The Brain
lecture presentation

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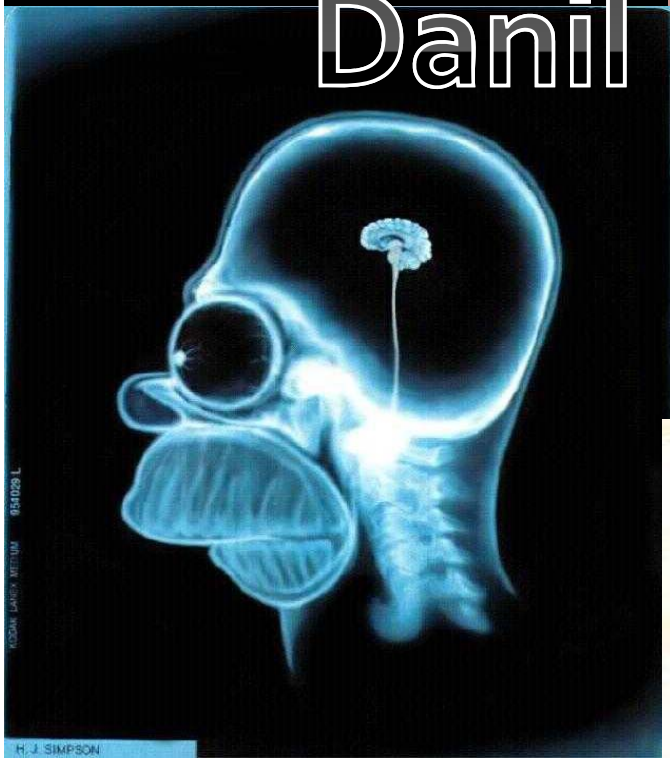
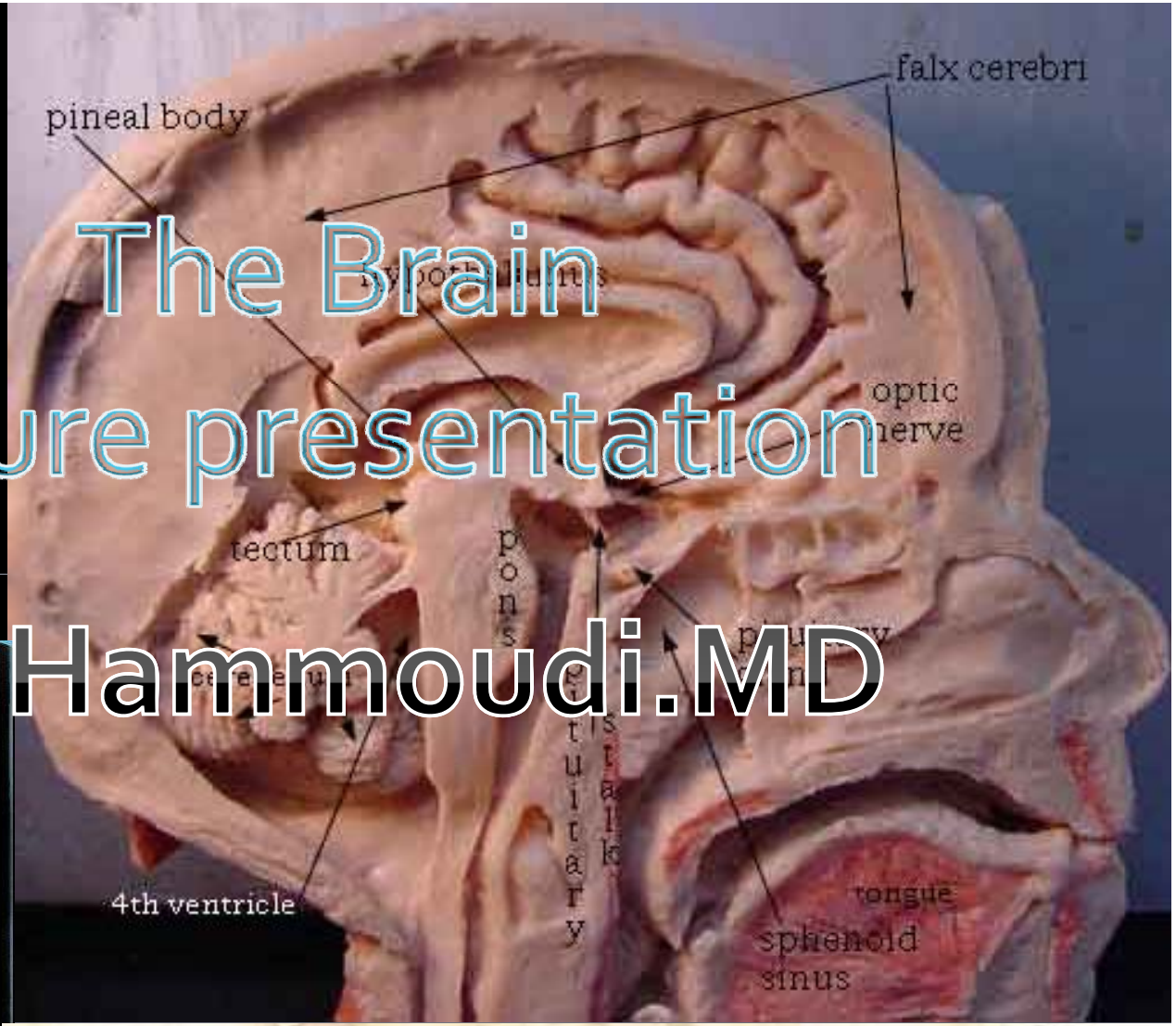




Telencephalon

Diencephalon

Prosencephalon
(forebrain)

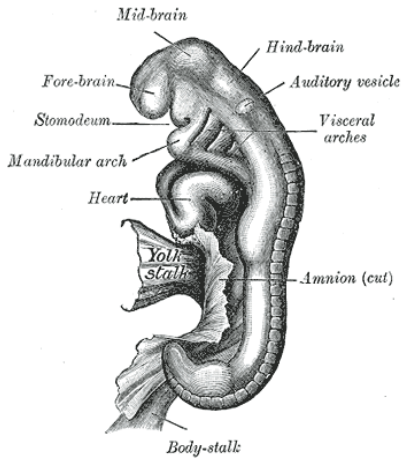
Mesencephalon
(midbrain)

Metencephalon

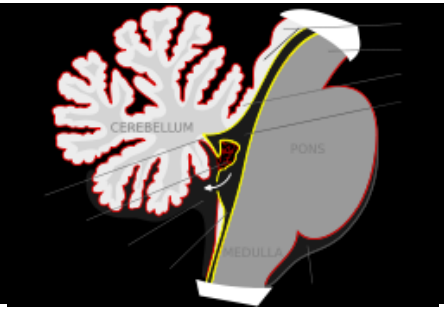
Myelencephalon

Rhombencephalon
(hindbrain)

Spinal cord



New Terms: Brain Division



Telencephalon

–Cerebral Cortex

–Limbic system

–Basal Ganglia

Diencephalon

Thalamus
Hypothalamus
Epithalamus

Mesencephalon

Metencephalon

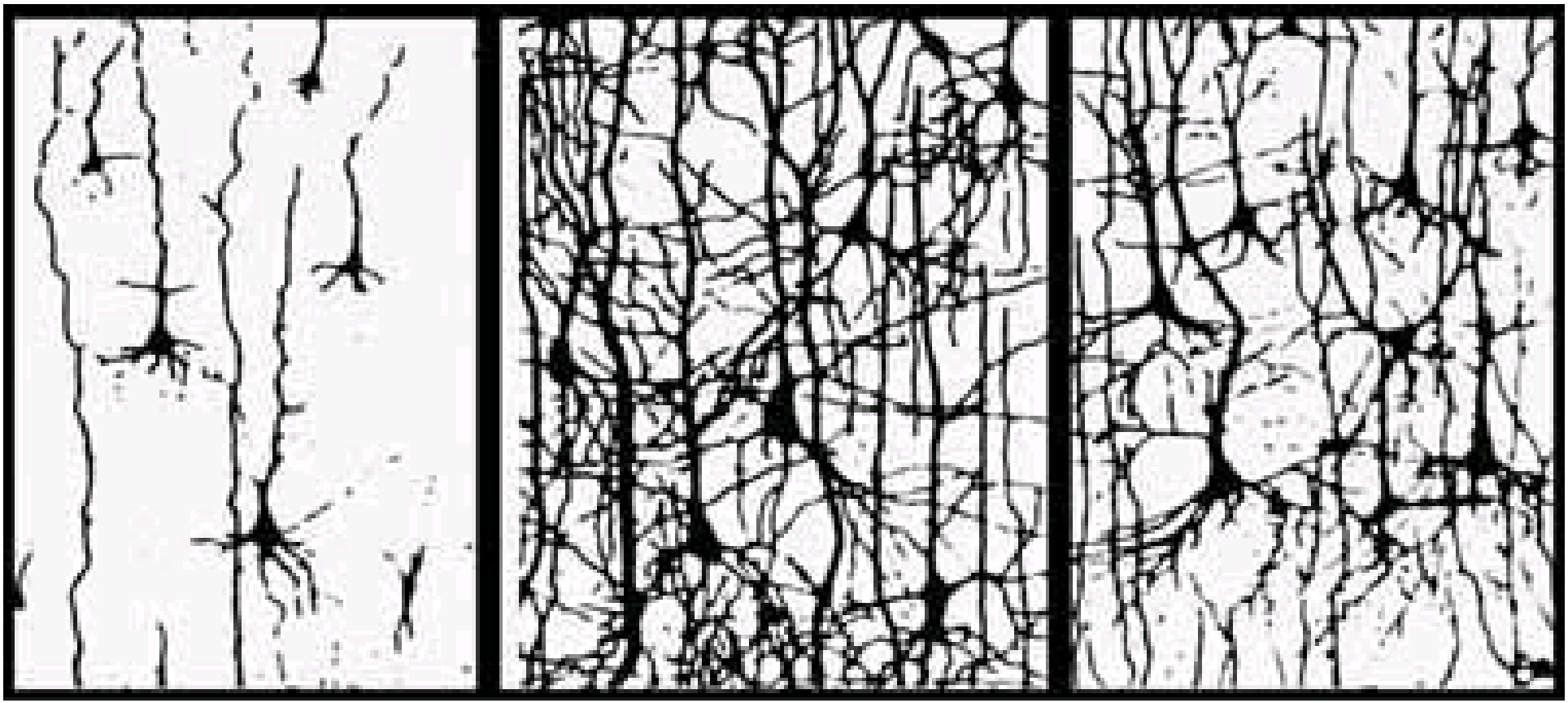
Pons:

Cerebellum

portion of the **fourth ventricle; trigeminal nerve (CN V), abducens nerve (CN VI), facial nerve (CN VII), and a portion of the vestibulocochlear nerve** (CN VIII).

Myelencephalon

Medulla



At Birth 6 Years Old 14 Years Old

Synaptic Density in the Human Brain

Key words that you need to know

- **Cerebrum :**
  - Cerebral hemispheres
  - Longitudinal fissures
  - Cerebral cortex
  - Sulcus
  - Gyri
  - all lobes
  - Gyruses
  - Insula
  - Cerebral white matter
  - Corpus callosum
  - Fornix
  - Septum pellucidum
  - ventricles

- **Cerebellum**
  - Transverse fissure
  - Vermis
  - Cerebellar hemispheres
  - Arbor vitae
- **Cranial nerves**
  - Olfactive
  - Olfactive bulbs
  - Olfactory tracts
  - Optic nerves
  - Optic chiasma
  - Oculomotor nerves
  - Trigeminal nerves

- **Diecephalon**
  - **Thalmus**
  - **Hypothalamus**
  - **Intermediate mass**
  - **Mamillary bodies**
  - **Pituitary gland**
  - **Infundibulum**
  - **Choroid plexus**
  - **3rd ventricle**
  - **Csf**
- **Brain stem**
  - Midbrain
  - Tectum
  - Corpora quadregemina
  - Superior and inferior colliculi
  - Pons
  - Nuclei
  - Medulla oblongata [medulla]
  - Cerebral aquaduct
  - 4th ventricle

Cerebrum

Cerebrum -The largest division of the brain.

- The cerebrum is divided in to two hemispheres, the right and left hemispheres each of which is divided into four lobes

- The dividing point is a deep grove called **the longitudal cerebral fissure**.

- The different sides of the cerebrum do different things for the opposite sides of the body.

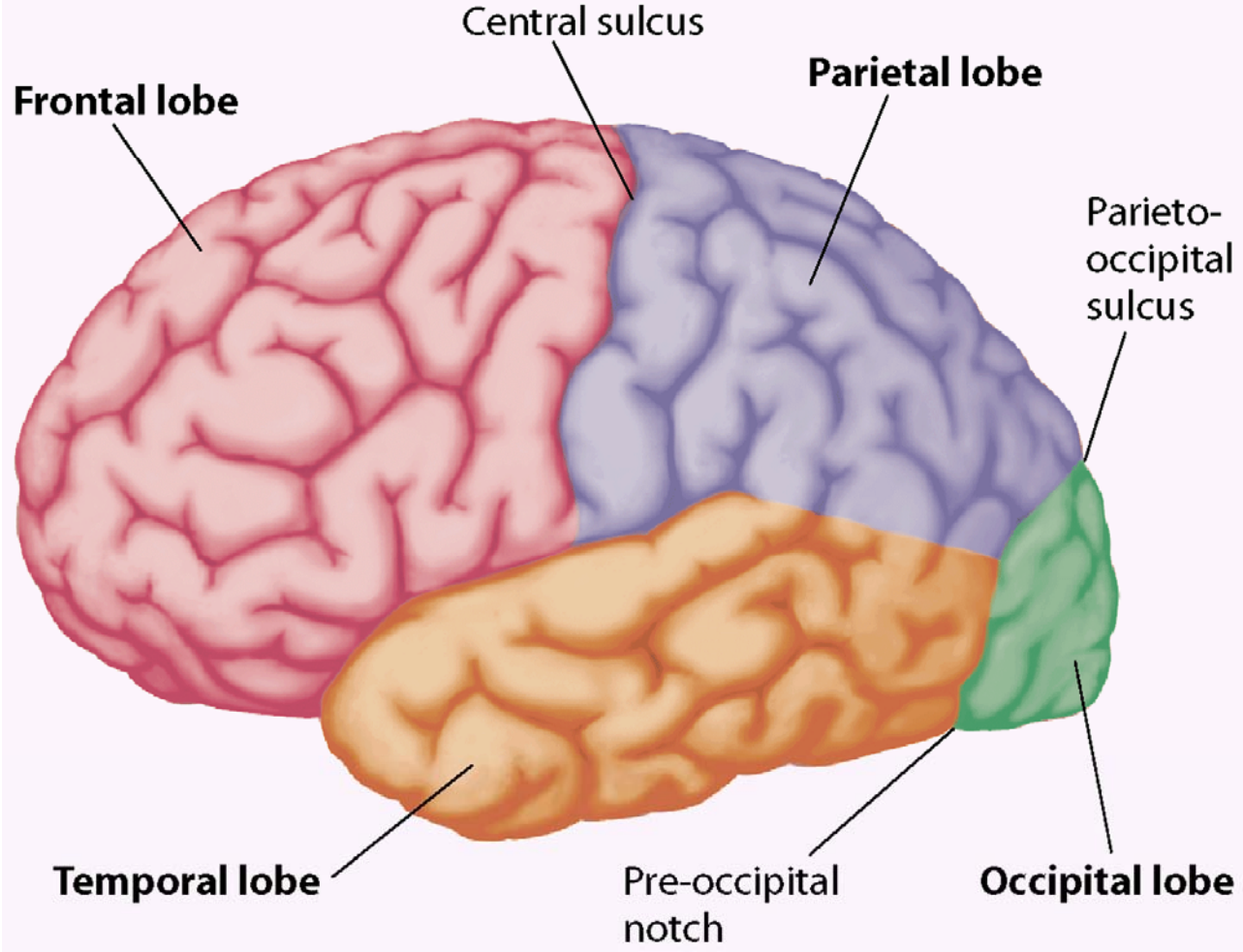
- **The right side of the cerebrum controls things such as imagination and 3-D forms.**

- **The other side of the brain, the left side, controls numbering skills, posture, and reasoning**.

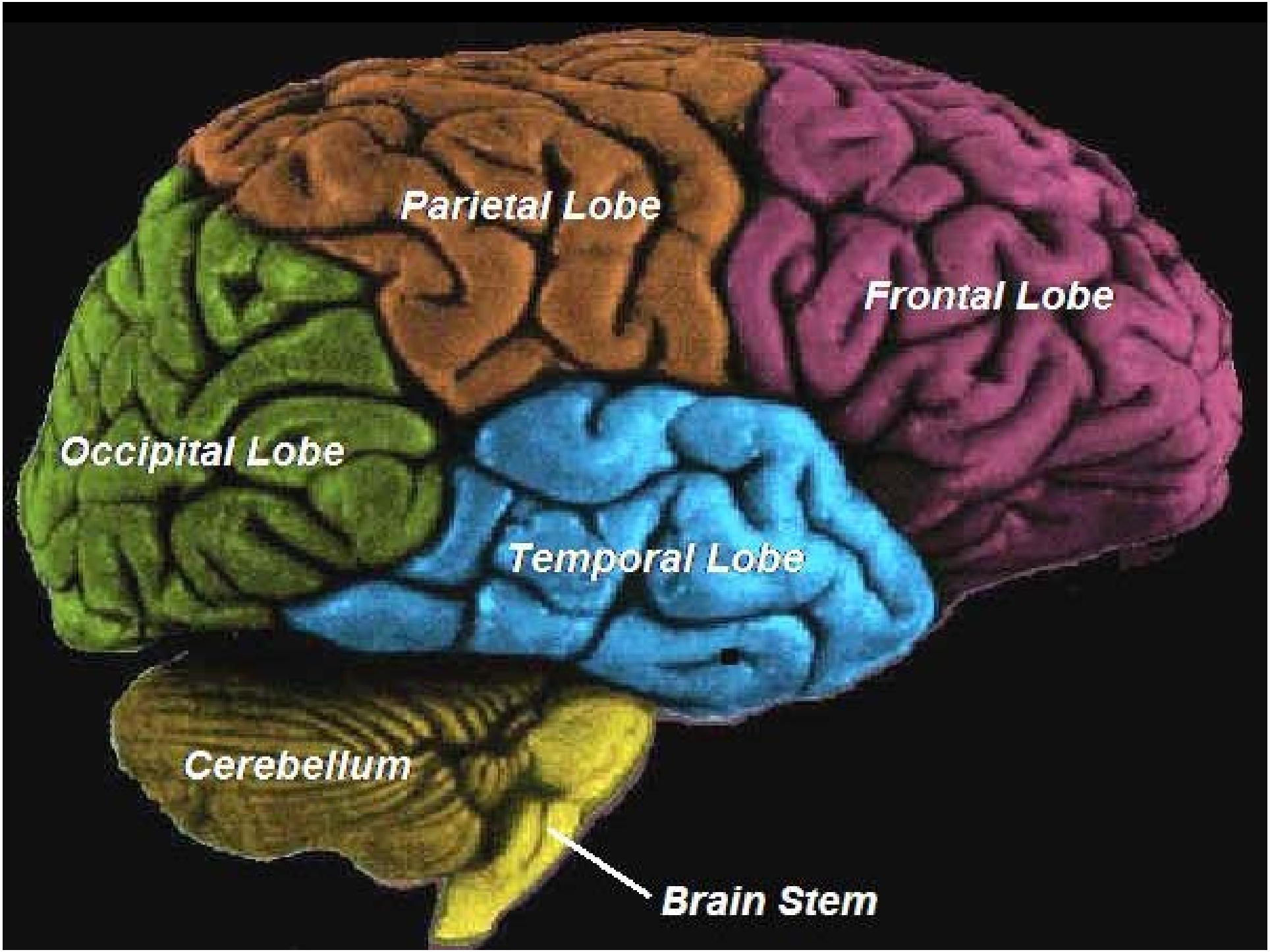
Major Structures of the Cortex

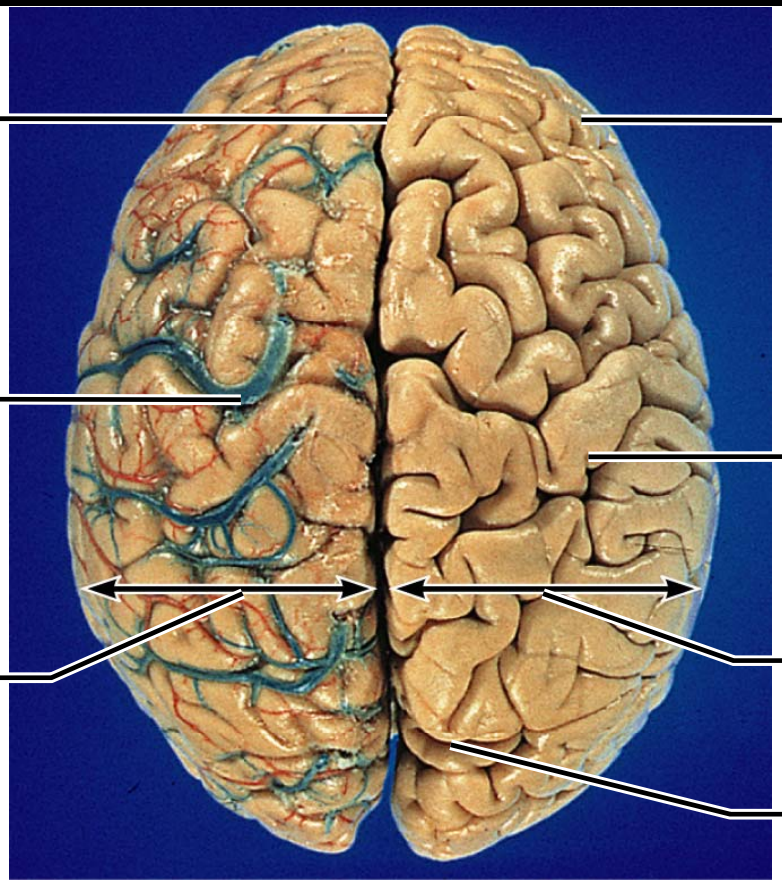
- 4 Lobes
  - –Frontal Lobe
  - –Parietal Lobe
  - –Occipital Lobe
  - –Temporal Lobe

- Major Fissures
  - –Central Sulcus
  - –Longitudinal Fissure
  - –Sylvian Fissure



- *The lobes are distinguished both structurally and functionally*


Parietal Lobe
Frontal Lobe
Occipital Lobe
Temporal Lobe
Cerebellum
Brain Stem


Longitudinal fissure
Frontal lobe
Cerebral veins and arteries covered by arachnoid
Parietal lobe
Left cerebral hemisphere
Right Cerebral hemisphere
Occipital lobe
Posterior

(c)

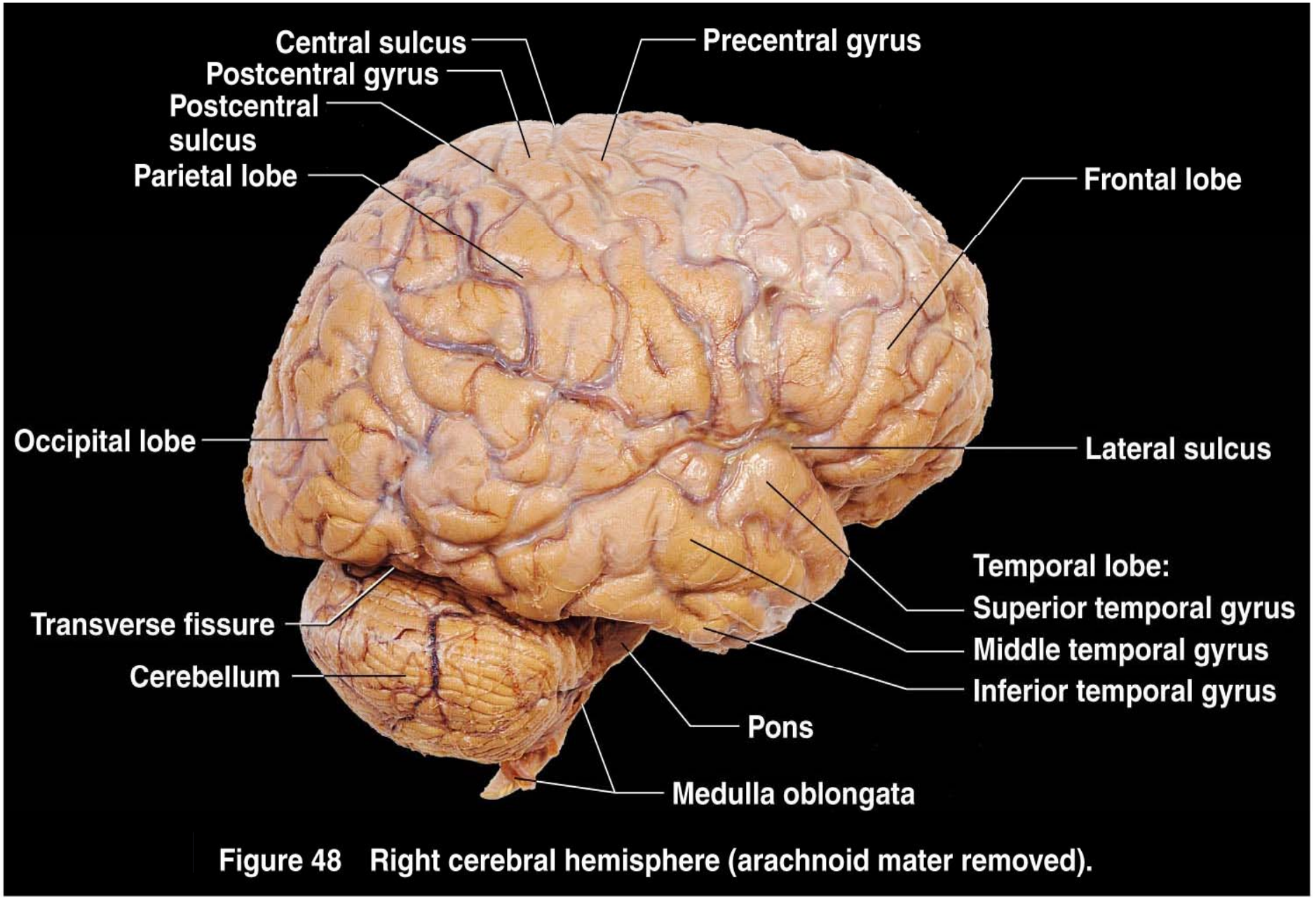
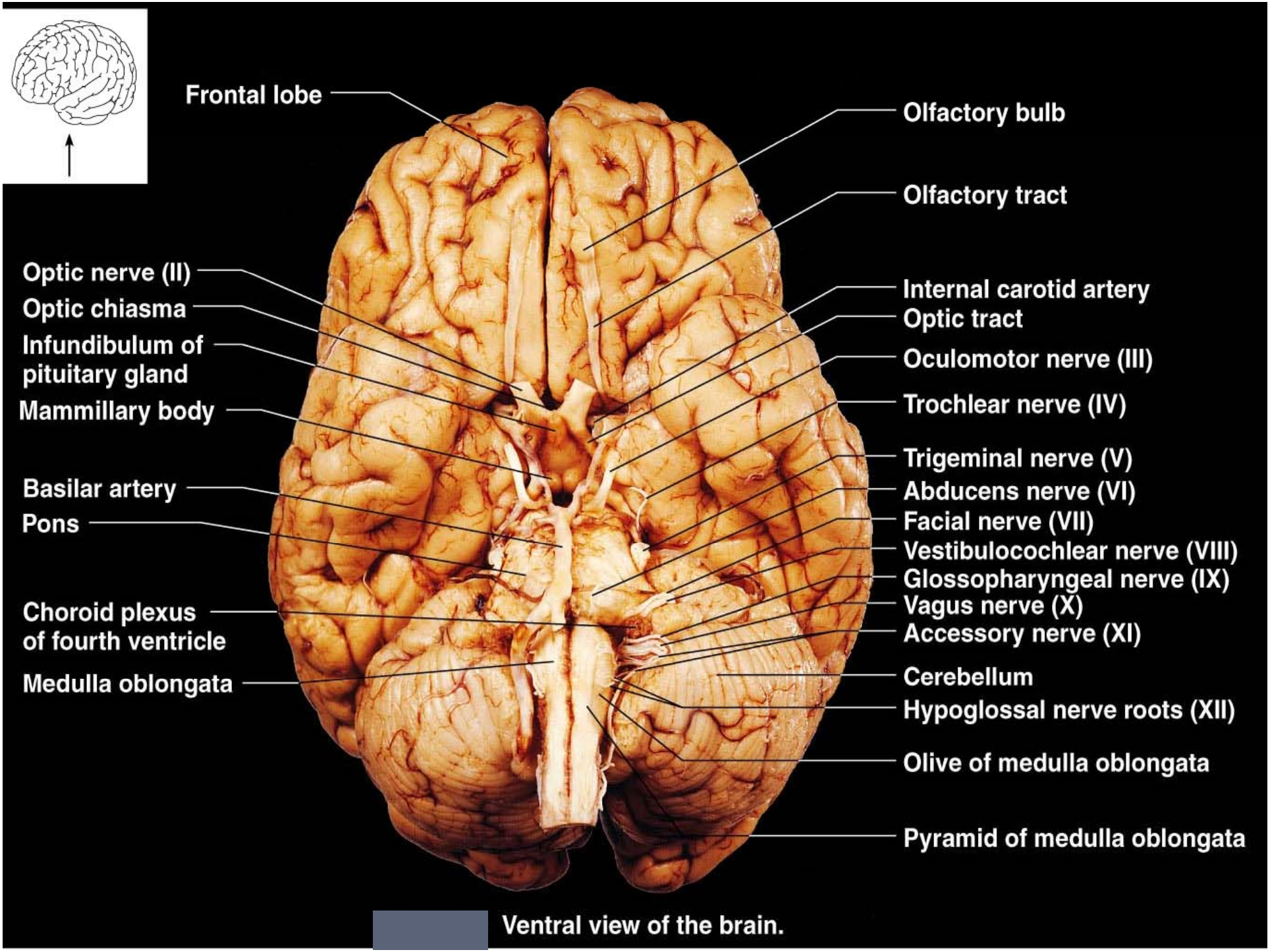


Figure 48 Right cerebral hemisphere (arachnoid mater removed).



Ventral view of the brain.

Cerebral hemisphere (*hemispherium cerebrale*)

•Is defined as one of the two regions of the brain that are delineated by the body's median plane.

•The brain can thus be described as being divided into **left** and **right cerebral hemispheres**. Each of these hemispheres has an outer layer of grey matter called the cerebral cortex that is supported by an inner layer of white matter.

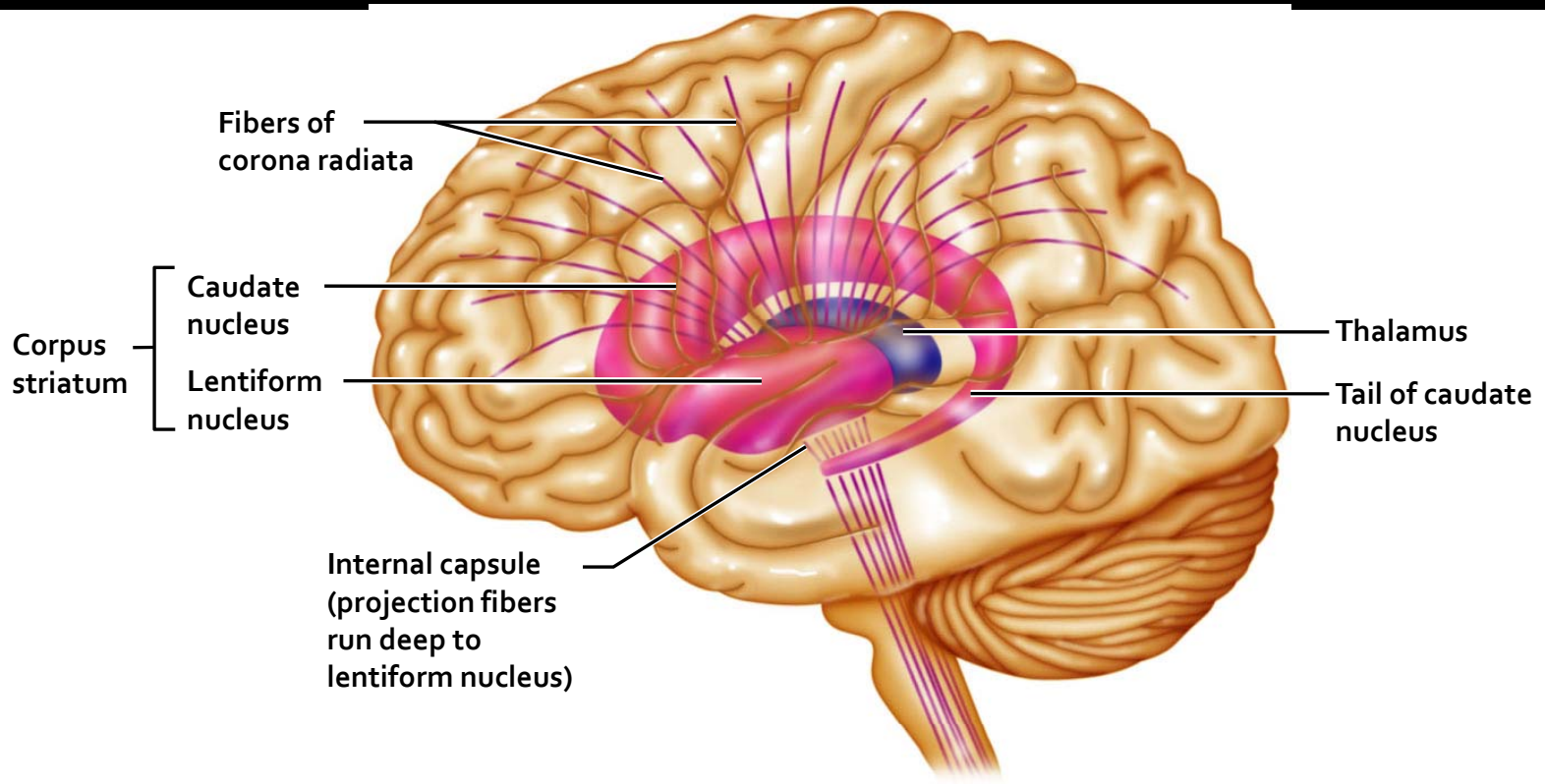
• **The hemispheres are linked by the corpus callosum**, a very large bundle of nerve fibers, and also by other smaller **commissures, including the anterior commissure, posterior commissure, and hippocampal commissure.**

•These commissures transfer information between the two hemispheres to coordinate localized functions.

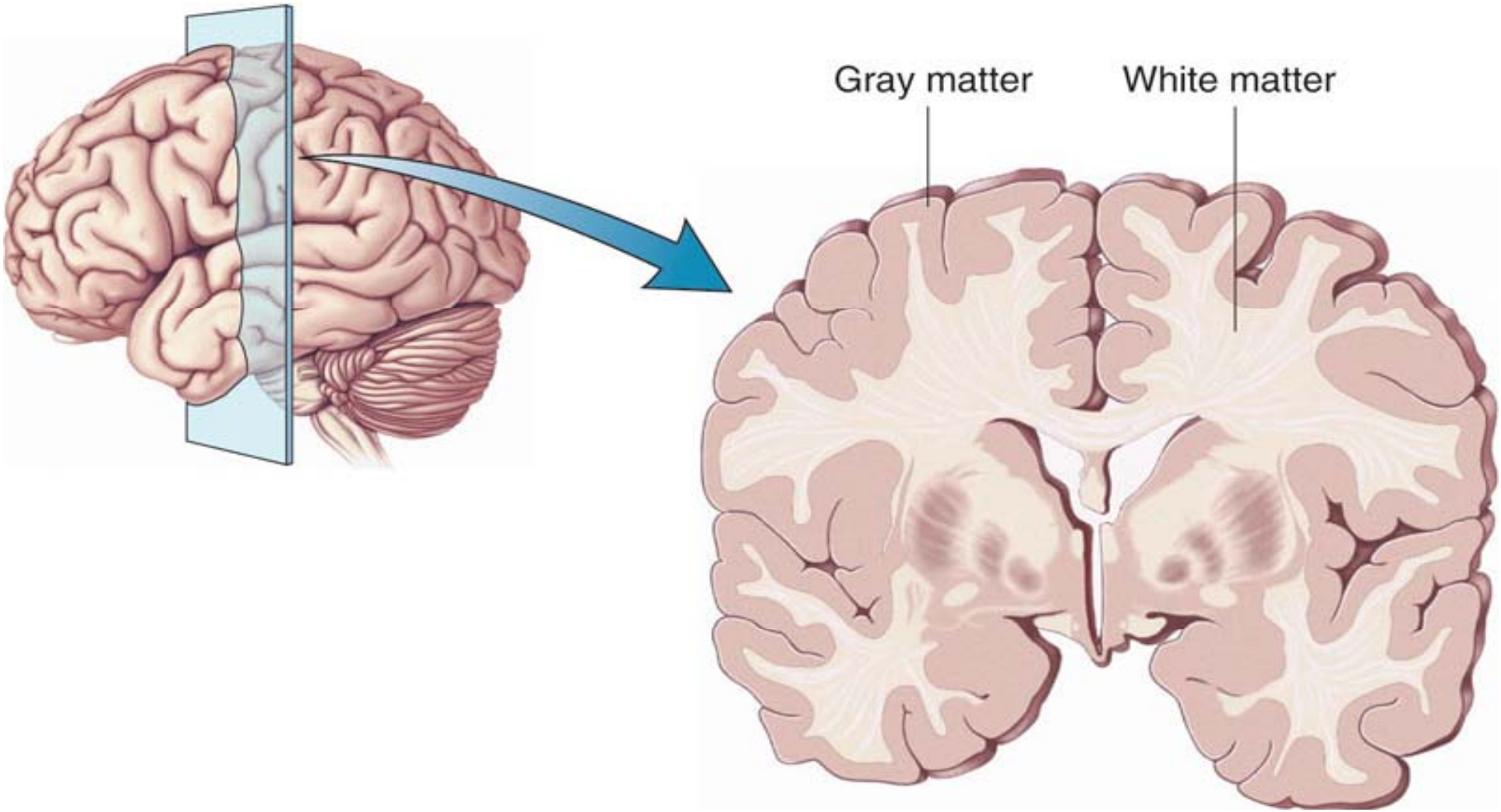
• The architecture, types of cells, types of neurotransmitters and receptor subtypes are all distributed among the two hemispheres in a markedly asymmetric fashion.

• However, it must be noted that, while some of these hemispheric distribution differences are consistent across human beings, or even across some species, many observable distribution differences vary from individual to individual within a given species.

Figure 12.11a: Basal nuclei, p. 444.



(a)


Gray matter
White matter

Cerebral Features:

- ***Cerebral Features:***

  - **Gyri** – Elevated ridges “winding” around the brain.

