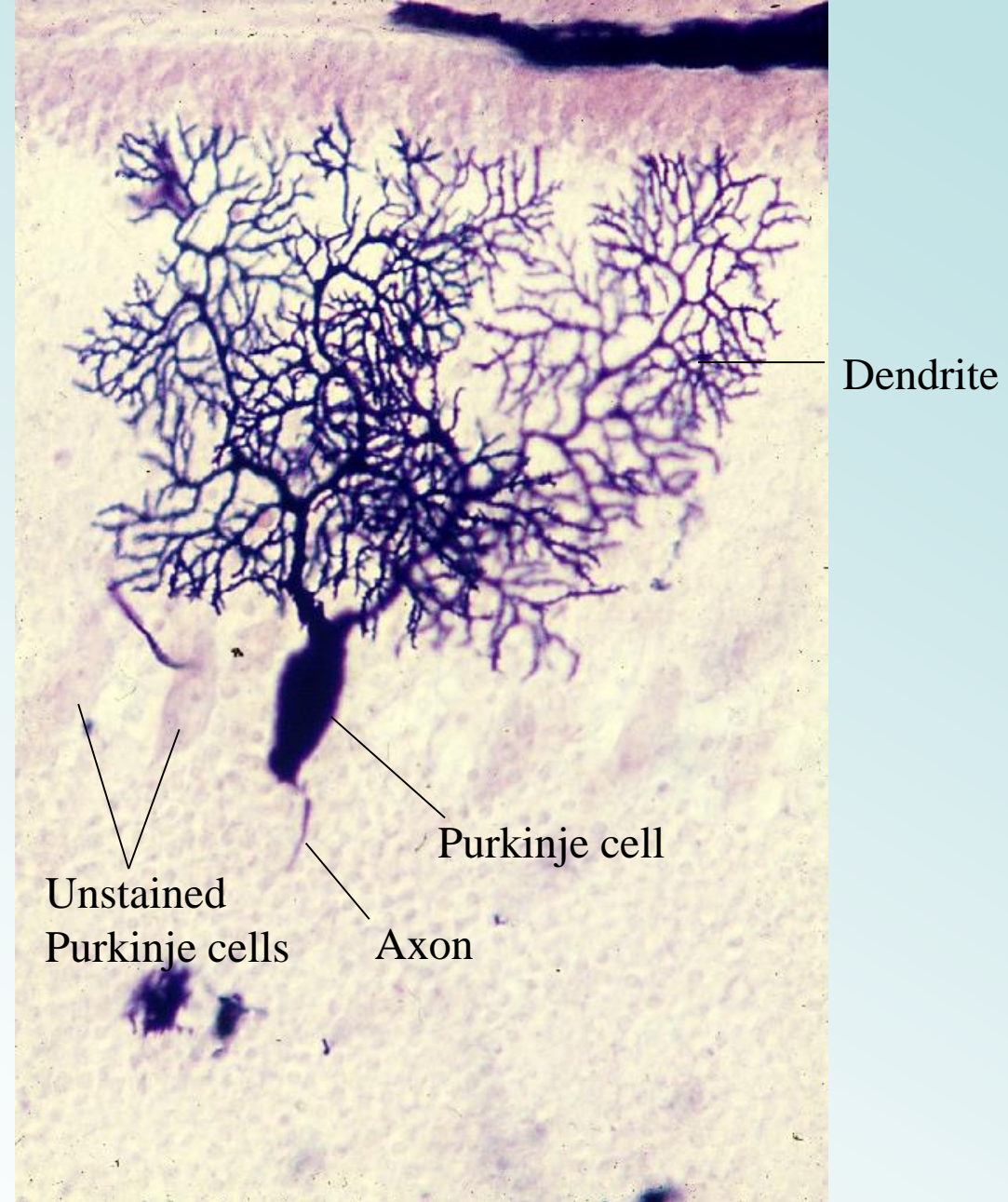
Dendrite

Purkinje cell

Unstained
Purkinje cells

Axon

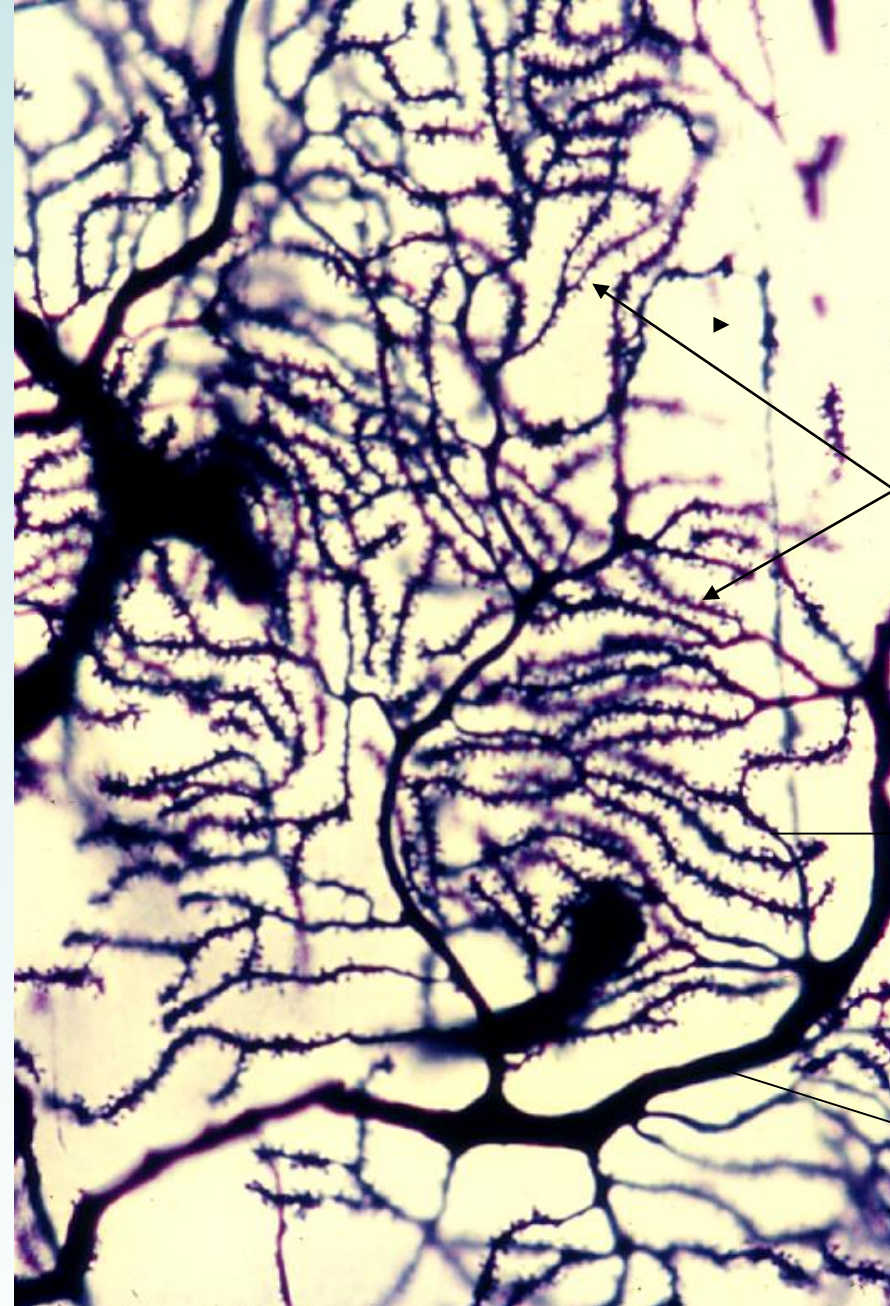**22-31 Cerebellar cortex 6. Dog, Golgi's silver impregnation, x 80.**