  - **Sulci** – Small grooves dividing the gyri

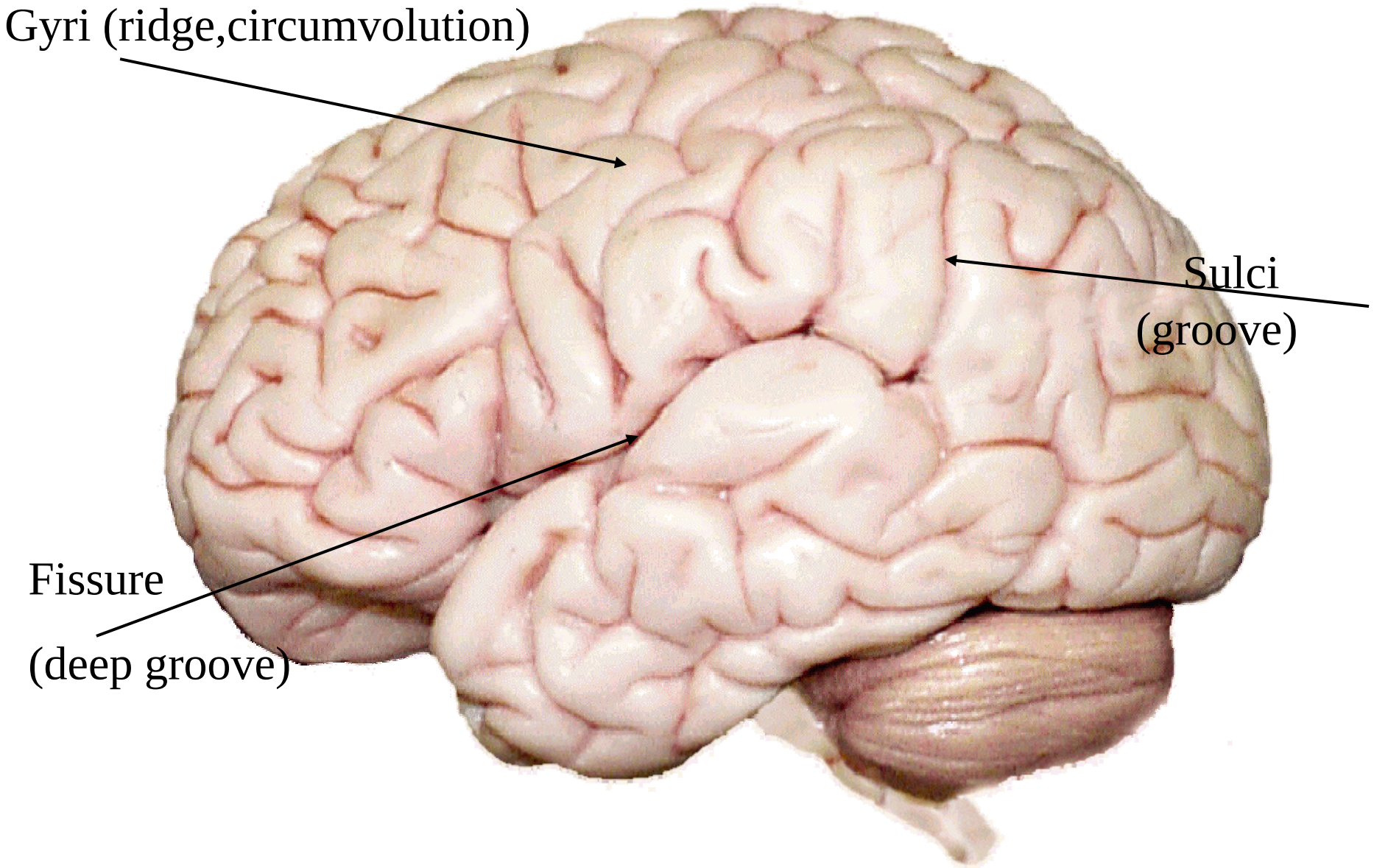
    – **Central Sulcus** – Divides the Frontal Lobe from the Parietal Lobe

  - **Fissures** – Deep grooves, generally dividing large regions/lobes of the brain

    – **Longitudinal Fissure** – Divides the two Cerebral Hemispheres

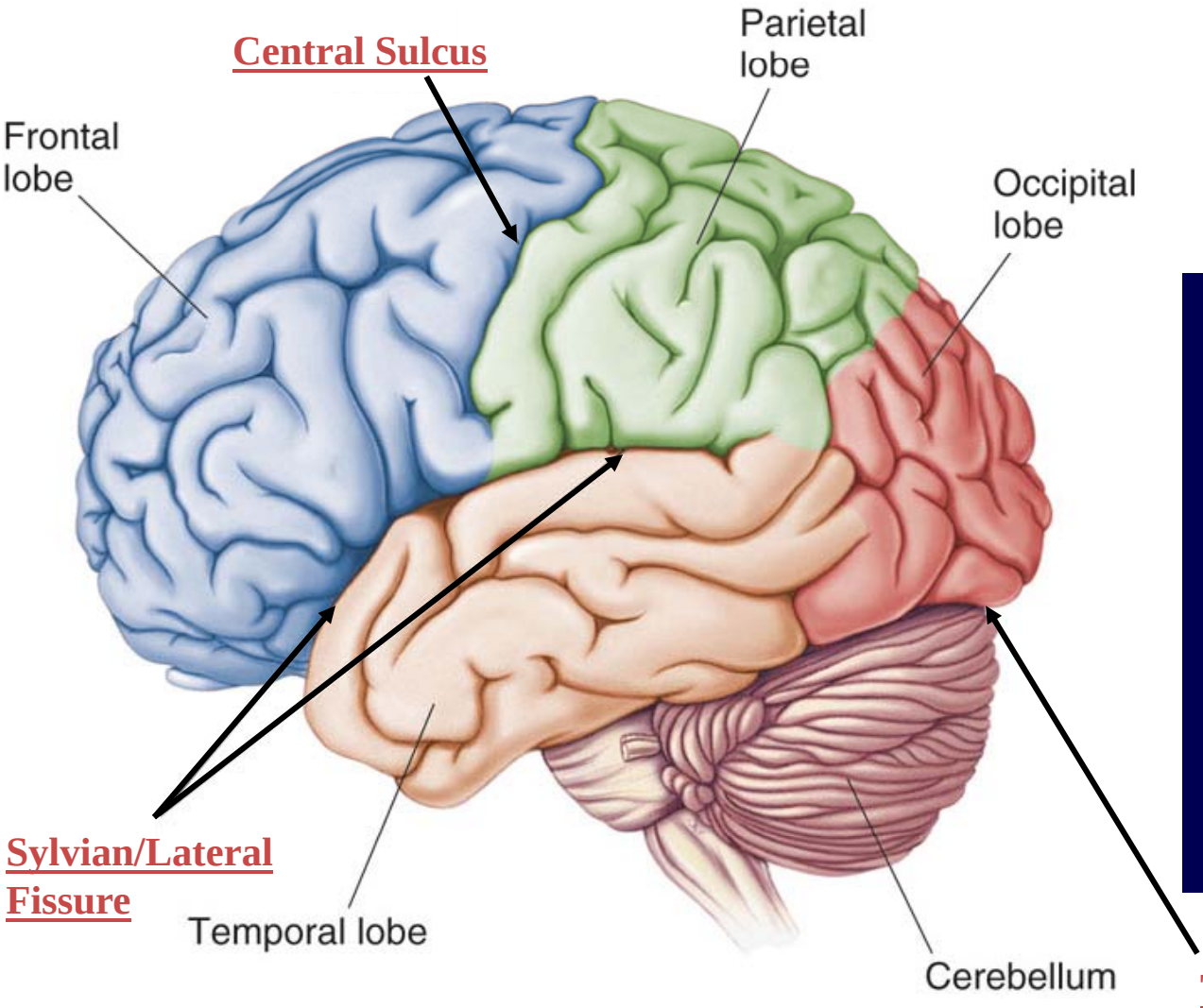
    – **Transverse Fissure** – Separates the Cerebrum from the Cerebellum

    – **Sylvian / Lateral Fissure** – Divides the Temporal Lobe from the Frontal and Parietal Lobes

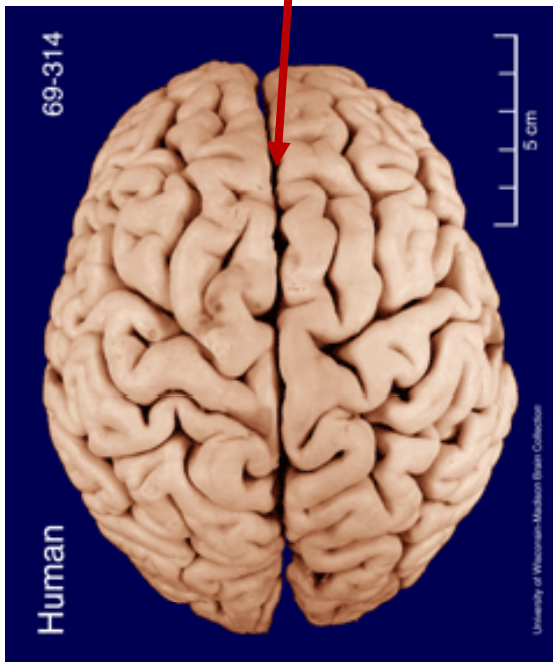


http://williamcalvin.com/BrainForAllSeasons/img/bonoboLH-humanLH-viaTWD.gif

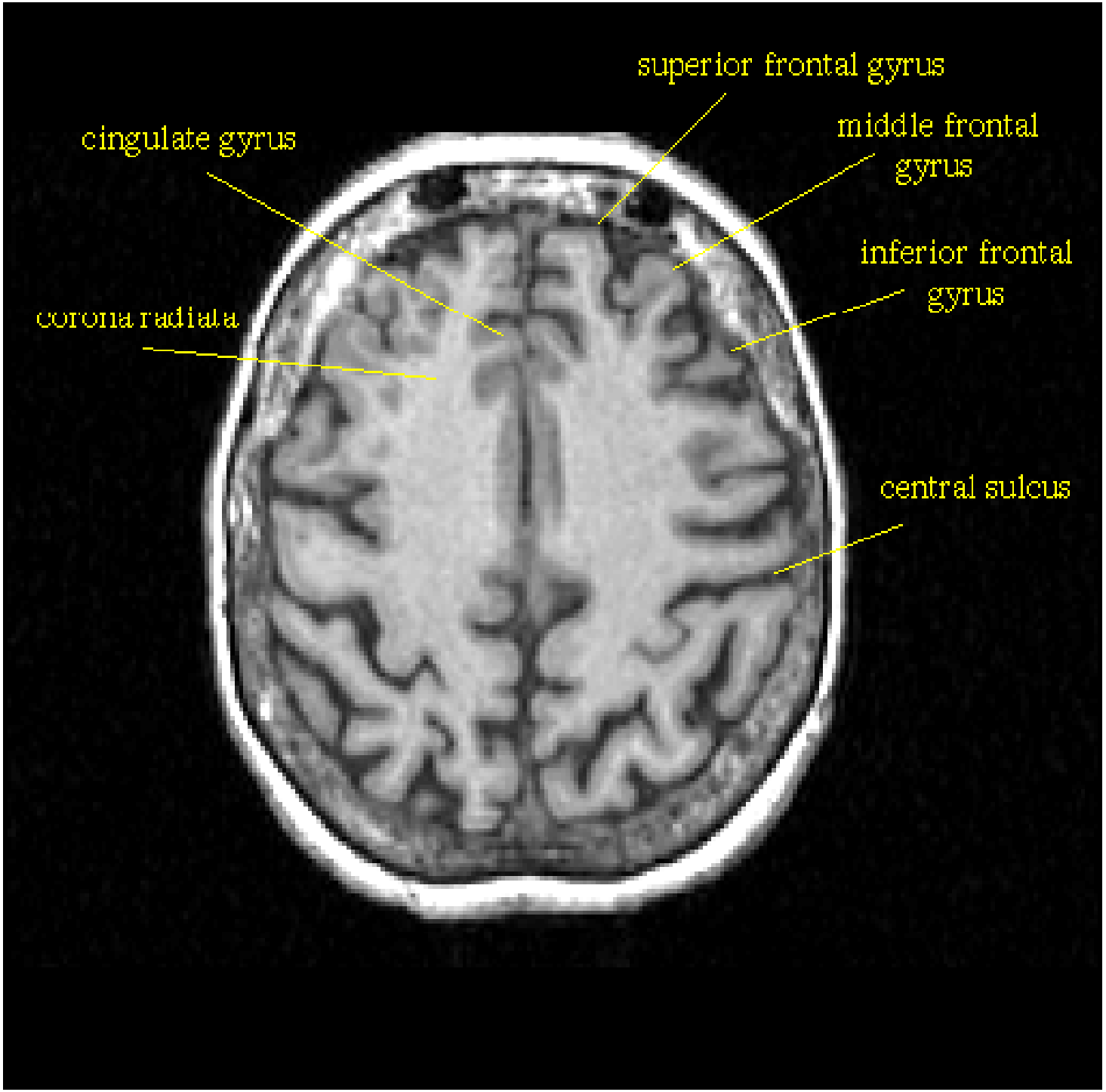
Specific Sulci/Fissures:



http://www.bioon.com/book/biology/whole/image/1/1-8.tif.jpg

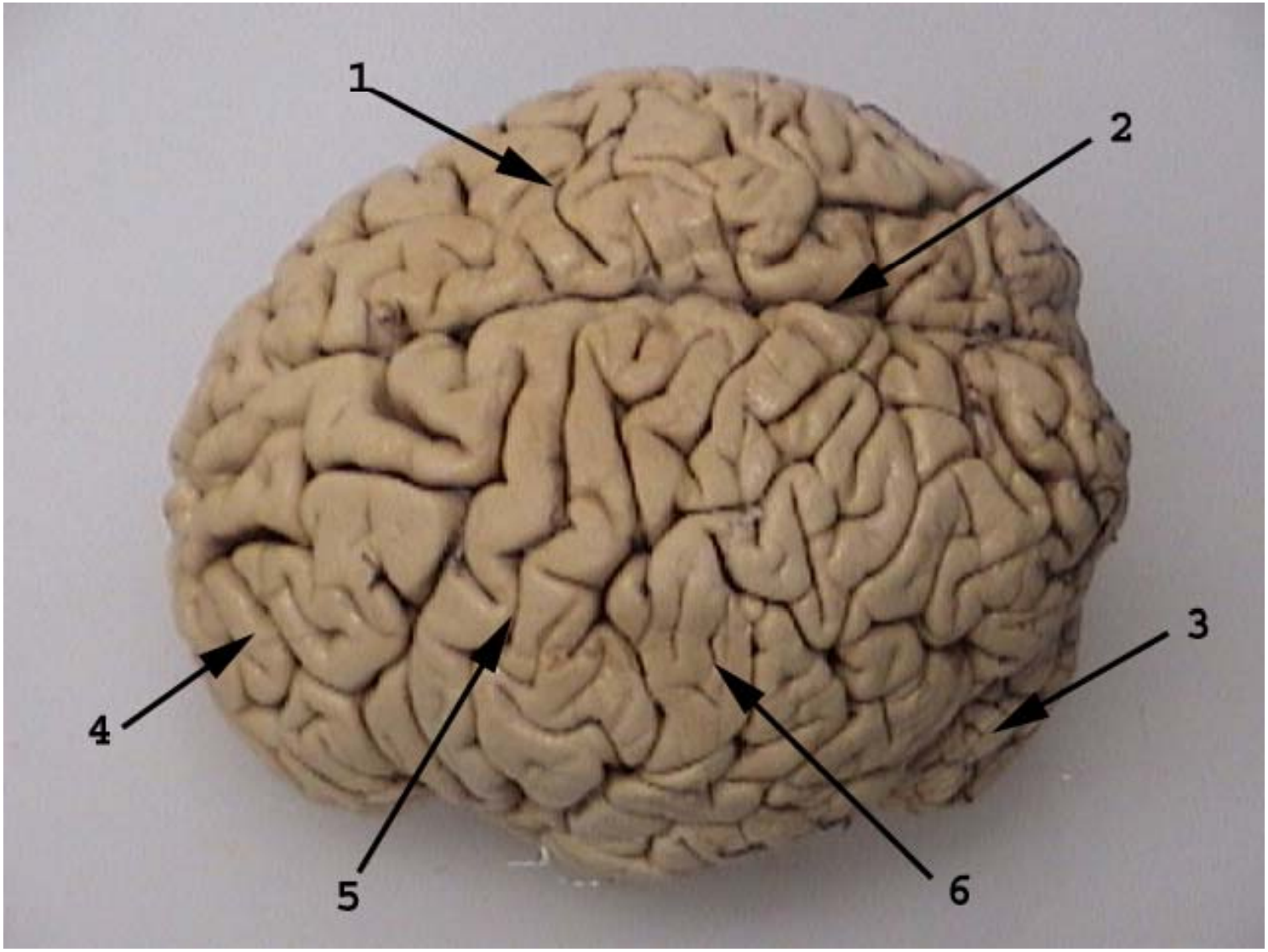


http://www.dalbsoutss.eq.edu.au/Sheepbrains_Me/human_brain.gif


superior frontal gyrus
cingulate gyrus
middle frontal gyrus
inferior frontal gyrus
corona radiata
central sulcus

The **medial longitudinal fissure** (or **longitudinal cerebral fissure,** or **longitudinal fissure,** or **interhemispheric fissure**) is the deep groove which separates the two hemispheres of the vertebrate brain.

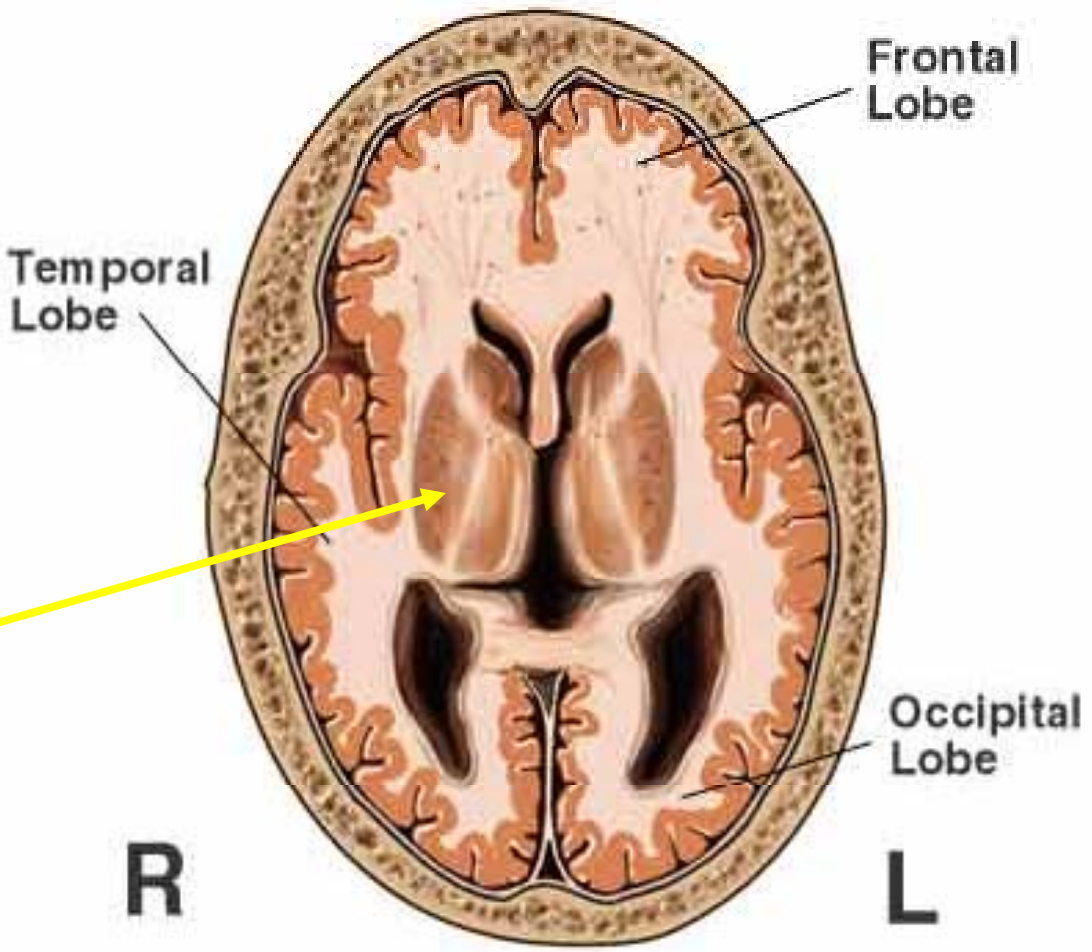
The falx cerebri, a dural brain covering, lies within the medial longitudinal fissure.



1. right cerebral cortex
2. longitudinal fissure
3. cerebellum
4. frontal lobe
5. central sulcus
6. parietal lobe

Cerebrum

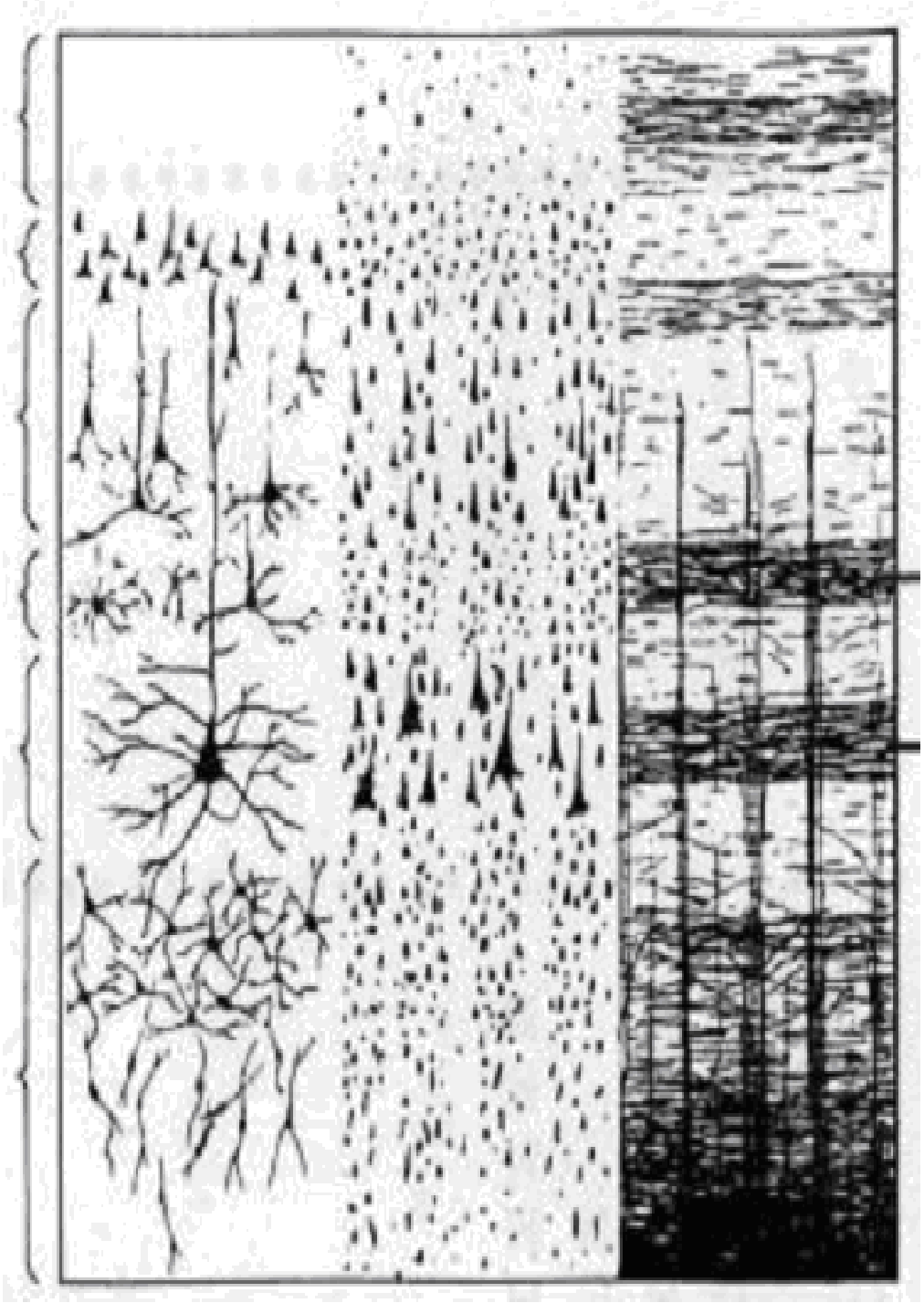
- Each cerebral hemisphere is divided into 3 regions:
  1. Superficial cortex of gray matter
  2. Internal white matter
  3. The basal nuclei – islands of gray matter found deep within the white matter

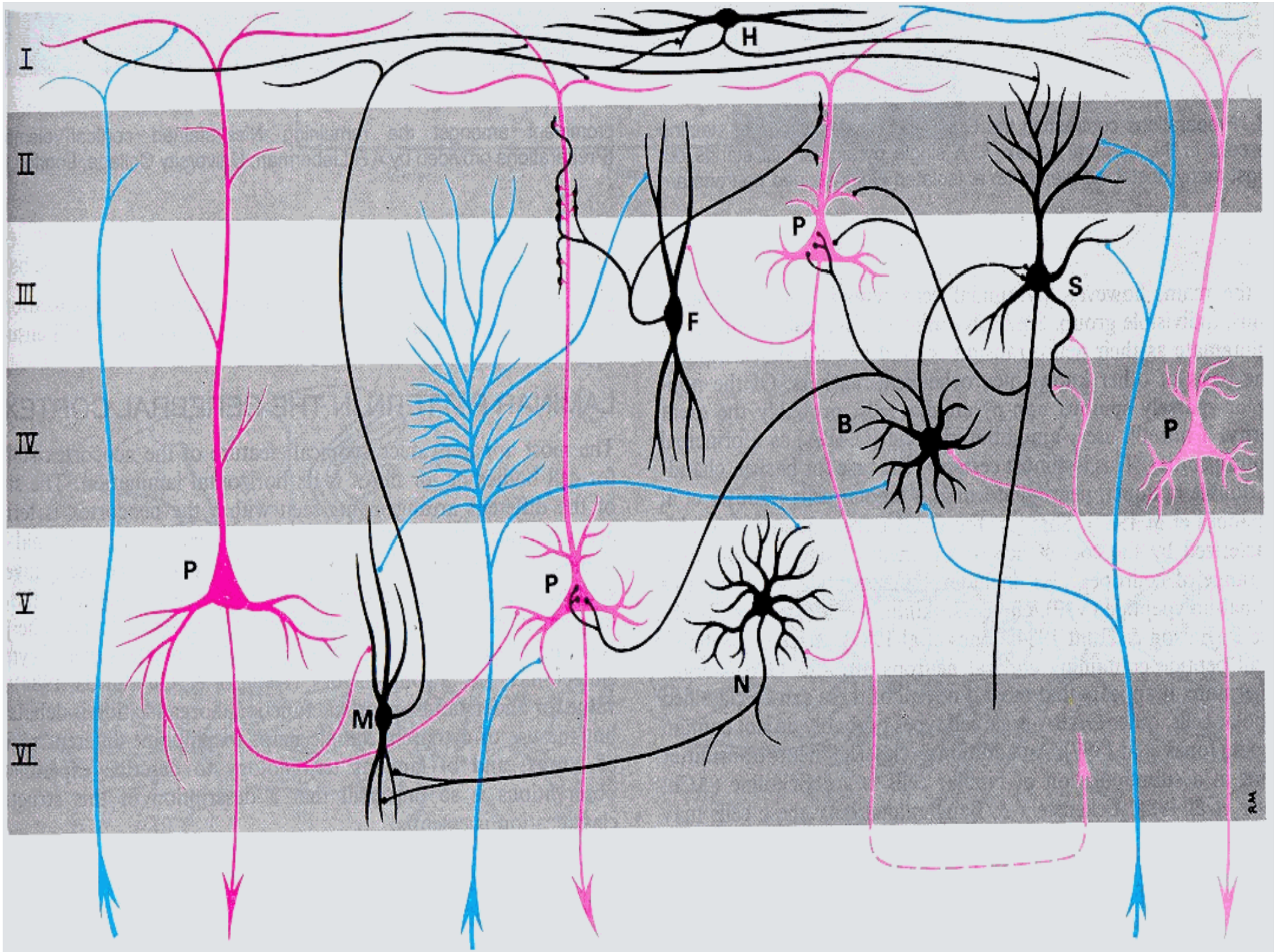


Horizontal section of the brain

The standard areas of cortex (isocortex) is characterized as having six distinct layers. From outside inward:

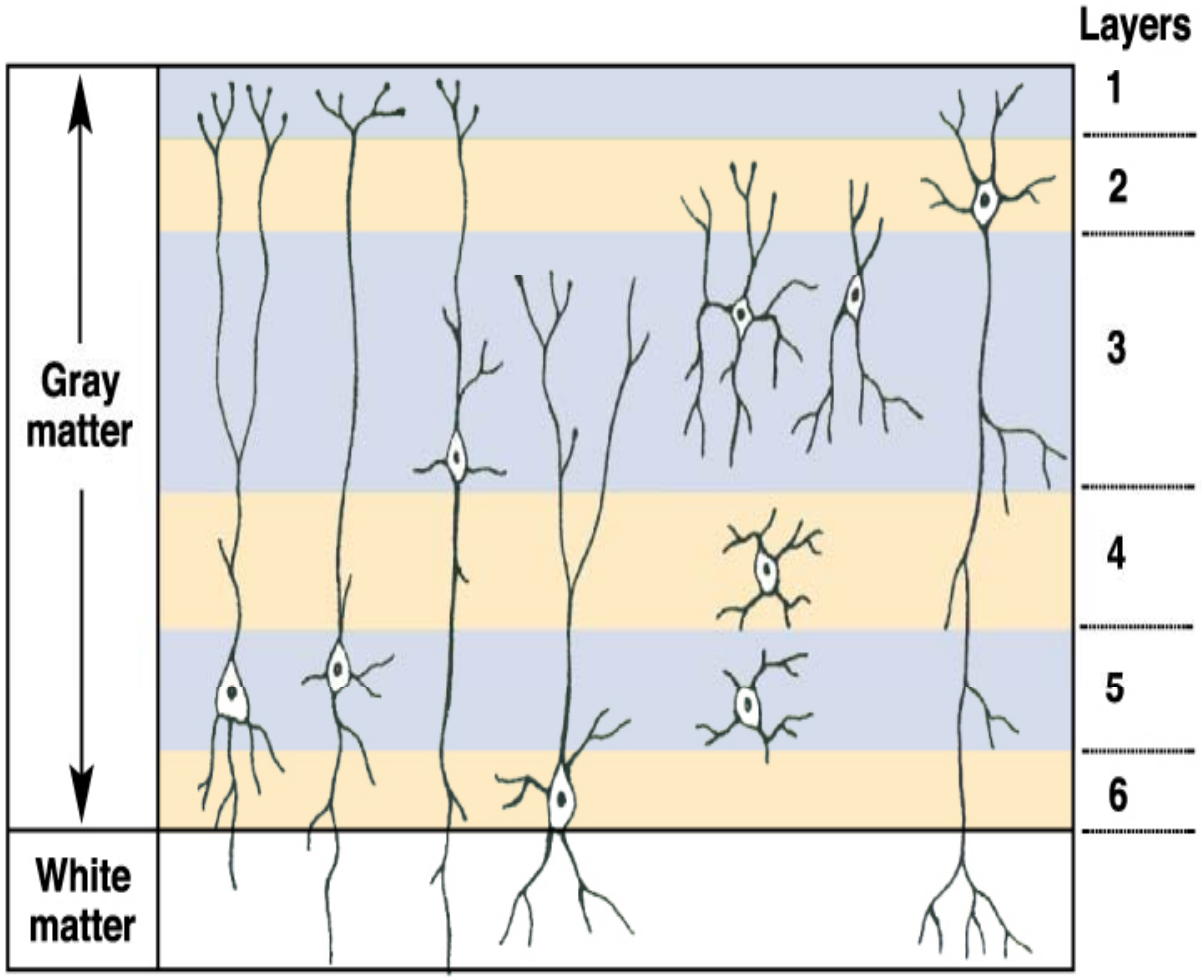
1. Molecular layer
2. External granular layer
3. External pyramidal layer
4. Internal granular layer
5. Internal pyramidal layer
6. Multiform layer.




I
II
III
IV
V
VI
H
F
P
S
B
P
P
P
M
N

Cerebral Cortex

- Allows for sensation, voluntary movement, self-awareness, communication, recognition, and more.
- Gray matter!
- 40% of brain mass, but only 2-3 mm thick.
- Each cerebral hemisphere is concerned with the sensory and motor functions of the opposite side (a.k.a. contralateral side) of the body.



CEREBRAL CORTEX

1. MOLECULAR LAYER **processes**

2. EXTERNAL GRANULAR LAYER

3. EXTERNAL PYRAMIDAL LAYER

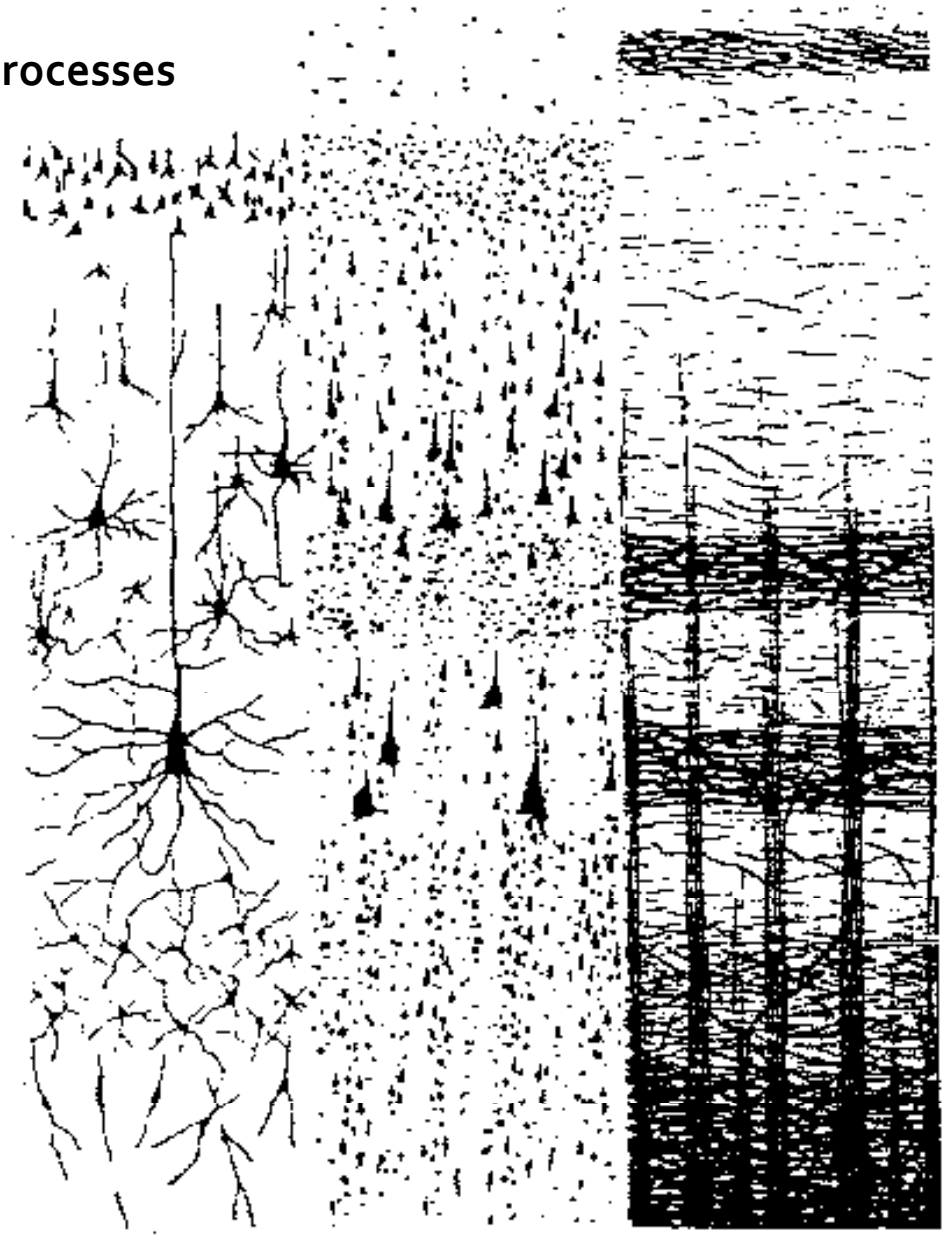
pyramidal cells

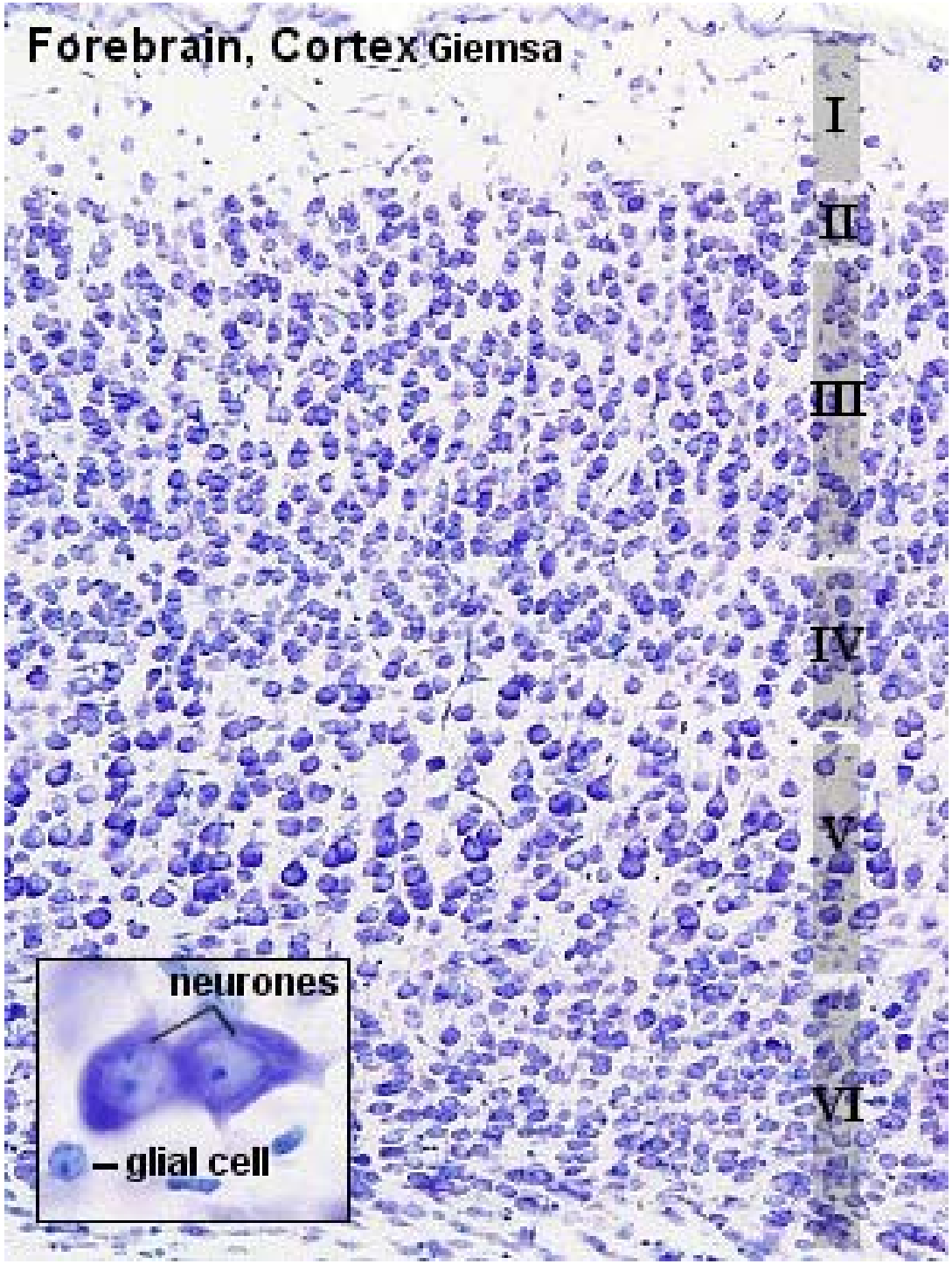
4. INTERNAL GRANULAR LAYER

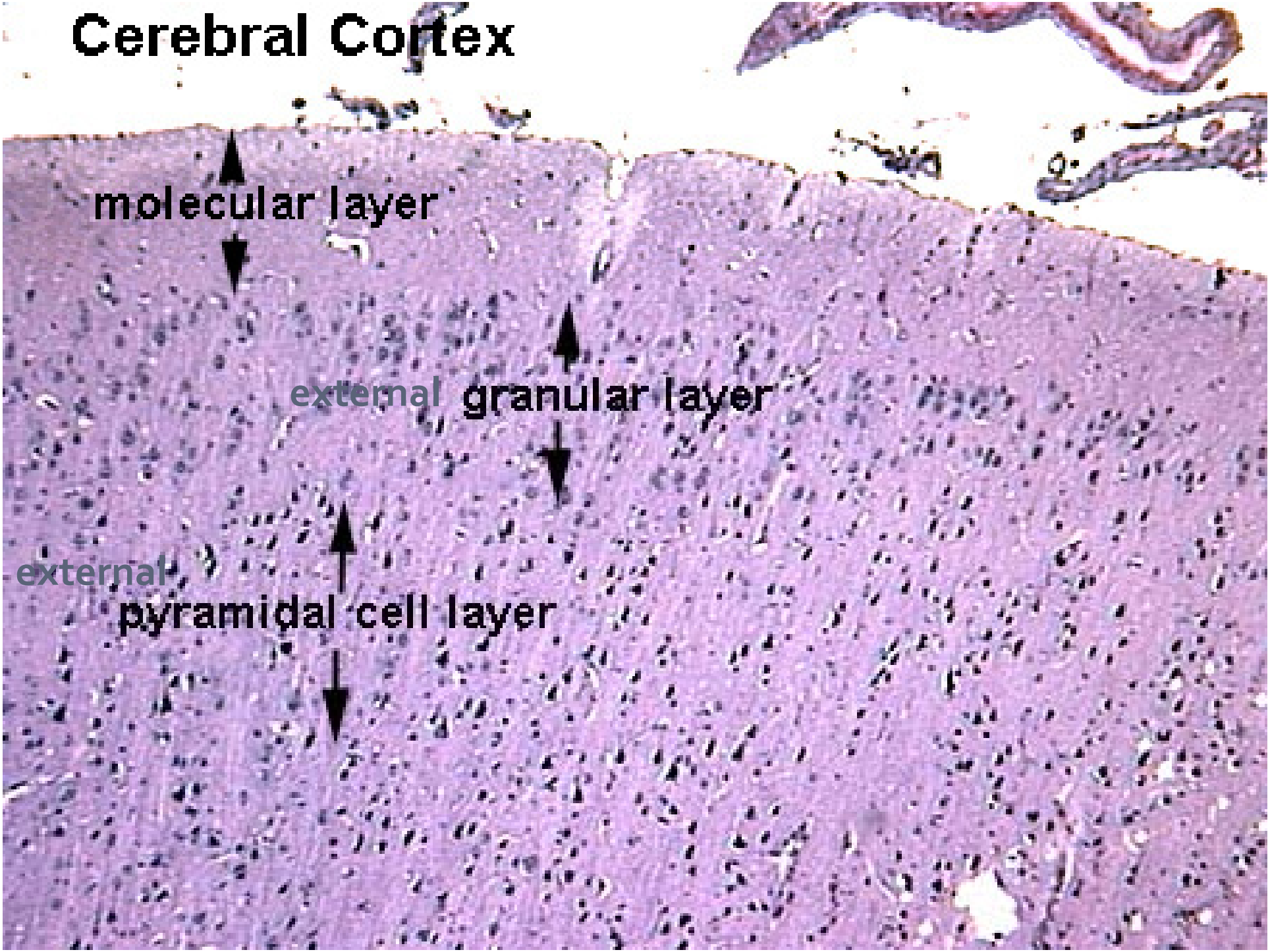
5. INTERNAL PYRAMIDAL LAYER

pyramidal cells

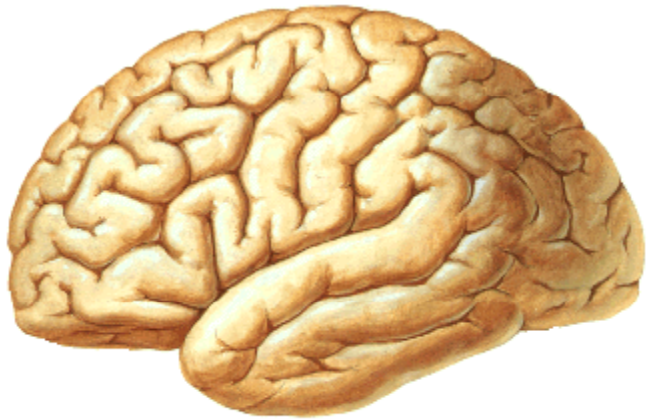
6. MULTIFORM LAYER




Forebrain, Cortex Giemsa
I
II
III
IV
V
VI
neurones
glial cell

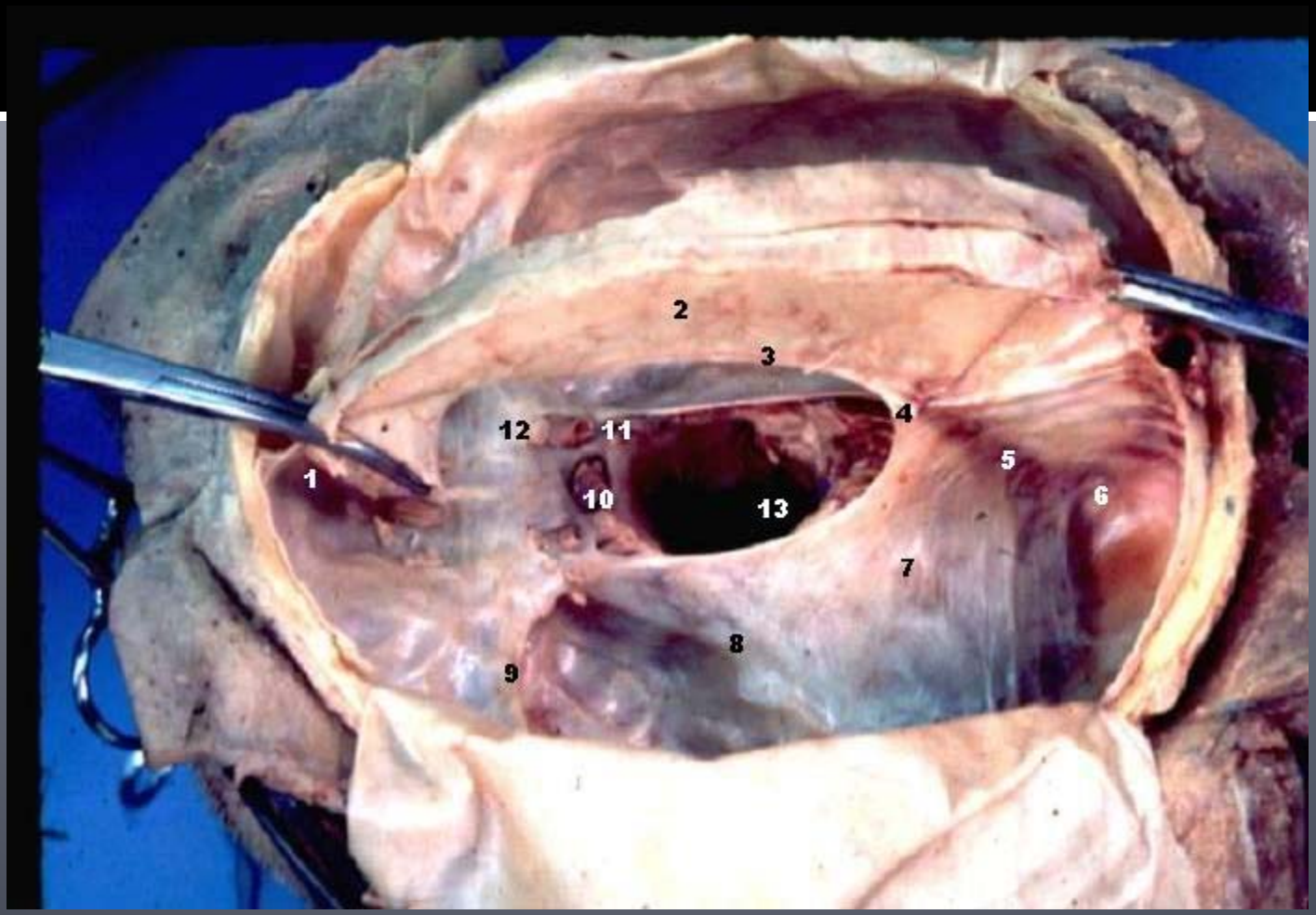

Cerebral Cortex
molecular layer
external
granular layer
external
pyramidal cell layer

Cerebral Cortex



- 3 types of functional areas:
  1. **Motor →** **Control voluntary motor functions**
  2. **Sensory →** **Allow for conscious recognition of stimuli**
  3. **Association →** **Integration**

Falx Cerebri

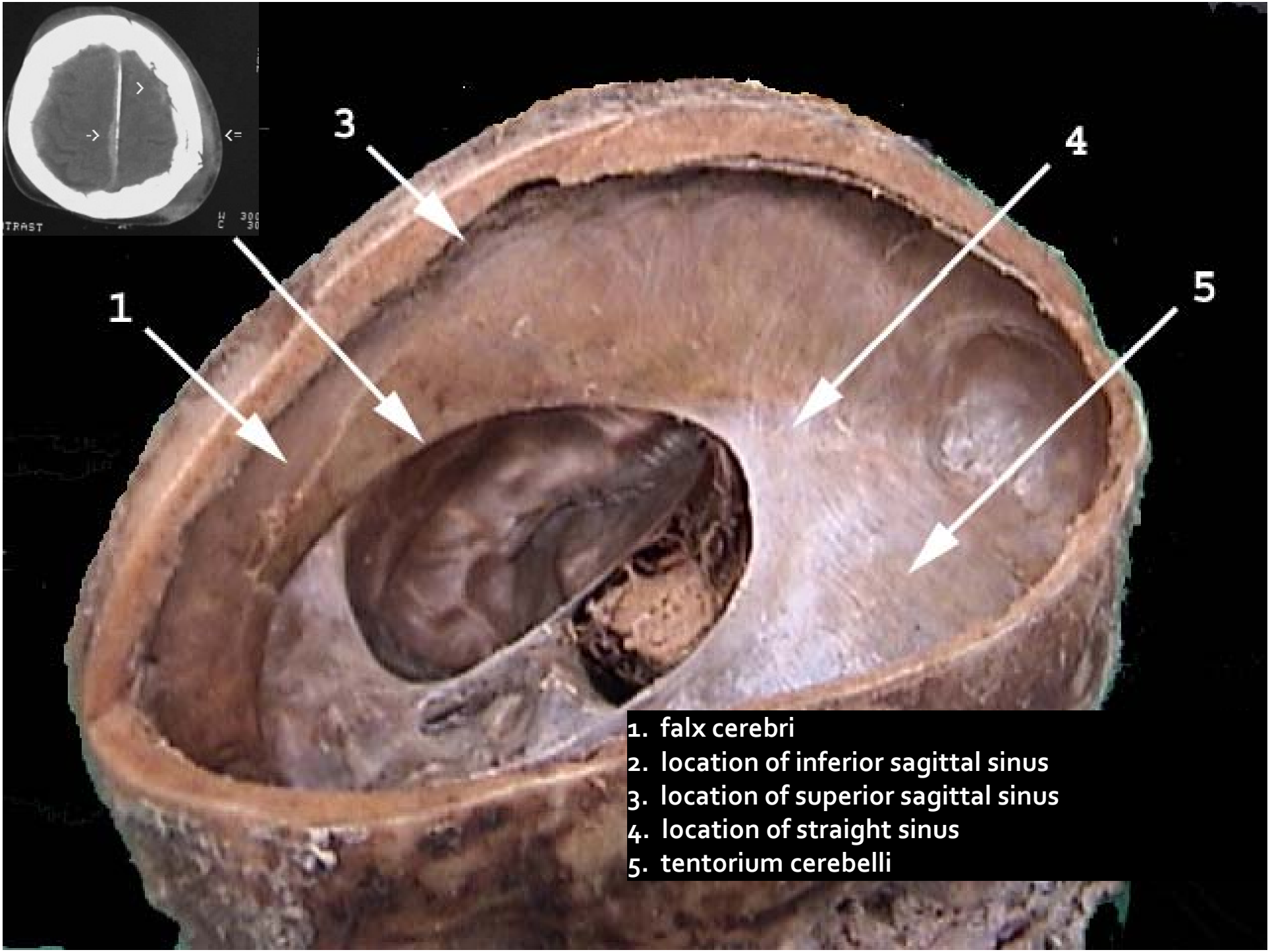


•Strong, arched fold of dura mater which descends vertically in the longitudinal fissure between the cerebral hemispheres.