Dendrites

Cell body

Axon

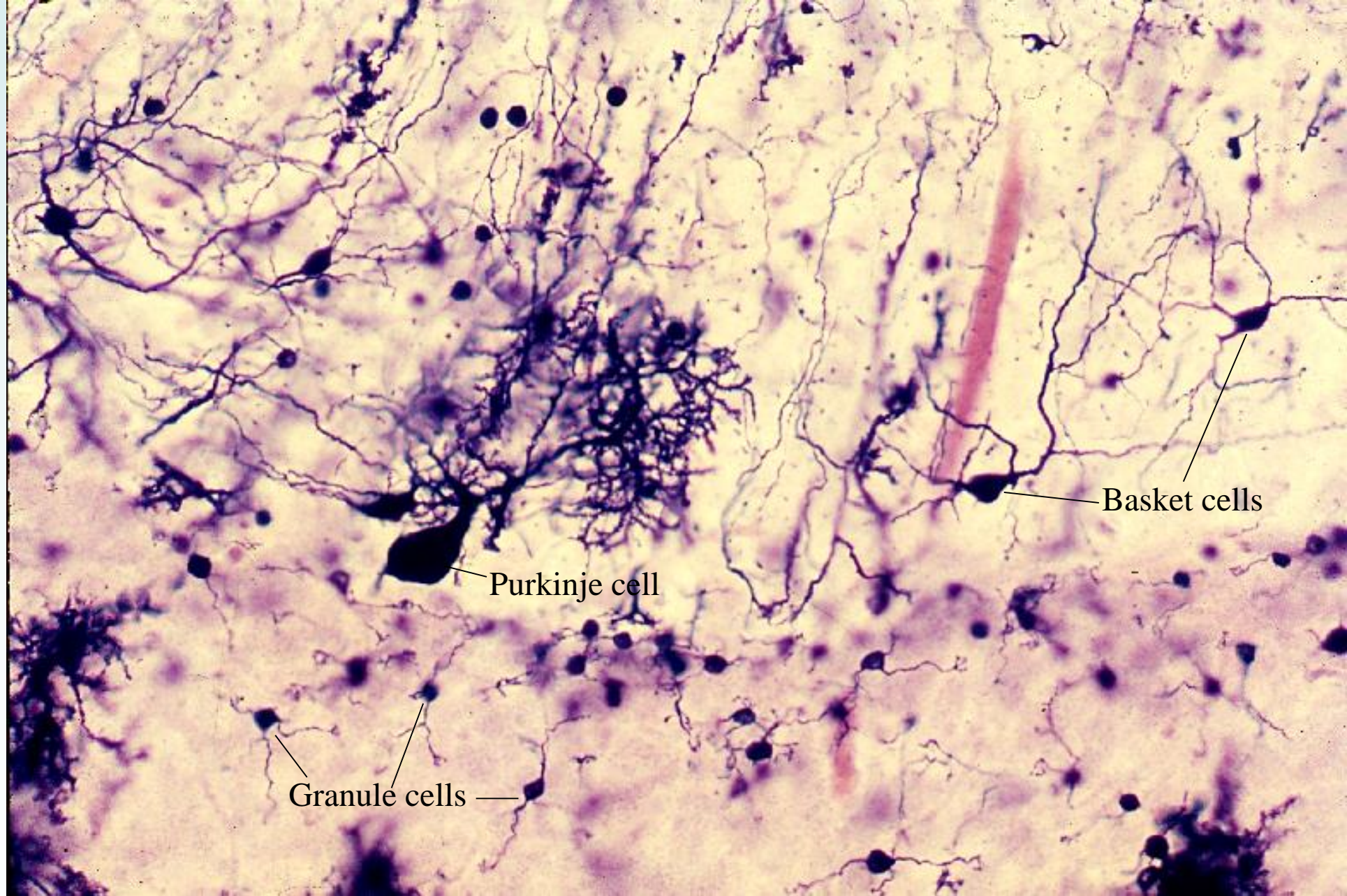**22-32 Cerebellar cortex 7. Human，Golgi's silver impregnation，x 80.**
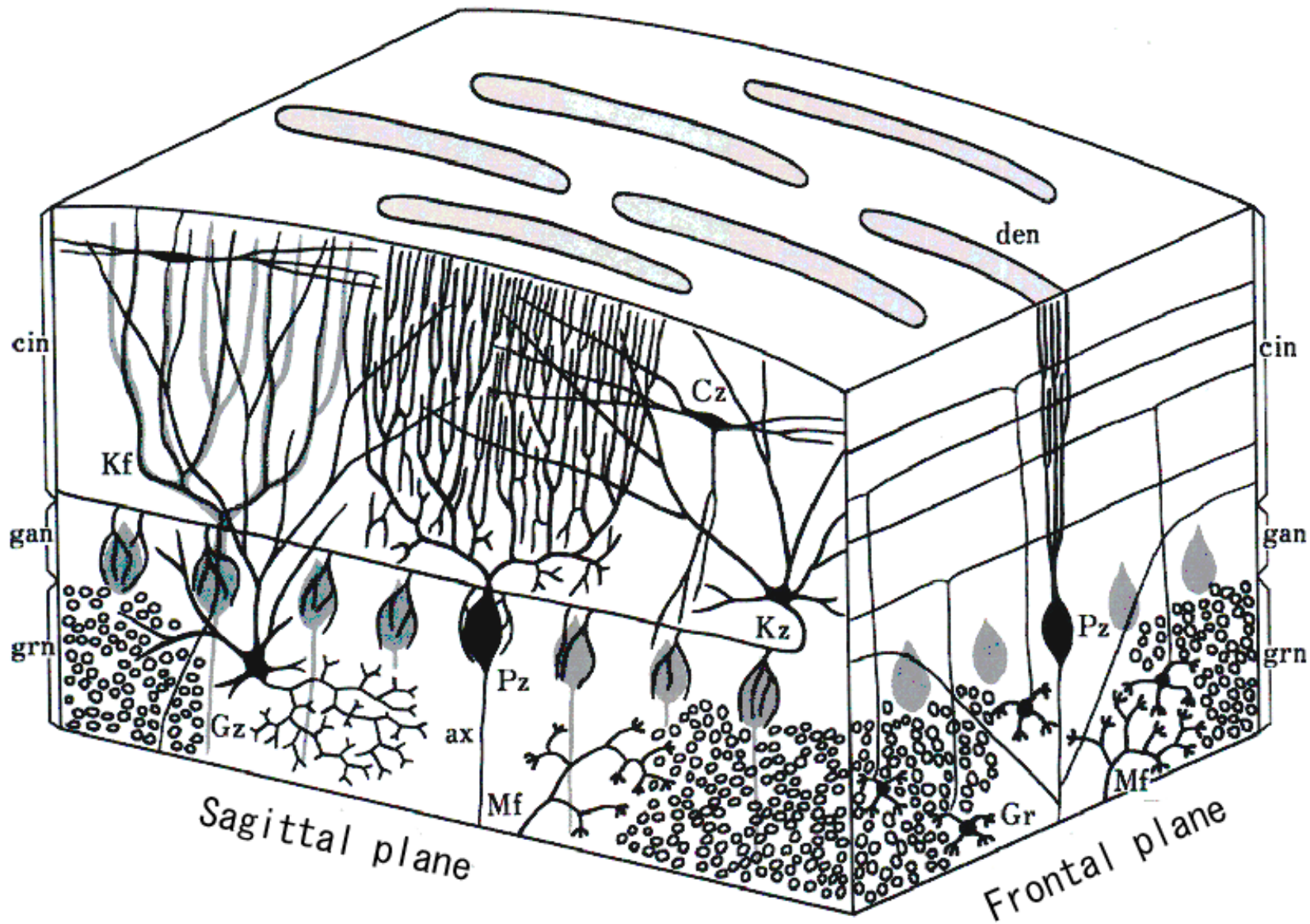
Spines of dendrite

Tertiary dendrite

Secondary dendrite

22-33 Cerebellar cortex 8. Human, Golgi's silver impregnation, x 200.

Basket cells

Purkinje cell

Granule cells

22-34 Cerebellar cortex 9. Dog，Golgi's silver impregnation，x 64.

22-35 Scheme showing the three dimensional structure of the cerebellar cortex.
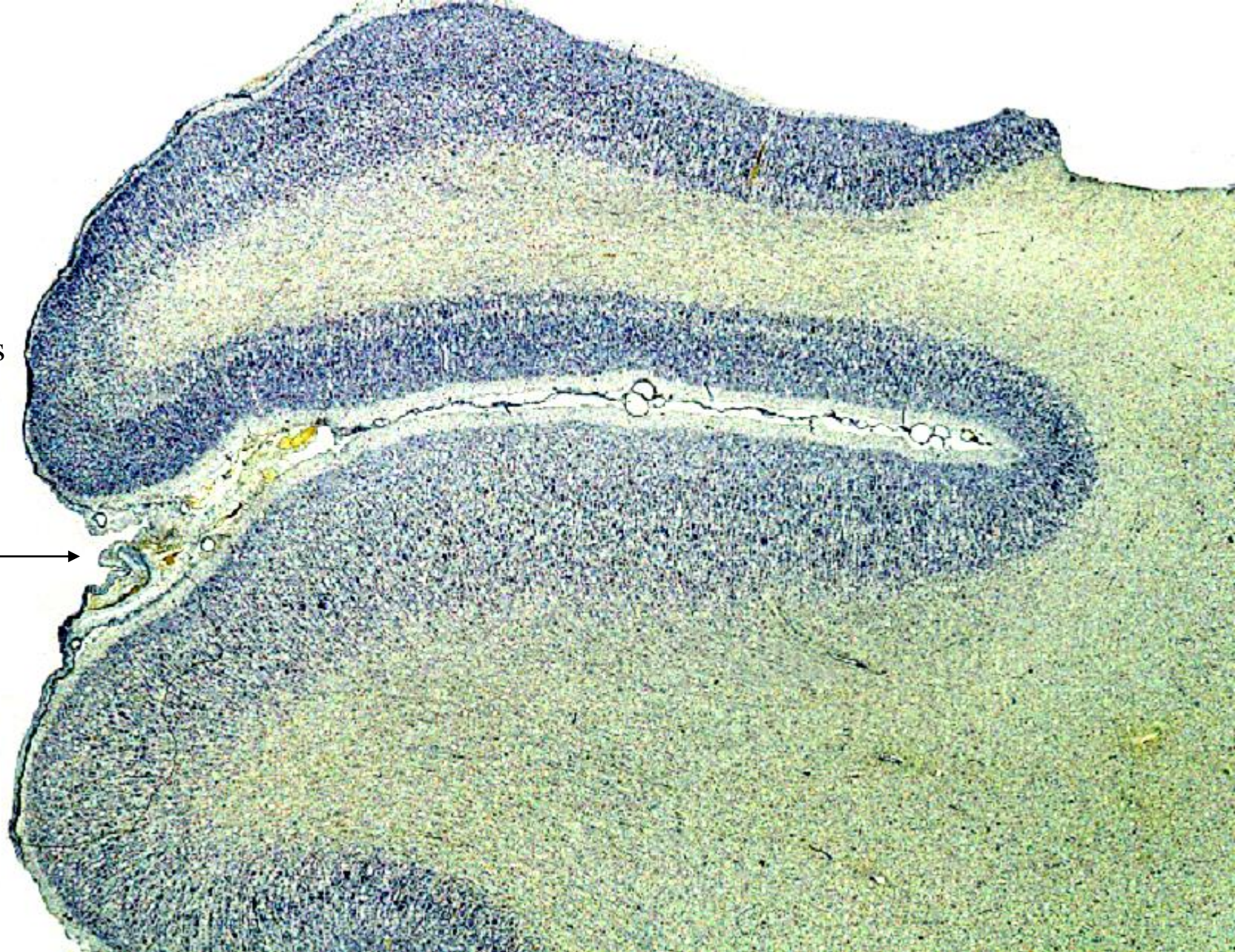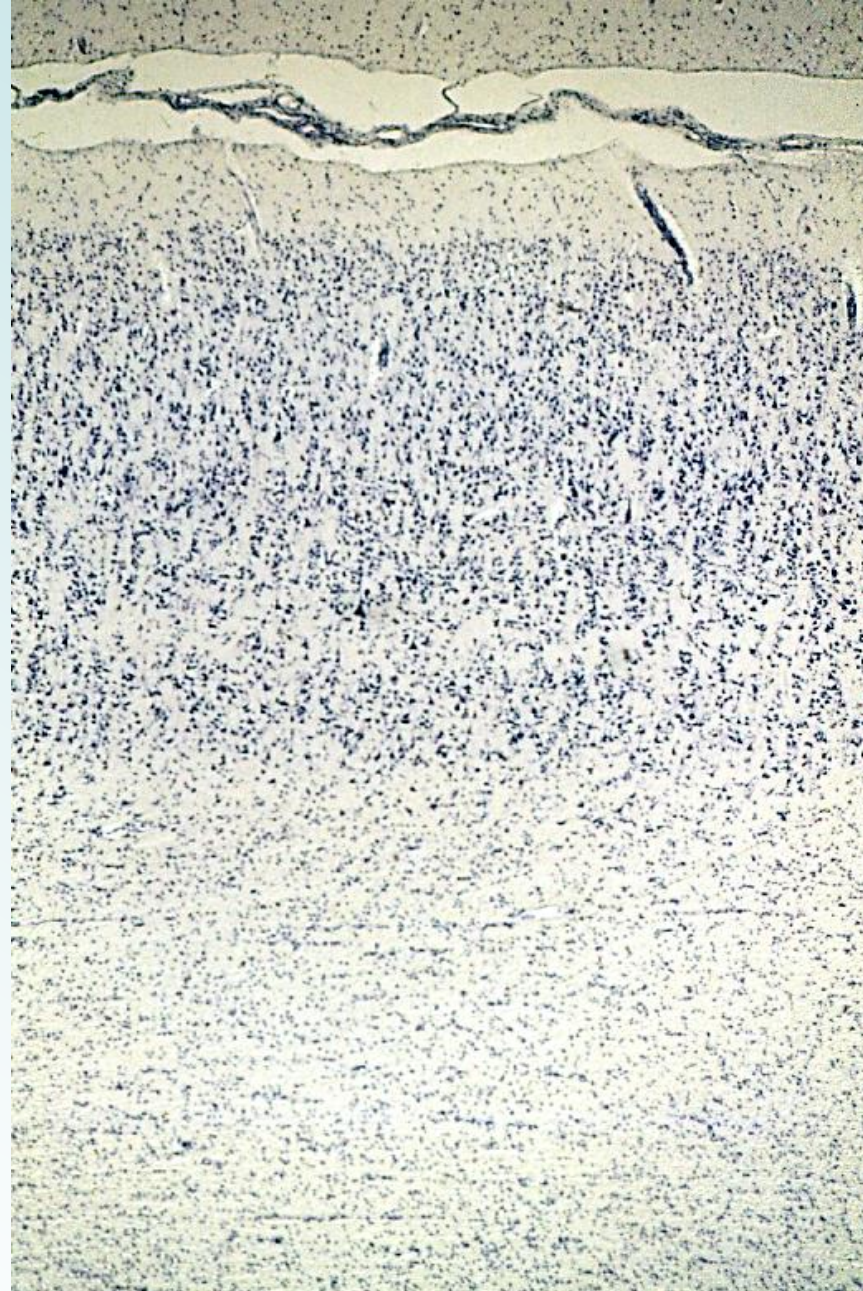
22-005
Cerebral Cortex

Gyrus postcentralis

Sulcus centralis ⟶

Gyrus precentralis

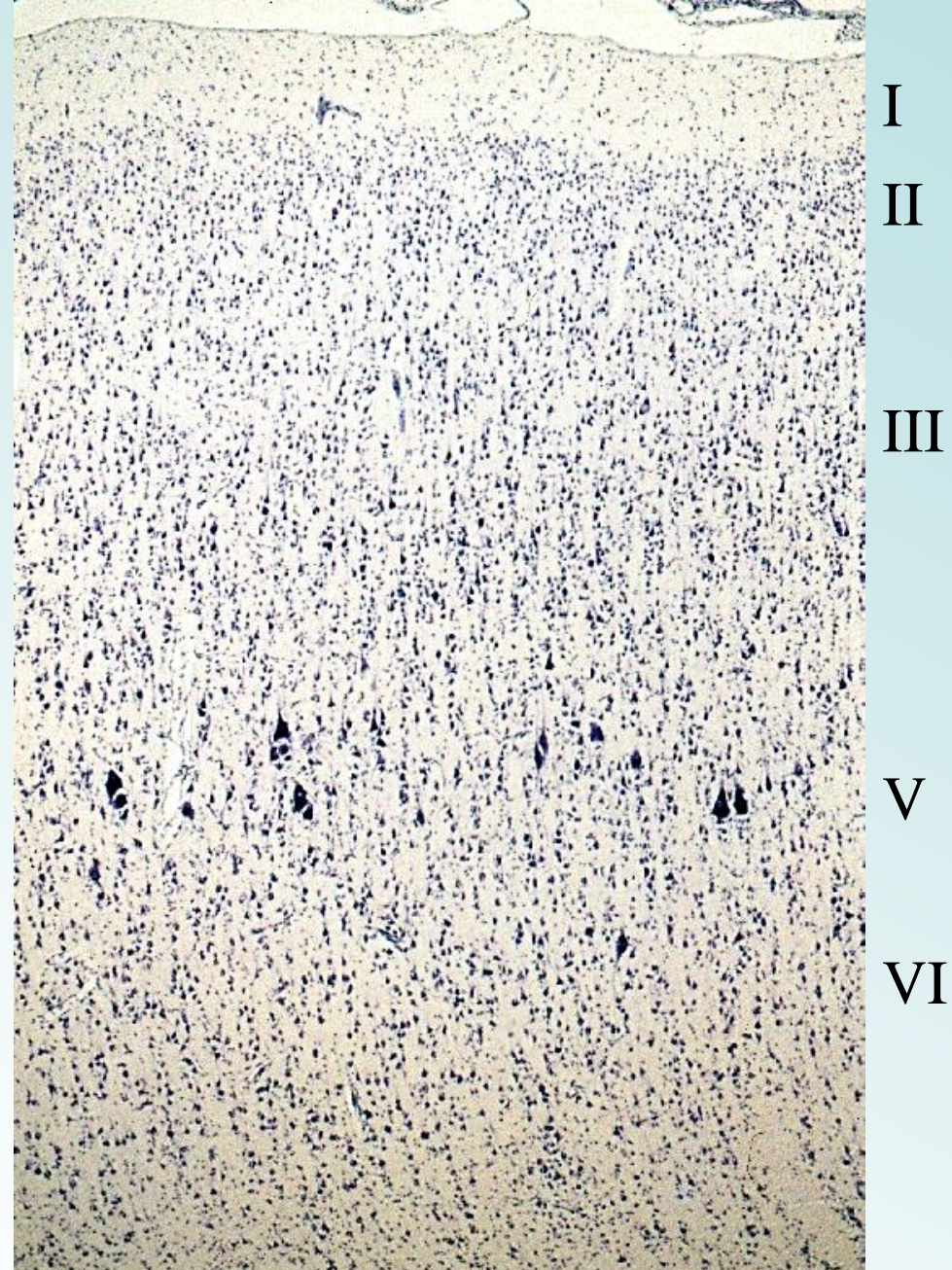**22-36 Cerebral cortex 1. Gyrus precentralis and gyrus postcentralis. Human, Nissl stain, x 1.5.**

I
II
III
IV
V
VI

22-37 Cerebral cortex 2. Gyrus postcentralis, Area 3. Human, Nissl stain, x 10.

I
II
III
V
VI

22-38 Cerebral cortex 3. Gyrus precentralis, Area 4. Human, Nissl stain, x 10.
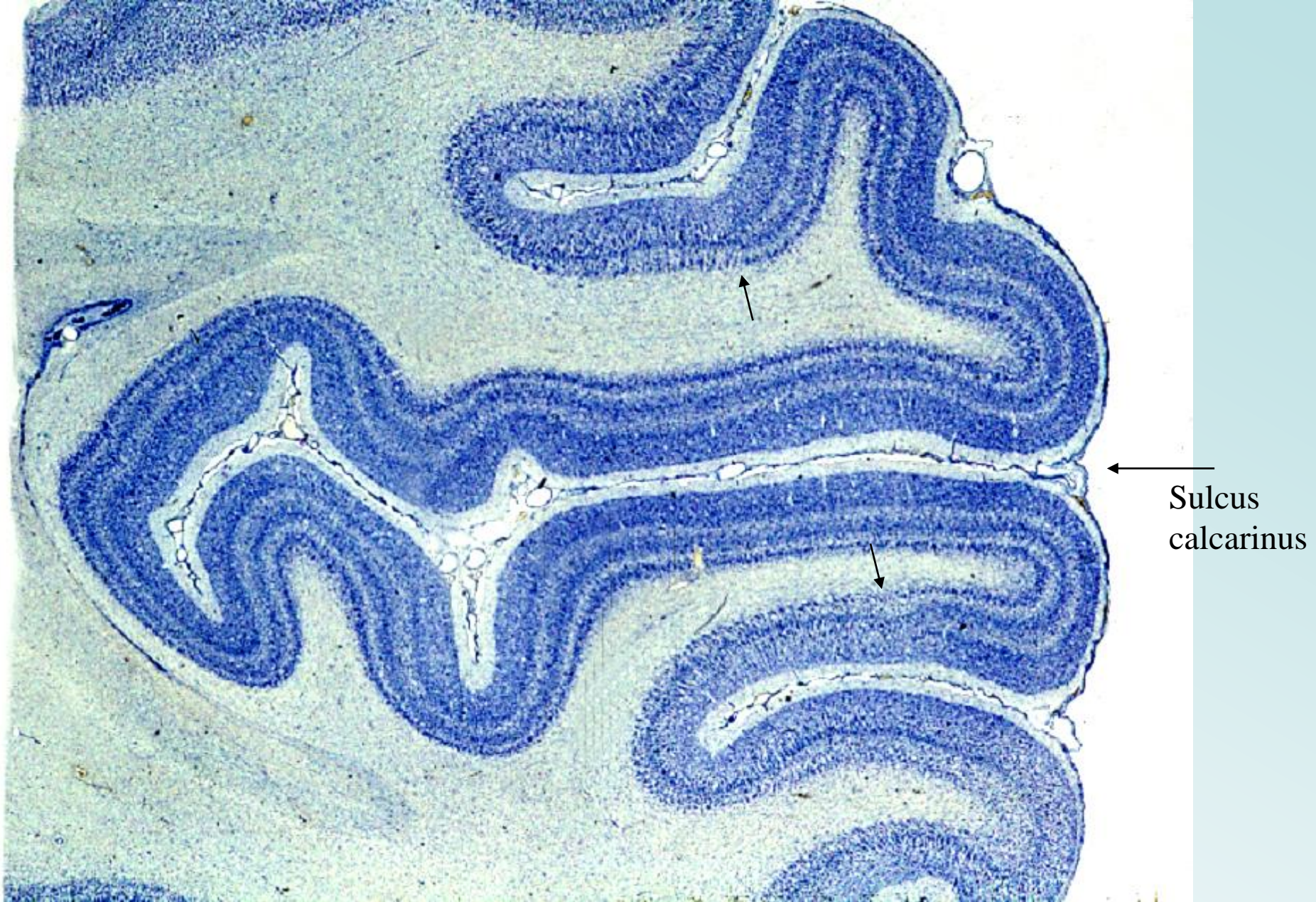
Sulcus
calcarinus

22-39 Cerebral cortex 4. Cortex surrounding the sulcus calcarinus. Human, Nissl stain, x 1.5.