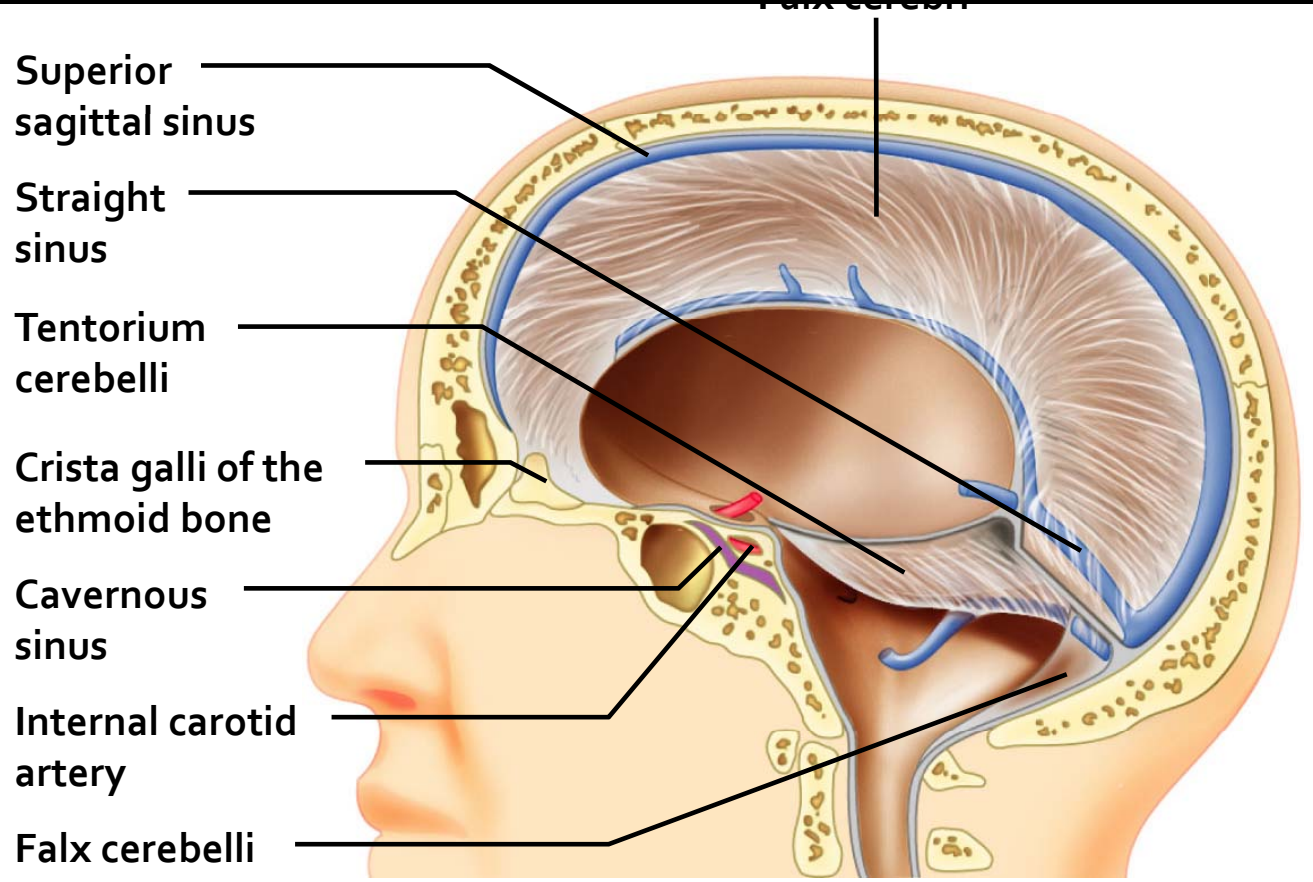
It is narrow in front, where it is attached to the crista galli of the ethmoid; and broad behind, where it is connected with the upper surface of the tentorium cerebelli.

Its upper margin is convex, and attached to the inner surface of the skull in the middle line, as far back as the internal occipital protuberance; it contains the superior sagittal sinus.

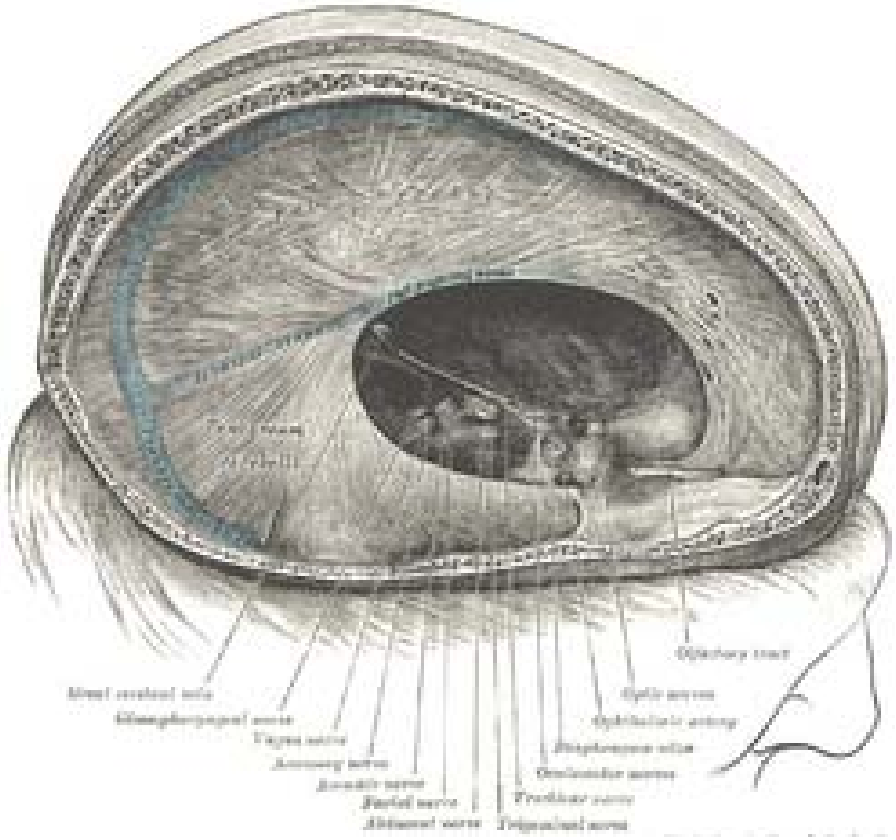
Its lower margin is free and concave, and contains the inferior sagittal sinus.


1
3
4
5
1. falx cerebri
2. location of inferior sagittal sinus
3. location of superior sagittal sinus
4. location of straight sinus
5. tentorium cerebelli

Partitioning folds of dura mater in the cranial cavity,



Falx cerebri



Central sulcus= between frontal and parietal lobes.

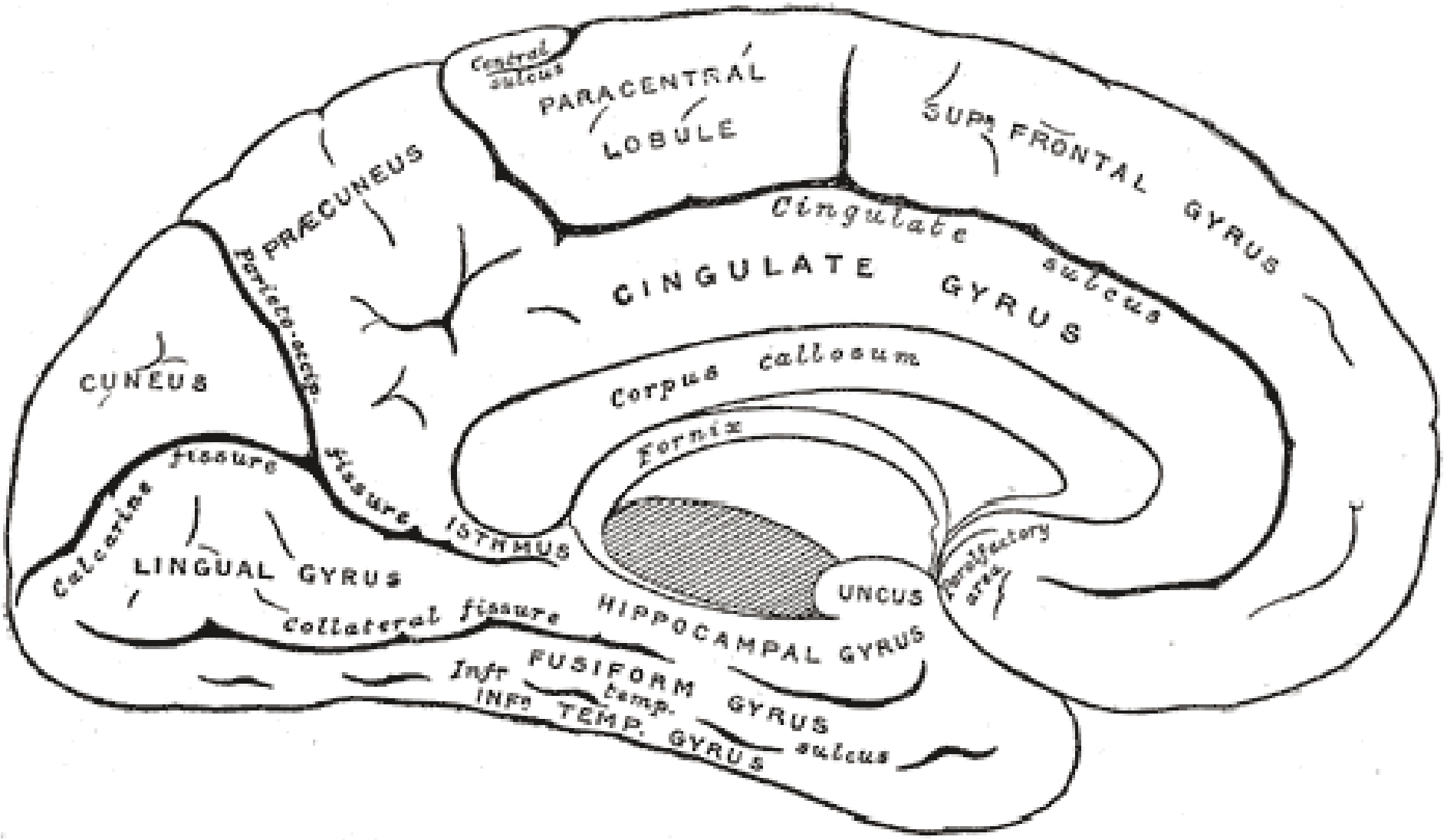
Frontal lobe:

precentral gyrus: motor neurons.

Parietal lobe:

Poscentral gyrus: somatesthetic sensation (cutaneous touch, pain, heat, muscles and joints).

MAP of motor and of sensory control (homunculus)


Central sulcus
PARACENTRAL LOBULE
SUPR FRONTAL GYRUS
PRÆCUNEUS
Cingulate sulcus
CINGULATE GYRUS
Parieto-occip. fissure
CUNEUS
Corpus callosum
Fornix
Calcarine fissure
fissure
ISTHMUS
LINGUAL GYRUS
UNCUS
Parahippocampal gyrus
Collateral fissure
HIPPOCAMPAL GYRUS
Infr temp. sulcus
INFR TEMP. GYRUS

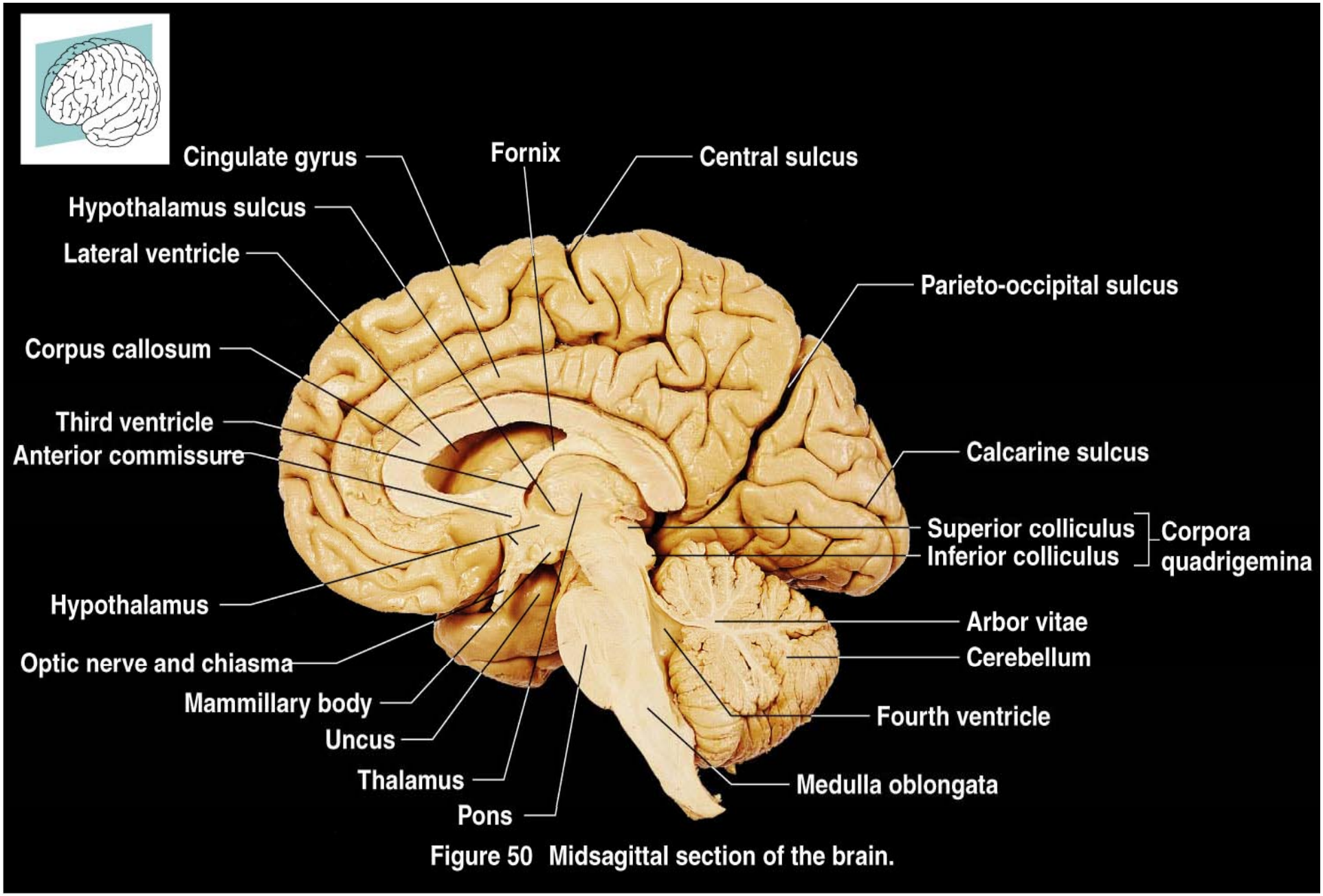


Figure 50 Midsagittal section of the brain.

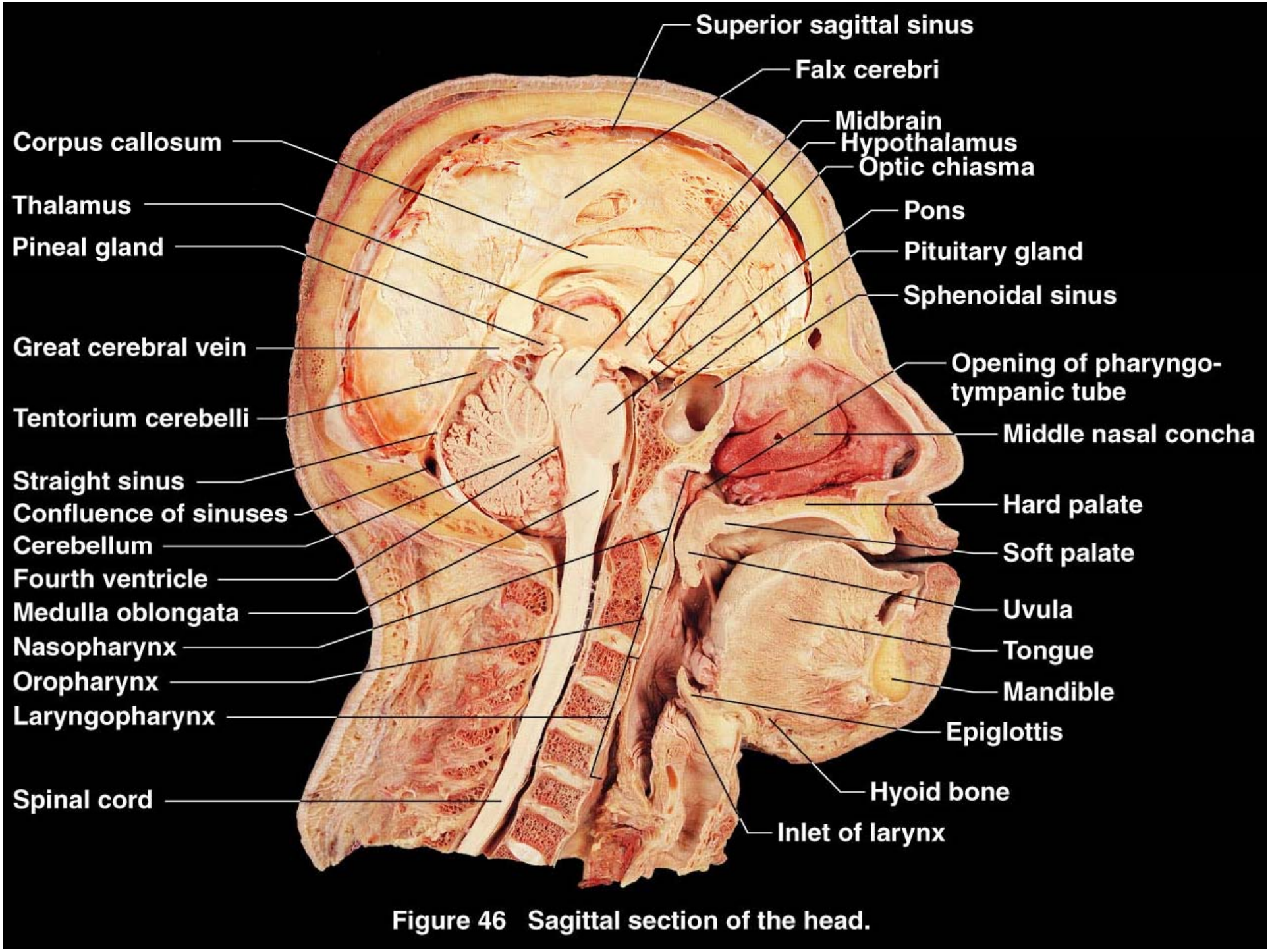


Figure 46 Sagittal section of the head.

The ventricles

The Four Ventricles

Lateral Ventricles:
largest

Third Ventricle:
"wall" divides brain into symmetrical halves

Cerebral aqueduct:
long tube that connects 3rd to 4th ventricle

Fourth Ventricle

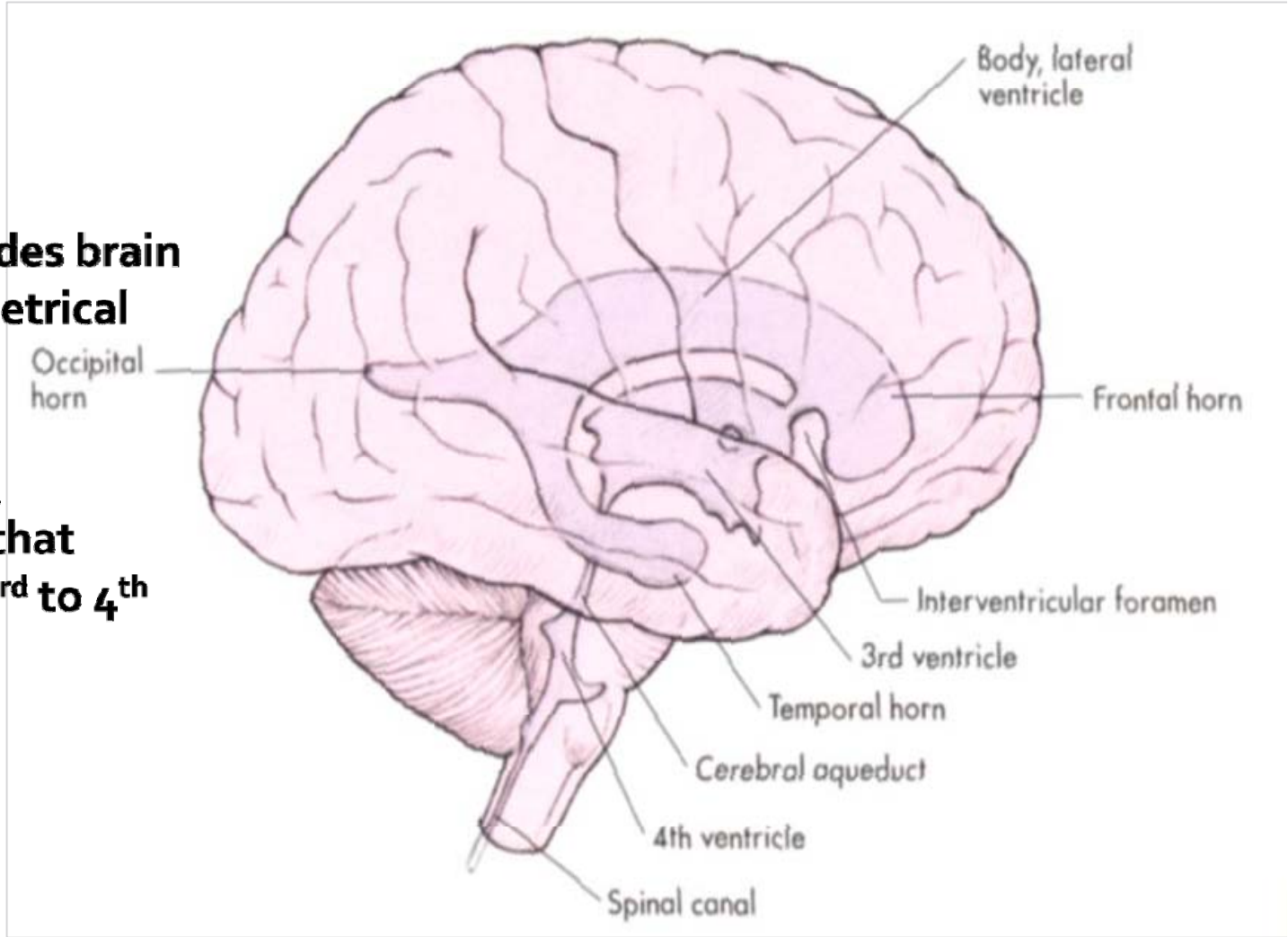
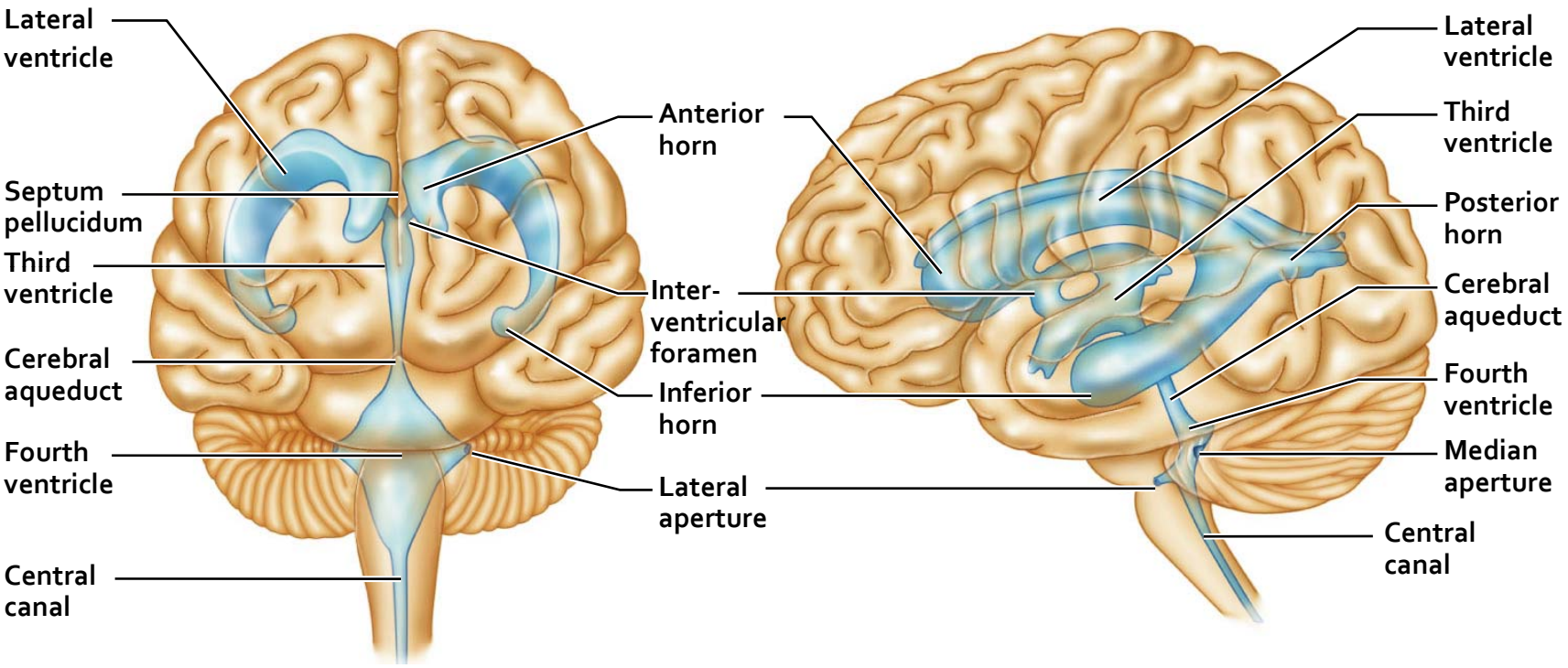


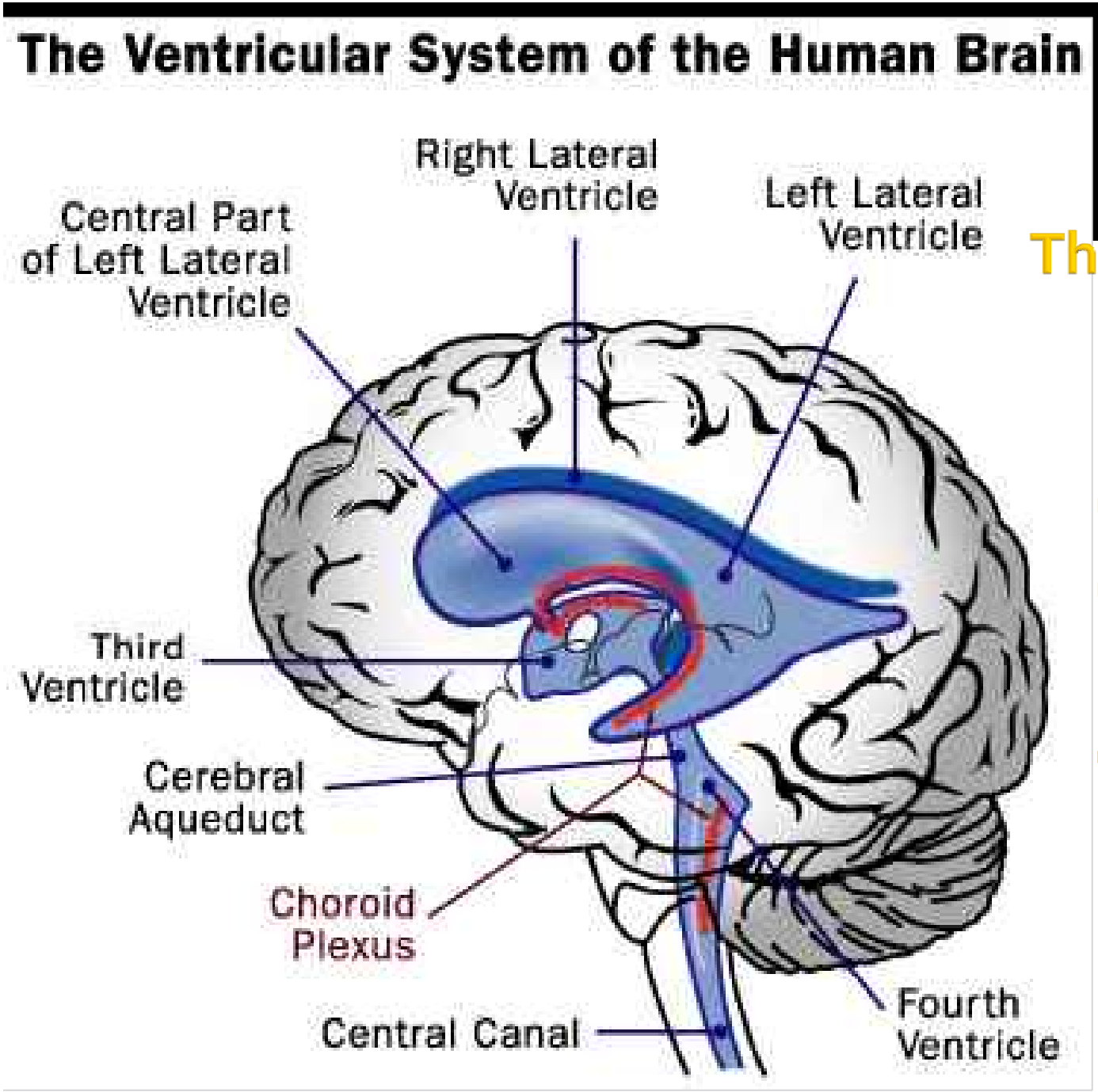
Figure 12.5: Ventricles of the brain, p. 434.



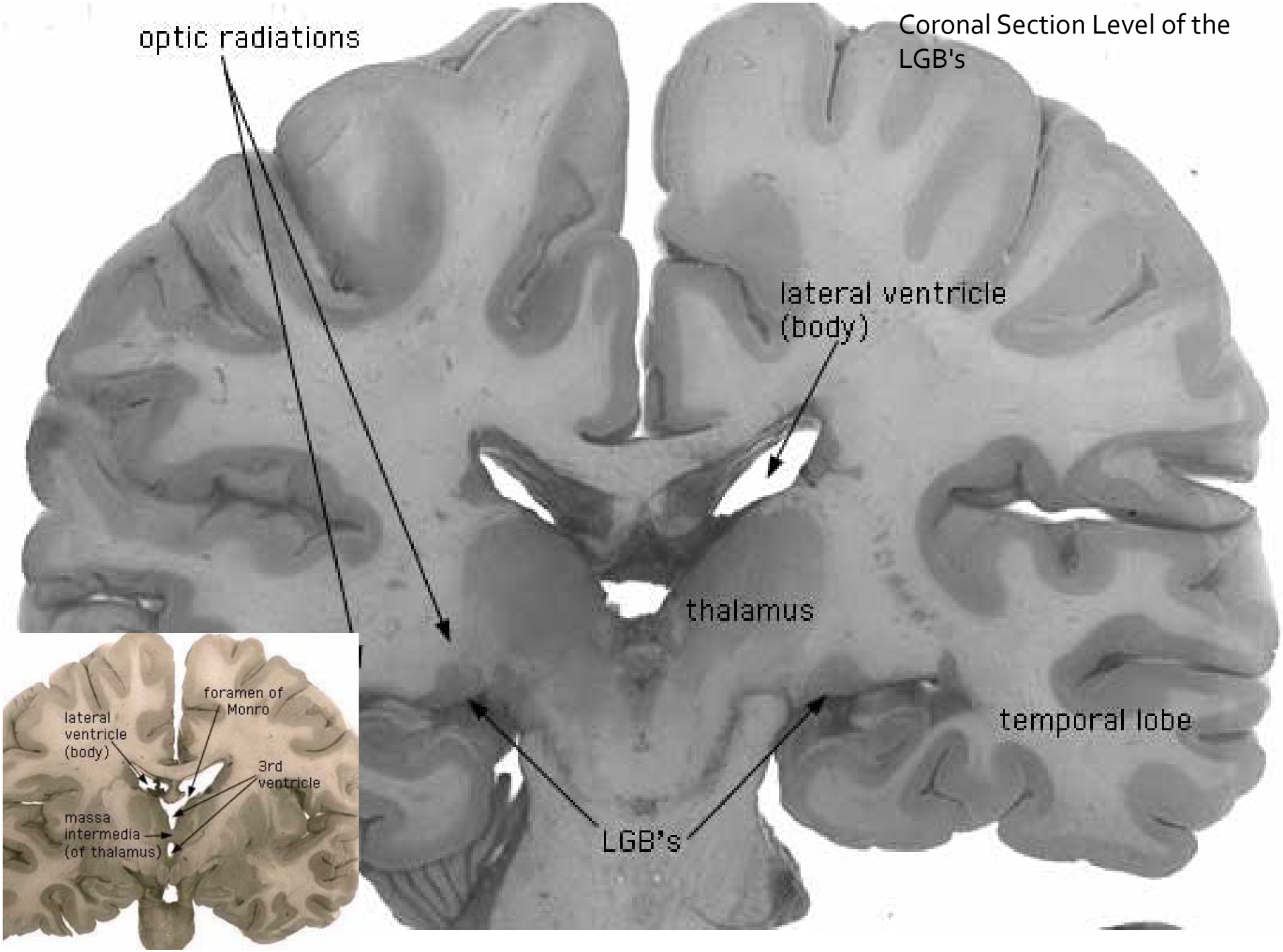
(a) Anterior view

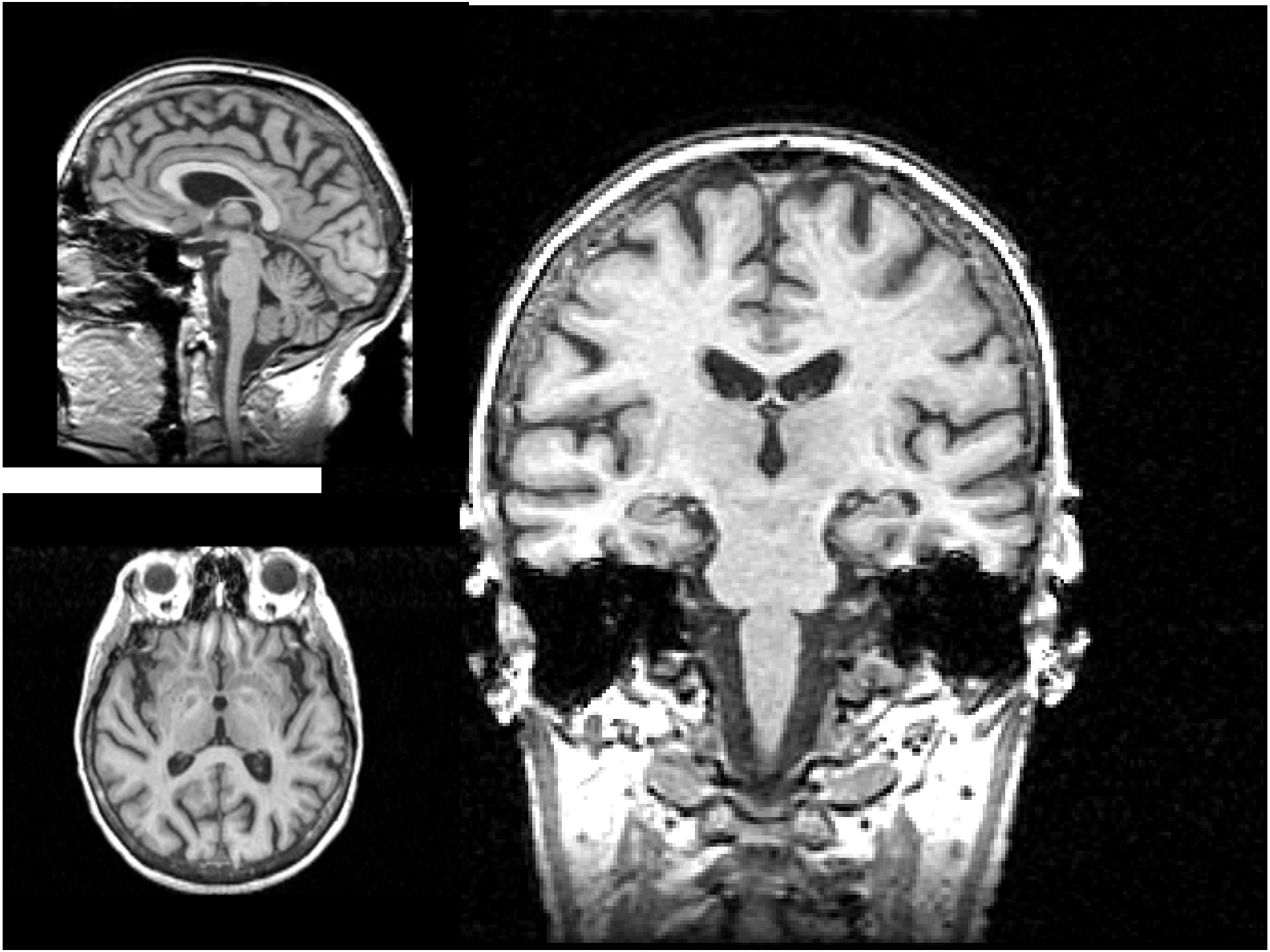
(b) Left lateral view

The Four Ventricles



- *Protects Brain From Trauma*
- *Provides Pathway for Circulation of CSF*
- *Continuous w/each other + central canal of spinal cord*


Coronal Section Level of the LGB's
optic radiations
lateral ventricle (body)
thalamus
temporal lobe
LGB's
lateral ventricle (body)
foramen of Monro
3rd ventricle
massa intermedia (of thalamus)



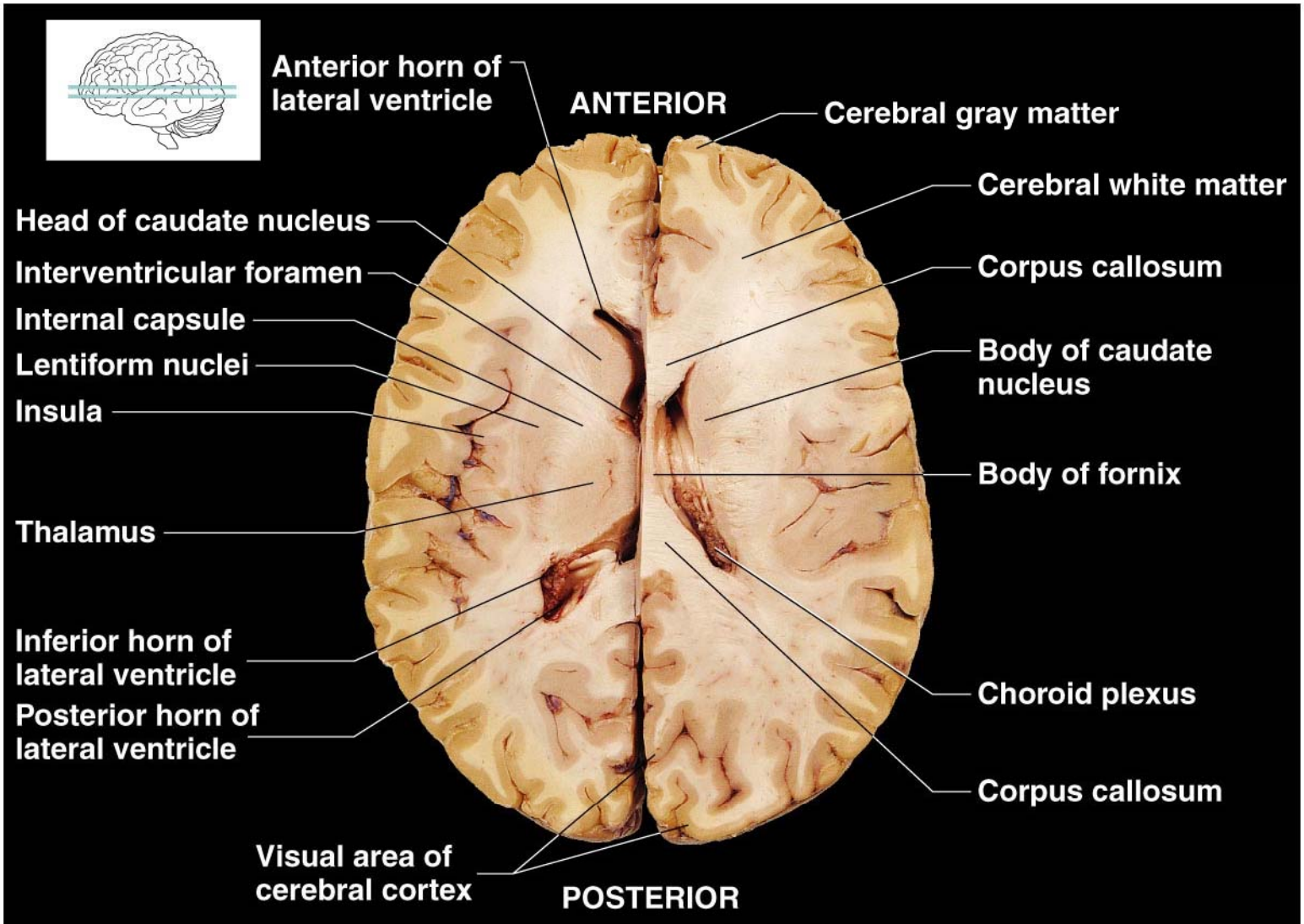
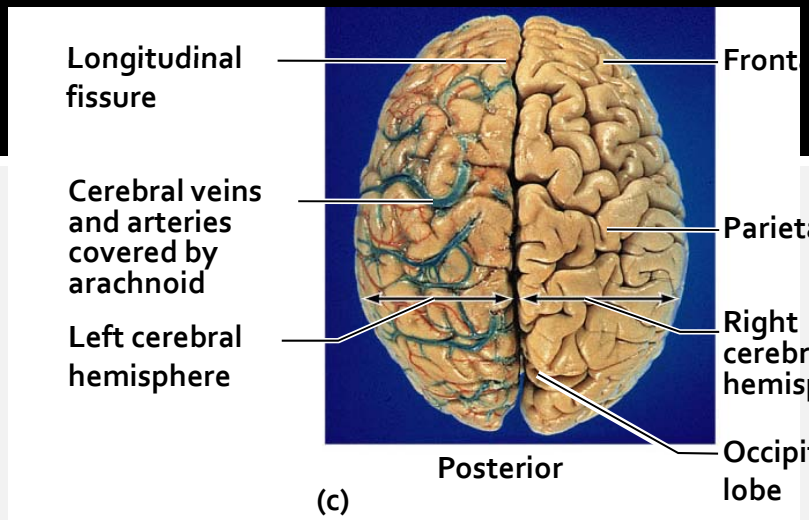
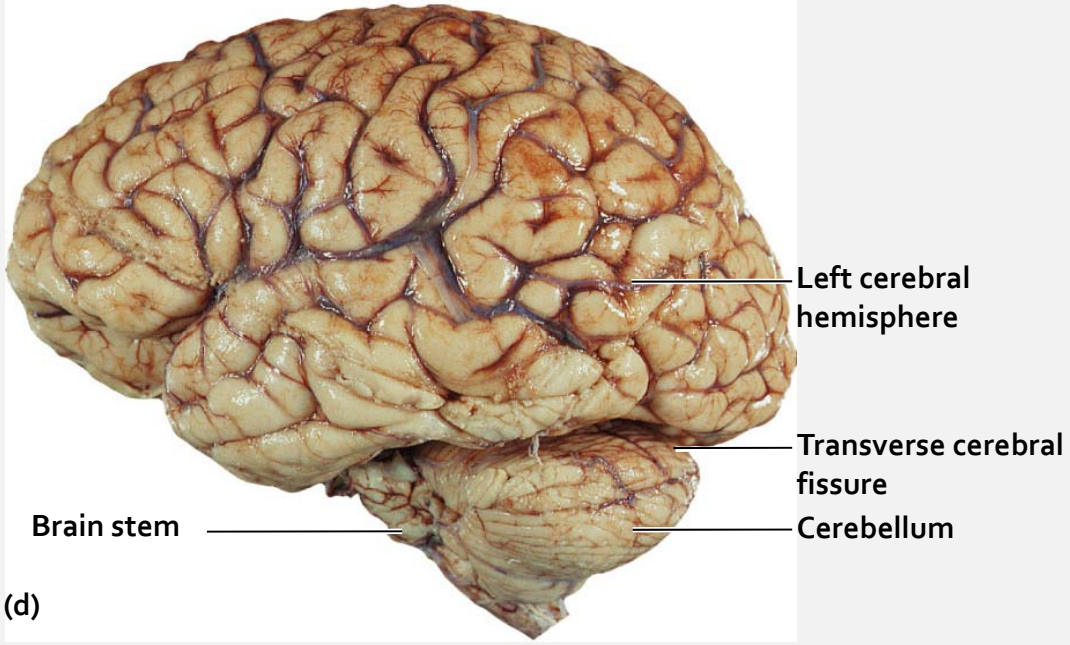


Figure 51 Transverse section of the brain, superior view. Left: on a level with the intraventricular foramen; right: about 1.5 cm higher.

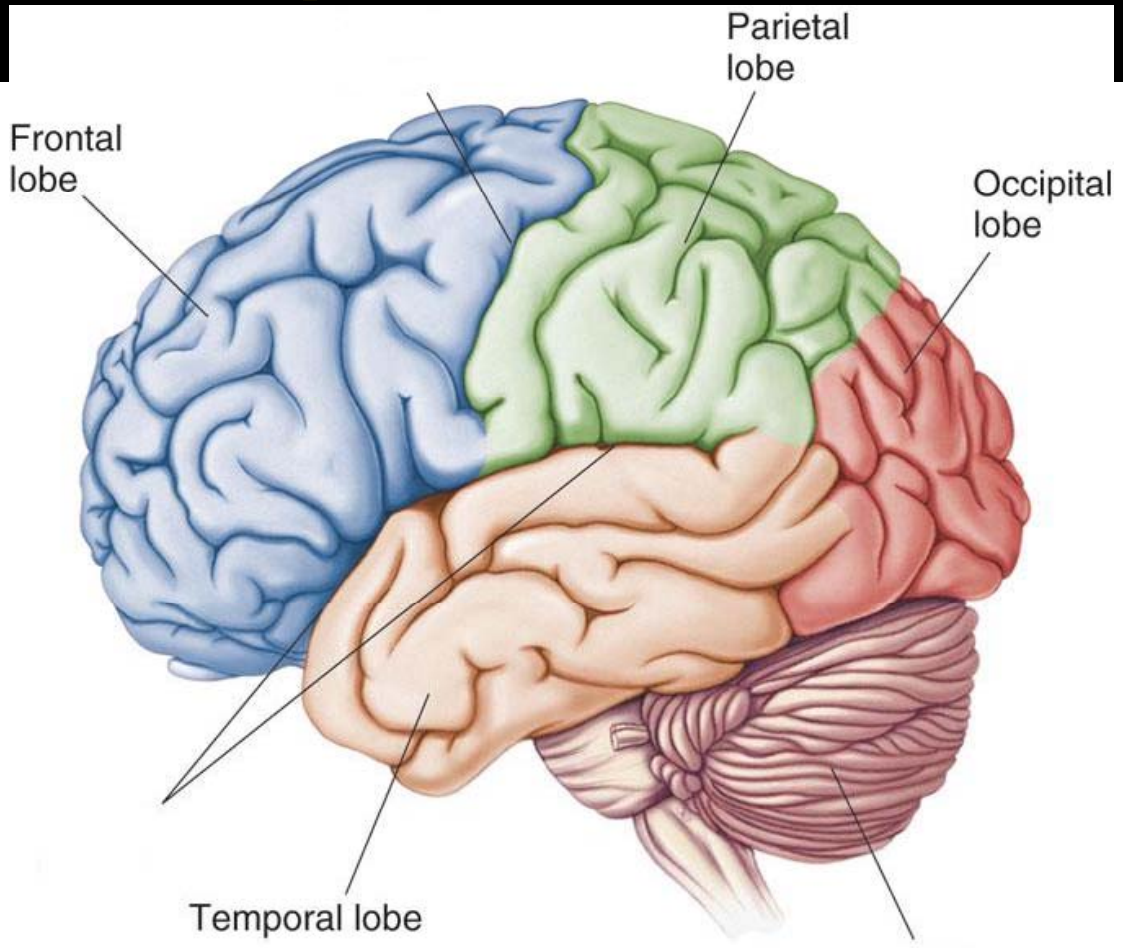
Lobes and fissures of the cerebral hemispheres,





Lobes of the Brain (4)

- Frontal
- Parietal
- Occipital
- Temporal

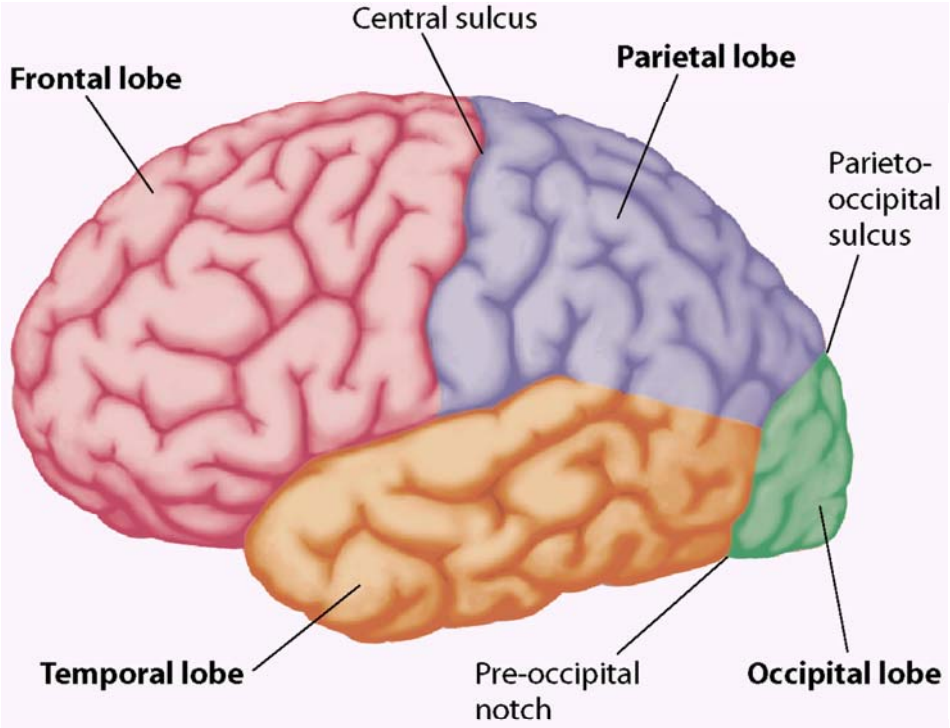


http://www.bioon.com/book/biology/whole/image/1/1-8.tif.jpg

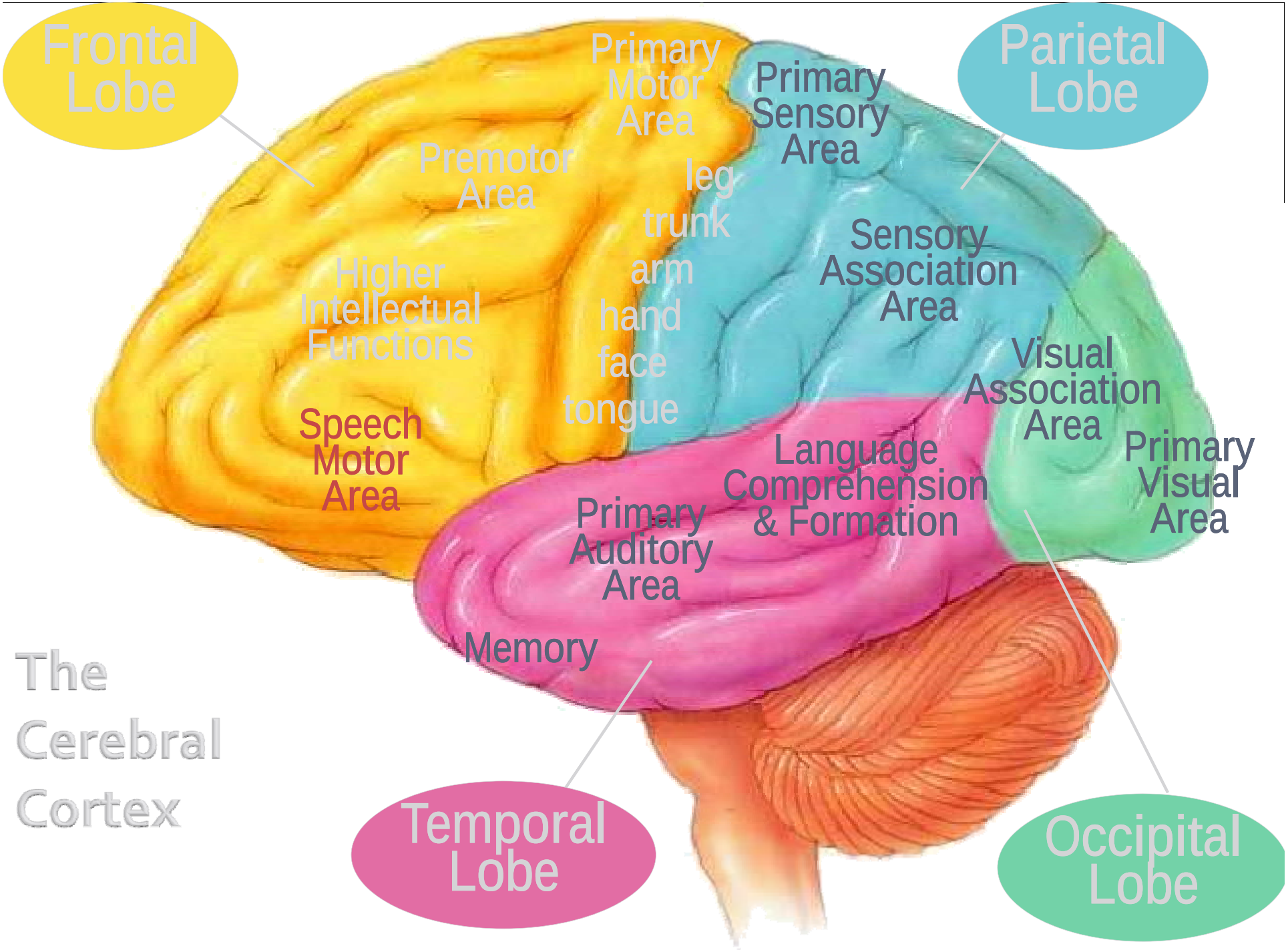
* Note: Occasionally, the Insula is considered the fifth lobe. It is located deep to the Temporal Lobe.

LOBES

Cortical Function



- Frontal Lobe
  - –Higher thought processing; decision making; abstract thinking
  - –Primary "precentral" motor area
- Parietal Lobe
  - –Primary "postcentral" somatosensory area: sensation of muscles, organs, and skin
- Occipital Lobe
  - –Visual processing
- Temporal Lobe
  - –Auditory & equilibrium processing
  - –Left temporal lobe involved in speech and comprehension of language



The Cerebral Cortex

HOMUNCULUS

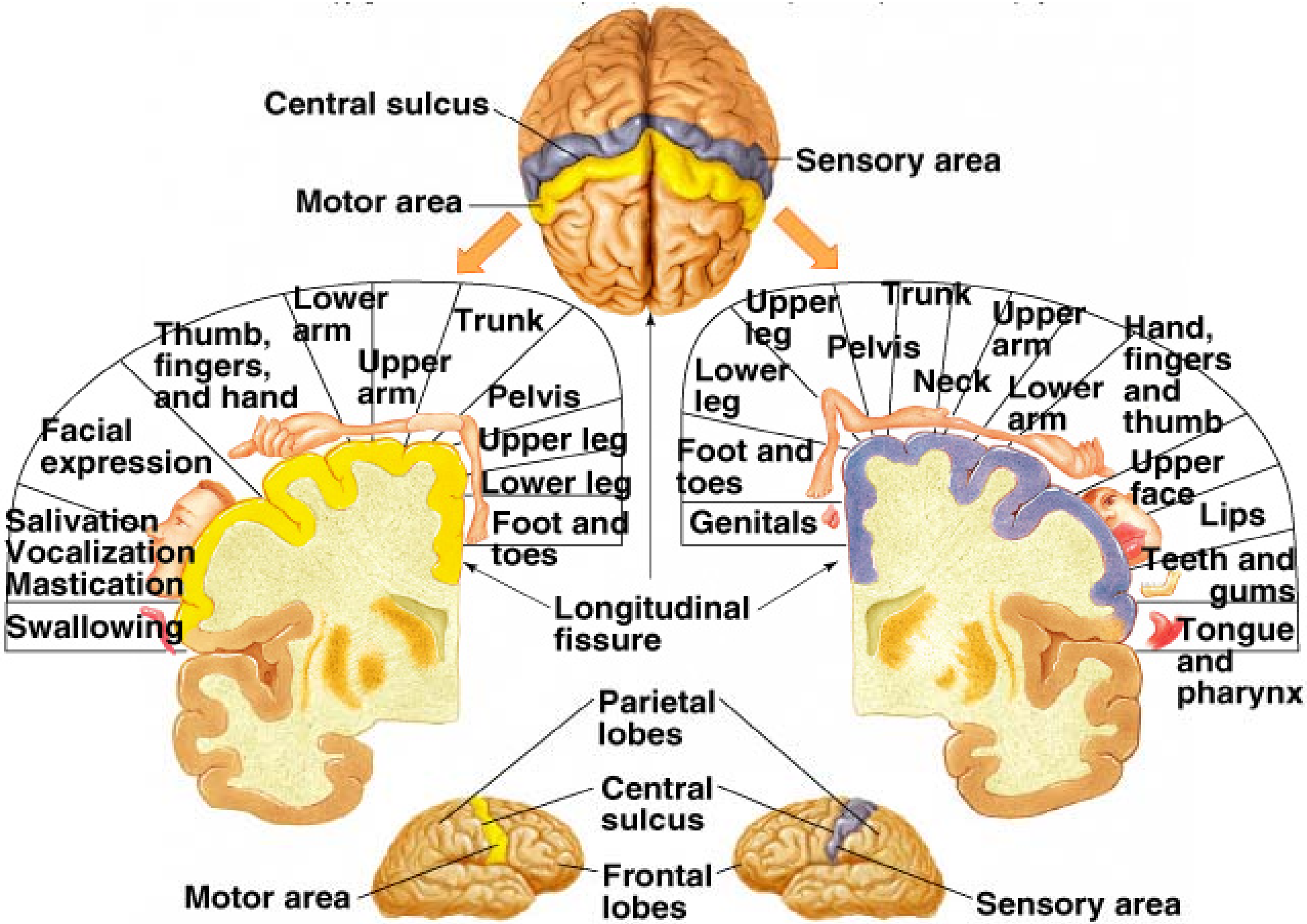

Central sulcus
Sensory area
Motor area
Lower arm
Thumb, fingers, and hand
Trunk
Upper arm
Pelvis
Facial expression
Upper leg
Lower leg
Salivation
Vocalization
Mastication
Foot and toes
Swallowing
Upper leg
Trunk
Pelvis
Upper arm
Hand, fingers and thumb
Lower leg
Neck
Lower arm
Foot and toes
Upper face
Genitals
Lips
Teeth and gums
Tongue and pharynx
Longitudinal fissure
Parietal lobes
Central sulcus
Frontal lobes
Motor area
Sensory area

Figure 12.9: Motor and sensory areas of the cerebral cortex, p. 438.

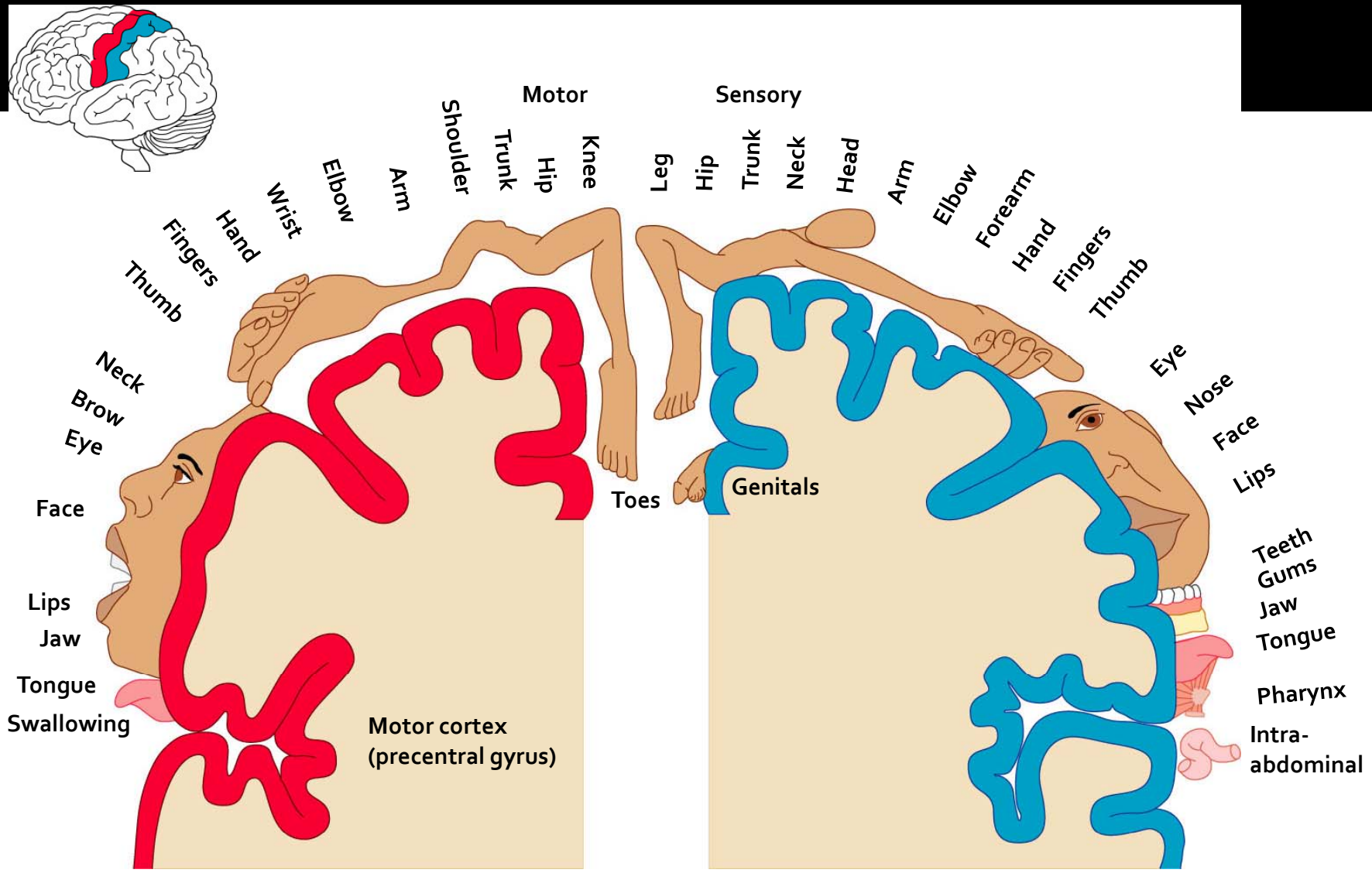
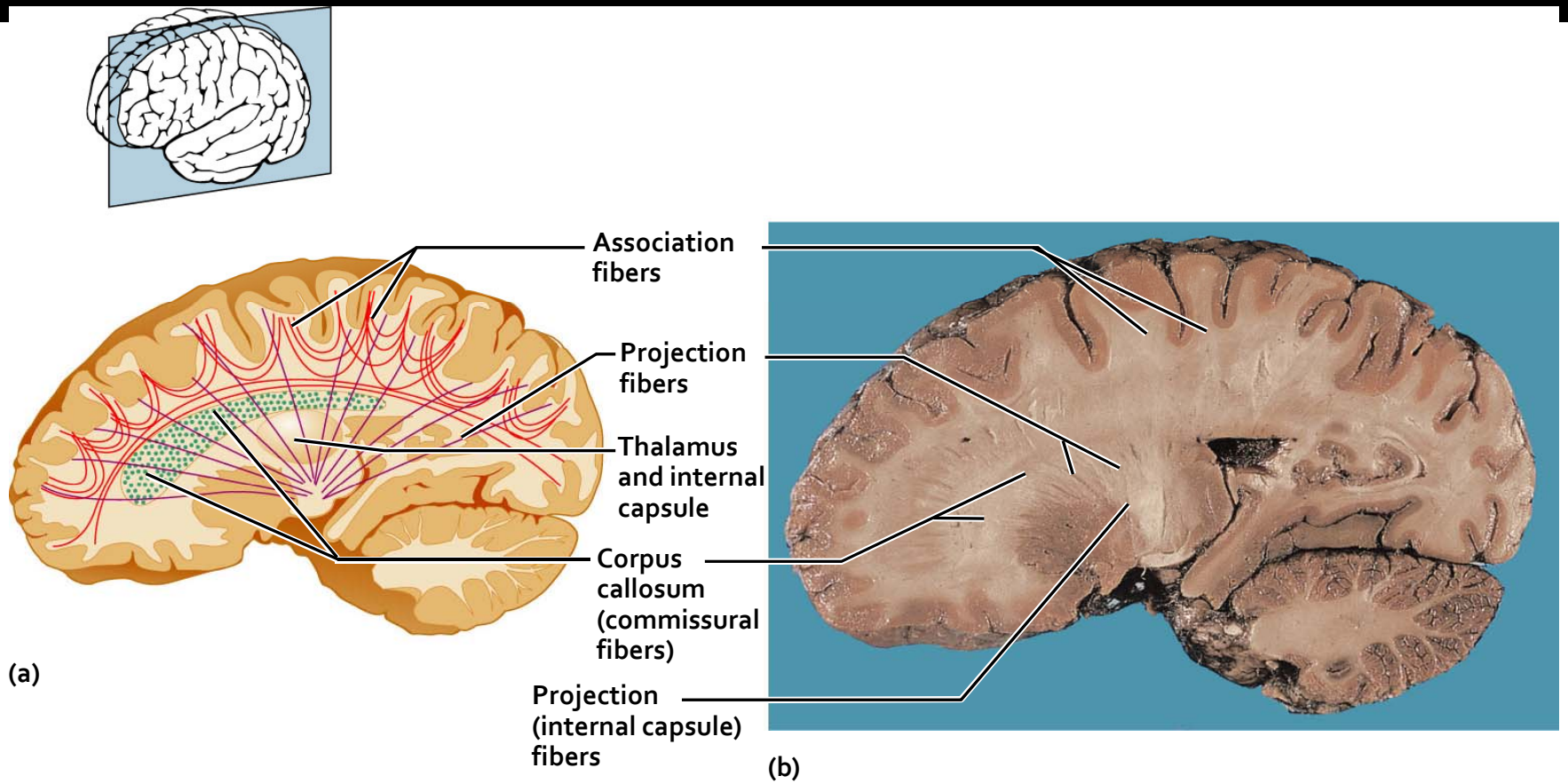
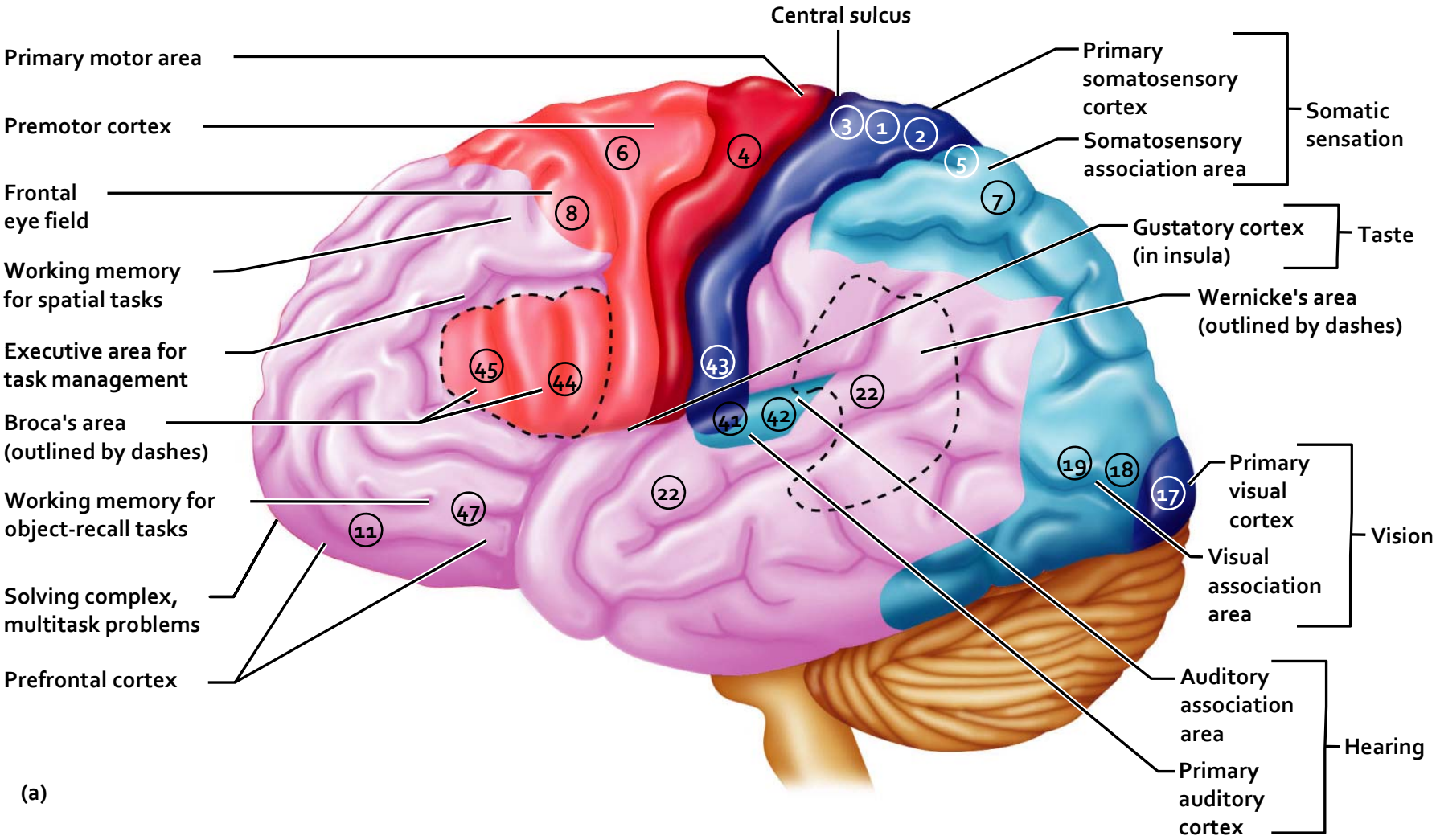


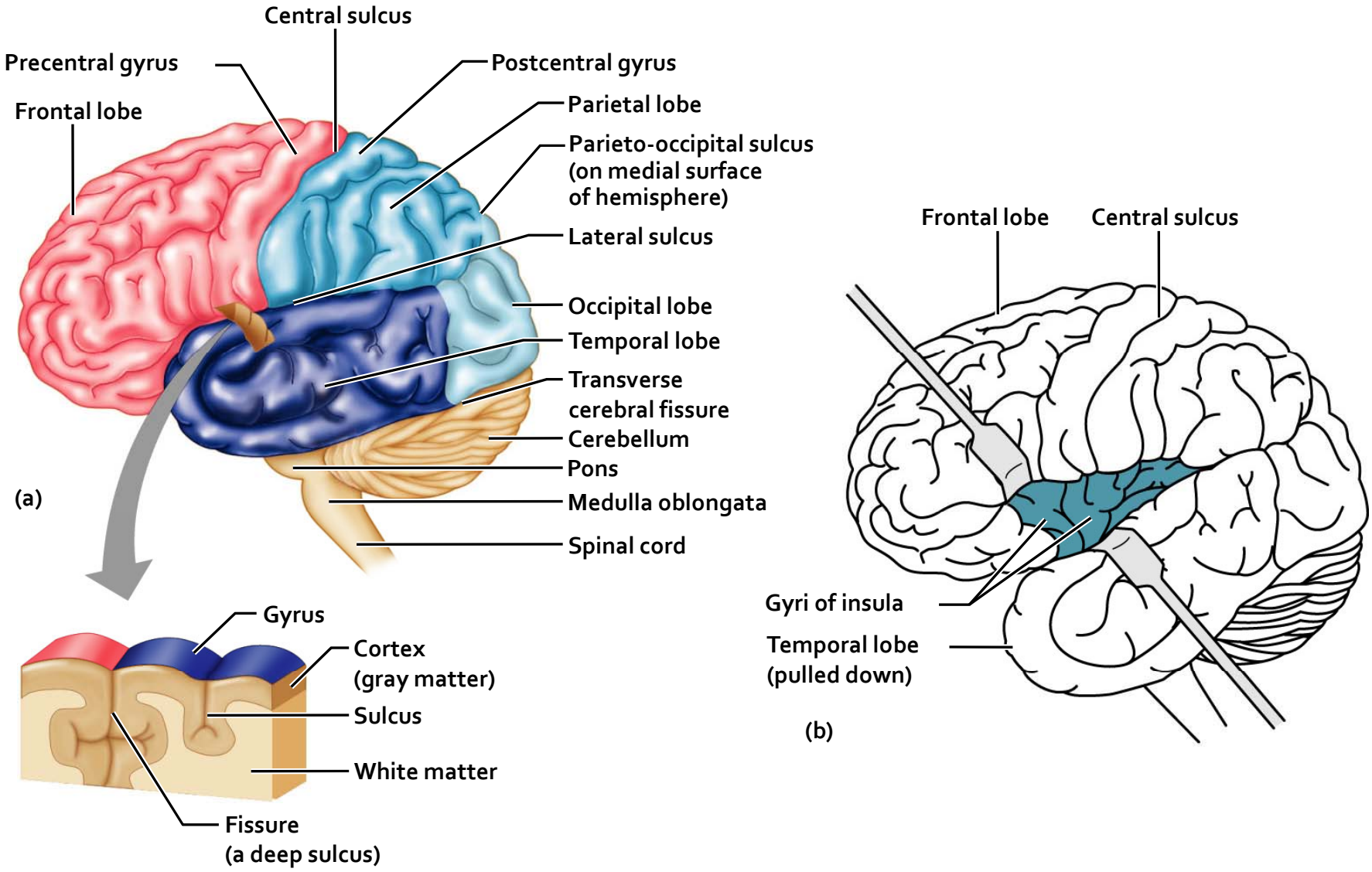
Figure 12.10a-b: Types of fiber tracts in white matter, p. 442.



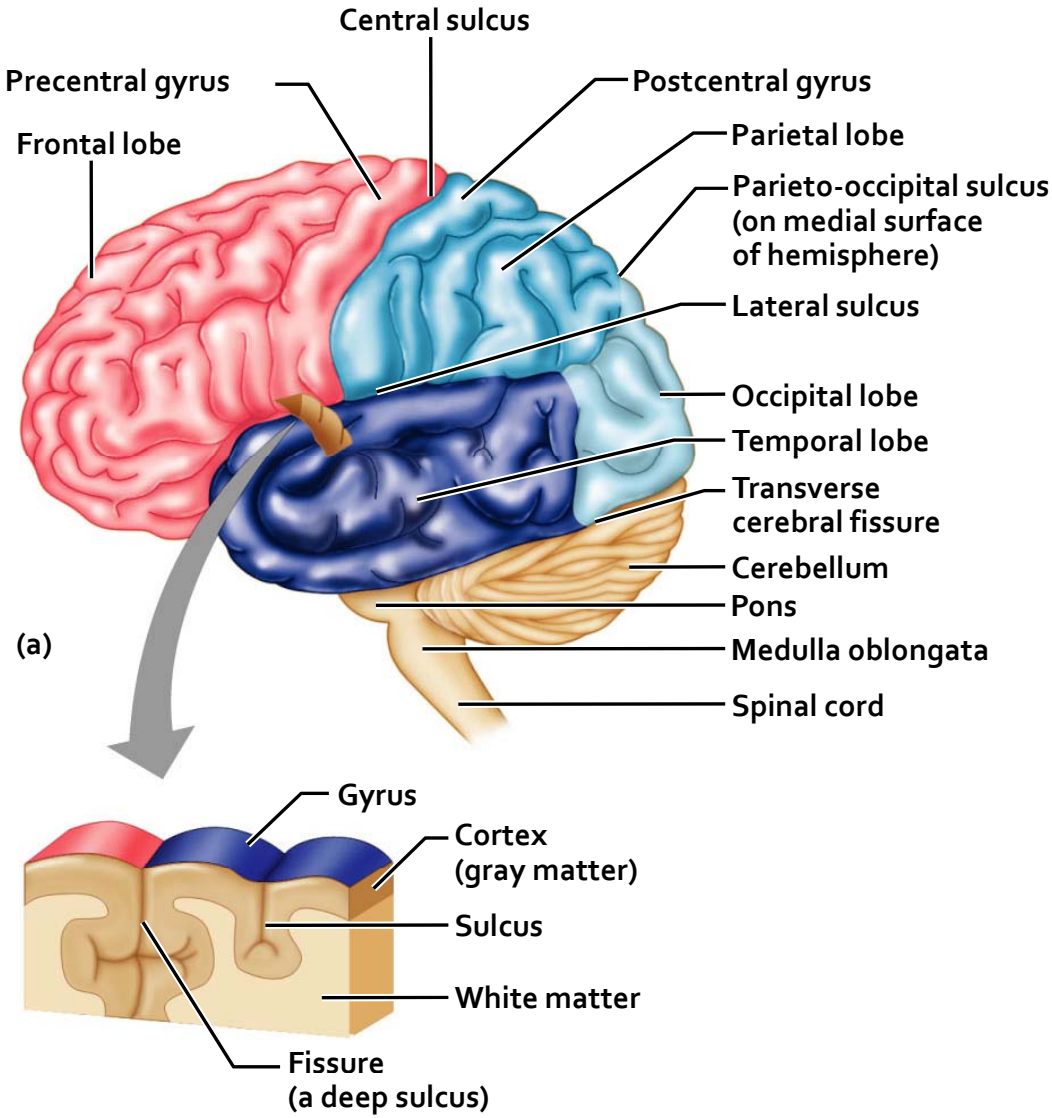
Functional and structural areas of the cerebral cortex

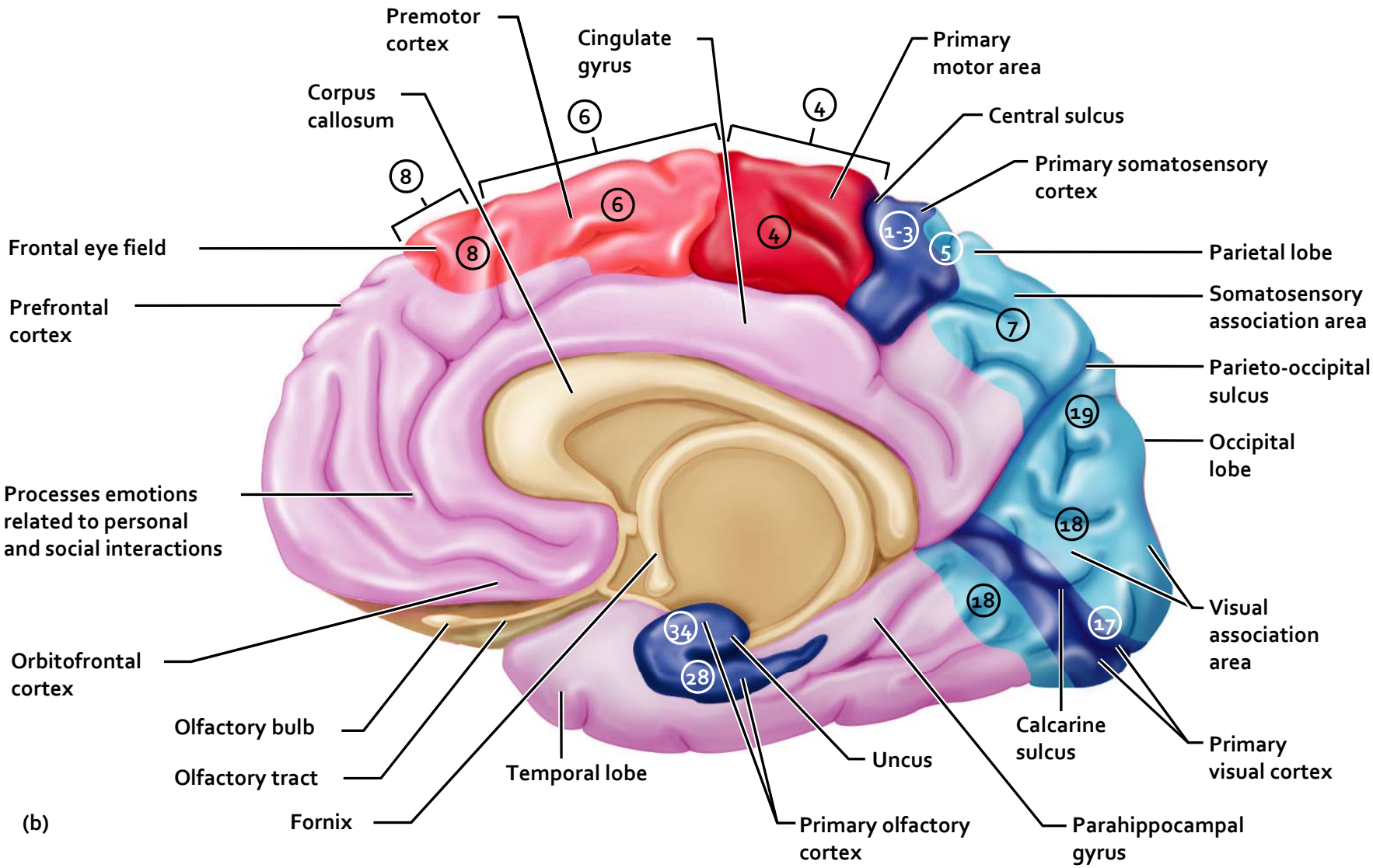


(a)


Central sulcus
Precentral gyrus
Postcentral gyrus
Frontal lobe
Parietal lobe
Parieto-occipital sulcus
(on medial surface
of hemisphere)
Lateral sulcus
Occipital lobe
Temporal lobe
Transverse
cerebral fissure
Cerebellum
Pons
Medulla oblongata
Spinal cord
(a)
Gyrus
Cortex
(gray matter)
Sulcus
White matter
Fissure
(a deep sulcus)
Frontal lobe
Central sulcus
Gyri of insula
Temporal lobe
(pulled down)
(b)

Lobes and fissures of the cerebral hemispheres,

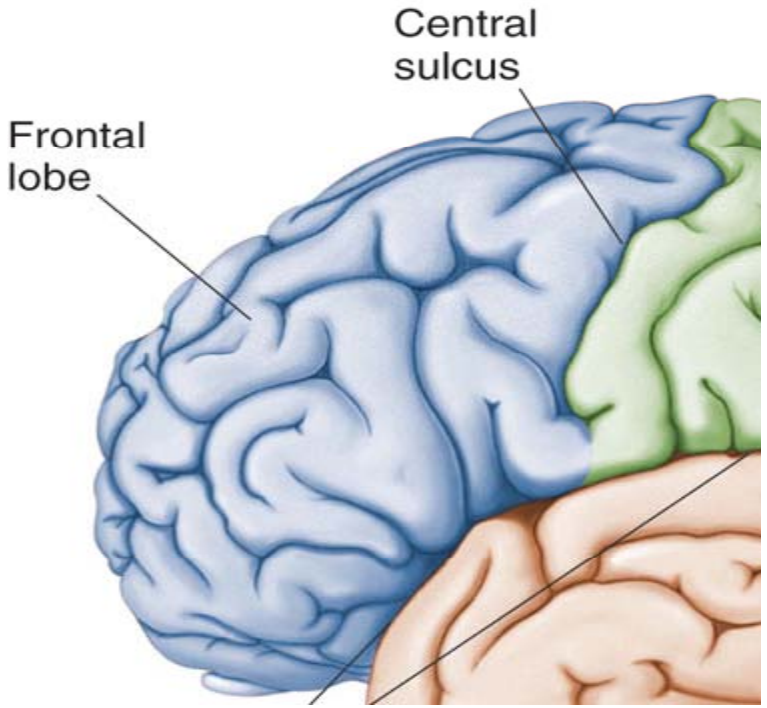



Premotor cortex
Cingulate gyrus
Primary motor area
Corpus callosum
Central sulcus
Primary somatosensory cortex
Frontal eye field
Parietal lobe
Prefrontal cortex
Somatosensory association area
Parieto-occipital sulcus
Occipital lobe
Processes emotions related to personal and social interactions
Visual association area
Orbitofrontal cortex
Olfactory bulb
Calcarine sulcus
Olfactory tract
Primary visual cortex
Temporal lobe
Uncus
Fornix
Primary olfactory cortex
Parahippocampal gyrus
(b)

Lobes of the Brain - Frontal

- The Frontal Lobe of the brain is located deep to the Frontal Bone of the skull.
- It plays an integral role in the following functions/actions:

  - Memory Formation
  - Emotions
  - Decision Making/Reasoning
  - Personality



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Frontal Lobe - Cortical Regions

• **Primary Motor Cortex (Precentral Gyrus) –** Cortical site involved with controlling movements of the body.

• **Broca's Area –** Controls facial neurons, speech, and language comprehension. Located on ***Left*** Frontal Lobe.

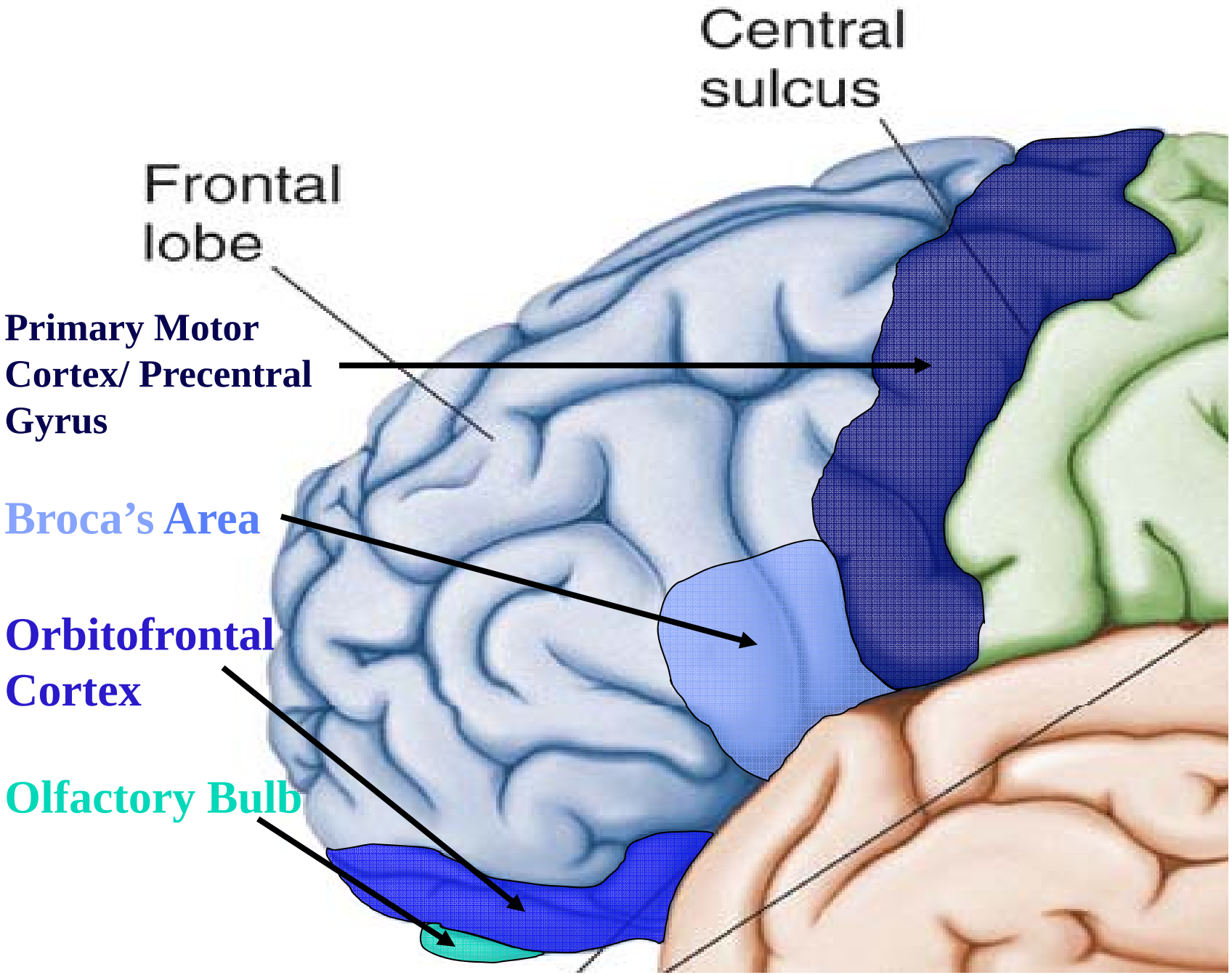
– **Broca's Aphasia** – Results in the ability to comprehend speech, but the decreased motor ability (or inability) to speak and form words.