I

II

III

IVa

IVb

IVc

V

VI

22-40 Cerebral cortex 5. Area 17. Human Nissl stain, x 25.

I

II

III

IV

V

VI

22-41 Cerebral cortex 6. Area 18. Human, Nissl stain, x 25.

Area 17   Area 18

22-42 Cerebral cortex 7. Area 17 and area 18.
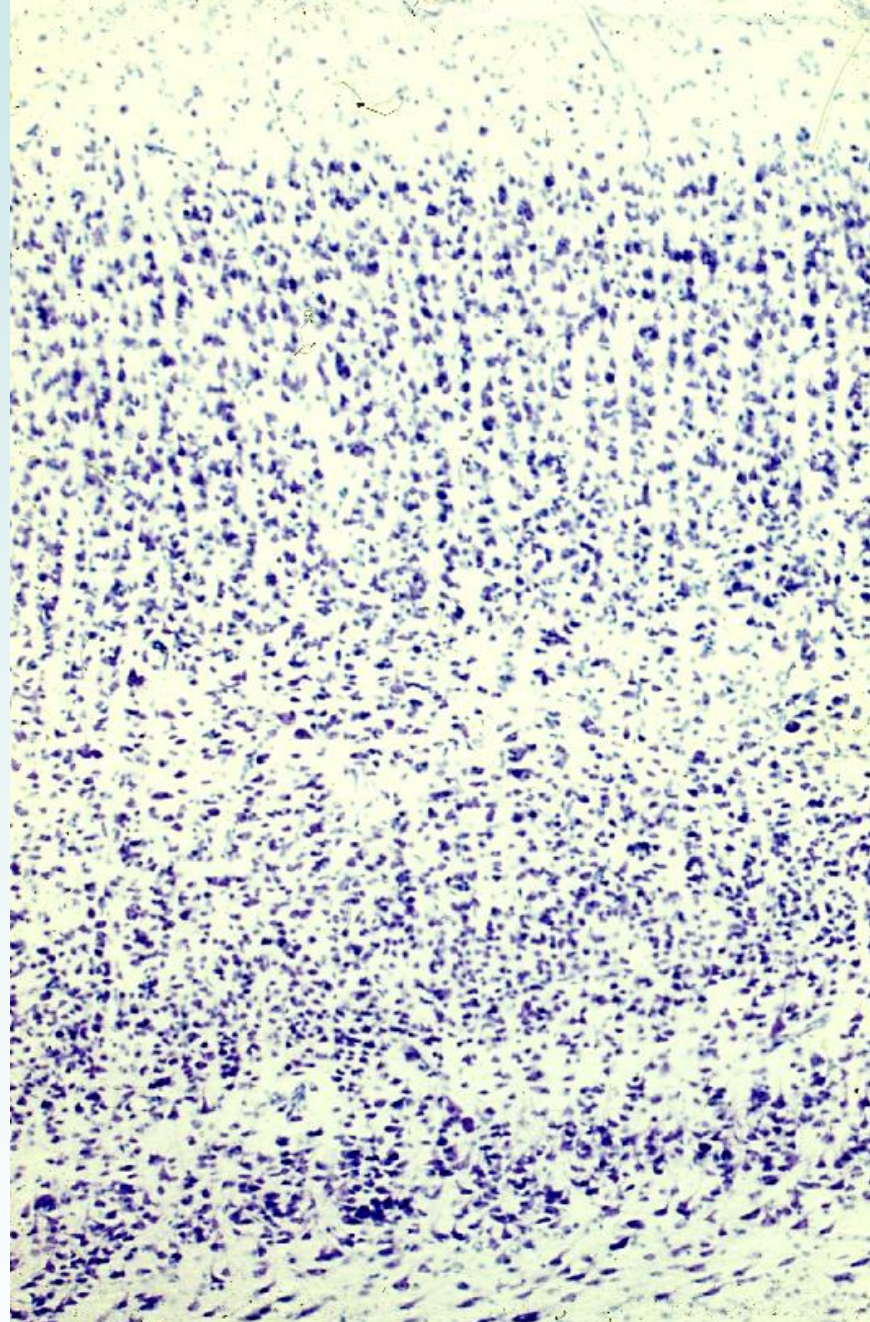
22-00 Central Nervous System

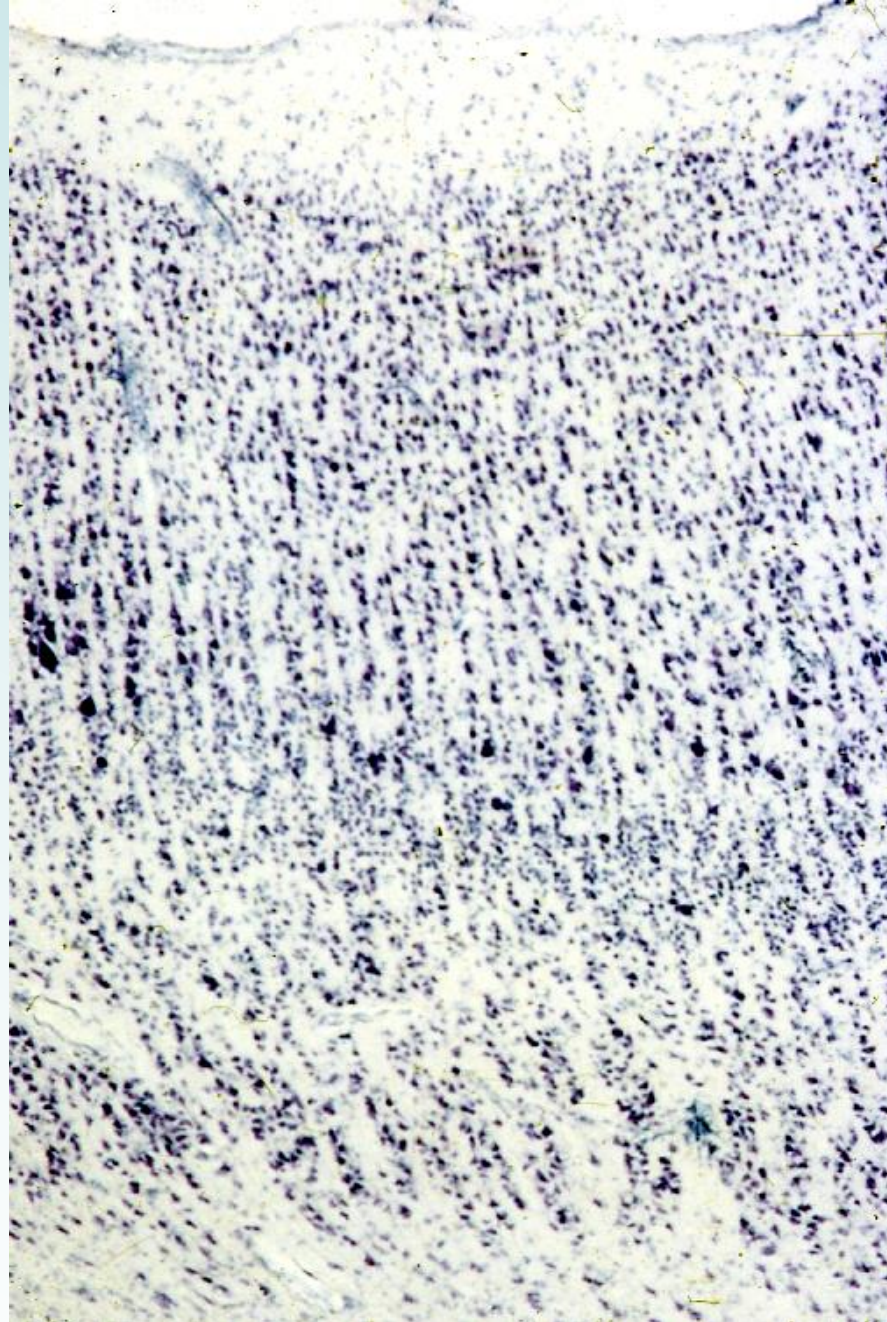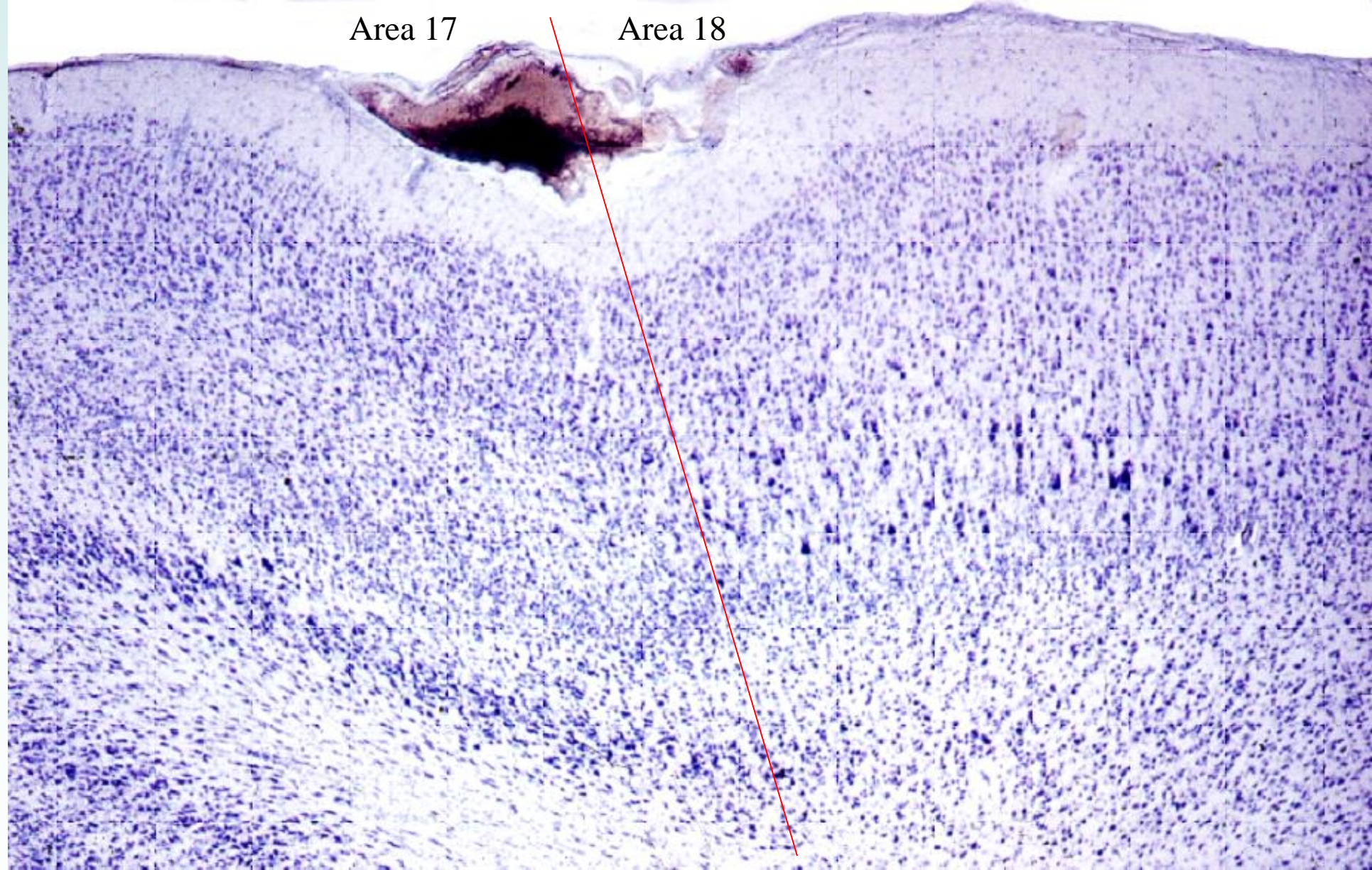- The central nervous system consists of the spinal cord and the brain. As is seen in "05-00 Nervous Tissue", the main constituents of the nervous tissue are the nerve cells, neurons, their processes, axons and dendrites, and neuroglia cells and their processes, that support the neurons. Both the spinal cord and the brain are composed of neurons and nerve fibers (axons), and neuroglia, but other tissue components are very few, except for the blood vessels and concomitant connective tissue.