- **Orbitofrontal Cortex** – Site of Frontal Lobotomies

  * **Desired Effects:**
    - Diminished Rage
    - Decreased Aggression
    - Poor Emotional Responses

  * **Possible Side Effects:**
    - Epilepsy
    - Poor Emotional Responses
    - Perseveration (Uncontrolled, repetitive actions, gestures, or words)

• **Olfactory Bulb -** Cranial Nerve I, Responsible for sensation of Smell



Regions

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Parietal Lobe - Cortical Regions

- **Primary Somatosensory Cortex (Postcentral Gyrus)** – Site involved with processing of tactile and proprioceptive information.

- **Somatosensory Association Cortex -** Assists with the integration and interpretation of sensations relative to body position and orientation in space. May assist with visuo-motor coordination.

- **Primary Gustatory Cortex** – Primary site involved with the interpretation of the sensation of Taste.

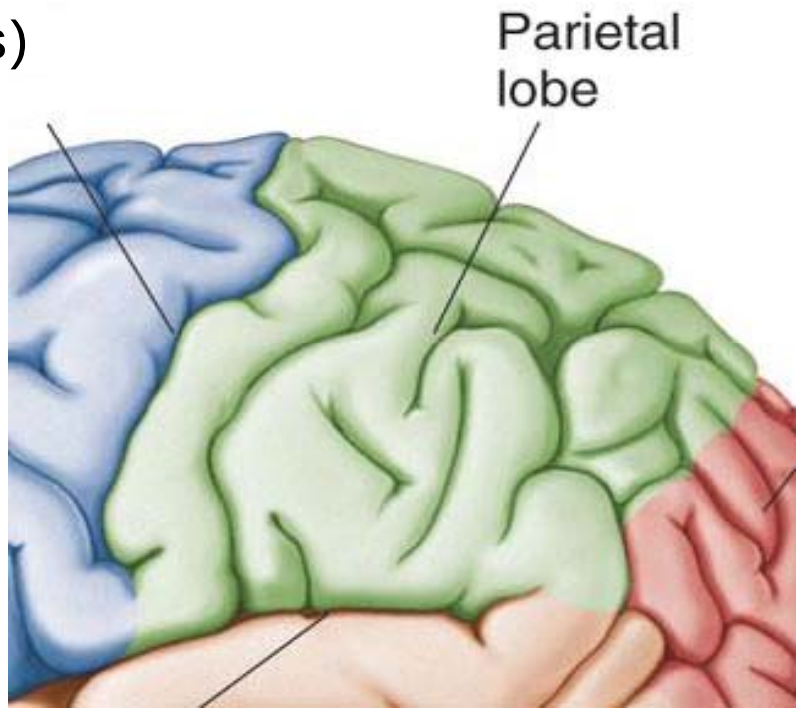
Lobes of the Brain - Parietal Lobe

- The Parietal Lobe of the brain is located deep to the Parietal Bone of the skull.

- It plays a major role in the following functions/actions:

  - Senses and integrates sensation(s)

  - Spatial awareness and perception (Proprioception - Awareness of body/ body parts in space and in relation to each other)



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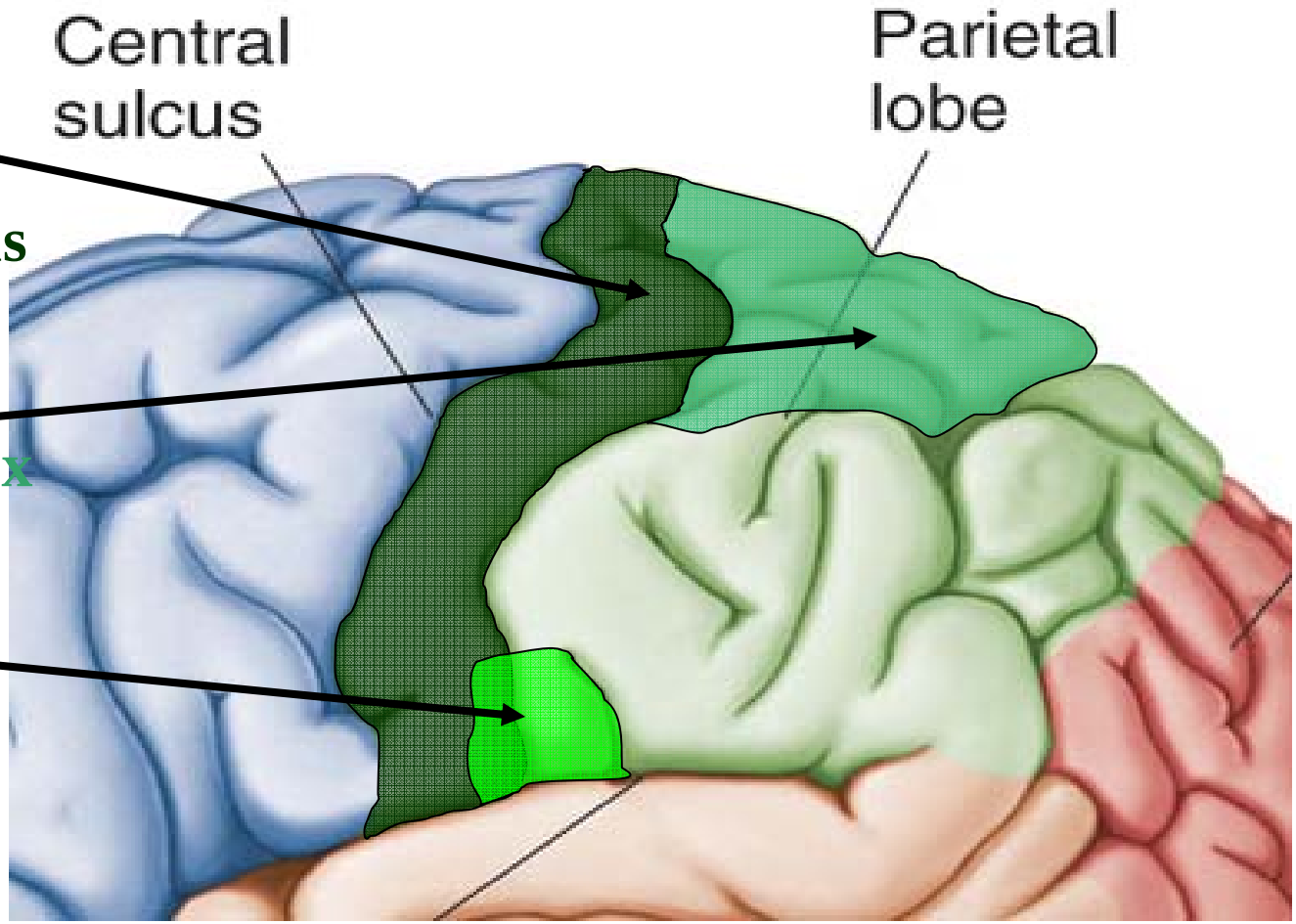
Primary Somatosensory Cortex/ Postcentral Gyrus

Somatosensory Association Cortex

Primary Gustatory Cortex



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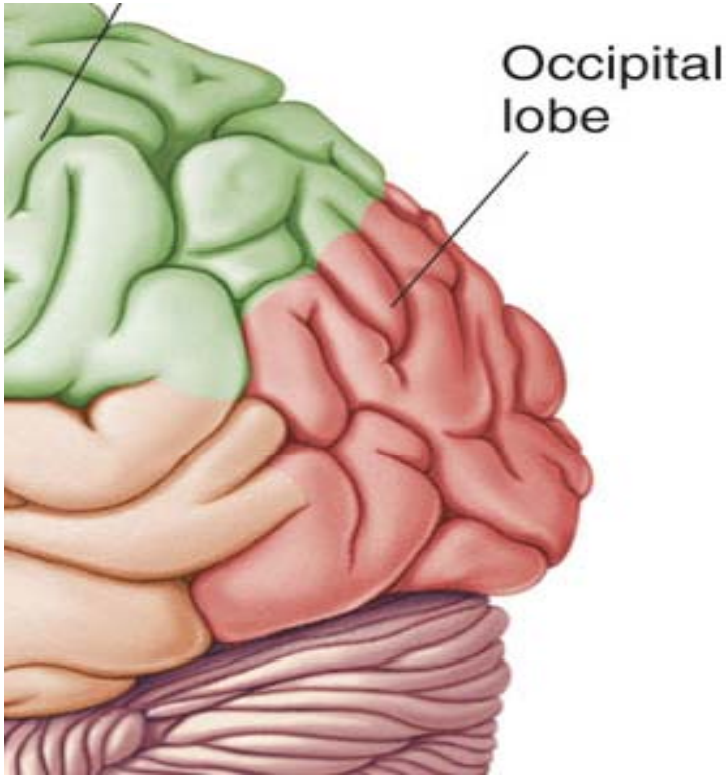
Regions

Lobes of the Brain – Occipital Lobe

- The Occipital Lobe of the Brain is located deep to the Occipital Bone of the Skull.

• Its primary function is the processing, integration, interpretation, etc. of VISION and visual stimuli.



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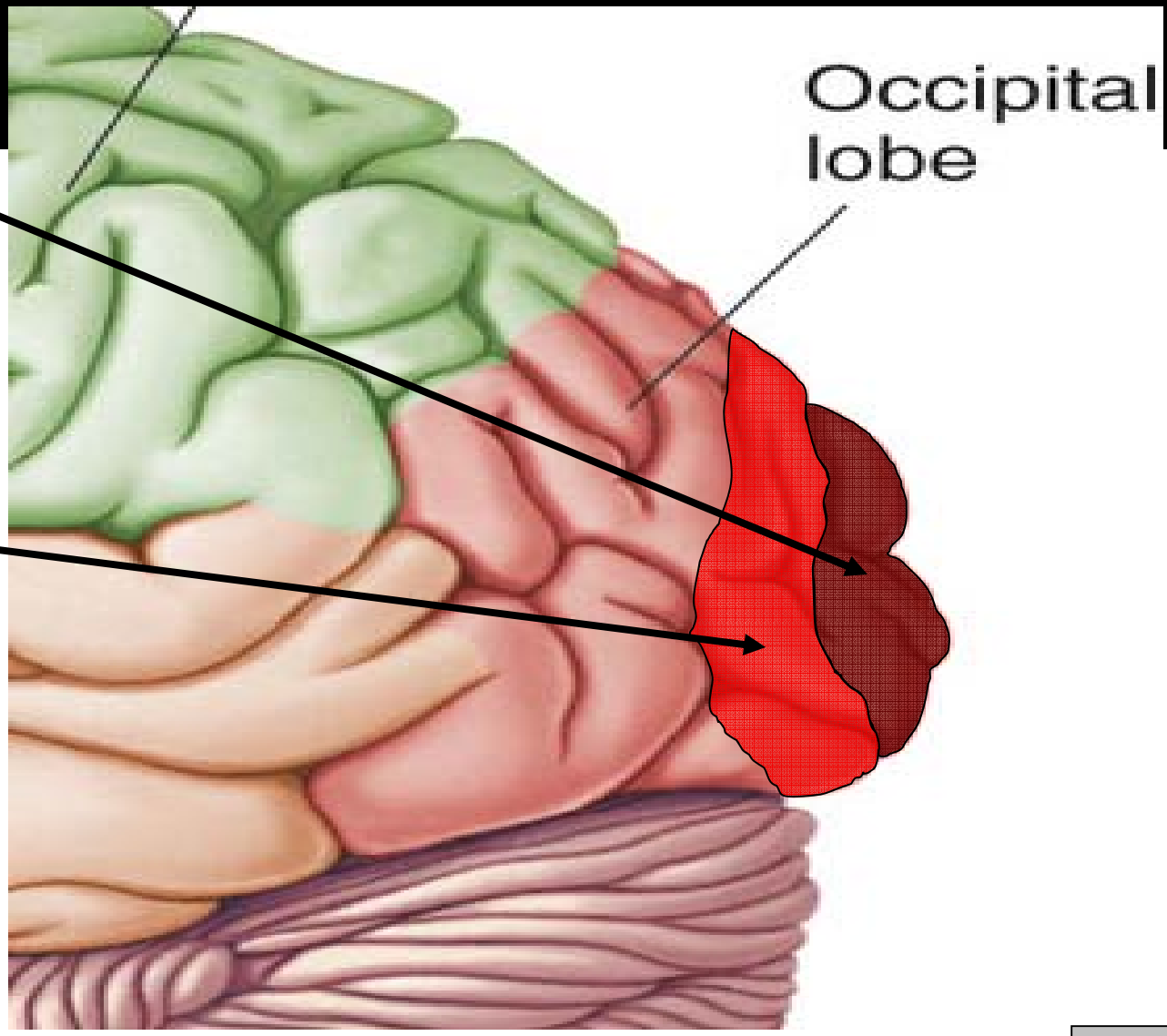
Occipital Lobe – Cortical Regions

- **Primary Visual Cortex** – This is the primary area of the brain responsible for sight - recognition of size, color, light, motion, dimensions, etc.

- **Visual Association Area** – Interprets information acquired through the primary visual cortex.

Primary Visual Cortex

Visual Association Area



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Regions

Lobes of the Brain – Temporal Lobe

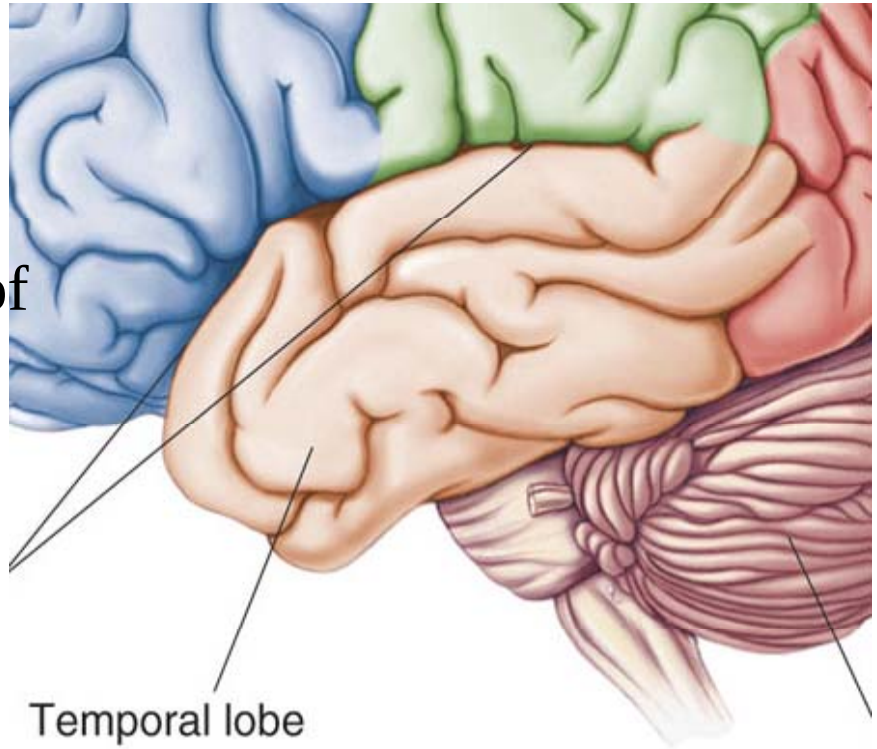
- The Temporal Lobes are located on the sides of the brain, deep to the Temporal Bones of the skull.

• They play an integral role in the following functions:

- Hearing

-Organization/Comprehension of language

- Information Retrieval (Memory and Memory Formation)



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Temporal Lobe – Cortical Regions

- **Primary Auditory Cortex** – Responsible for hearing

• **Primary Olfactory Cortex** – Interprets the sense of smell once it reaches the cortex via the olfactory bulbs. (Not visible on the superficial cortex)

• **Wernicke's Area** – Language comprehension. Located on the ***Left*** **Temporal Lobe**.

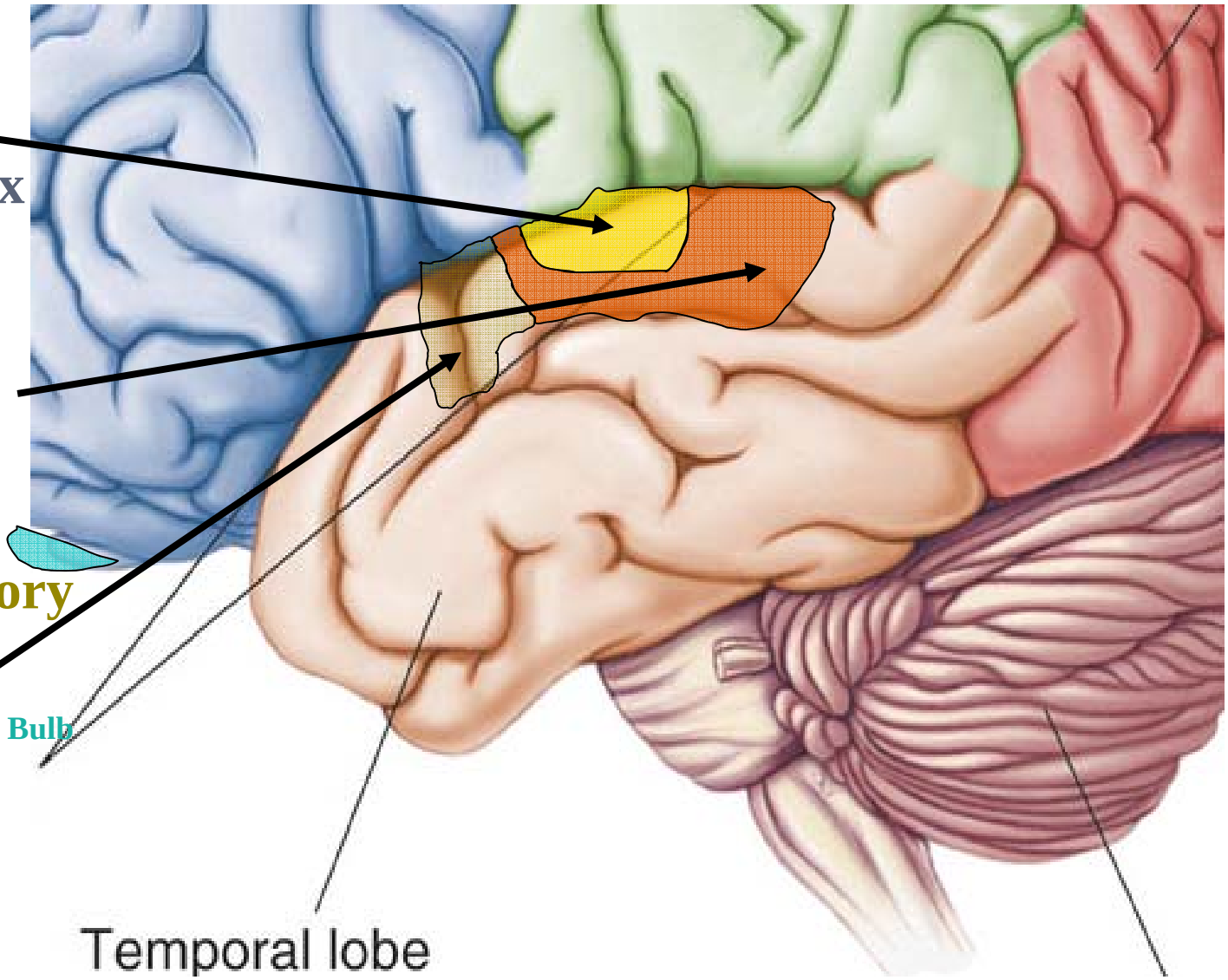
- Wernicke's Aphasia – Language comprehension is inhibited. Words and sentences are not clearly understood, and sentence formation may be inhibited or non-sensical.

Primary Auditory Cortex

Wernike's Area

Primary Olfactory Cortex (Deep)

Conducted from Olfactory Bulb



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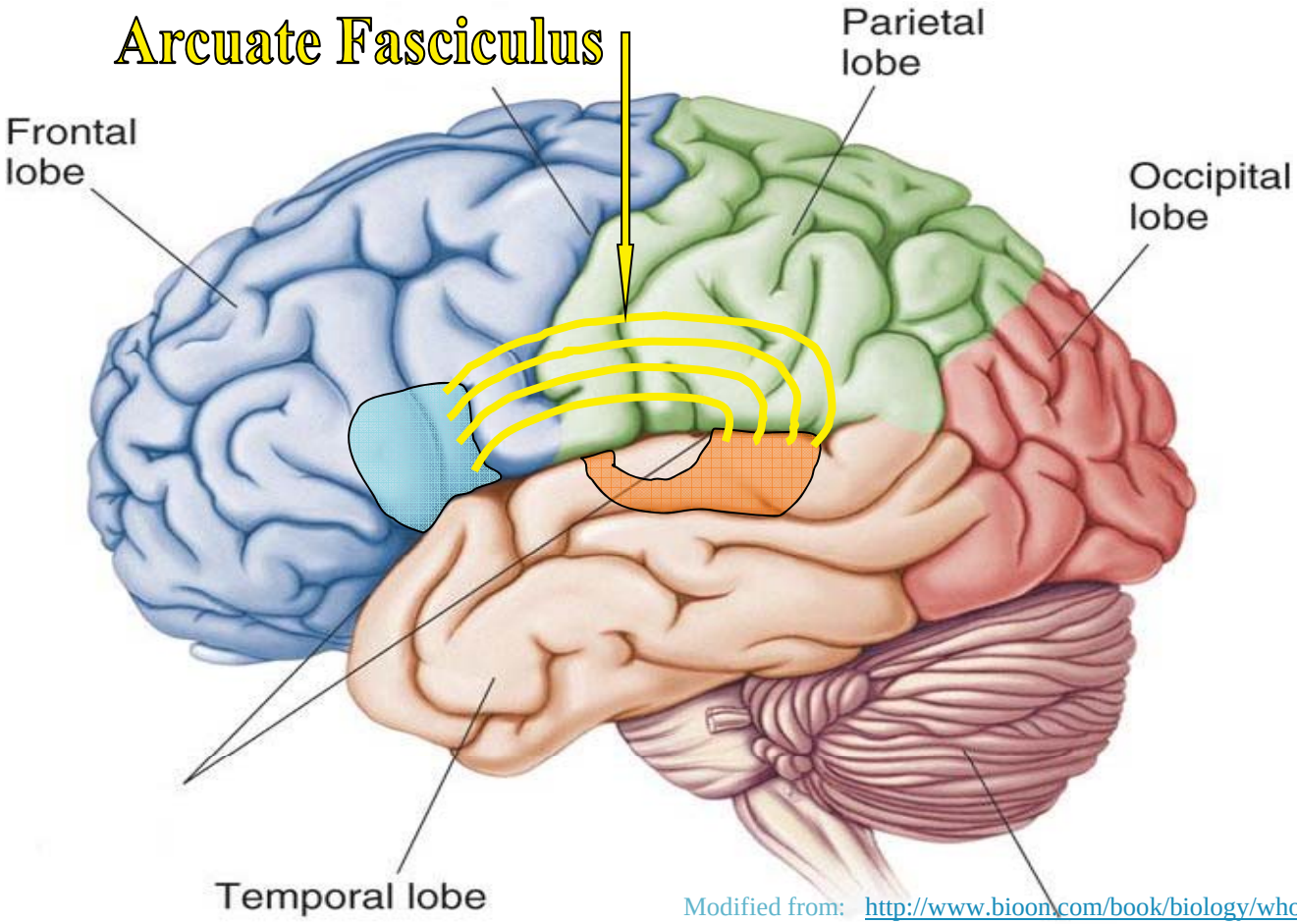
Regions

• **Arcuate Fasciculus** - A white matter tract that connects Broca's Area and Wernicke's Area through the Temporal, Parietal and Frontal Lobes. Allows for coordinated, comprehensible speech. Damage may result in:

- **Conduction Aphasia** - Where auditory comprehension and speech articulation are preserved, but people find it difficult to repeat heard speech.



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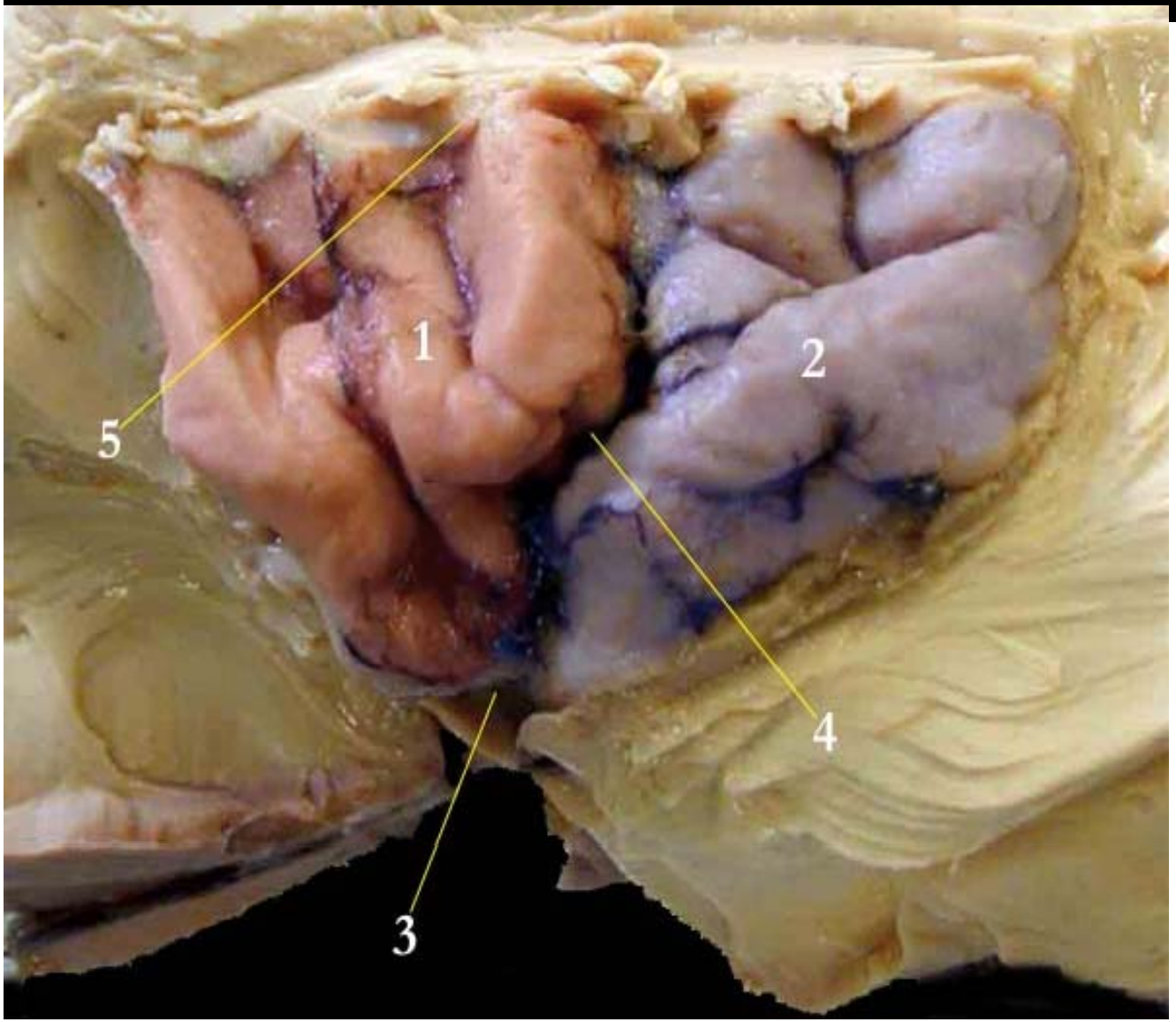
Insular cortex



These overlying cortical areas are known as opercula (meaning "lids"), and parts of the frontal, temporal and parietal lobes form opercula over the insula. The latin name for the insular cortex is *lobus insularis*.

insular cortex is also known by the name **Island of Reil,**

1. Gyri breves insula
2. Gyri longi insula
3. Limen insula
4. Sulcus centralis insula
5. Sulcus circularis insula

Insula:

Implicated in memory encoding.

Integration of sensory information with visceral responses.

Coordinated cardiovascular response to stress.

The insular cortex is a complex structure which contains areas that subserve visceral sensory, motor, vestibular, and somatosensory functions.

The role of the insular cortex in auditory processing was poorly understood until recently.

However, recent case studies indicate that bilateral damage to the insulae may result in total auditory agnosia. Functional imaging studies demonstrate that the insulae participate in several key auditory processes, such as allocating auditory attention and tuning in to novel auditory stimuli, temporal processing, phonological processing and visual-auditory integration. These studies do not clarify the issue of further specialisation within the insular cortex, e.g. whether the posterior insulae are primarily sensory areas, while the anterior insulae serve mainly as integration/association auditory areas, two hypotheses that would be compatible with the cytoarchitectonic structure and connectivity of the insulae.

The insula (Island of Reil) and its role in auditory processing. Literature review.

- Bamiou DE,
- Musiek FE,
- Luxon LM.

Neuro-Otology Department, National Hospital for Neurology and Neurosurgery, Queen Square, London WC1N 3BG, UK. doris-eva.bamiou@uclh.org

Figure 12.14: Ventral aspect of the human brain, showing the three regions of the brain stem, p. 447.

Olfactory bulb (synapse point of cranial nerve I)

Optic chiasma

Optic nerve (II)

Optic tract

Mammillary body

Pons

Temporal lobe

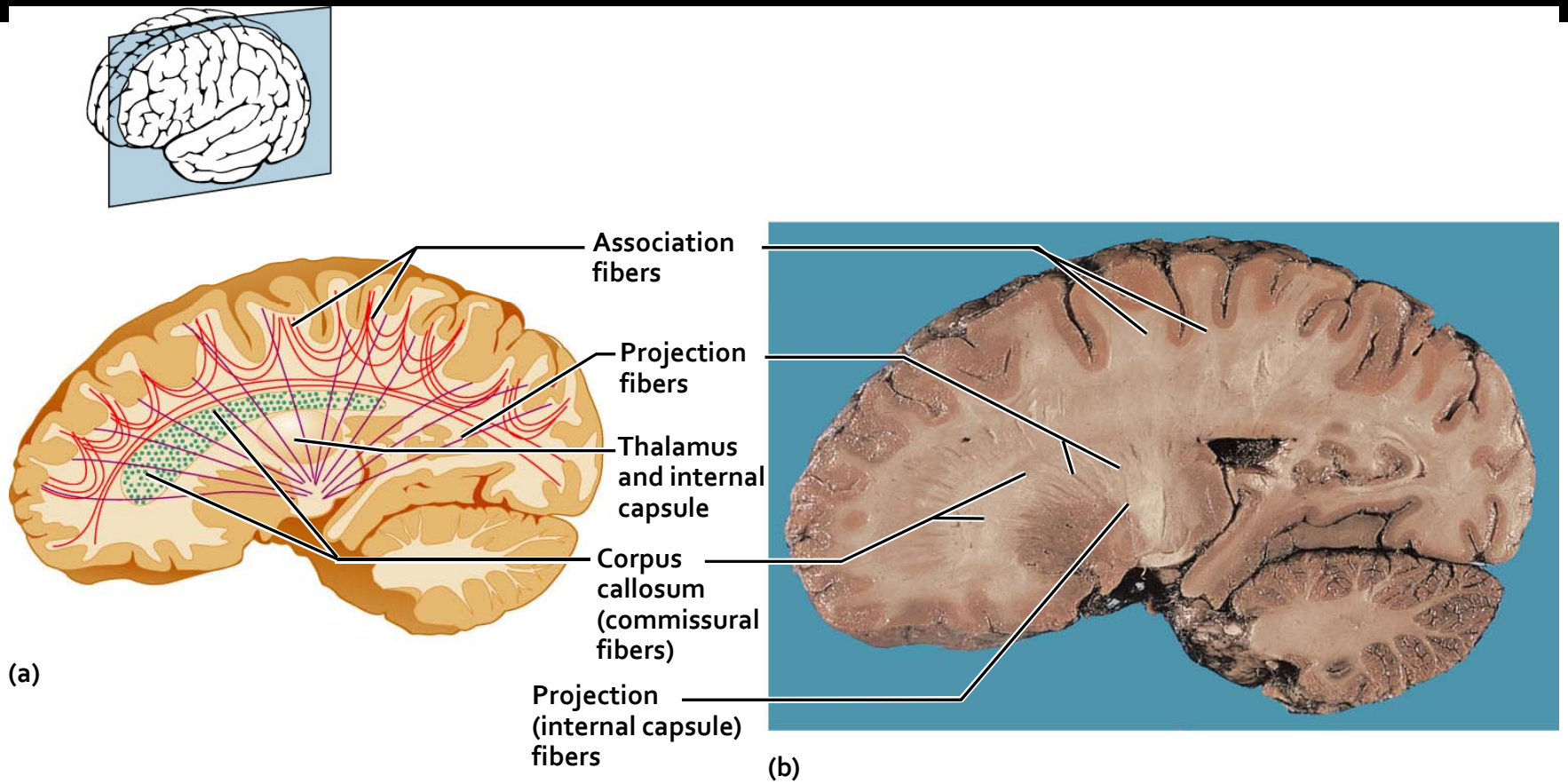
Medulla

Cerebellum

Spinal cord

Midbrain

Figure 12.10a-b: Types of fiber tracts in white matter, p. 442.



Cerebral White Matter

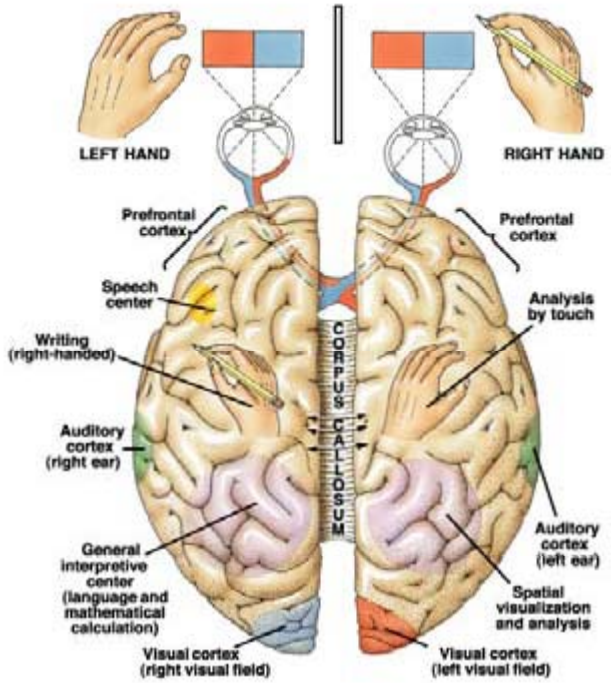
• Is white matter involved in communication?

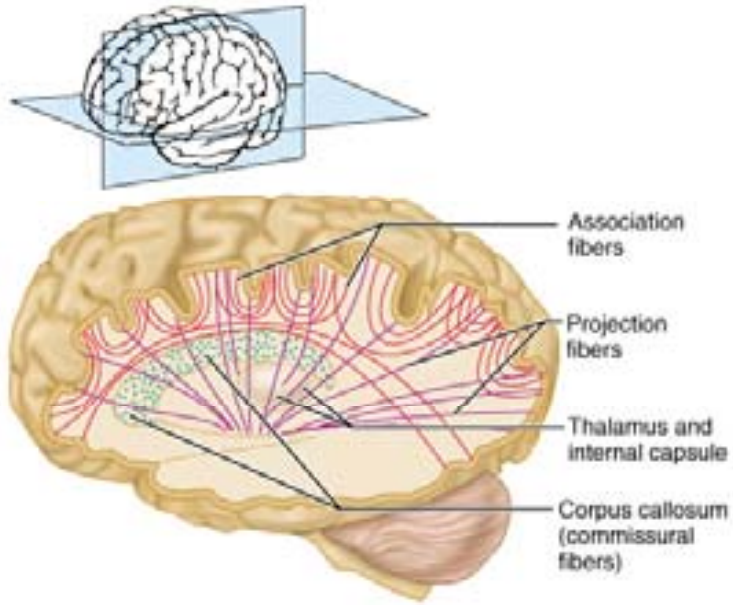
• **<u>3 types of fibers:</u>**

1. Commissural –connect corresponding areas of the hemispheres. Largest is the corpus callosum.

2. Association fibers –connect different parts of the same hemisphere

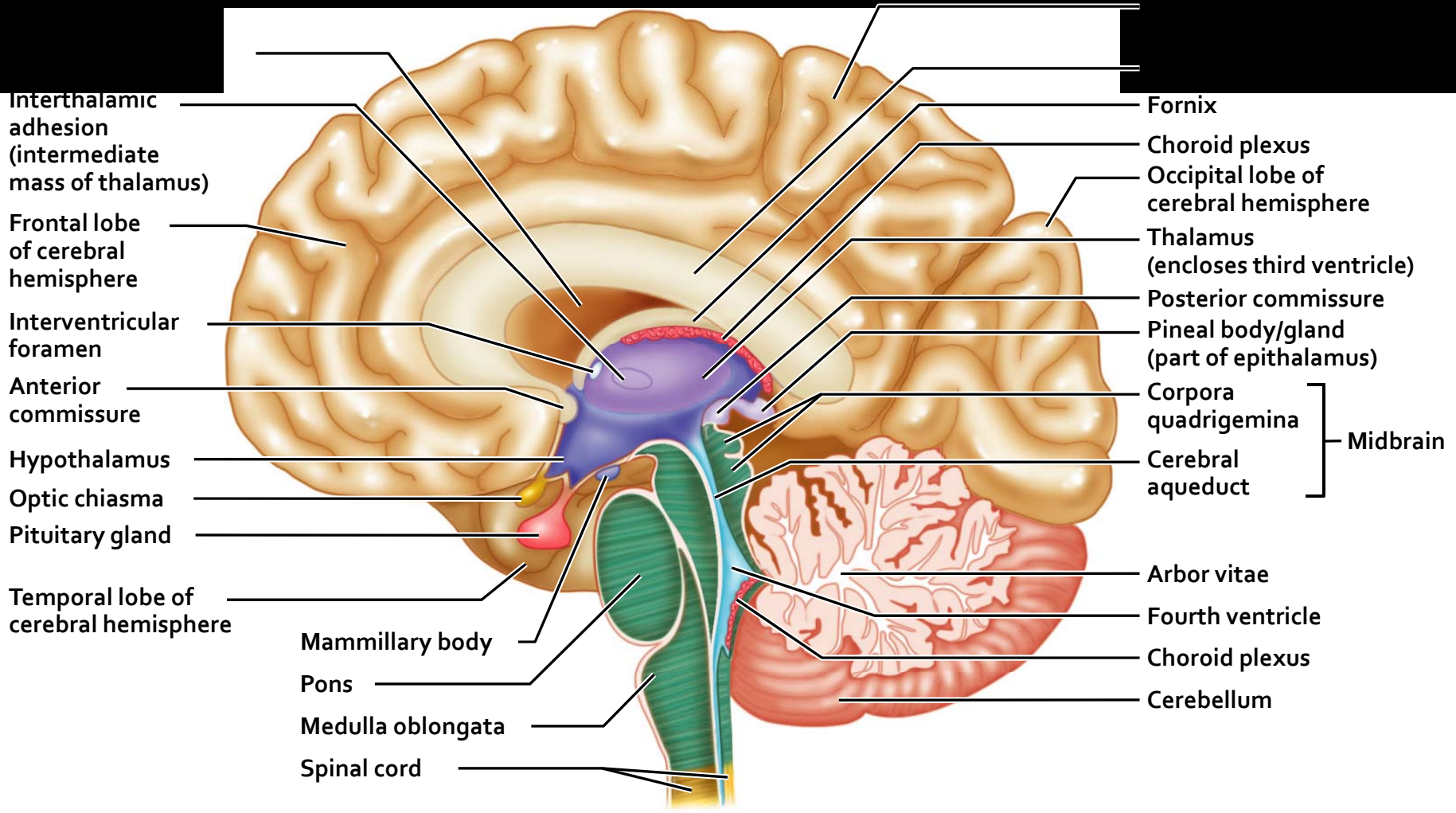
3. Projection fibers – Fibers entering and leaving the cerebral hemispheres from/to lower structures

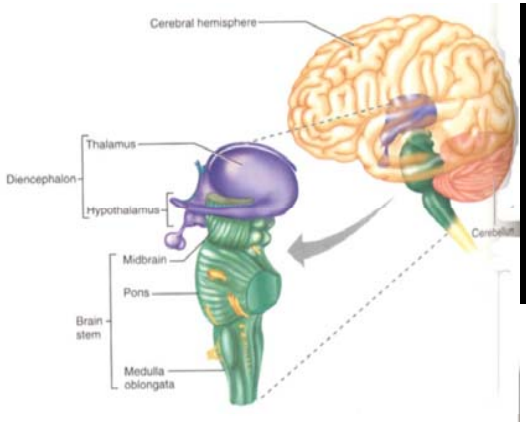




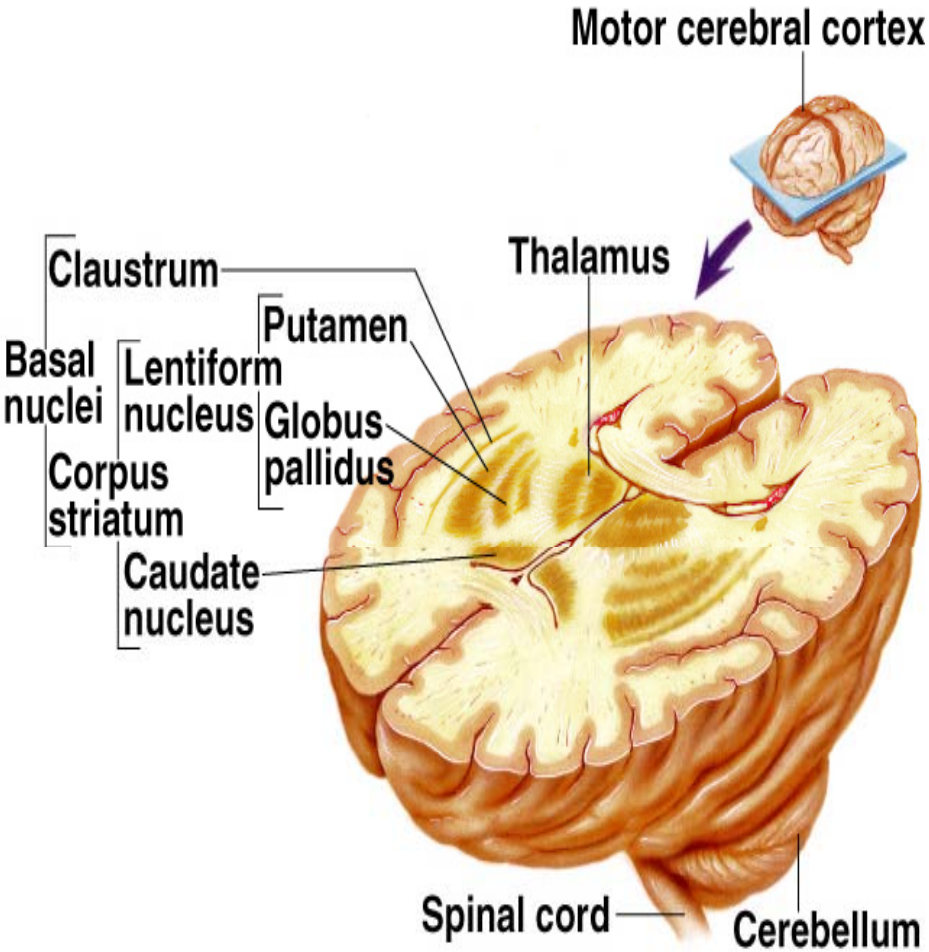
DIENCEPHALON

Figure 12.12: Midsagittal section of the brain illustrating the diencephalon and brain stem, p. 445.