- In the central nervous system, area containing numerous nerve cells appears gray in color and is called the gray matter, whereas, that consisting of myelinated nerve fibers, brilliant white, and called white matter.

- In the spinal cord as well as in the brain, nerve cells are distributed in groups bearing the specific functions; they are called nuclei (singl. nucleus). The myelinated nerve fibers are also grouped to form the tracts conducting specific impulses. Especially in the brain stem distribution of nuclei and tracts differs from section to section. Therefore, it is not possible, with one section to represent the whole brain stem. The precise descriptions about the nuclei and tracts, especially with their functions, are the essential matter of the neurology. The following descriptions are limited to indicate the names of important structures. If necessary to know the functions of these structures, please refer to the books of neurology.

22-001 Spinal Cord

- The spinal cord is a long white columnar organ, about 10 mm in diameter and about 40 to 45 cm in length, and locates in the vertebral canal. It continues cranially with the caudal end of the medulla oblongata and ends at the caudal extremity with a spindle shaped enlargement. From its ventrolateral and dorsolateral portions go out and come in the root fibers of 31 pairs of the spinal nerves.

- The general structure of the spinal cord can be seen on the transverse sections. From 22-01 to 22-04, sections of dog spinal cord stained by different staining methods are demonstrated.
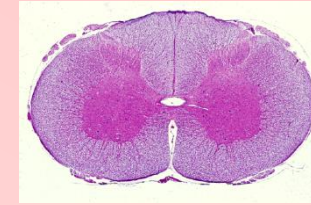
- This is a transverse section of dog lumbar cord, H-E stained. At center penetrates a narrow canal, central canal, throughout the whole length of the spinal cord. Dorsal and ventral to it, the posterior median sulcus and ventral median fissure, respectively, divide the spinal cord into left and right halves, in each of that the central portion contains numerous neurons, the gray matter, surrounded by the white matter consisting of transversely sectioned myelinated nerve fibers. The ventral (anterior) half of the gray matter consists of large multipolar neurons, oriented with wide intercellular spaces; this is called the ventral (anterior) column or anterior horn. On the contrary, the dorsal half of the gray matter consists of smaller spindle shaped neurons and is called the posterior horn. The left and right gray matters are connected with thin gray matter surrounding the central canal.

- The white matter of each side, is divided into three portions, anterior, lateral and posterior fascicles.
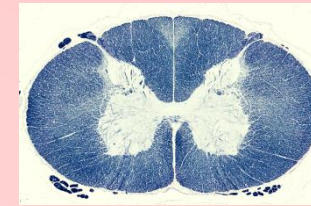
・   The Weigert stain stains the myelin sheath selectively deep blue. In this specimen the white matter is conspicuous from the gray matter. In this figure, the anterior and posterior radix fiber bundles are evident. The white matter consists of very densely packed myelinated nerve fibers, mostly transversely sectioned.

- Nissl stain visualizes the cell body of nerve cells exclusively, and others, only nuclei of the neuroglia cells and that of the endothelial cells. In this specimen boundary between the gray and white matters is not evident. In the anterior horn numerous nerve cells of larger and smaller size are recognized. In the posterior horn neurons are in general smaller in size.

- Bodian's silver impregnation visualizes the neurofibrils, filling the cell body of the nerve cells, dendrites and also axons. In the anterior horn several large neurons are observed and as the dendrites and axons are also stained, the intercellular spaces in the anterior as well as in the posterior horn, consisting of dendrites neuritis, are also stained. In the white matter only transversely sectioned axons are stained.

- As here shown, the study of the central nervous system should employ several different staining methods.

22-002 Human Brain Stem

- From 22-05 to 22-19, the representative sections from a successive series of human brain stem are shown. They are transverse section and stained with Weigert's method.

- As explained in 22-02, the Weigert's stain reveals only the myelin sheath of the myel- inated nerve fibers and therefore with this method only a few informations can be obtained about the gray matter. But, because this stain is very durable and is useful to study the fundamental organization of the central nervous system, especially about the brain stem, serial sections of the brain stem stained by Weigert's method has been widely utilized in the classical neurology.

- The figures are arranged from the first cervical segment of the spinal cord ascending upward until the upper portion of the midbrain.
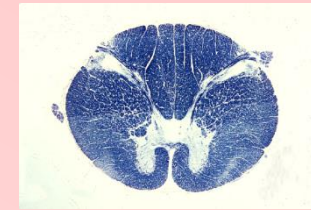
- In the first cervical segment, nerve cells in the gray matter are less numerous; the white matter, on the centrally, consists of a lot of myelinated nerve fivers ascending from spinal cord to the brain as well as those descending from the brain to the spinal cord. So, as is here seen, the white matter occupies the most of the transverse section, and the gray matter, only a small portion of it. Necessary names of the structures are given in the figure. The dorsal fascicle consists of gracile fascicle and cuneate fascicle; they are composed of ascending sensory fibers from the body surface（skin）to the brain; The sensory fibers from the spinal ganglion come into the spinal cord as posterior radix fibers and ascend upward forming the gracile fascicle（from the lower half of body）and cuneate fascicle (from the upper thorax, cervix and upper extremity）. Ventrolateral to the posterior horn there is a large round area occupied by the descending fibers; that is the pyramidal tract. The anterior horn is narrow containing less numerous neurons, because their innervating skeletal muscles are small and less numerous.
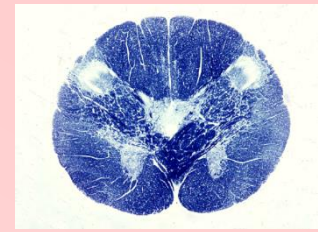
・　This is the section passing through the inferior portion of the pyramidal decussation. Ventral（anterior）to the central gray matter the mass of myelinated fibers is crossing from ventromedial to dorsolateral arriving at the ventromedial portion of the posterior horn; that is the pyramisal tract. At the dorsolateral end of the posterior horn enlarges the gray matter; that is the spinal nucleus of the trigeminal nerve. The gracile fascicle（Goll's fascicle）and cuneate fascicle（Burdach's fascicle）are both very conspicuous.
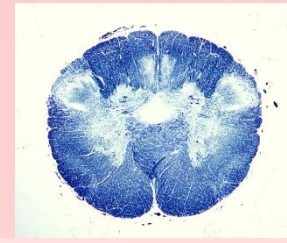
· At the center, ventral to the central gray matter, is the pyramidal decussation. The anterior horn and the head of posterior horn are enlarged; within the gracile fascicle appears the gray matter, the nucleus gracilis; at the ventral area of the cuneate fascicle also appears the nucleus cuneatus. Left and right to the median fissure there are large areae occupied by the descending fibers; that are the pyramidal tracts.
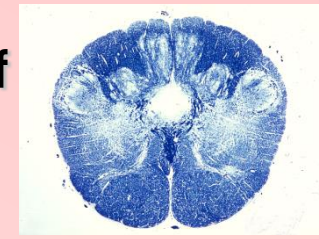
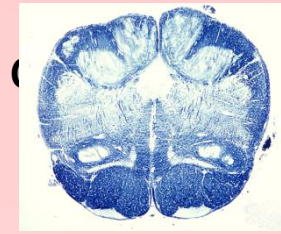· At the center, ventral to the central gray matter there are crossing fibers stained deeply; this is the decussation of the medial lemniscus. The fibers, constituting the gracile as well as the cuneate fascicles, terminate in the respective nucleus making the synapses with the nerve cells therein. The nerve fibers, starting from these neurons, go ventromedial-ward and cross the midline and arrive at the area lateral to the midline, form the medial lemniscus, and further proceed until the thalamus. Lateral to the lem- niscus appears the medial olivary nucleus. Nuclei gracilis as well as cuneatus, and the spinal nucleus of trigeminal nerve enlarge evidently. The spinal tract of trigeminal nerve is also recognized. Anterior horn is no longer perceived; instead in the medial half of the lateral fascicle nerve cells intermingle with the meshwork of the white matter; this condition is called reticular formation. Left and right to the median fissure the pyramid enlarges markedly.

- The nerve fibers starting from the gracile as well as cuneate nuclei run around the central gray matter and cross the mid line and join the medial lemniscus of opposite side. Nuclei gracilis and cuneatus, and spinal nucleus of trigeminal nerve are marked. The reticular formation is widened. Upper to the medial accessory olivery nucleus appears the caudal end of the principal olivary nucleus. Along the ventral surface of the large pyramid there is the arcuate nucleus.
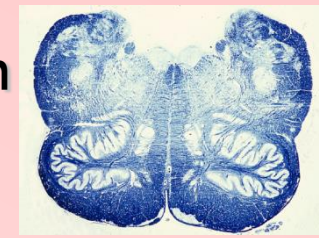
- The central canal opens into the fourth ventricle and the central gray matter forms its floor, the fossa rhomboidea, in which the nucleus of hypoglussus nerve and lateral to it ala cinerea, i.e. glossoppharyngeus and vagus area, are recognized. At the upper lateral corner gracile and cuneate nuclei are seen. Between these and nucleus of hypoglossus nucleus, a conspicuous transverse sectioned fiber bundle and attaching nucleus are seen; that are solitary fascicle and its nucleus. Inferior to the cuneate nucleus the spinal nucleus and spinal tract of trigeminal nerve are recognized; lateral end of this figure occupies a massive area of deeply stained nerve fibers, called corpus restiforme, consisting of fibers from spinal cord to the cerebellum. Left and right side of the midline occupies the medial lemniscus, dorsal end of which is a small area of deeply stained fibers; that is the fasciculus longitudinalis dorsalis. From the nucleus of the hypoglossus nerve run downward several radix fibers along the lateral edge of the medial lemniscus. The ventral half of the figure occupy the massive principal olivary nucleus and pyramidal tract. ① and ② are gracile and cuneate nuclei.
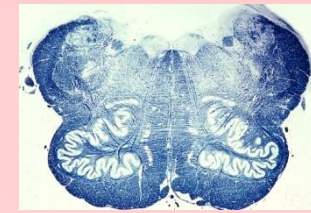
- The ventral half becomes larger and is occupied by the large principal olivary nucleus and the massive pyramidal tract. In the dorsal half is about the same of the previous section except for the disappeared gracilis and cuneate nuclei and instead the appearance of the vestibular nuclei; dorsolateral to the solitary fascicle(①)is the medial vestibular nucleus(②)and ventrolateral to it is the inferior vestibular nucleus(③). Hypoglossus nerve nucleus and radix fibers of hypoglossus nerve are evident. ④ is ala cinerea, ⑤, lemniscus medialis, ⑥, spinal tract of V. nerve, ⑦, spinal nucleus of V nerve.

22-12 Boundary of medulla oblongata to the pons. The level of the lateral recessus of the fourth ventricle. x 1.6.

- The upper edge of this figure is opened in both sides as the recessus lateralis of the fourth ventricle, where the terminal nucleus of cochlear nerve is seen(①). The hypoglossus nerve nucleus is disappeared. Medial to the cochlear nucleus medial(②) and lateral(③) vestibular nuclei, and radix fibers of vagus nerve are seen. At the lateral end on both sides, a massive transversely sectioned fiber area, the corpus restiforme, is evident, consisting of fibers from spinal cord and also from olivery nucleus into the cerebellum. Medial to it the spinal tract(④)and spinal nucleus(⑤)of trigeminal nerve and wide reticular formation(⑧)are seen. In the ventral half, the massive medial lemniscus(⑥)and pyramidal tract, and reduced principal olivary nucleus are observed. At the dorsal end of lemniscus medialis deeply stained fasciculus longitudinalis dorsalis (⑦) is evident.

22-13 Pons 1. The level of the nucleus of facial nerve. x 1.6.
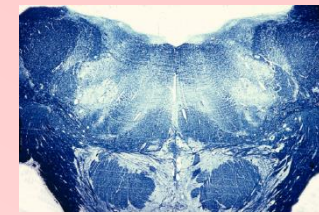
- The figure is divided into two, dorsal and ventral halves. The ventral half consists of large pyramidal tract and surrounding nuclei pomtis ⑨, and massive pontocerebellar fibers ⑧. In the dorsal half, dorsolateral corner occupies the corpus restiforme (⑩), consisting of fibers from the spinal cord and principal olivary nucleus into the cerebellum. Medial to it, medial ① and lateral ② vestibular nuclei and spinal nucleus ③ and spinal tract ④ of trigeminal nerve are seen. Medial to them the nucleus if facial nerve is evident. The ventral bondary of the dorsal half of the figure limits the medial lemniscus, locating now horizontally. With its lateral end is continuous the lemniscus lateralis ⑤ and above the lateral end of the medial lemniscus is the corpus trapezoideum ⑦ which is called often as superior olivary nucleus. The reticular formation ⑥ is wide and is often called the tegmentum, ventrolateral portion of which occupies the large facial nucleus ⑫.

- The width of the fossa rhomboidea is somewhat reduced. On both side of the midline locates the nucleus of abducens nerve ① and from its ventromedial portion start the radix fiber bundles ⑤ of the abducens nerve and run ventral ward penetrating the tegmentum ⑩. From the ventrolateral corner of this nucleus runs the thick radix fiber bundles of facial nerve ④ ventrolateral ward. Lateral to it are the medial ② and lateral ③ nucleus of vestibular nerve. Ventral to them are the spinal nucleus ⑧ and spinal tract ⑨ of the trigeminal nerve. Beneath the tegmentum ⑩ limits the medial lemniscus ⑥ and with its lateral end continues the lateral lemniscus ⑦. Dorsomedial to it is the corpus trapezoideum ⑬. The inferior aspect of the medial lemniscus conti- nue the massive nuclei pontis ⑪ containing numerous transversely running thick fiber bundles, the transverse pontine fibers. Among the pontine nuclei penetrate the massive fiber bundles, the pyramidal tract and on both sides of them limits the middle cerebellar peduncle ⑫, consisting of fibers from pontine nuclei to the cerebellum. The dorsolateral corner of this figure occupies the corpus restiforme, the inferior cerebellar peduncle.

- At the dorsolateral corner of this figure, there are the motor nucleus ① and the principal sensory nucleus ② of the trigeminal nerve and radix fiber bundles of trigeminal nerve ③. Ventromedial to them is the lateral lemniscus ④, medial to which continues the medial lemniscus ⑫ locating horizonlally and limiting the tegmentum ⑬ from the basilar part of pons. Above the lateral end of the medial lemniscus is the trapezoid body ⑩. At the dorsomedial corner of the tegmentum is the conspicuous dorsal longitudinal fascicle ⑪. Inferior to the medial lemniscus there are massive nuclei pontis ⑥with numerous tansverse fiber bundles and further inferior, the massive pyramidal tract. Lateral to these structures limits the white matter consisting of the middle cerebellar peduncle ⑨ and corpus restiforme ⑧. The rhaphe.is indicated by ⑦.
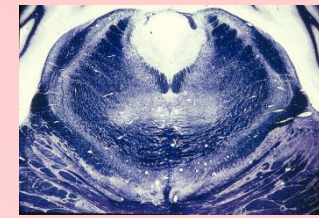
- This section passes through the limit between the rhombencephaton and midbrain. The fourth ventricle is very narrow and becomes the aquaeduct ⑥; dorsolateral to it the radix fiber bundle of trochlear nerve ① is seen. Lateral and ventrolateral to it is a wide field of nerve fibers ②. This is the superior cerebellar peduncle, coming into the tegmentum and now crossing. ③ is the cerebellar commissure. The inferior limit of the tegmentum is now constituted by the medial lemniscus ④, which is continuous with the lateral lemniscus ⑤ at its doesolateral end. Inferior to the medial lemniscus is the continuation of the basilar part of pons ⑦, consisting of pontine nuclei and the mass of descending fiber bundles.

- This is the section passing through the inferior culliculus. On both sides at the top of the figure is a large round nucleus, rich in myelinated fibers; this is the nucleus of inferior colliculus ①, which accepts fibers partly from the lateral lemniscus ②at its ventrolateral pole. The right and left colliculi are connected by commissure of inferior colliculus ⑧. Medial and ventromedial to the nucleus of inferior colliculus is the wide central gray matter penetrated longitudinally by narrow aqueduct ③. Ventromedial to the inferior colliculus is the tegmentum of midbrain ⑦, ventral boundary of which limits the medial lemniscus ④, which continues laterally with lateral lemniscus ②. Medial portion of the tegmentum occupies the decussation of superior cerebellar peduncles ⑤, a wide area of crossing fibers. Above it, in the dorsal longitudinal fascile ⑥ there is a small round nucleus of trochlear nerve ⑧. Ventral to the medial lemniscus is a massive gray matter, the substantia nigra ⑨, to which follows further ventrally the crus cerebri ⑩.
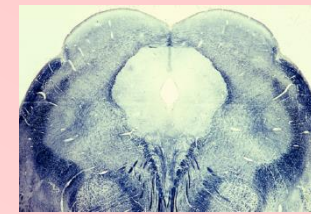
- At the center the aqueduct of midbrain penetrates longitudinally the central gray matter. Dorsolateral to it protrudes the superior colliculus showing a conspicuous layered structure, namely, from surface inward, ① zonal layer, ② superficial gray layer, ③ optic layer, ④ intermediate gray layer, ⑤ intermediate white layer, ⑥ deep gray layer, ⑦ deep white layer. Ventral to the central gray matter there is, on both sides of midline, the conspicuous nucleus of oculomotor nerve ⑧, from which numerous radix fiber bundles run ventrally and ventrolaterally. Around the central gray matter is the tegmentum ⑬ of midbrain, which is bounded by the medial lemniscus ⑩ vemtro- laterally and laterally. Fibers of the medial lemniscus partly enter into the fifth layer of the superior colliculus. On both sides, ventromedial to the tegmentum a large round nucleus is evident, the nucleus ruber ⑪, which limits the medial lemniscus medially. Ventrolateral to the medial lemniscus is the substantia nigra. The dorsolateral edge of the tegmentum is composed of brachium of inferior colliculus ⑨, an area of trans- versely sectioned myelinated nerve fibers.