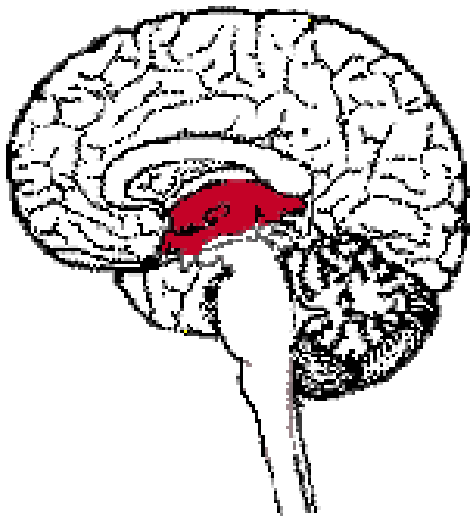
DIENCEPHALON



2 Major Structures

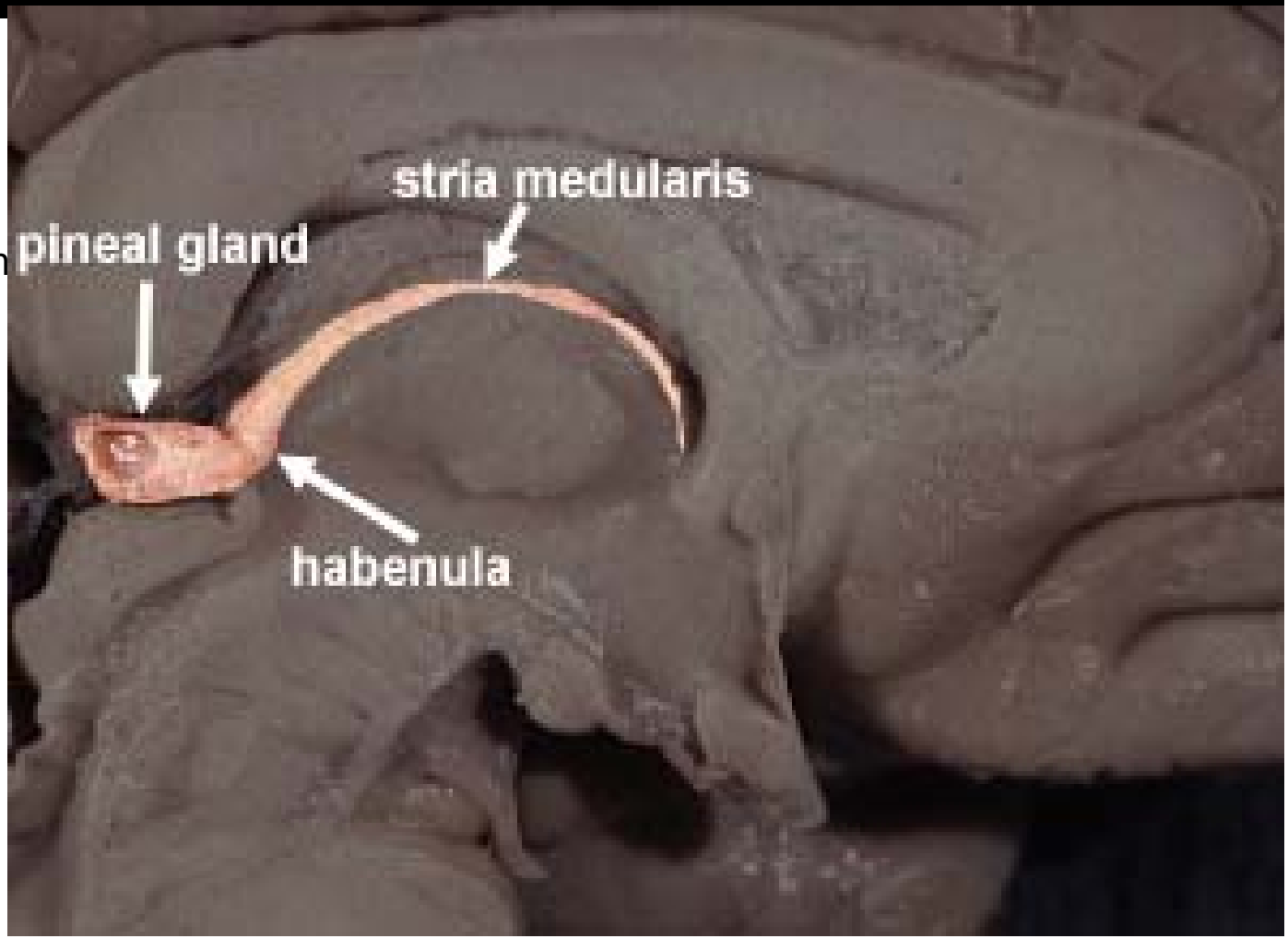
- Thalamus
- Hypothalamus

EPITHALAMUS



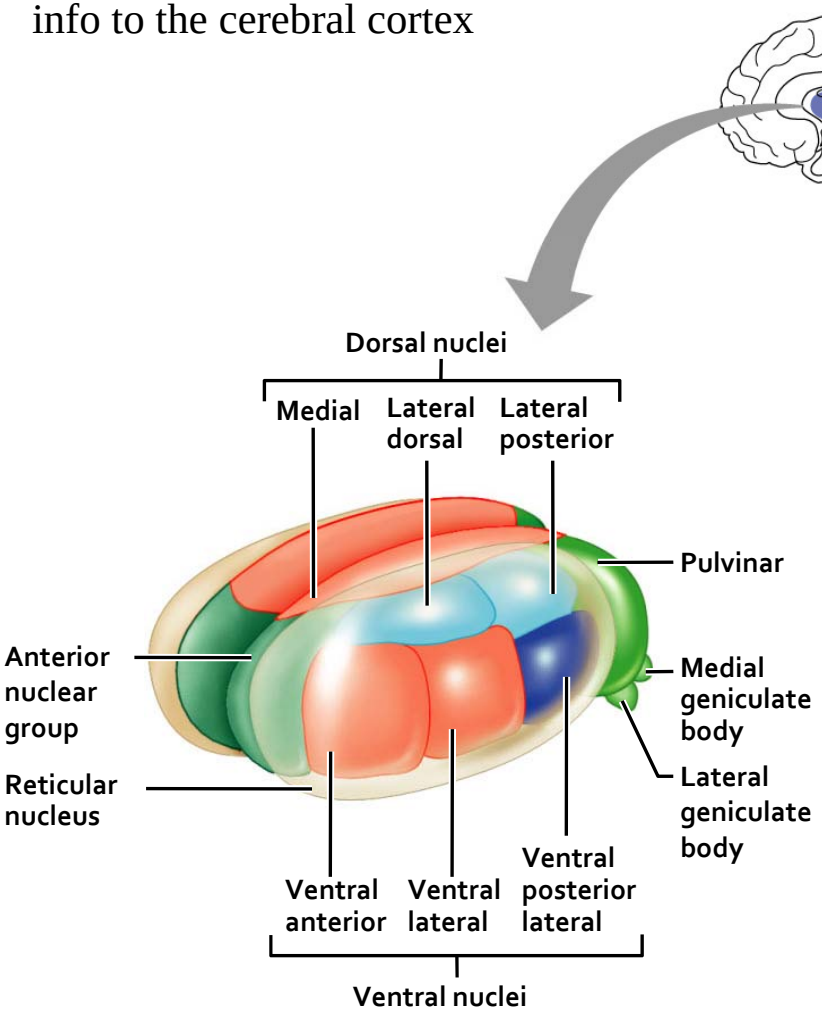
Epithalamus

- Above the thalamus
- Contains the pineal gland which releases melatonin (involved in sleep/wake cycle and mood).
- Contains a structure called the habenula – involved in food and water intake



Thalamus

- Two lobes that relay sensory projection fiber info to the cerebral cortex

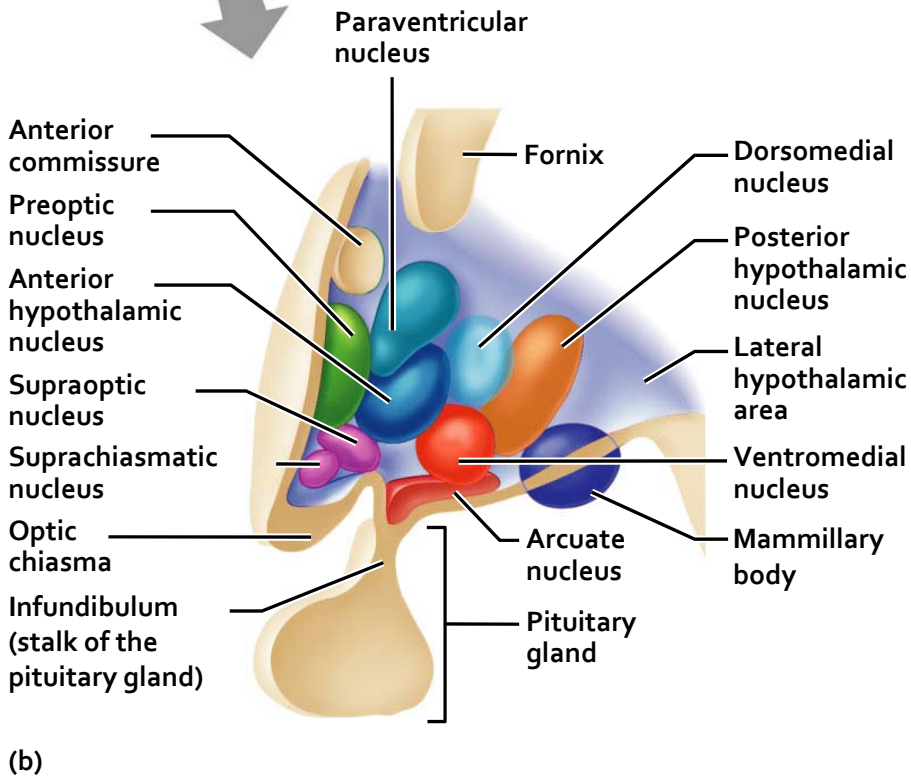


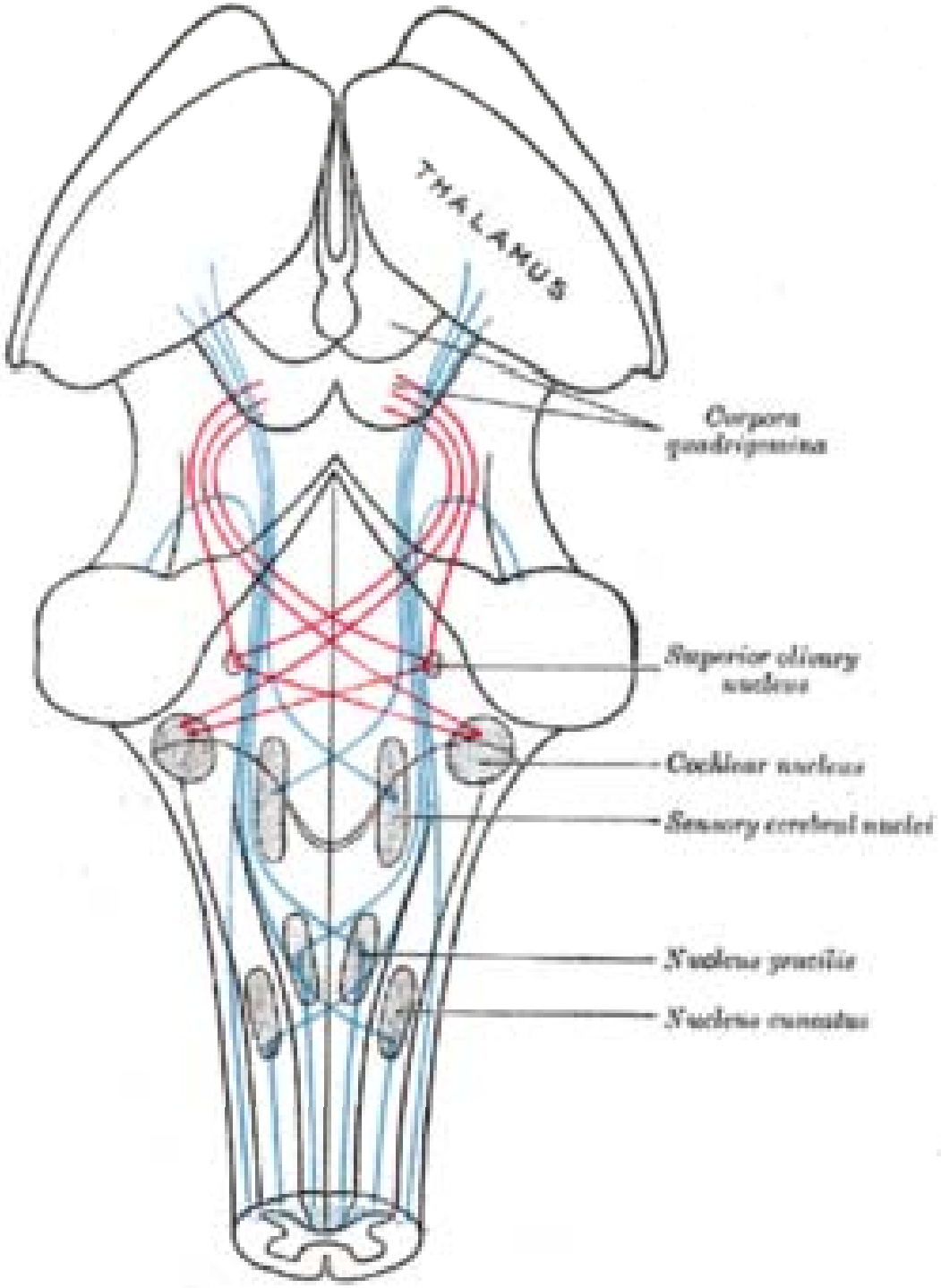
Hypothalamus

- Lies at the base of the brain

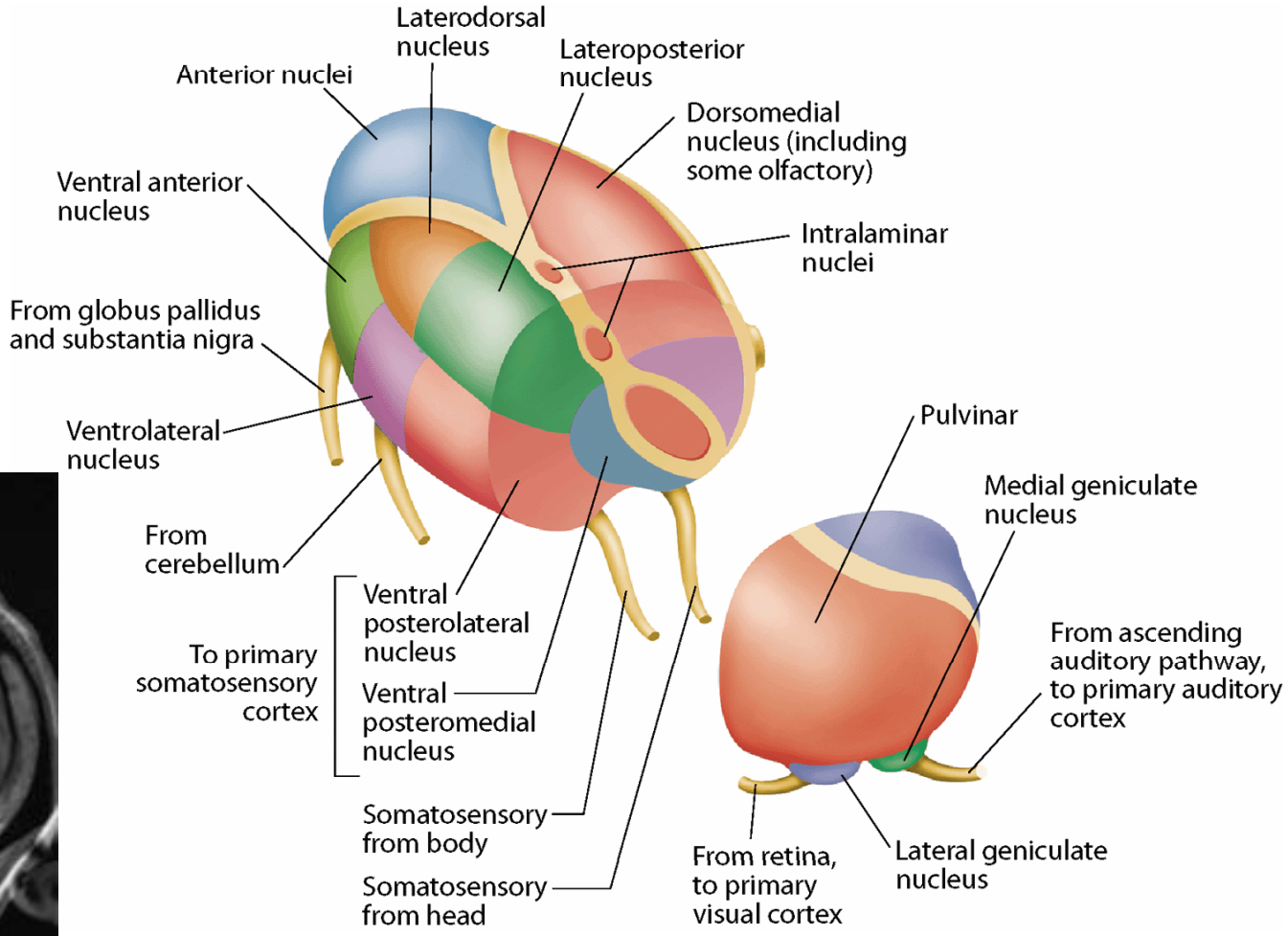
- Controls and regulates the endocrine system (hormones), autonomic system, species survival (the four Fs) and sleeping.

- Contains many nuclei and fiber tracts




THALAMUS
Corpora quadrigemina
Superior olivary nucleus
Cochlear nucleus
Sensory cerebral nuclei
Nucleus gracilis
Nucleus cuneatus

Thalamus



- *All sensory modalities relay through the thalamus*

Thalamus – "gateway" to the cerbral cortex

Afferent impulses from all senses converge and synapse in the thalamus

Impulses of similar function are sorted out, "edited", and relayed as a group to the appropriate area of the sensory cortex or association areas

All inputs ascending to the cerebral cortex pass through the thalamus

Plays a key role in mediating sensation, motor activities, cortical arousal, learning, and memory

The thalamus act as a translator for which various inputs are processed into a form readable by the cerebral cortex.
The thalamus is believed to both process and relay sensory information selectively to various parts of the cerebral cortex, as one thalamic point may reach one or several regions in the cortex.
The thalamus also plays an important role in regulating states of sleep and wakefulness.
Thalamic nuclei have strong reciprocal connections with the cerebral cortex, forming thalamo-cortico-thalamic circuits that are believed to be involved with consciousness.

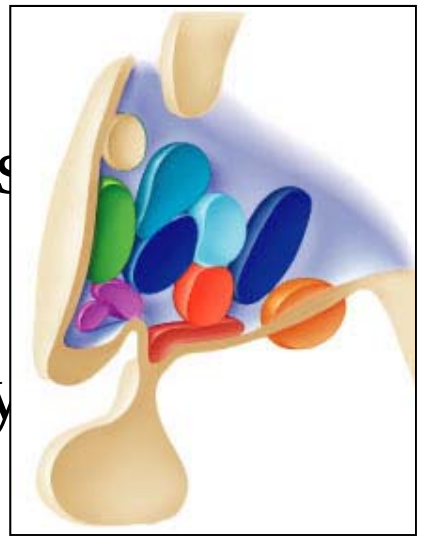
The thalamus plays a major role in regulating arousal, the level of awareness, and activity.
Damage to the thalamus can lead to permanent coma.

This is at first the case for sensory systems (which excepts the olfactory function) auditory, somatic, visceral, gustatory and visual systems where localised lesions provoke particular sensory deficits.
A major role of the thalamus is devoted to "motor" systems.
This has been and continues to be a subject of interest for investigators. VIm, the relay of cerebellar afferences, is the target of stereotactians particularly for the improvement of tremor.
The role of the thalamus in the more anterior pallidal and nigral territories in the basal ganglia system disturbances is recognized but still poorly known. The contribution of the thalamus to vestibular or to tectal functions is almost ignored. The thalamus has been thought of as a "relay" that simply forwards signals to the cerebral cortex. Newer research suggests that thalamic function is more complicated.

Hypothalamus

forms the inferolateral walls of the third ventricle

Mammillary bodies - small, paired nuclei bulging anteriorly from the hypothalamus - relay stations for olfactory pathways

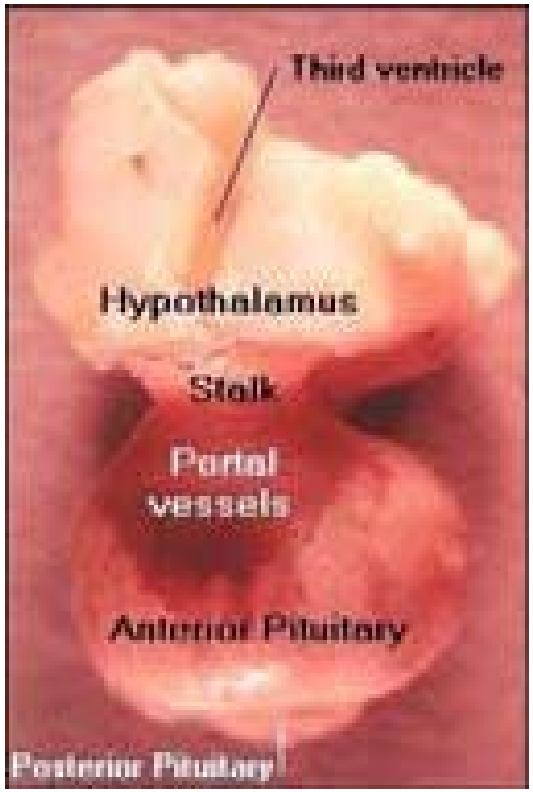


Infundibulum – stalk of the hypothalamus connecting to the pituitary gland

Main visceral control center of the body important to overall body homeostasis

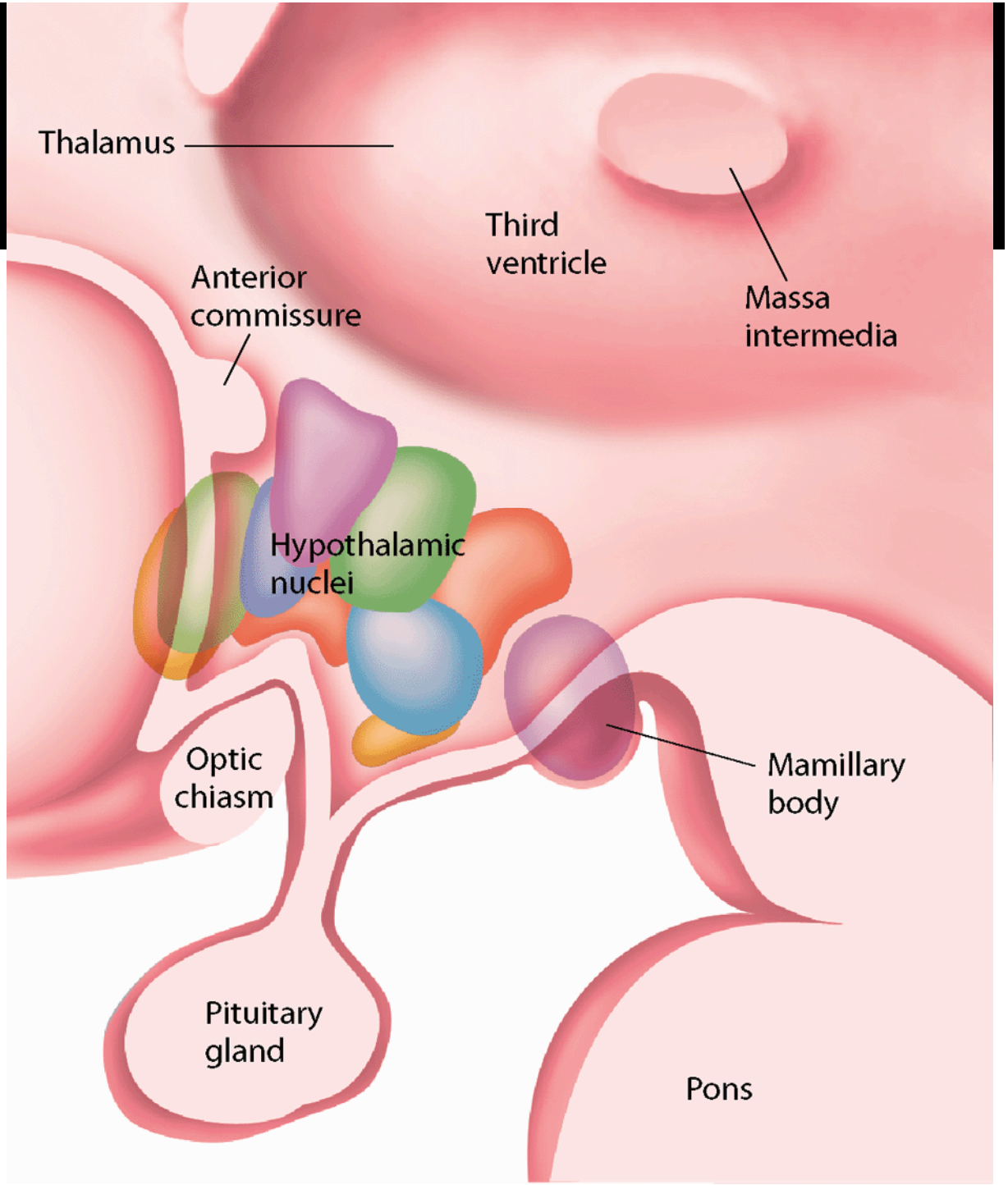
Hypothalamus

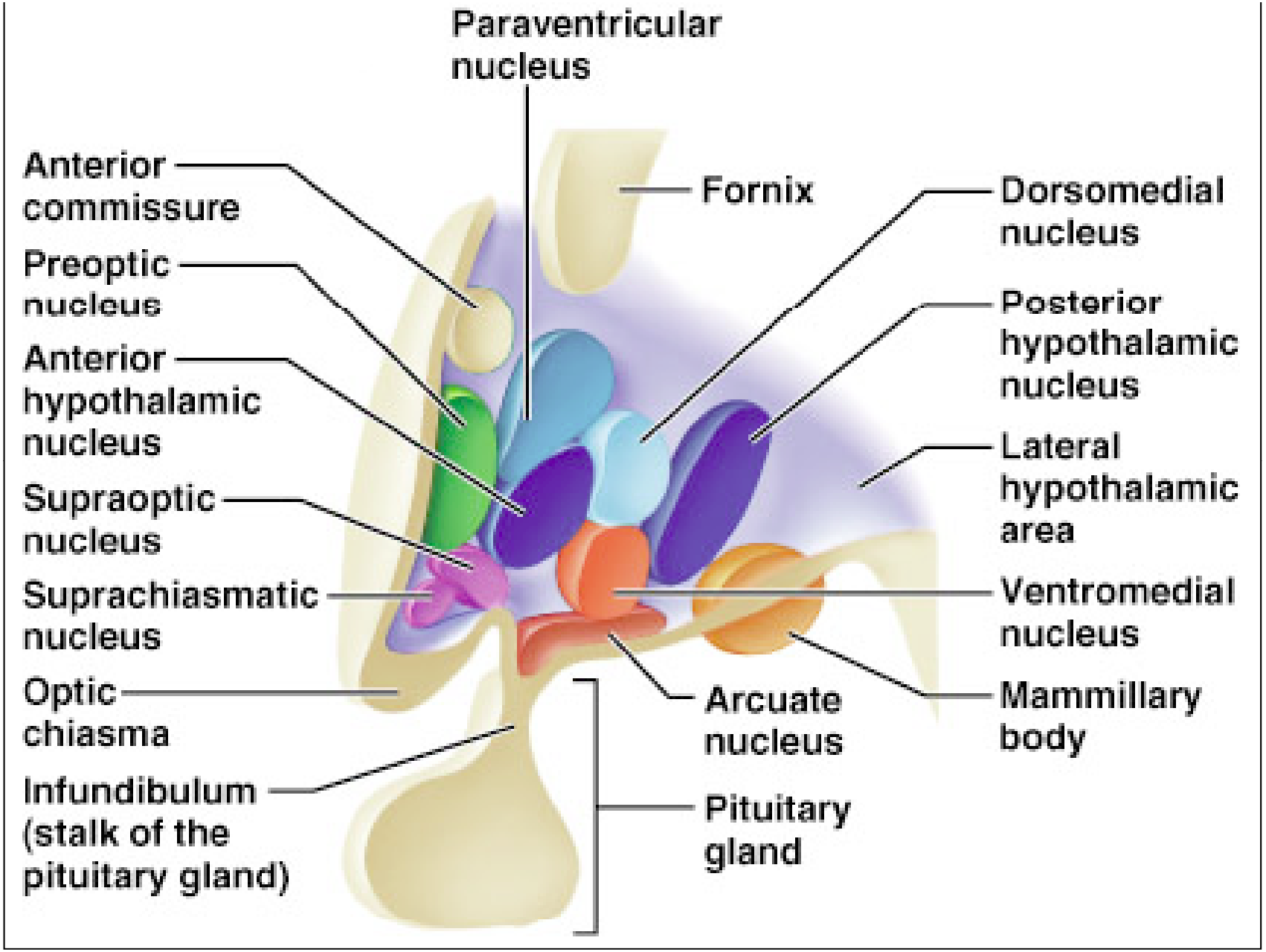
- Functions:
  - Autonomic regulatory center
    - Influences HR, BP, resp. rate, GI motility, pupillary diameter.
    - Can you hold your breath until you die?
  - Emotional response
    - Involved in fear, loathing, pleasure
    - Drive center: sex, hunger
  - Regulation of body temperature
  - Regulation of food intake
    - Contains a satiety center
  - Regulation of water balance and thirst
  - Regulation of sleep/wake cycles
  - Hormonal control
    - Releases hormones that influence hormonal secretion from the anterior pituitary gland.



Hypothalamus

- *A group of nuclei critical for regulating homeostasis, the four Fs, and hormones*





Hypothalamic Nuclei

Hypothalamic Function

Regulates blood pressure, rate and force of heartbeat, digestive tract motility, respiratory rate and depth, pupil size, and many other visceral activities

Center for emotional response - involved in perception of pleasure, fear, rage

Regulates body temperature – the body's "thermostat"

Regulates food intake - feelings of hunger and satiety

Regulates sleep-wake cycle

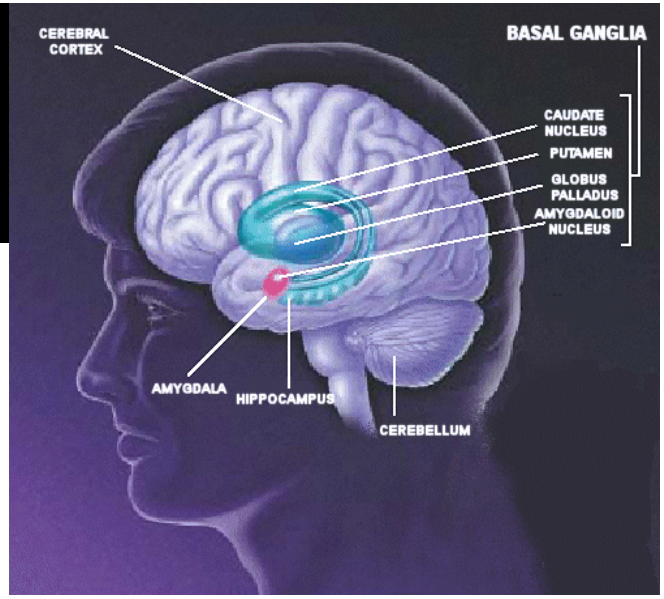
Endocrine Functions of the Hypothalamus

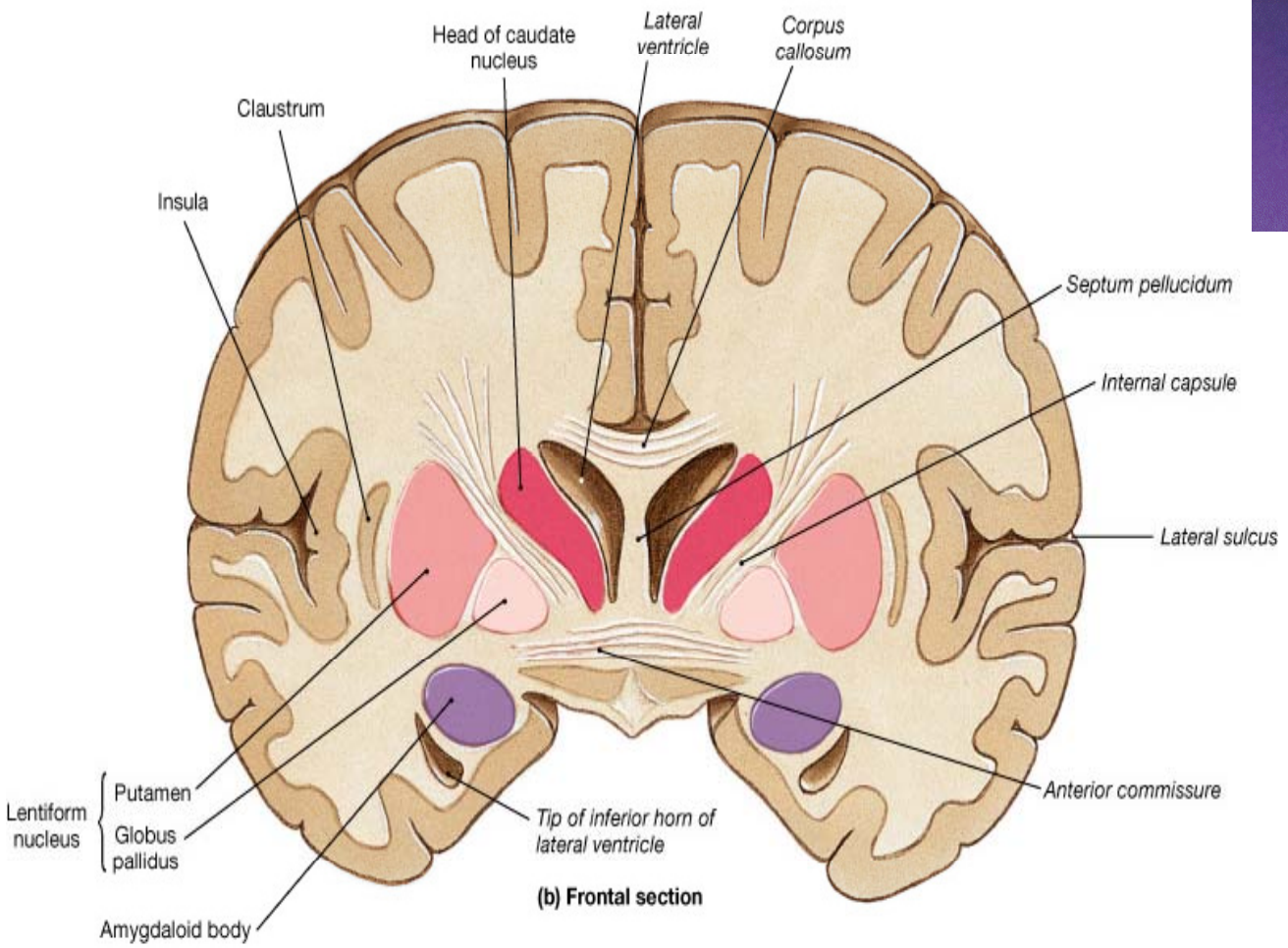
Releasing hormones control the secretion of hormones by the anterior pituitary

Stimulates ADH release from the posterior pituitary

Anti-diuretic hormone- causes kidneys to retain water

Basal nuclei





Basal Nuclei

Caudate nucleus: control walking movements

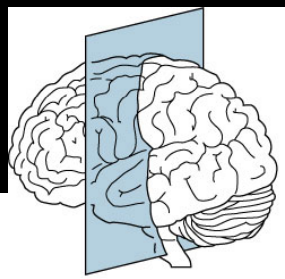
Amygdala: subconscious visual processing

Claustrum: subconscious visual processing

Putamen: control walking movements

Globus pallidus: controls/adjusts appendicular muscle tone

Figure 12.10c: Types of fiber tracts in white matter, p. 442.



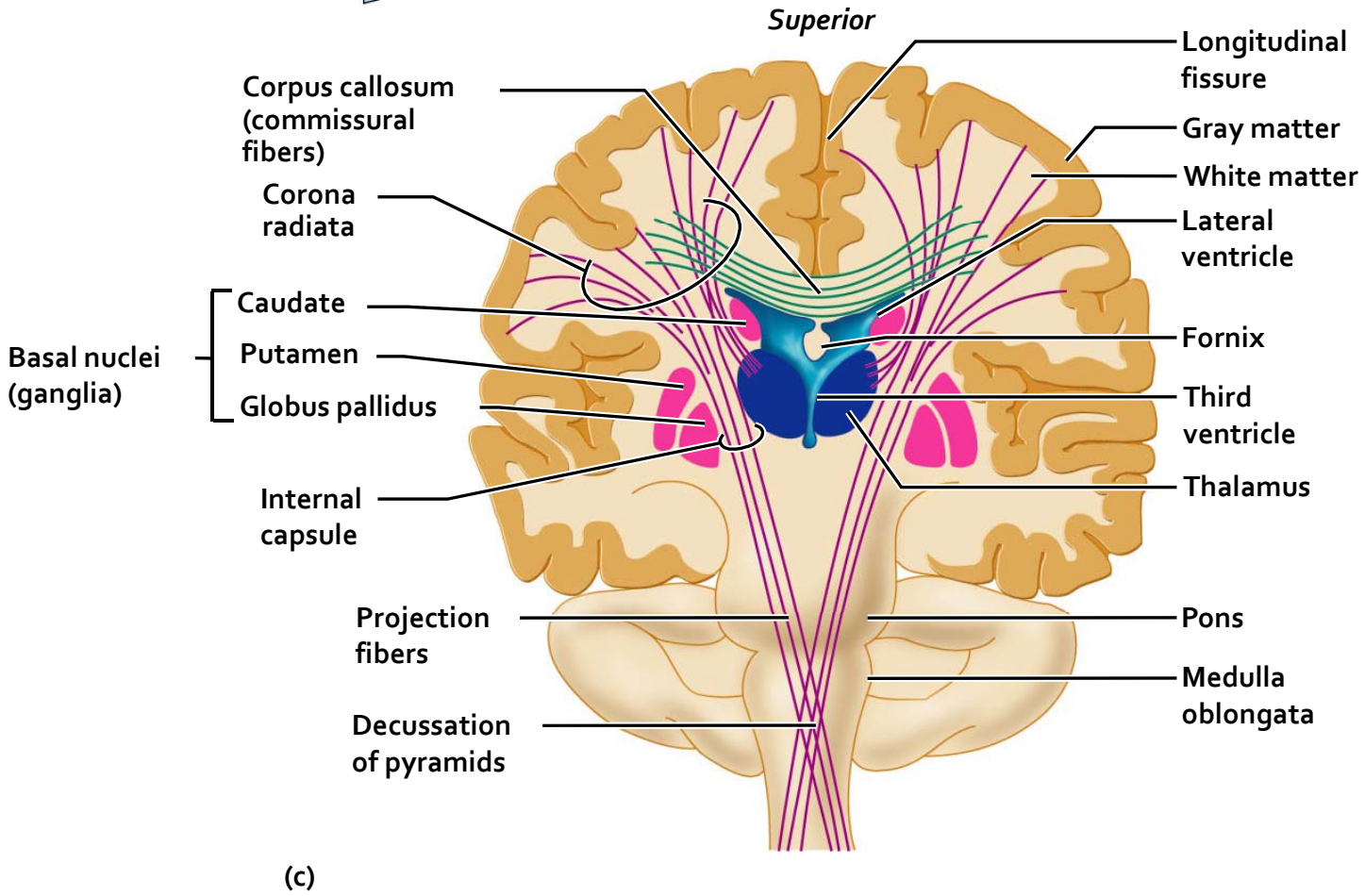
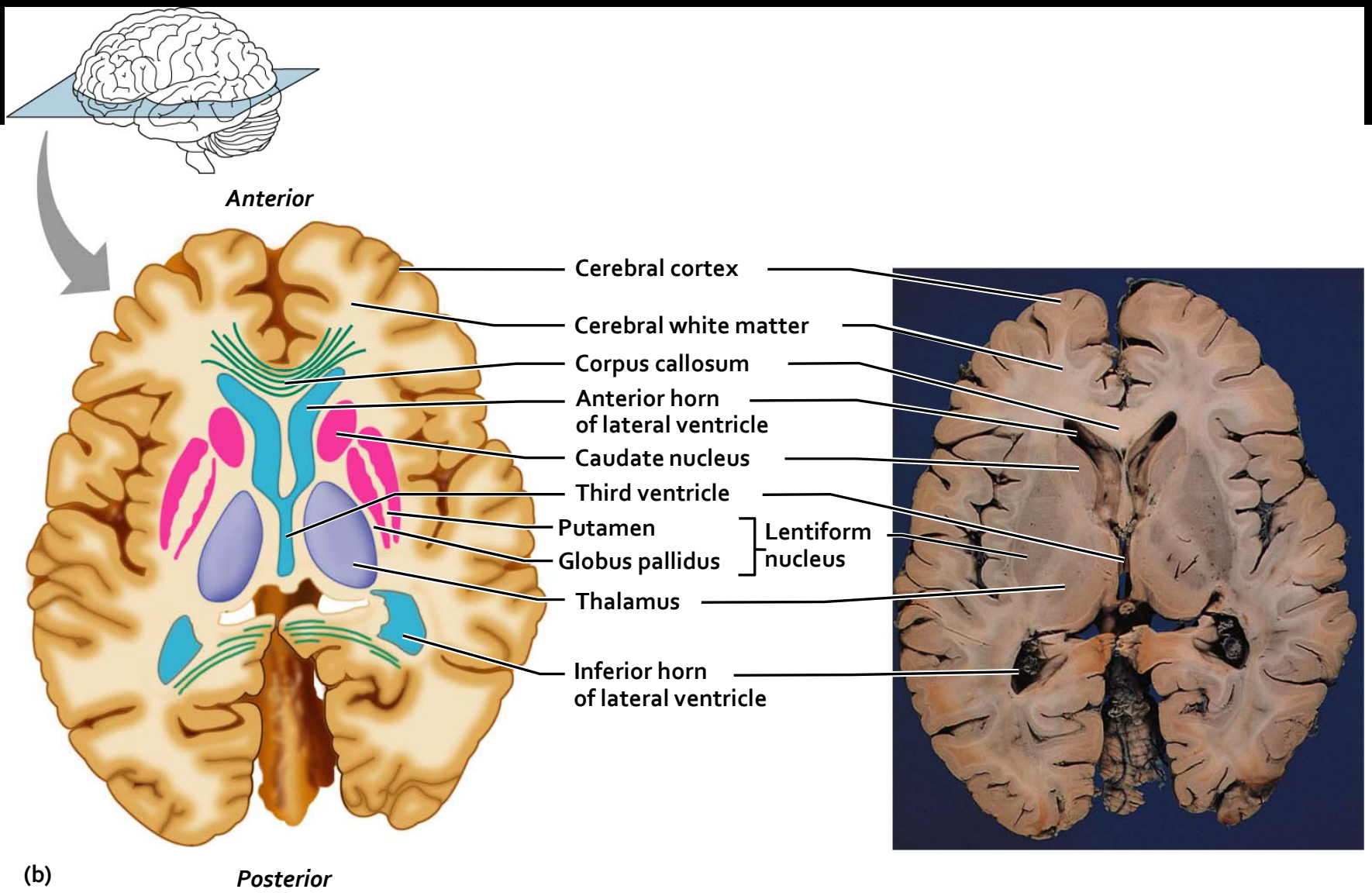
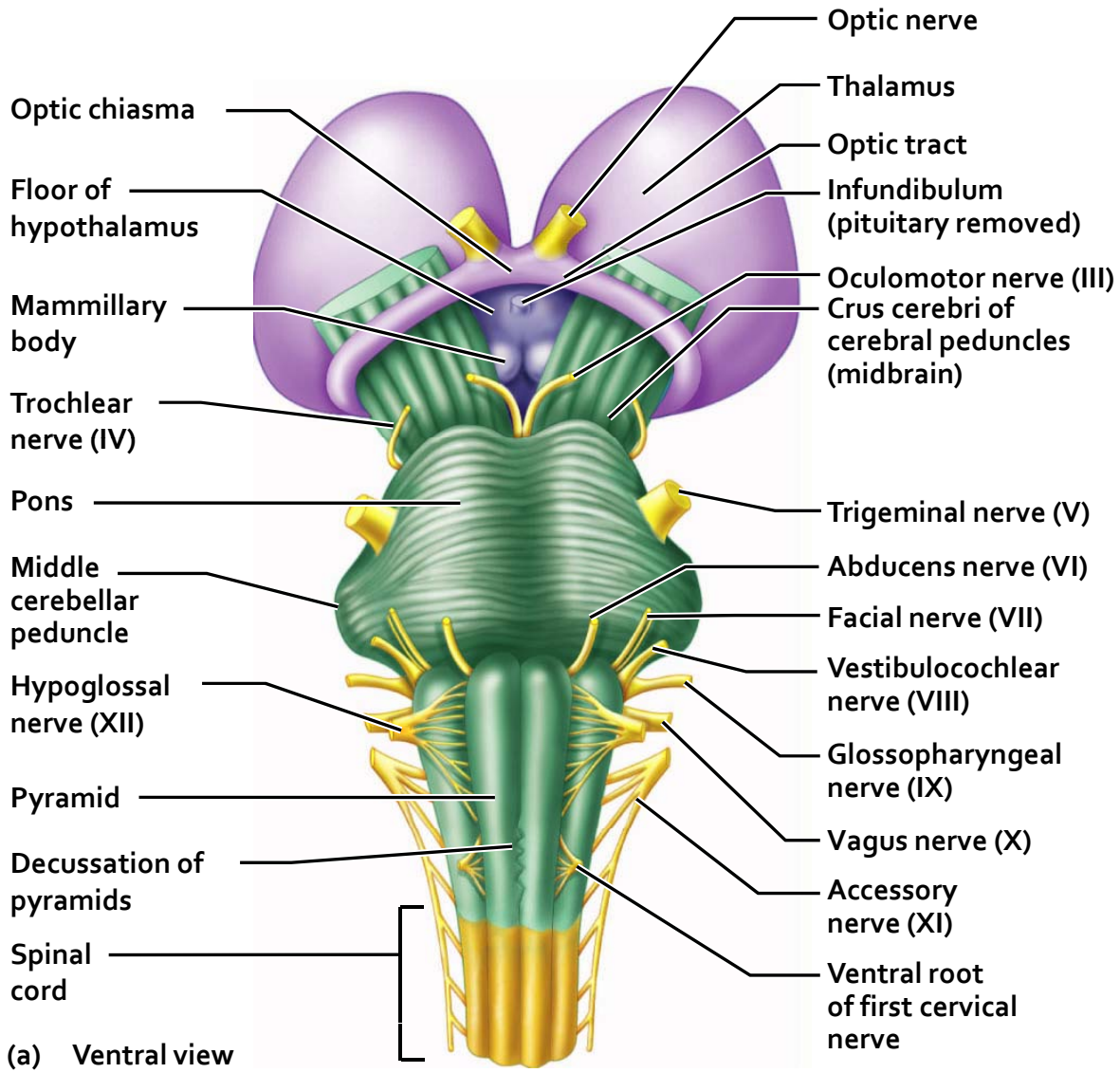
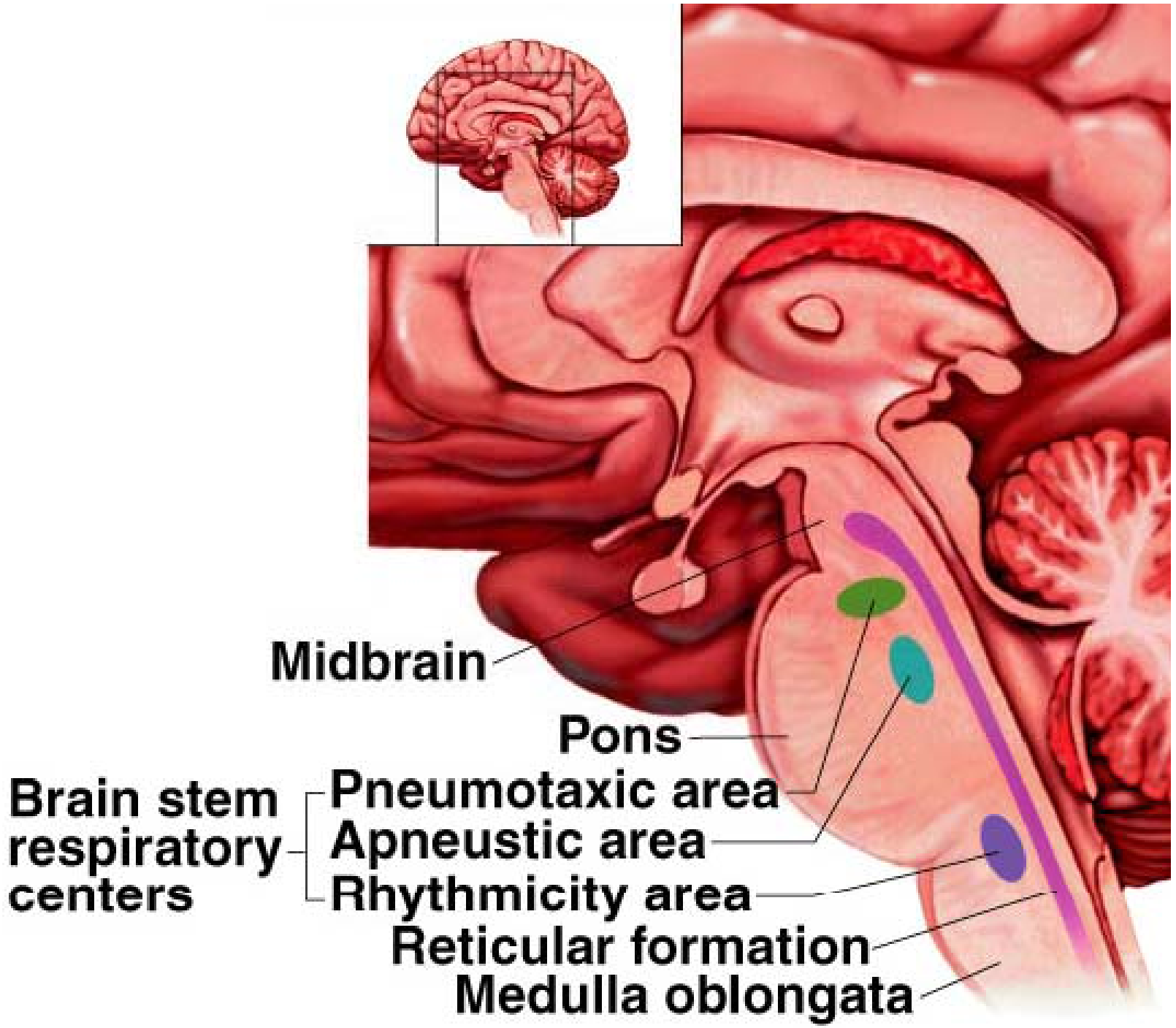


Figure 12.11b: Basal nuclei, p. 444.