- This is the ventral continuatuin of 22-18. At about one fourth from the right passes the midline of the specimen and here the ventral surface of the brain becomes hollow deeply as interpeduncular fossa; dorsal to it nuclei of oculomotor nerve ③ and its radix fiber bundles are seen. Dorsolateral to the fossa there is a big round nucleus, the nucleus ruber ③ and ventrolateral to it is a big gray matter, the substantia nigra ④. The ventrolateral extremity is composed by the cerebral crus, consisting of a lot of descending fibers, namely, pyramidal tract (corticospinal fibers, corticonuclear fibers), and corticopontine fibers. Dorsolateral to the nucleus ruber limits the medial lemniscus ① the tegmentum, and medial to the nucleus ruber is an area of transversely sectioned fibers, the central tegmental tract ②. Ventrolateral edge of this figure occupies the massive fibrous area, namely, crus cerebri ⑤, consisting of pyramidal tract and cortico-pontine tracts. ⑥ is the oculomotor nucleus.

22-003　Human Cerebrum (Frontal section)

・　From 22-20 to 22-24 are the frontal sections of whole human brain, Weigert' stain, x 1/5, showing the principal structures of the cerebrum. Following descriptions are limited to give the general information about the human cerebrum
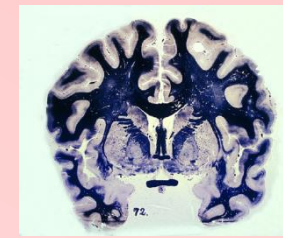
・ At the center the massive corpus callosum connects the right and left hemispheres and radiate the commissural fibers widely until each of the cerebral gyrus. Lateral to the corpus callosum there is a wide area of white matter, called the centrum semiovale.

・ At the center of the inferior surface of the corpus callosum attaches the thin septum pellucidum and inferior to it the colmna fornicis. Inferior to it the anterior commissure unites the right and left basal ganglia, consisting of pallidum and putamen, dorso-medial to them runs capsula interna from the centrum semiovale ventromedially to the lateral end of the anterior commissure. Dorsomedial to the internal capsule is a big gray matter, nucleus caudatus（caput）, which limits the lateral ventricle laterally. Inferior to the anterior commissure is a narrow space, the ventrofrontal end of the third ventricle, which is closed inferiorly by the optic chiasm. The gray matter, inferior to the pallidum and putamen, is called anterior perforate substance. The inferior end of putamen is continuous with amygdaloid nucleus of the temporal lobe. The name of each cerebral gyrus can not be identified on this section.

22-21 Section passing through the infundibulum and hypophysis.
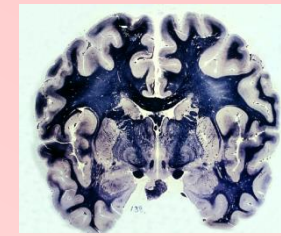
- At the center there is a narrow gap between the right and left hemispheres, the third ventricle, which is closed inferiorly by infundibulum and hypophysis. The right and left wall of the third ventricle consists of thalamus, which is separated laterally by capsula interna from the pallidum and putamen. The third ventricle is closed superiorly by the chorioid plexus and fornix. The lateral ventricle is now enclosed by corpus callosum nucleus caudatus, a part of thalamus, fornix and septum pellucidum. The nucleus amygdaloideum is large and continuous with the inferior portion of the putamen. The pallidum is now divided into four segment by thin layers of nerve fibers. At the inferior portion of the wall of the third ventricle a thick bundle of transverse sectioned nerve fibers is conspicuous, the fornix, ventrolateral to which is a thick fiber bundle of the optic nerve, attaching to the inferior surface of the brain.
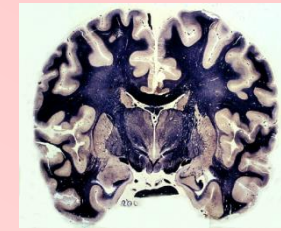
- In this section the thalamus, constituting the right and left walls of the third ventricle, becomes very large and several areas within it are discerned. The capsula interna runs from the centrum semiovale ventromedial ward and attains the vental surface of the brain as crus cerebri. At center of the inferior surface of the brain a paired round nuclei are conspicuous, the corpus mammillare. The putamen and nucleus amygdaloideum are still large but the pallidum reduces in size.
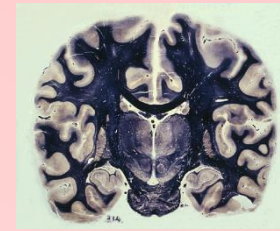
· The thalamus attains its maximal size and is divided into medial and lateral nuclei. Inferior to the thalamus the round nucleus ruber is on both sides very conspicuous, from which a thick fiber bundle runs dorsolaterally into the lateral thalamic nucleus. ventral to the nucleus ruber is substantia nigra also evident. The capsula interna runs from the centrum semiovale ventrally along the lateral edge of the thalamus and appears on the ventral surface of the brain, becoming the crus cerebri, and comes into the basal portion of the pons. The putamen as well as the pallidum reduce markedly in size. In the temporal lobe the dentate gyrus facing to the inferior cornu of the lateral ventricle is evident.
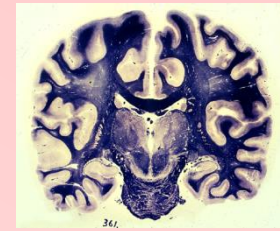
- At the center the thalamus appears in its maximal size, in which the medial and lateral nuclei, and between them, the centre median are evident. Inferior to the thalamus the nucleus ruber is on both sides conspicuous. Ventral and ventrolateral to it stand out the substantia nigra and crus cerebri. Lateral to the place where the capsula interna shifts to the crus cerebri locates the lateral geniculate body. In the temporal lobe the dentate gyrus and parahippocampal gyrus are evident. The pallidum is disappeared and the putamen reduces the size greatly.

22-004 Cerebellar Cortex

- The cerebellum is a large brain mass protruding dorsally from the pons and consists of the central small portion, vermis, and large right and left hemispheres. Observing macroscopically, there are numerous parallel grooves on the surface, called sulci(singl. sulcus) and between them narrow protrudings of about 1.5 to 2.0 mm in width, gyri (singl. gyrus). With these sulci and gyri, the cerebrum has enormously wide surface. They are all arranged roughly perpendicular to the craniocaudal (longitudinal) axis of the brain stem. In the cerebellum, contrary to the spinal cord and brain stem, the gray matter covers the surface and the white matter locates deeply. The gray matter covering the surface is called the cerebellar cortex.

22-25 A cerebellar lobe. Human, Nissl stain, x 1.7.
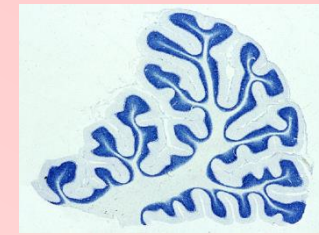
· This is a cerebellar lobe, consisting of deeply locating white matter and surface covering cortex. The centrally locating white matter, as the stem of a tree, ramifies and sends off branches repeatedly. Such arborization has been called "arbor vitae". The gray matter, cortex, covers each of these branches entirely. The cortex consists of colorless superficial layer and deeply blue stained deep layer.
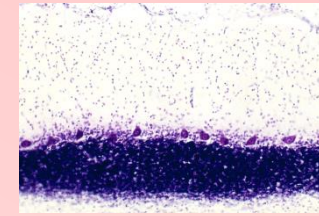
- The cerebellar cortex consists of three layers, namely, a thick superficial layer, molecular layer, Purkinje cell layer, and thick granular layer. The molecular layer is a thick lucent layer, in which numerous small nerve sells are scattered. Blood capillaries are also numerously encountered. In the Purkinje cell layer, large nerve cells of about 40 to 50μm x 50 to 60μm in size, the Purkinje cells, form a line, they are very conspicuous; besides, small nerve cells loosely fill the space between them. The granular layer is composed of very densely packed small cells, granule cells. By routine staining methods with dye, only their nuclei can be visualized.
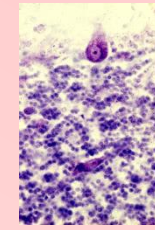
22-27 Cerebellar cortex 2. Human, Nissl stain, x 64.
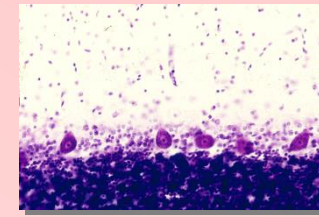
- Higher magnification of 22-26. In this figure some small nerve cells in the molecular layer are identified. In the granular layer nothing is seen except for the nuclei of the granule cells. The large Purkinje cells are very conspicuous.
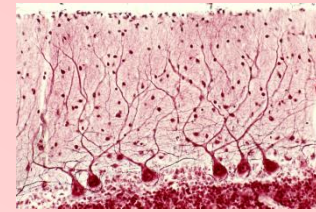
- Looking thin sections, we can identify some nerve cells among the granule cells. The arrangement of the granule cells is not even and cell clusters and cell free narrow areas are arranged alternately.

- Because this impregnation visualizes the dendrites and axons, the sight of the cerebellar cortex is quite different from that obtained by Nissl stain. The Purkinje cells send marvelous dendrites into the molecular layer. They ramify three or four times, become thinner, spread in the sagittal plane, and fill the entire molecular layer. Besides, in the deeper half of the molecular layer numerous small nerve cells with dendrites and axons are demonstrated（arrows）. Their axons run horizontally and during the course make the baskets around the cell body of the Purkinje cells. They are called basket cells. By this impregnation no information is obtained about the granule cells.
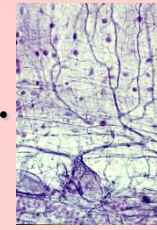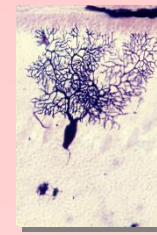
- In this figure dendrites of the Purkinje cells are identified in sequence from the primary, secondary and tertiary. Above the Purkinje cell run the parallel fibers nume- rously and around the cell body of the Purkinje cell basket of fibers is conspicuous.