Relationship of the brain stem and the diencephalon,




Midbrain
Pons
Brain stem respiratory centers
Pneumotaxic area
Apneustic area
Rhythmicity area
Reticular formation
Medulla oblongata

: Relationship of the brain stem and the diencephalon, p. 448.

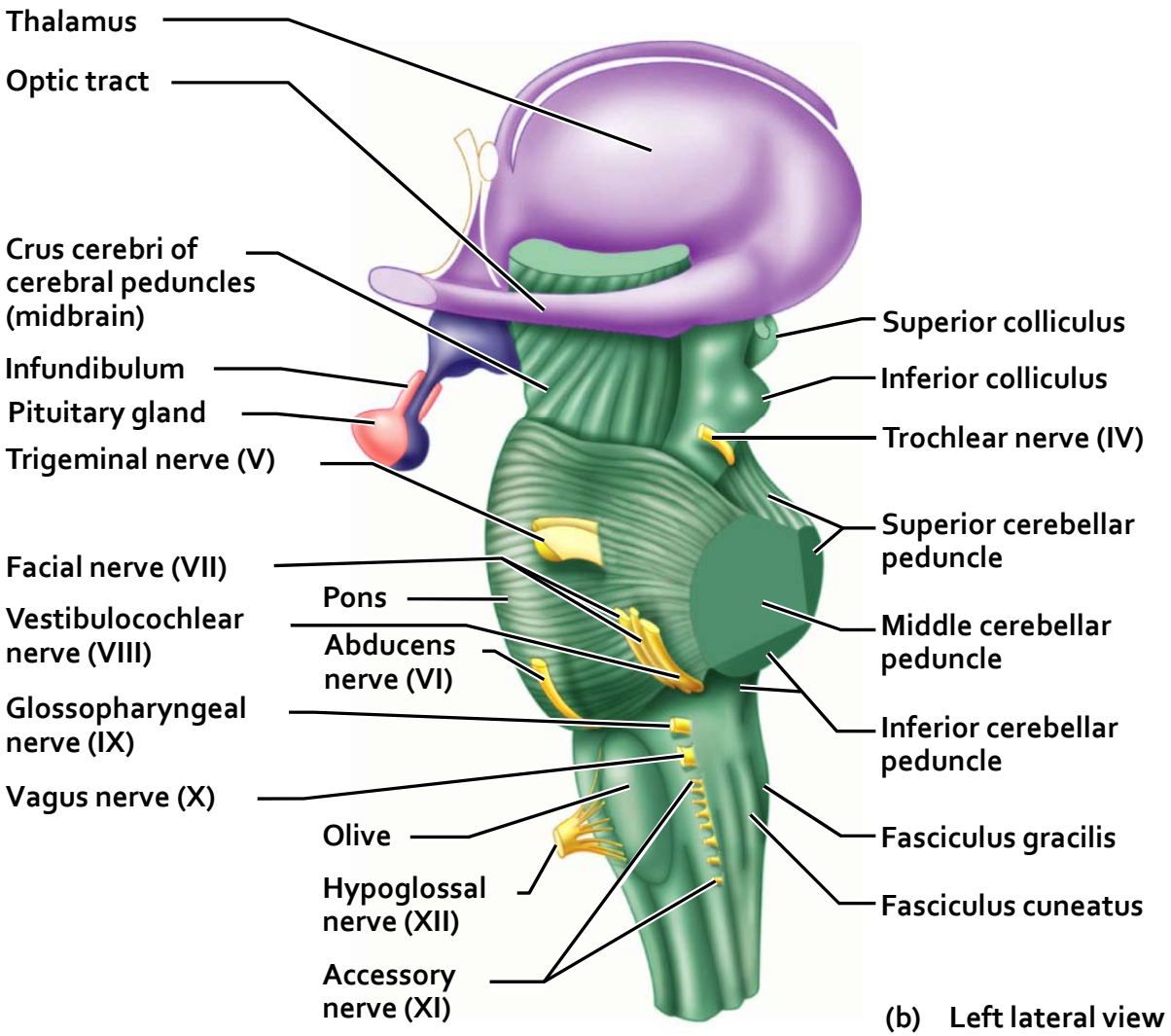
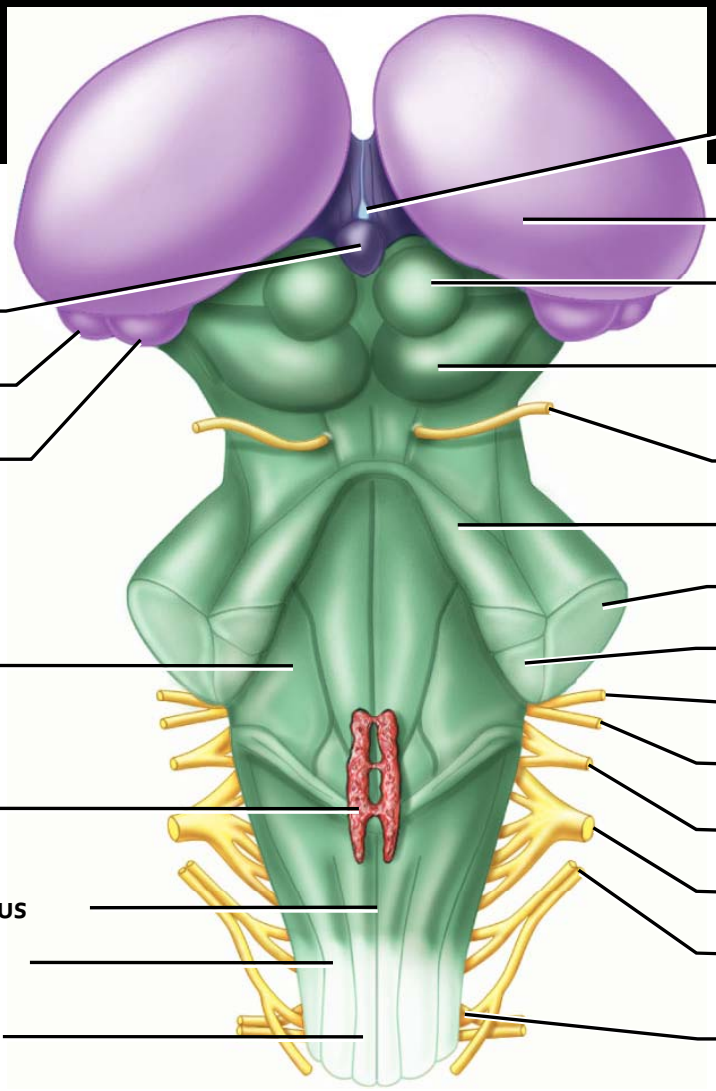


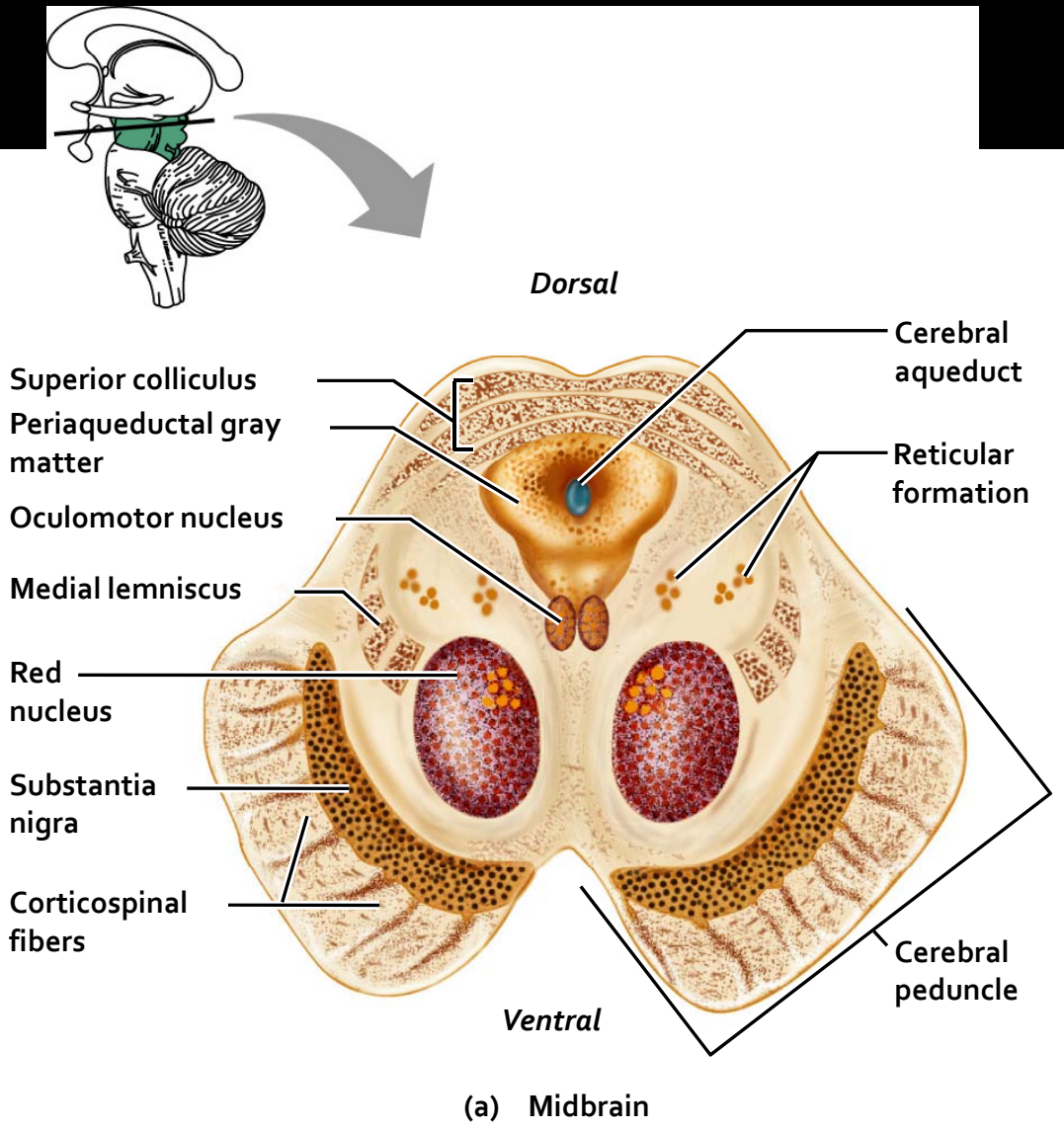
Figure 12.15c: Relationship of the brain stem and the diencephalon, p. 449.



Thalamus
Pineal gland
Superior colliculus
Corpora quadrigemina of tectum
Lateral geniculate nucleus
Inferior colliculus
Medial geniculate nucleus
Trochlear (IV) nerve
Midbrain
Superior cerebellar peduncle
Middle cerebellar peduncle
Pons
Anterior wall of fourth ventricle
Inferior cerebellar peduncle
Facial (VII) nerve
Vestibulocochlear (VIII) nerve
Choroid plexus (fourth venticle)
Glossopharyngeal (IX) nerve
Medulla
Posterior median sulcus
Vagus (X) nerve
Fasciculus cuneatus
Accessory (XI) nerve
Fasciculus gracilis
Posterior (dorsal) root of first cervical nerve

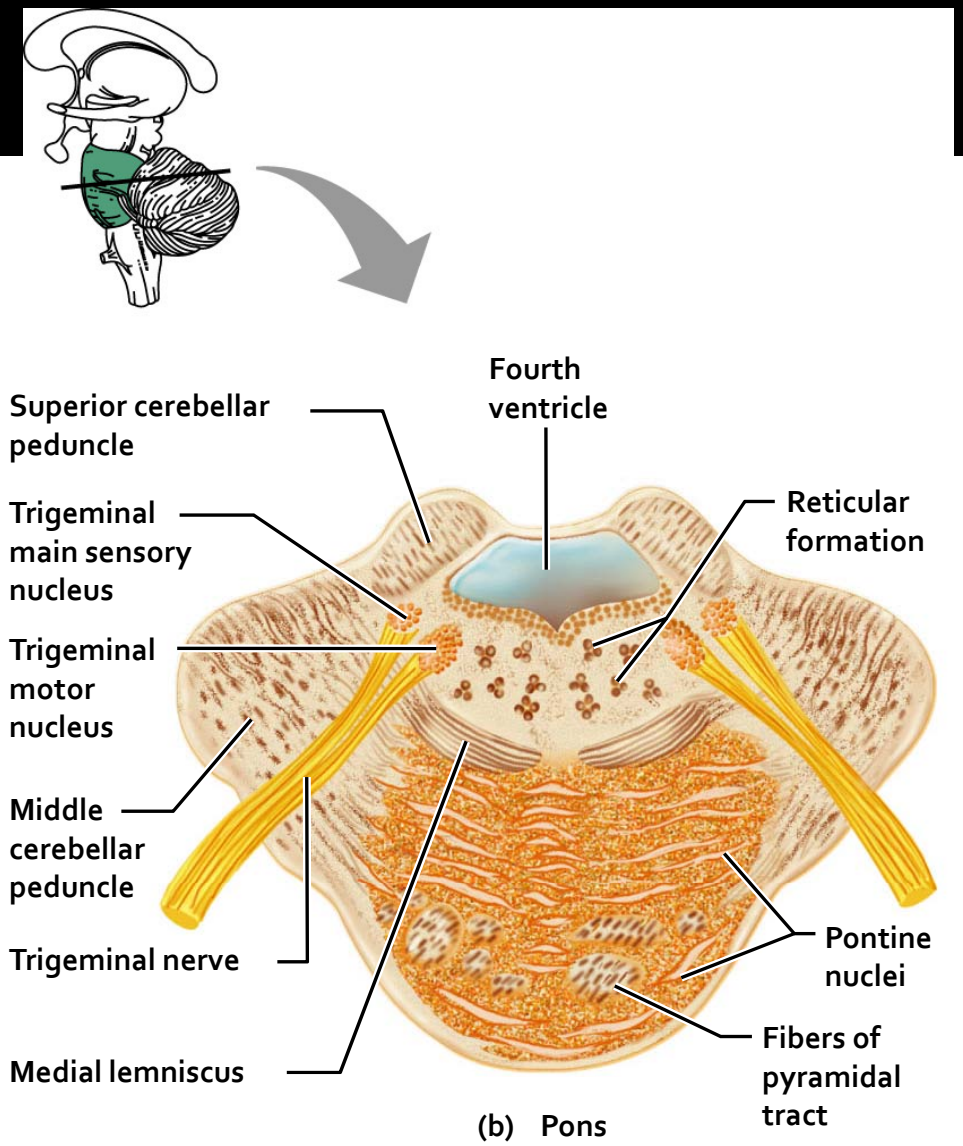
(c) Dorsal view

Figure 12.16a: Important brain stem nuclei, p. 450.



(a) Midbrain

Figure 12.16b: Important brain stem nuclei, p. 450.



Pons:

Connects other parts.

several nuclei associated with cranial nerves

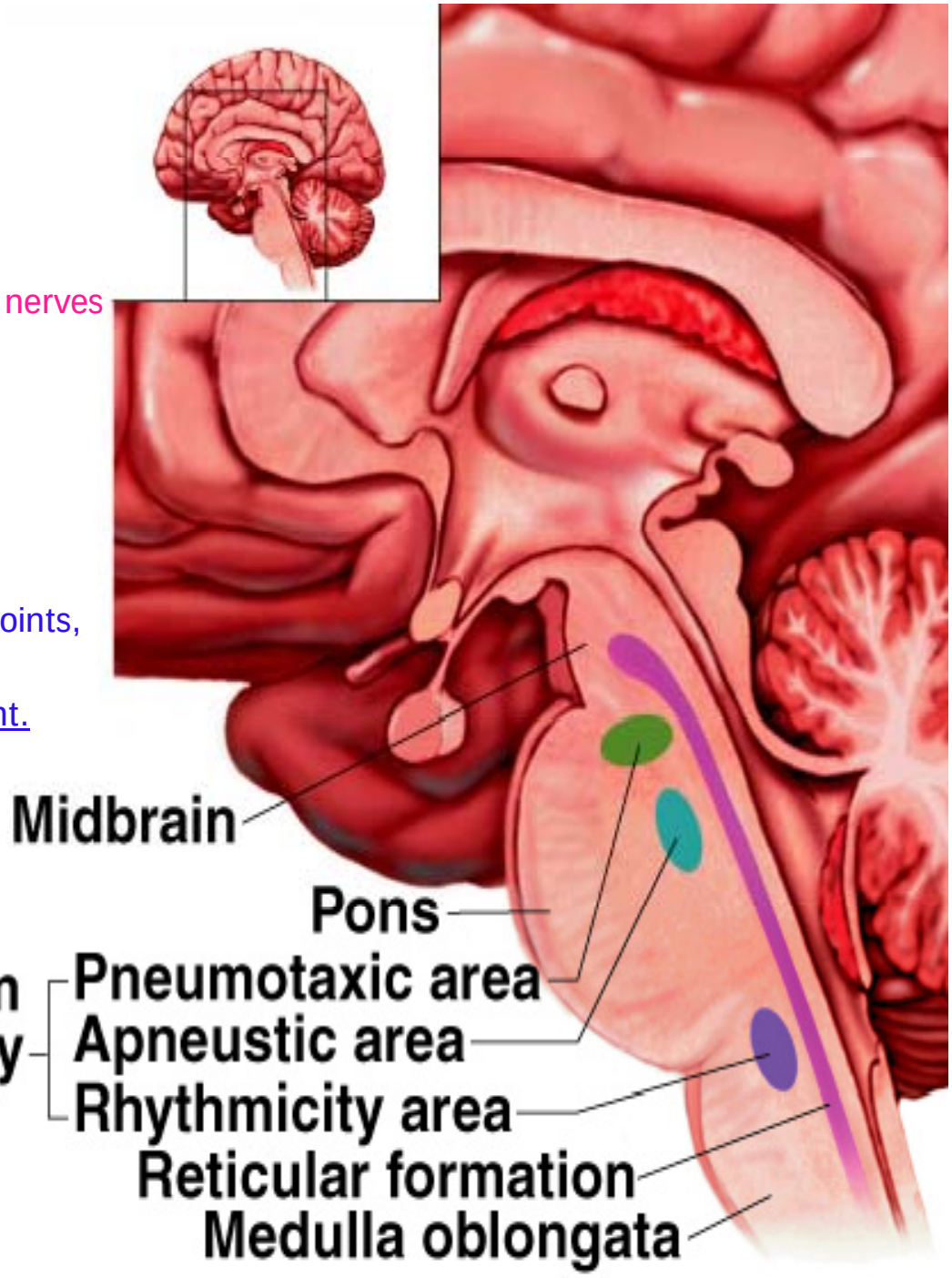
respiratory centers.

Cerebellum:

"little brain"

Receives input from proprioceptors (joints, muscles, tendons).

Refinement/coordination of movement.



CEREBELLUM

Function: **adjusting posture (semi-conscious, via red nucleus), program/fine tune voluntary & involuntary movements. Is *ipsilateral***

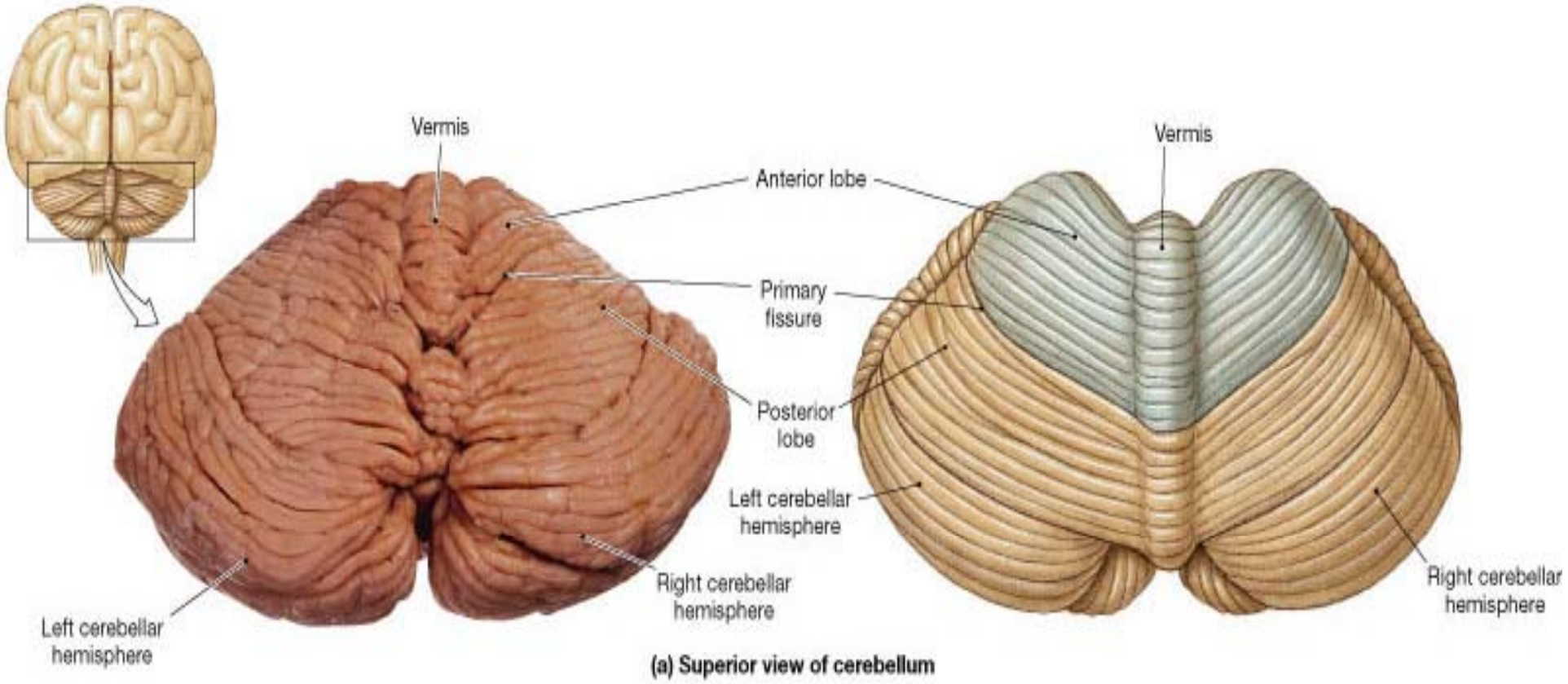
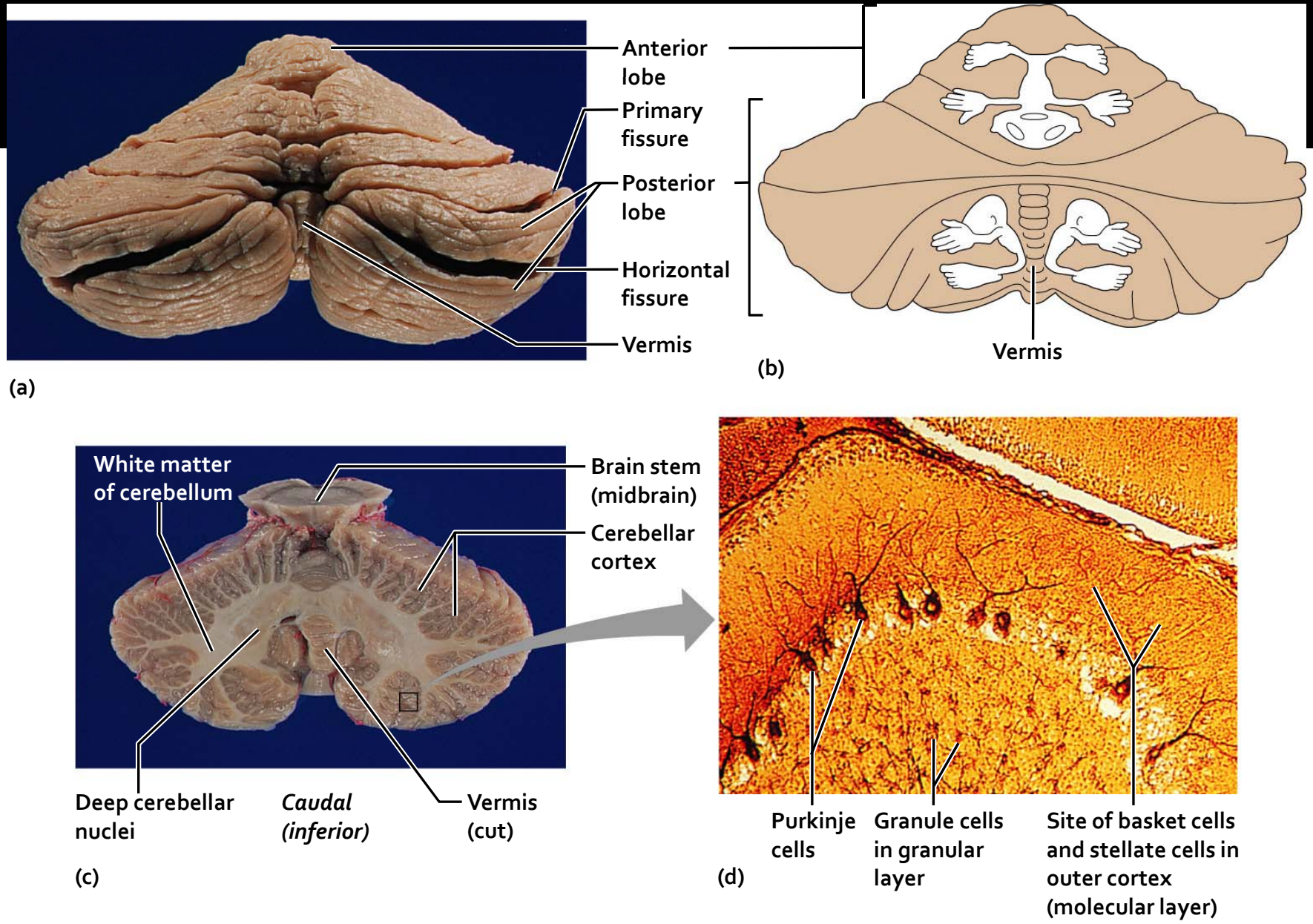


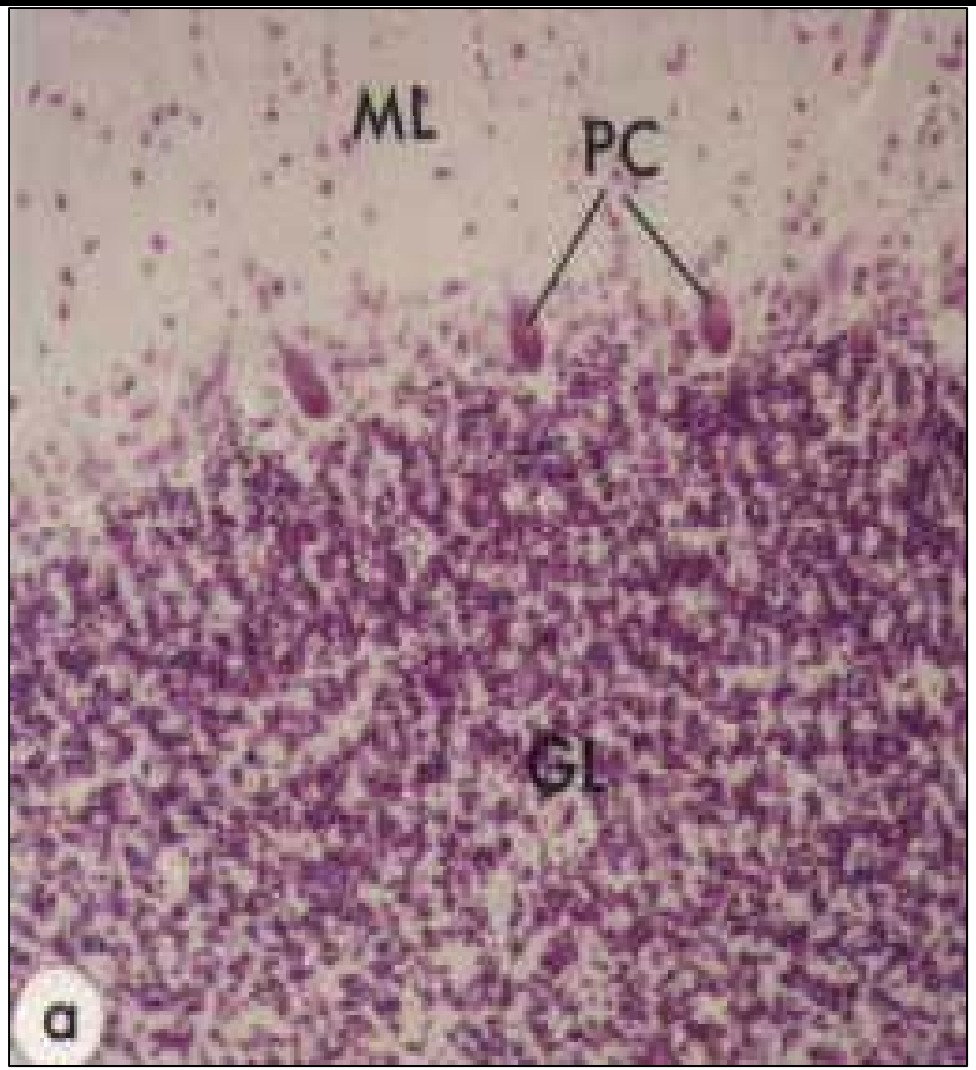
Figure 12.17: Cerebellum, p. 452.



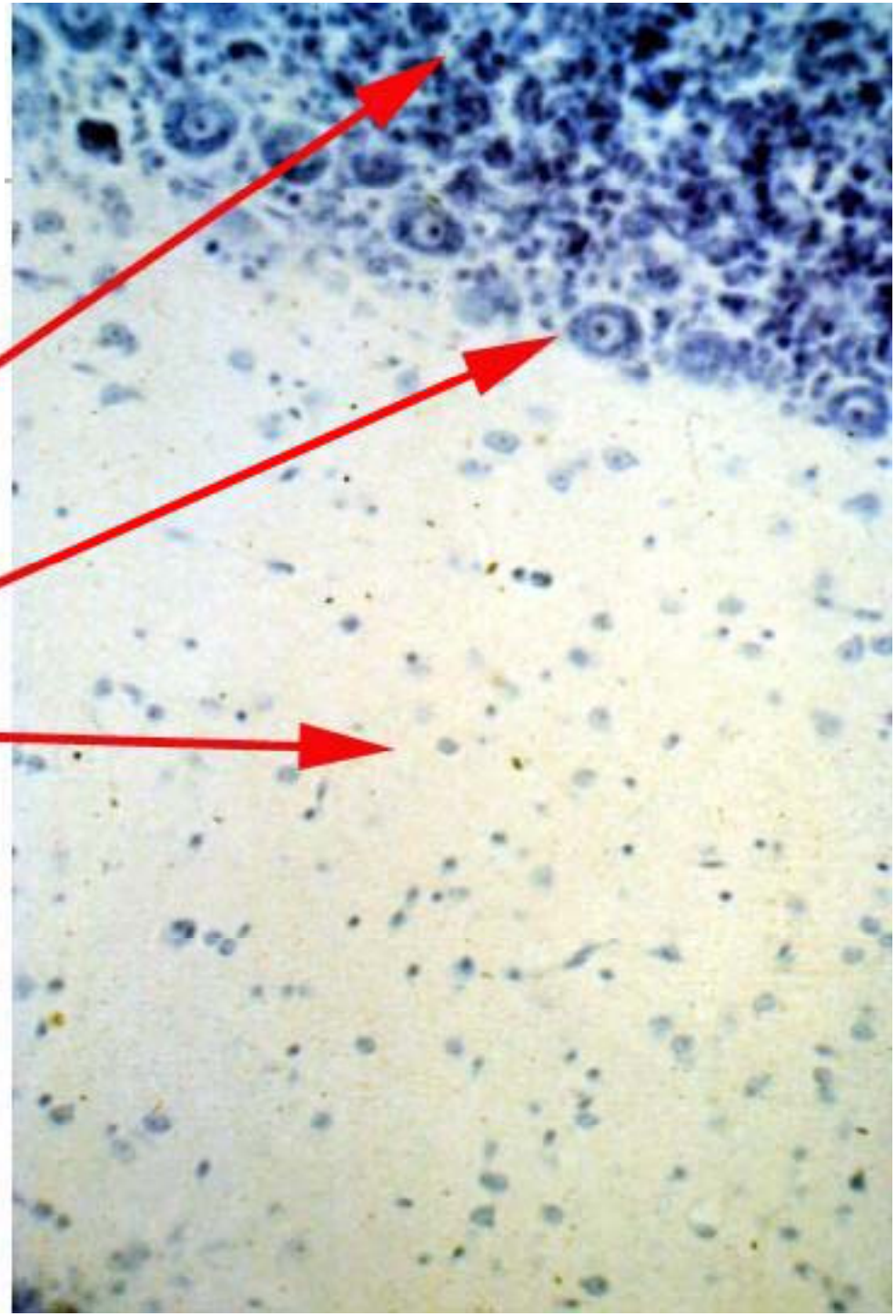
Cerebellum

Cerebellum

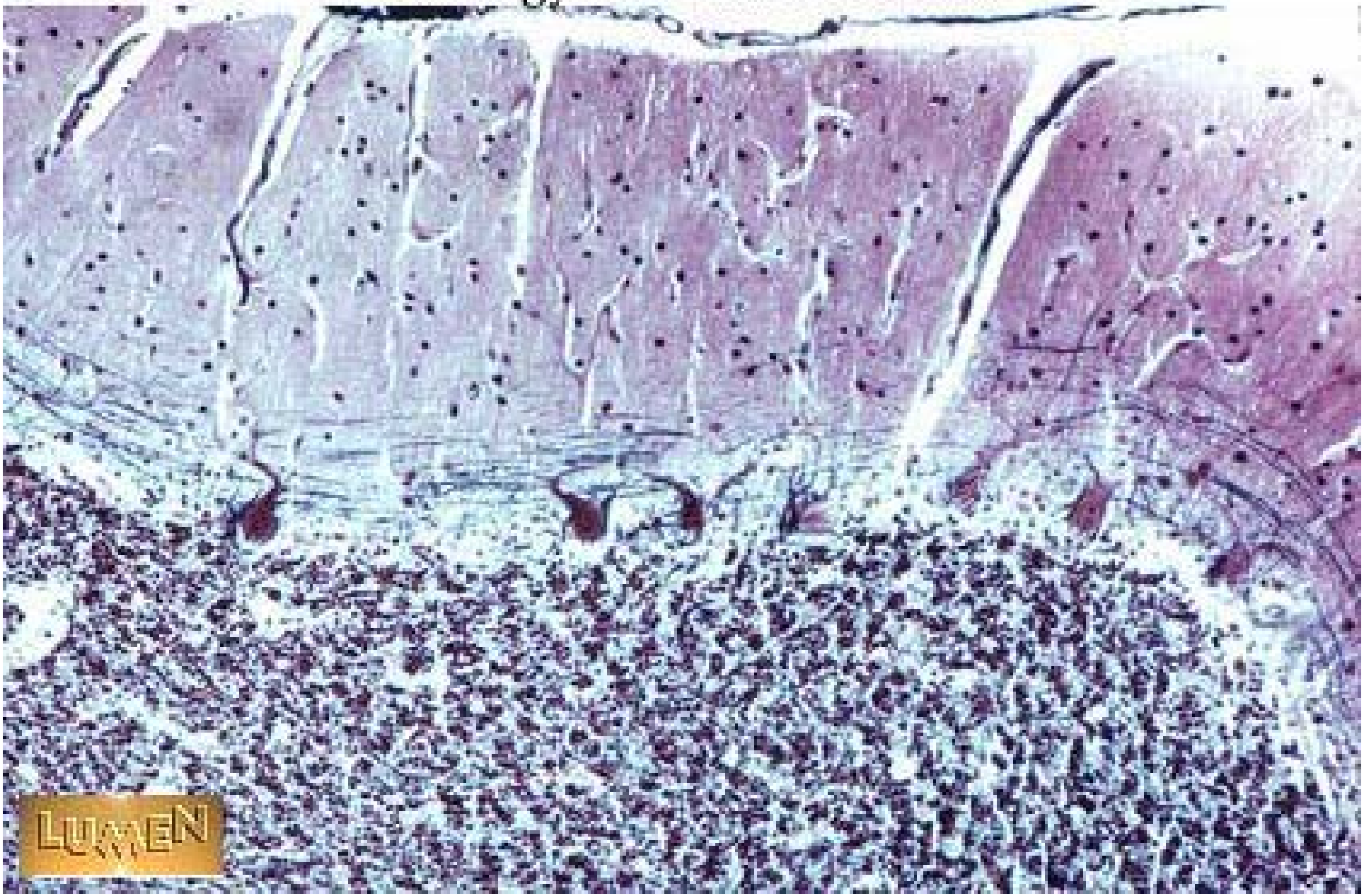
- Cerebellar cortex consists of 3 layers
- Outer molecular (ML) – few neurons but abundant neuronal processes
- Inner granular layer (GL) with many densely packed granular cells
- Layer of Purkinje cells

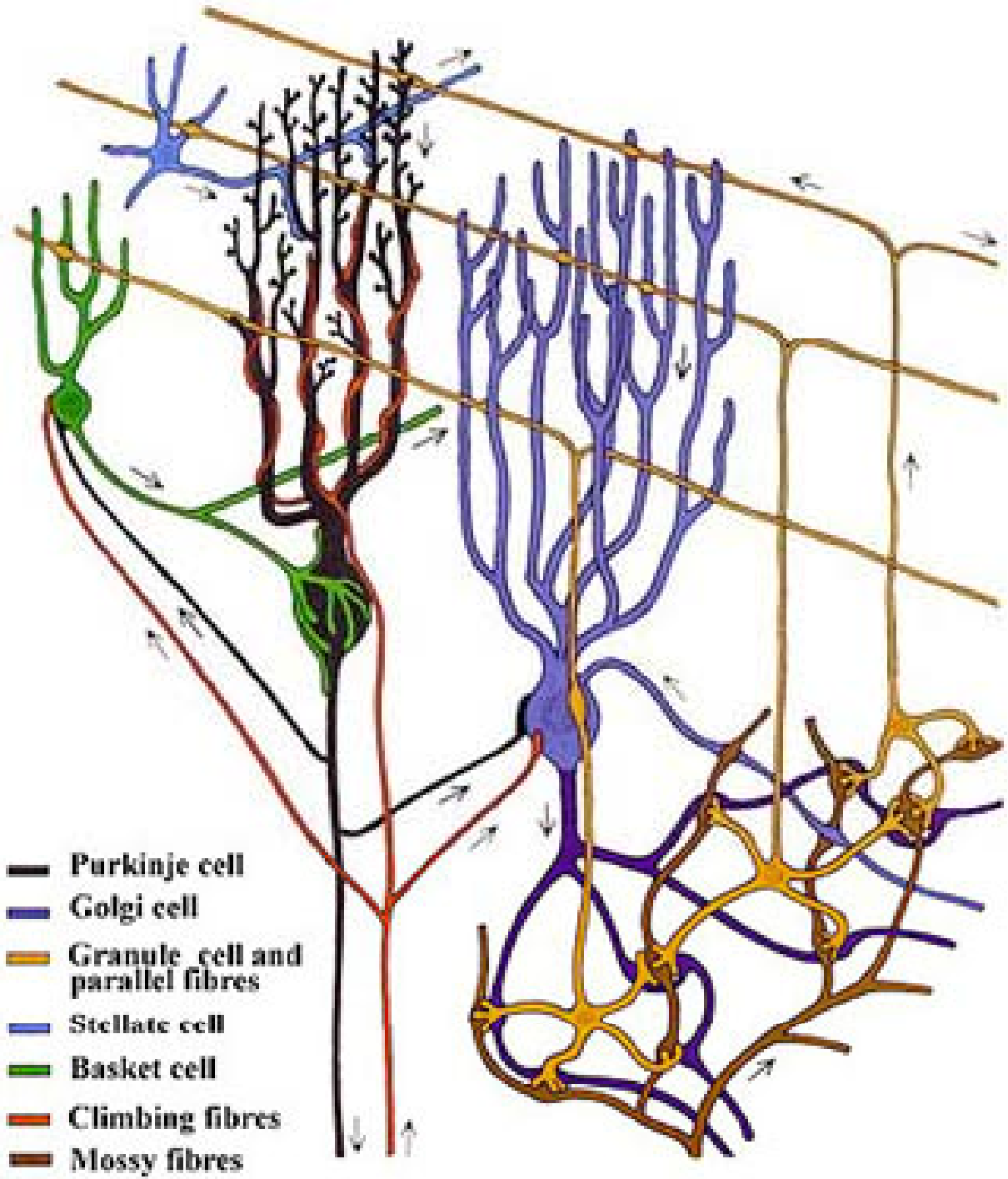


- Layers in the cerebellar cortex
  - Granule layer
  - Purkinje cell layer
  - Molecular layer