- Golgi's silver impregnation plates nerve cells with silver or osmium and if succeeded the whole figure of neurons, cell body, dendrites, and axon, will be clearly demonstrated; but the results of this method are very capricious, and to obtain the good results is quite by chance.

- This figure was obtained from a puppy, treated with the Kopsch's modification of Golgi-method. Luckily only one Purkinje cell is demonstrated and all neighboring ones are not. Such figure of the Purkinje cell with thick dendrites is not able to imagine from other staining methods.
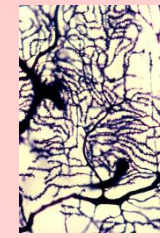
22-32 Cerebellar cortex 7. Human， Golgi's silver impregnation， x 80.

- This figure was obtained from an aged female， treated with Kopsch's modification of Golgi-method. The cell body and ramifying dendrites are identified in sequence from the primary， secondary， and tertiary. The terminal dendrites possess numberless tiny spines.
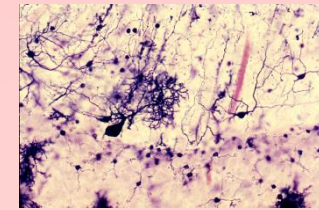
· Higher magnification of 22-32. In this figure the mode of ramifying the dendrites and tiny spines on the terminal dendrites are clearly demonstrated.

- This figure was obtained from a dog, treated with Golgi's original method with osmium. In this figure one Purkinje cell is imperfectly demonstrated; but numerous basket cells with their long dendrites are clearly shown, and more the granule cells with dendrites are numerously visualized. The granule cells have four dendrites, each of which soon make small terminal ramifications.
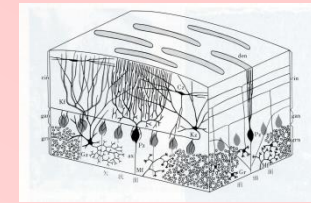
· This scheme shows the three dimensional structure of the cerebellar cortex. The fundamental structure of the cerebellar cortex is built in two planes, namely, in the sagittal plane and frontal plane. The dendrites of the Purkinje cells spread exactly in the sagittal plane and axons of the basket cells run also in this plane. The axons of the granule cells run first into the molecular layer and here divide into two and run in the frontal plane parallel to the surface.

· In the superficial portion of the molecular layer there are small spindle shaped neurons, called cells of Cajal.

· Abbreviations: cin: molecular layer; gan: layer of Purkinje cells; grn: granular layer; Pz: Purkinje cell; ax: axon of Purkinje cell; Cz: cell of Cajal; Gz: cell of Golgi; Kf: climbing fiber; Kz: basket cell; Gr: granule cell; Mf: mossy fiber; den: dendrites of Purkinje cell.

22-005 Cerebral Cortex

- On the surface of the cerebral hemisphere there are numerous irregular grooves, sulci cerebri, and protrusions between two neighboring sulci, gyri cerebri. By this way the cerebral hemispheres possess enormously wide surface, which is entirely covered by the cerebral cortex, consisting of huge numbers of nerve cells. In most areas of the cerebral cortex nerve cells are arranged in six layers, namely,

    I   Lamina zonalis,
    II   Lamina granularis externa,
    III Lamina pyramidalis externa,
    IV   Lamina granularis interna,
    V   Lamina pyramidalis interna,
    VI   Lamina multiformis.

- Lamina zonalis is the superficial lucent layer containing a few small nerve cells.

- Lamina granularis externa is a thin layer consisting of densely packed small pyramidal cells.

- Lamina pyramidalis externa is a wide layer occupying about the half of the cortex, consisting of pyramidal nerve cells. They are small in size and arranged densely in the superficial portion and larger in size and arranged looser in the deeper portion.

- Lamina granularis interna is again a thin layer consisting of small pyramidal cells. They are arranged again densely.

- Lamina pyramidalis interna is also a thin layer consisting of a few pyramidal cells. In some area large nerve cells appear in this layer.

- Lamina multiformis is a relatively thick layer consisting of nerve cells of variable size and variable form.

- The cytoarchitecture of the cerebral cortex varies greatly from place to place. In the year 1909 Brodmann proposed 52 areas according to his comprehensive study about the cytoarchitecture of the cerebral cortex. Following figurers are limited only to the repre- sentative areas

22-36 Cerebral cortex 1. Gyrus precentralis and gyrus postcentralis. Human, Nissl stain, x 1.5.
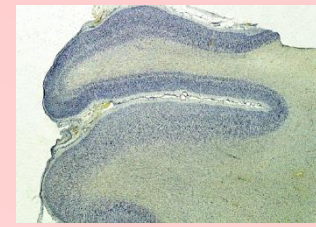
- On the lateral surface of the cerebral hemisphere there is a conspicuous groove, the sulcus centralis, from the center of the upper edge to down-forward. The cerebral cortex anterior to this sulcus, gyrus precentralis, and that posterior to this sulcus, gyrus post- centralis show quite different cytoarchitecture.

- In this figure the lower two thirds is gyrus precentralis and upper one third is gyrus postcentralis; between them traverses the sulcus centralis. The width of the gyrus pre- centralis is about two times of the gyrus postcentralis, and in such low power magnifi- cation difference of cytoarchitecture of these two areas is evident.

・ Higher magnification of 22-36. The area 3 is the primary sensory center accepting the somatic sensory fibers via thalamus. The six layers are here roughly identified. The external and internal granular layers, consisting of small pyramidal cells concern the sensory acceptance and transmit the impulses to the external and internal pyramidal layers, of effective character. Because the area 3 is of receptive character, external and internal granular layers develop well, whereas external and internal pyramidal layers of effective character, not well. The internal pyramidal layer appears as a narrow cell- scanty band. The multiform layer shows here moderate development

- Higher magnification of 22-26. Area 4 is the cortical motor center and of effective cha- racter. In this area the external granular layer is poorly developed and internal granular layer is not recognized. On the contrary to them, the external pyramidal layer develops very well and occupies about the half of the whole width of the cortex and without any boundary shifts to the internal pyramidal layer, in which very large nerve cells, giant pyramidal cells, appear in one line. The giant pyramidal cells, 35 to 40 μ m／ 60 to 80 μ m in size, send one very long axon downward until the nuclei of motor cranial nerves and also until the anterior horn of the spinal cord to control the muscle move- ment. Each giant pyramidal cell sends one thick tip dendrite upward into the molecular layer, where it divides into two in Y-form and further runs horizontally (see 05-06 and 05-07). The multiform layer develops also well and makes a thick layer. The cortex of Area 4 is thick and its width is about two times of that of area 3, and identification of six layers is almost impossible.
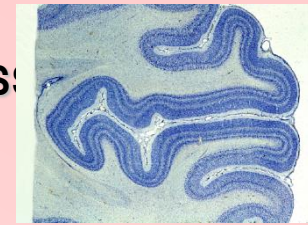
- On the inner surface of the occipital lobe, there is a straight horizontal groove from the occipital end to inward, that is sulcus calcarinus (long arrow). The cerebral cortex upper and lower to this sulcus is constructed quite characteristically. Here terminate optic sensory fibers via corpus geniculatum laterale, very orderly. Here in the middle portion of the cortex a white line runs parallel to the cortical surface. This white line running parallel to the surface, in the middle of the gray cortex, is even macroscopically evident so that this cortex is called area striata.

- The cortex neighboring to the area striata is called area parastriata, in which no such white line exist. The boundary of these areas is indicated with short arrows.
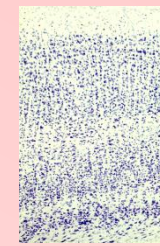
- Higher magnification of 22-39. This figure shows the typical cytoarchitecture of the Area 17, area striata. The external granular layer consists of densely packed small pyramidal cells and shifts without clear boundary to the external pyramidal layer which consists of also small pyramidal cells. At the deeper portion it shifts to the internal granular layer consisting of three sublayers. The IVa sublayer is continuous with the external pyramidal layer and consists of smaller pyramisal cells with denser arrange- ment. The IVb sublayer looks somewhat cell-scanty layer and consists of spindle-shaped or rhomboid cells orienting horizontally. This layer coincides with the white line in the area striata. The IVc sublayer consists of small pyramidal cells. Going deeper, cells become smaller and arranged denser. The internal pyramidal layer is a narrow cell- scanty layer containing small number of pyramidal or polyhedral cells. Some nerve cells are oriented horizontally. The multiform layer is a relatively thin but conspicuous layer consisting of cells, somewhat larger and of irregular form, arranged densely.
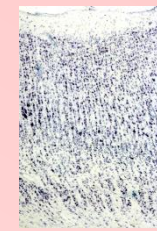
・　The area 18, area parastriata, continues directly with area 17, area striata, (see 22-39, and 22-42). The cytoarchitecture of the area 18, consisting of six layers, is typical and easy to identify the six layers. Here the external pyramidal layer is thick and occupies about the half of the whole thickness of the cortex. At its deeper portion appear relatively large pyramidal nerve cells commonly. In the internal pyramidal layer appear sometimes relatively large spindle-shaped or polyhedral neurons oriented randomly. The multiform layer consists of nerve cells of triangular, spindle-shaped or polyhedral in shape, staining deep blue, and densely oriented.
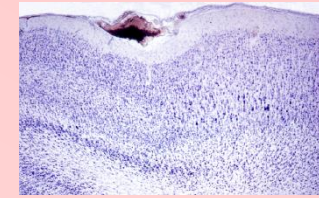
- This figure shows the uniting place of the area 17 with area 18, indicated by a red line. The cytoarchitecture of respective area is evident and the mode of uniting two areas is not gradual but quite abrupt. The layer IV of the area 18 shifts to area 17 and divides into three sublayers, IVa, Ivb, and Ivc.