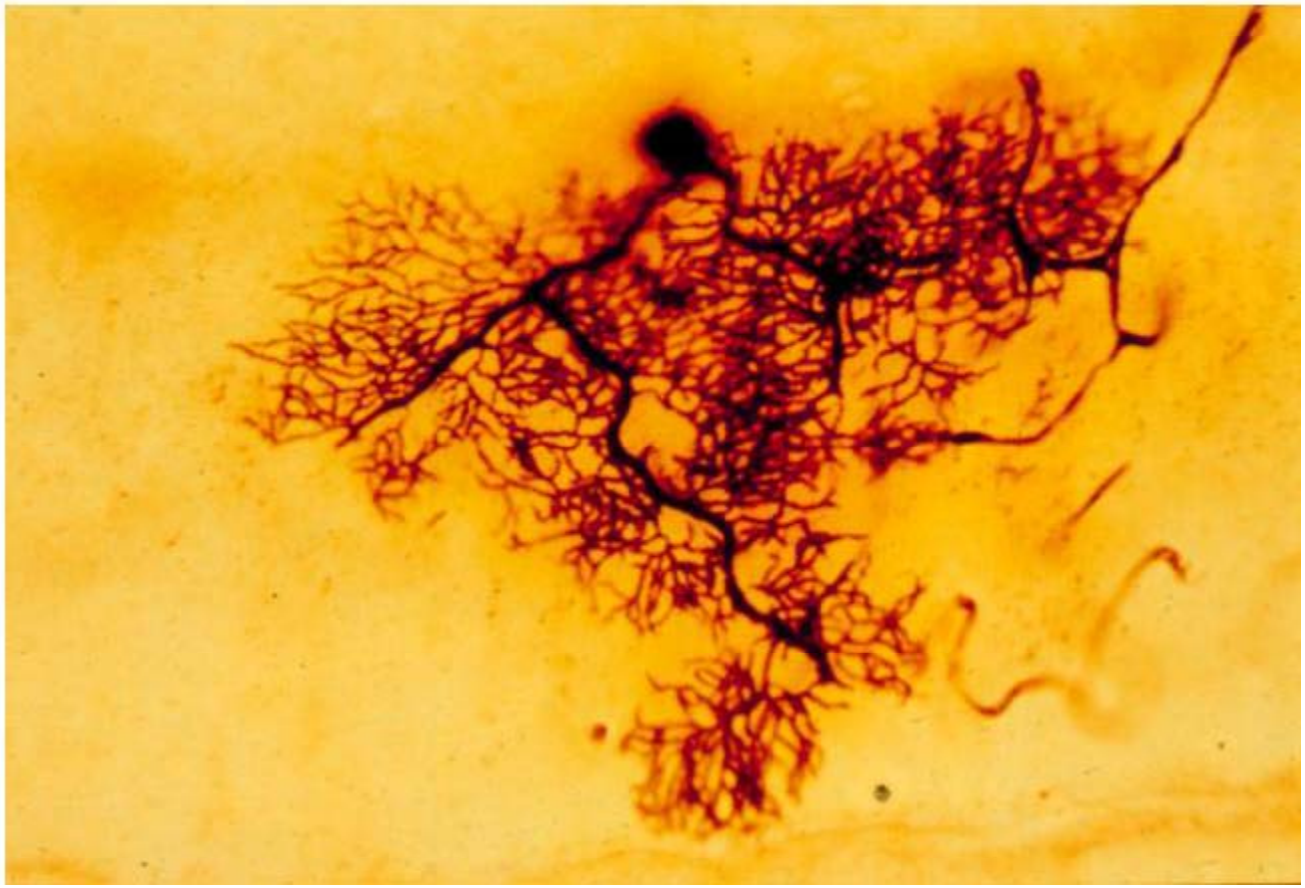


Histology Lab Part 6: Slide 29



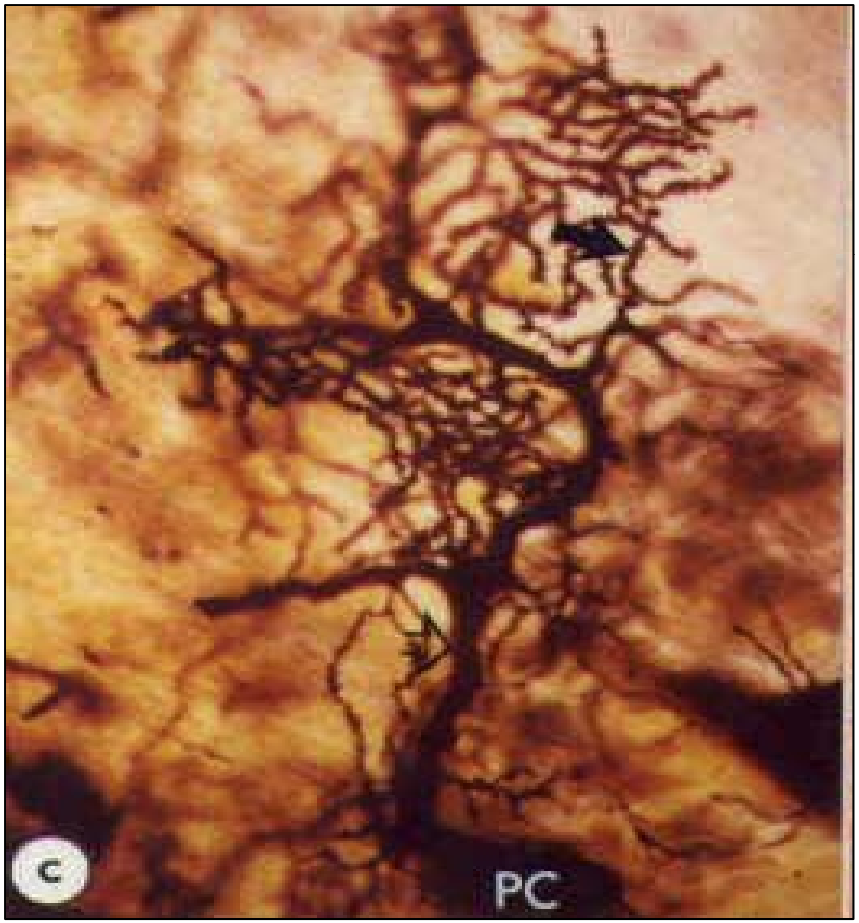

Purkinje cell
Golgi cell
Granule cell and parallel fibres
Stellate cell
Basket cell
Climbing fibres
Mossy fibres

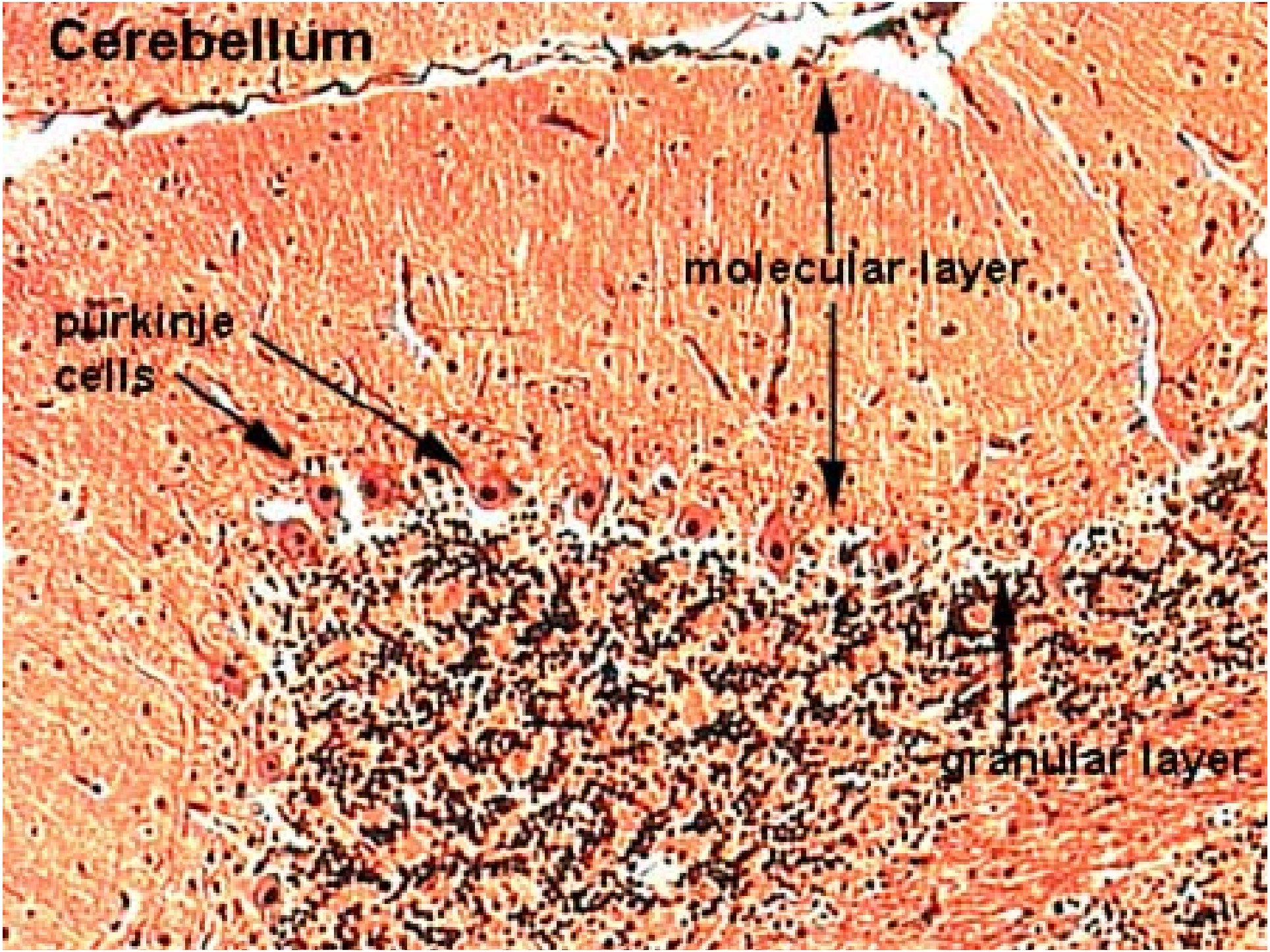
Golgi stain of Purkinje cell

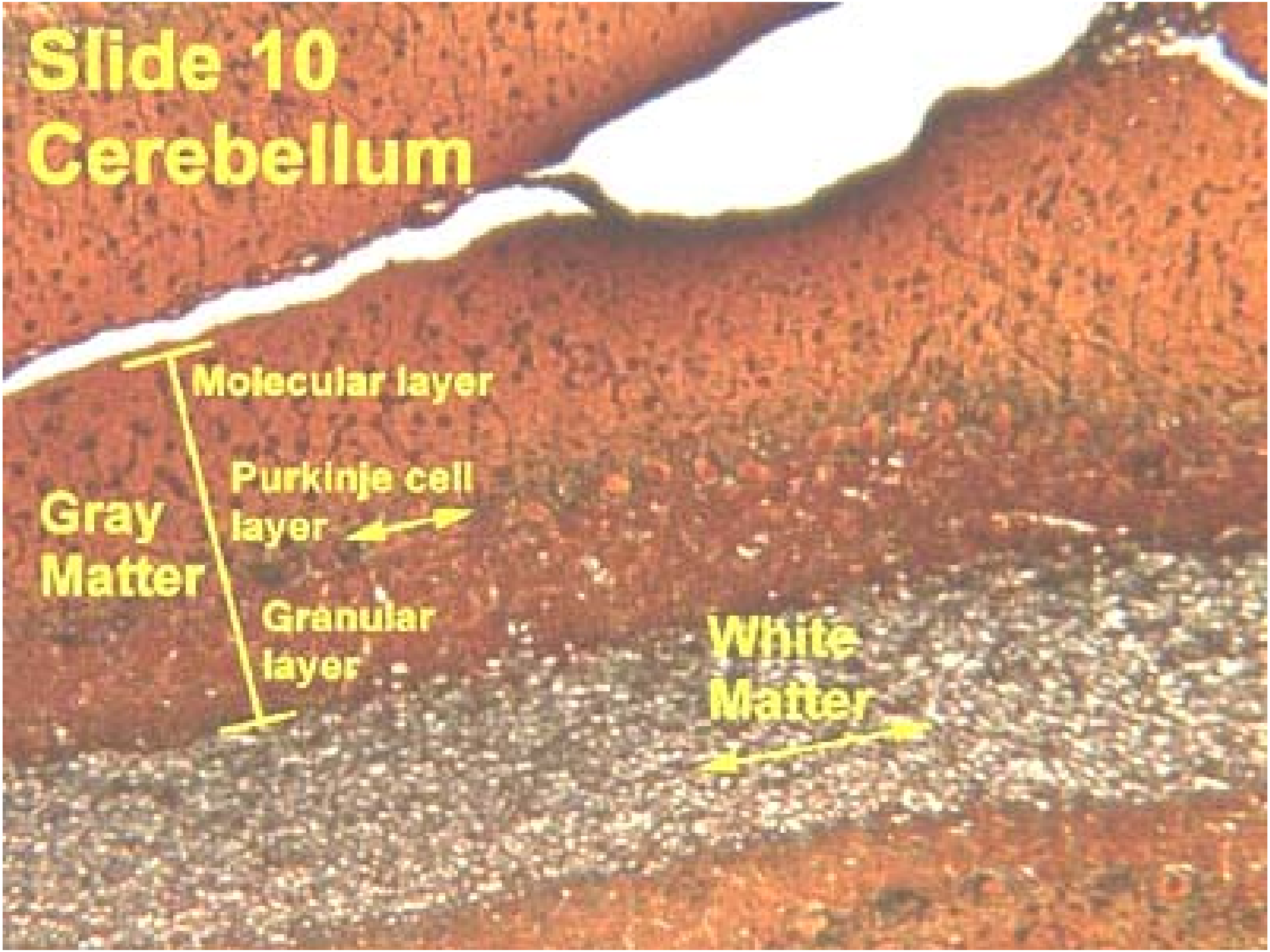


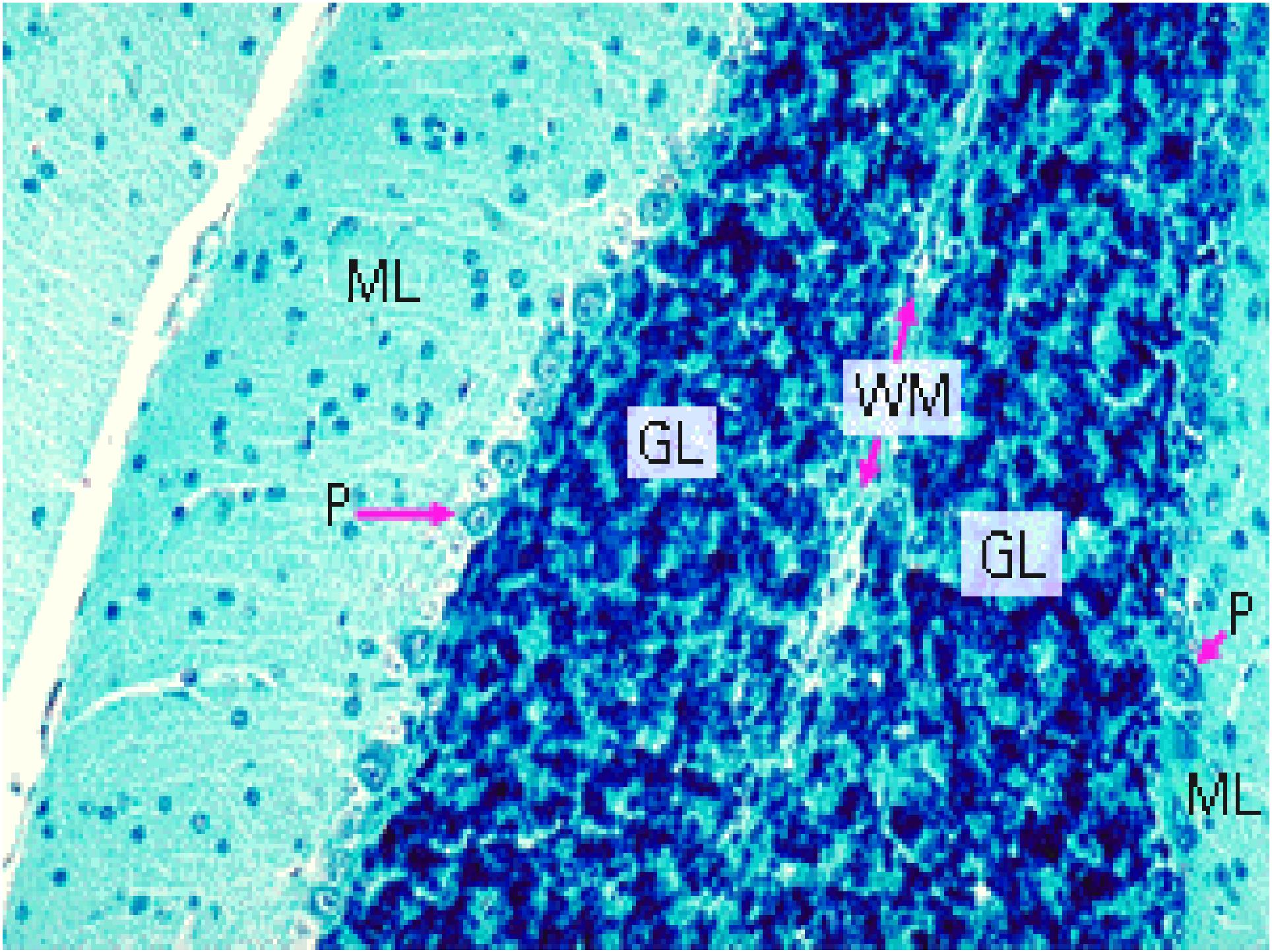
Cerebellum – Purkinje Cells

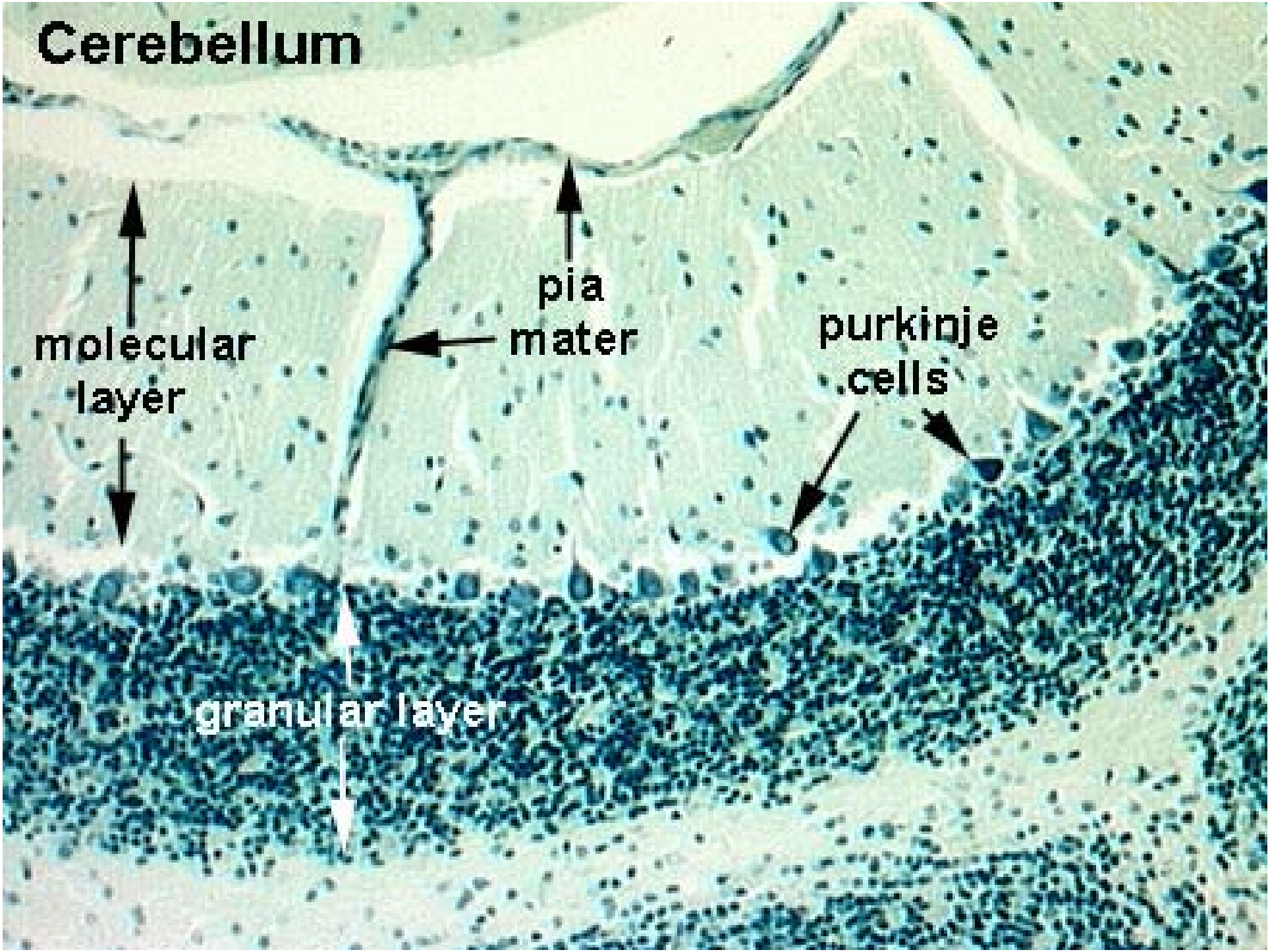
- Purkinje cell with elaborate dendritic tree
- Initial branches are larger & smooth with later (tertiary) branches spinous

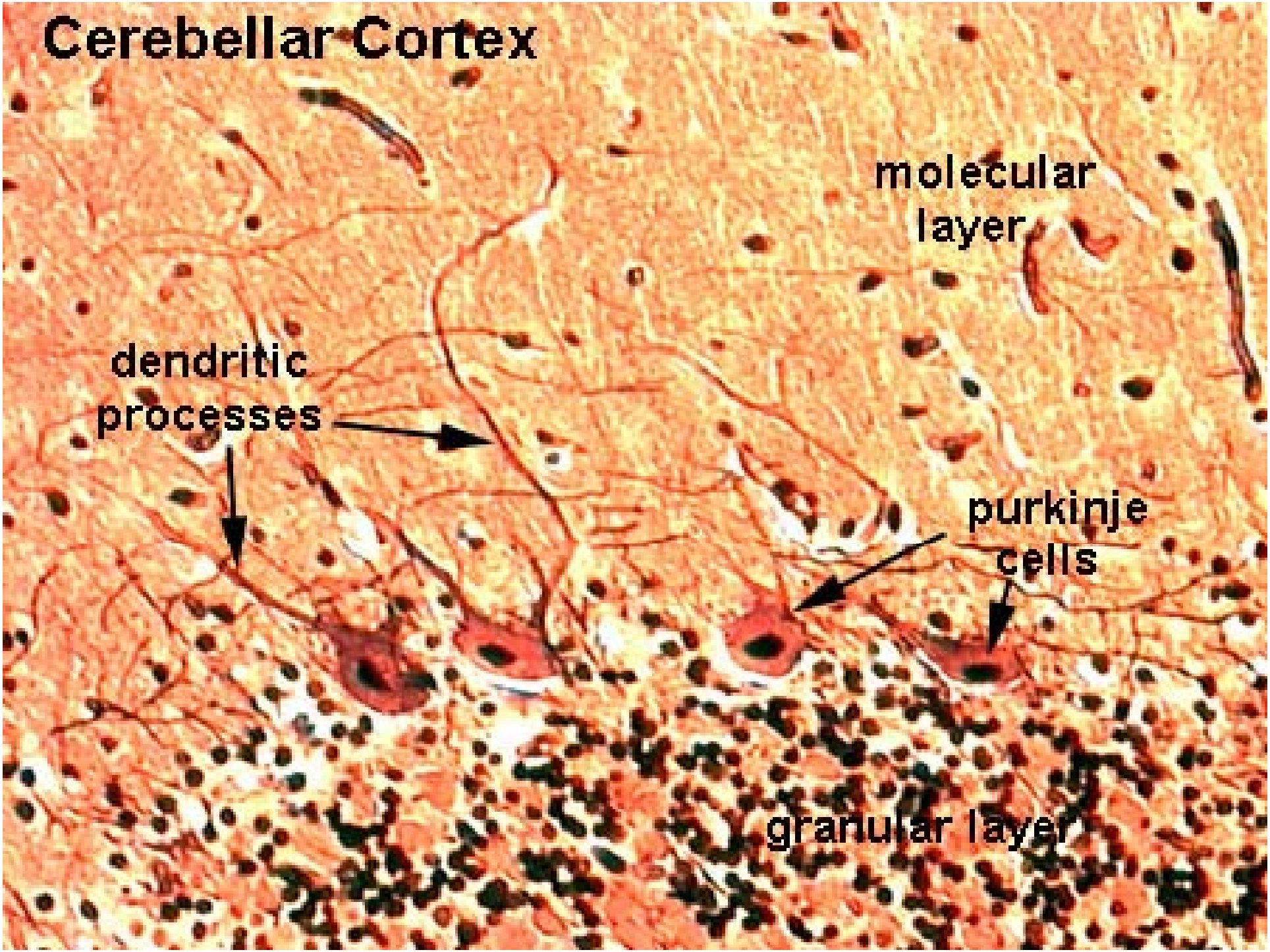


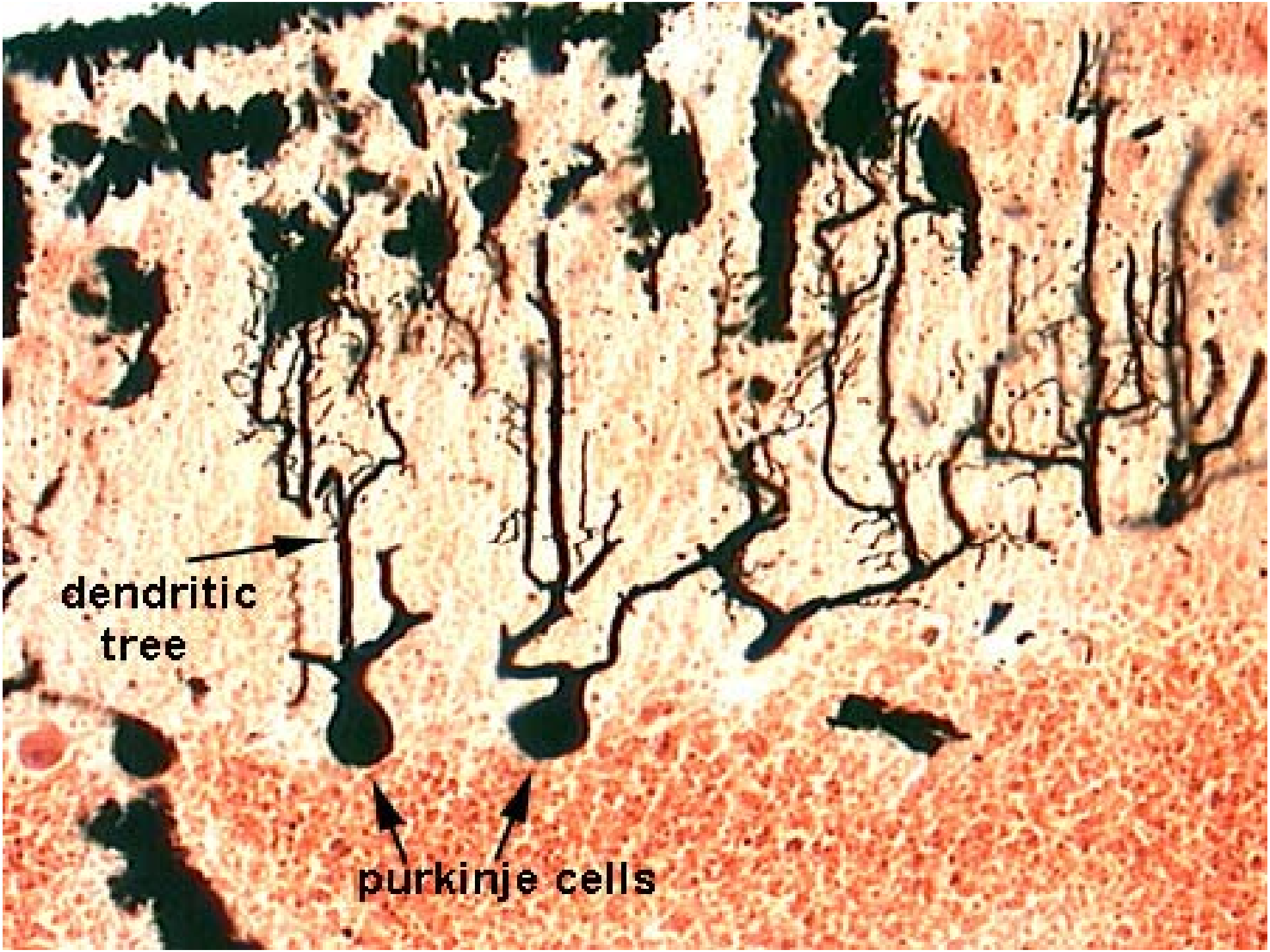

Cerebellum
molecular layer
purkinje cells
granular layer

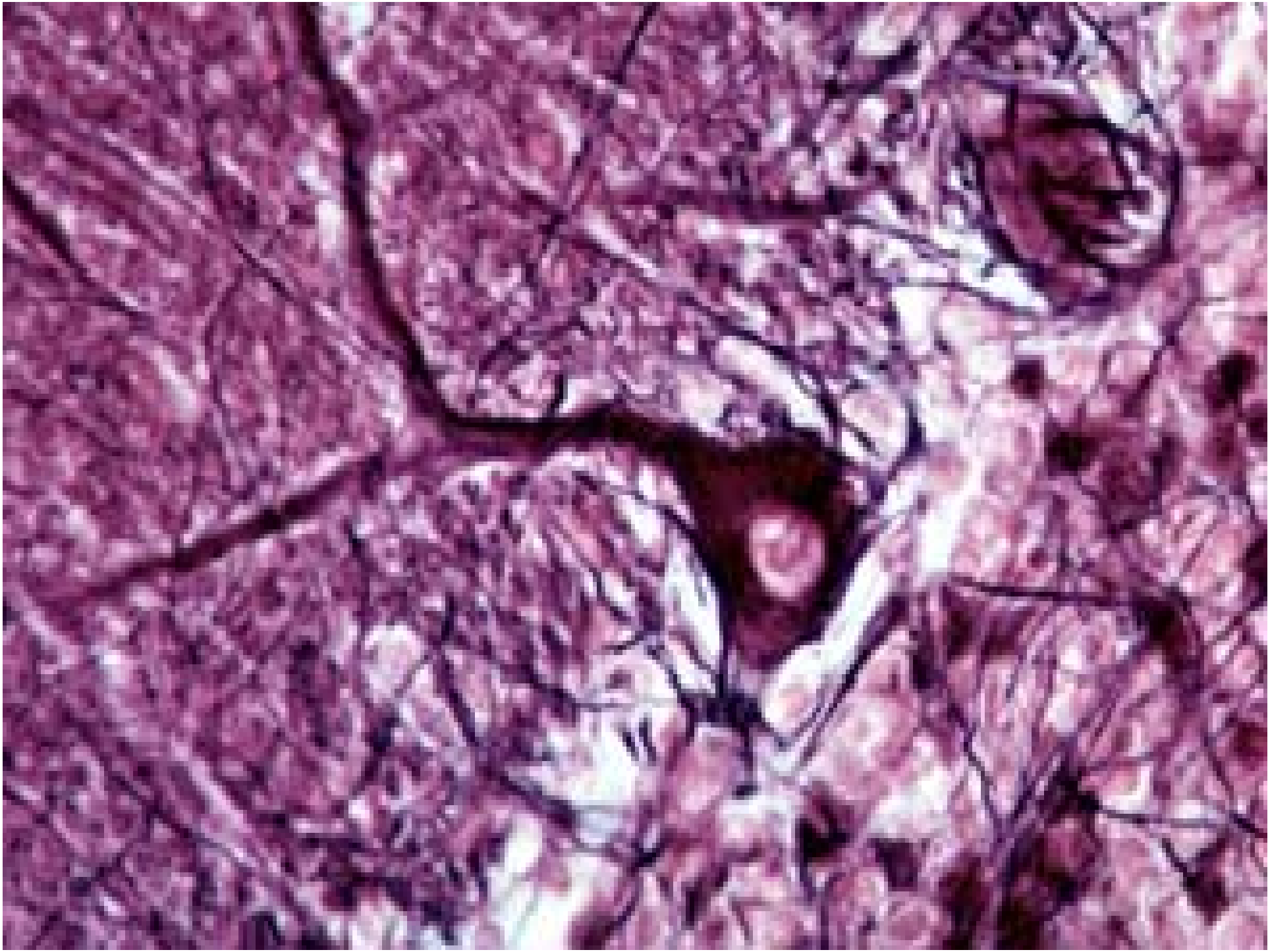

Slide 10
Cerebellum
Molecular layer
Purkinje cell layer
Gray Matter
Granular layer
White Matter


ML
WM
GL
P
GL
P
ML


Cerebellum
molecular layer
pia mater
purkinje cells
granular layer


Cerebellar Cortex
molecular layer
dendritic processes
purkinje cells
granular layer

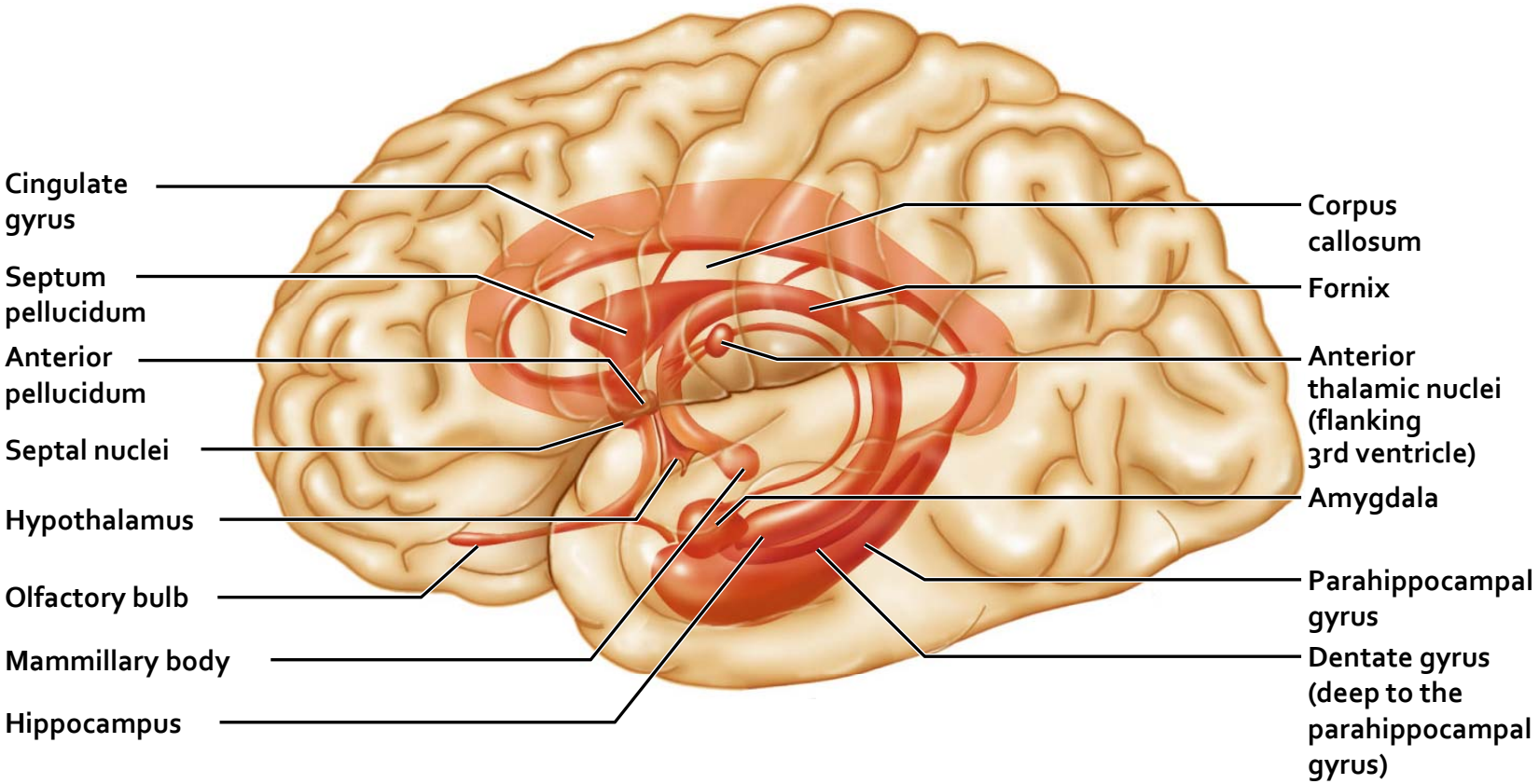

dendritic
tree
purkinje cells



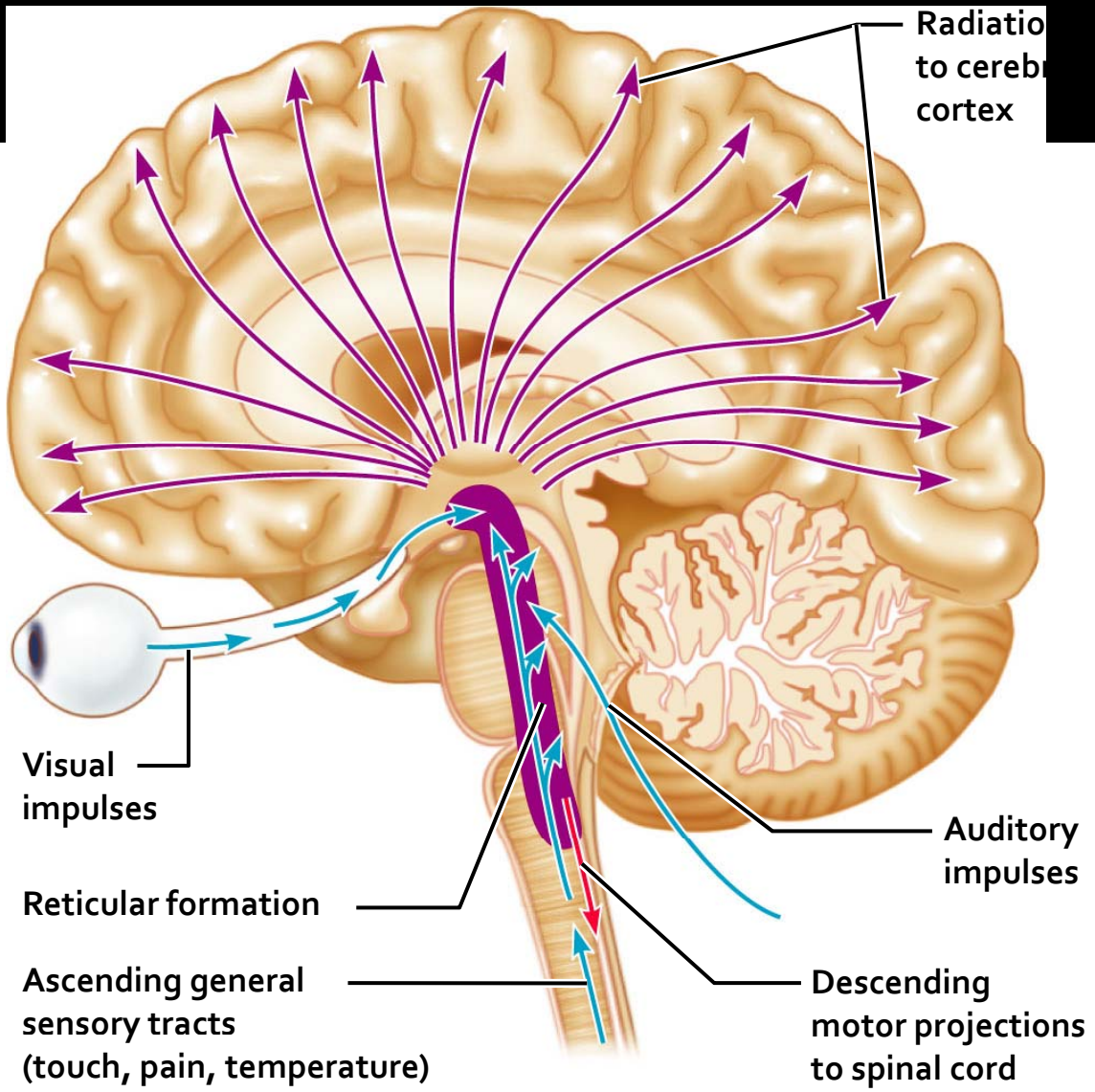
LIMBIC SYSTEM

The limbic system operates by influencing the endocrine system and the autonomic nervous system

The limbic system,.



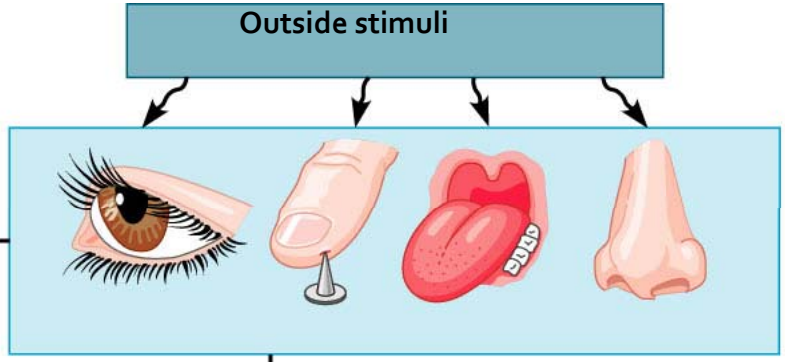
The reticular formation,



Memory

- Memory is the storage and retrieval of information
- The three principles of memory are:
  - Storage – occurs in stages and is continually changing
  - Processing – accomplished by the hippocampus and surrounding structures
  - Memory traces – chemical or structural changes that encode memory

Memory processing,



Outside stimuli

General and special sensory receptors

Afferent inputs

Temporary storage
(buffer) in cerebral cortex

Data permanently lost

Automatic
memory

Data selected
for transfer

Forget

Short-term
memory

Forget

Retrieval

Data transfer
influenced by:

Excite ment

Re hearsal

Association of
old and new data

Long-term
memory

Data unretrievable

Stages of Memory

- The two stages of memory are short-term memory and long-term memory
- Short-term memory (STM, or working memory) – a fleeting memory of the events that continually happen
- STM lasts seconds to hours and is limited to 7 or 8 pieces of information
- Long-term memory (LTM) has limitless capacity

Transfer from STM to LTM

- Factors that affect transfer of memory, from STM to LTM include:
  - Emotional state – we learn best when we are alert, motivated, and aroused
  - Rehearsal – repeating or rehearsing material enhances memory
  - Association – associating new information with old memories in LTM enhances memory
  - Automatic memory – subconscious information stored in LTM

Categories of Memory

- The two categories of memory are fact memory and skill memory
- Fact (declarative) memory:
  - Entails learning explicit information
  - Is related to our conscious thoughts and our language ability
  - Is stored with the context in which it was learned

Skill Memory

- Skill memory is less conscious than fact memory and involves motor activity
- It is acquired through practice
- Skill memories do not retain the context in which they were learned

Structures Involved in Fact Memory

- Fact memory involves the following brain areas:
  - Hippocampus and the amygdala, both limbic system structures
  - Specific areas of the thalamus and hypothalamus of the diencephalon
  - Ventromedial prefrontal cortex and the basal forebrain

Structures Involved in Skill Memory

- Skill memory involves:
  - Corpus striatum – mediates the automatic connections between a stimulus and a motor response
  - Portion of the brain receiving the stimulus
  - Premotor and motor cortex

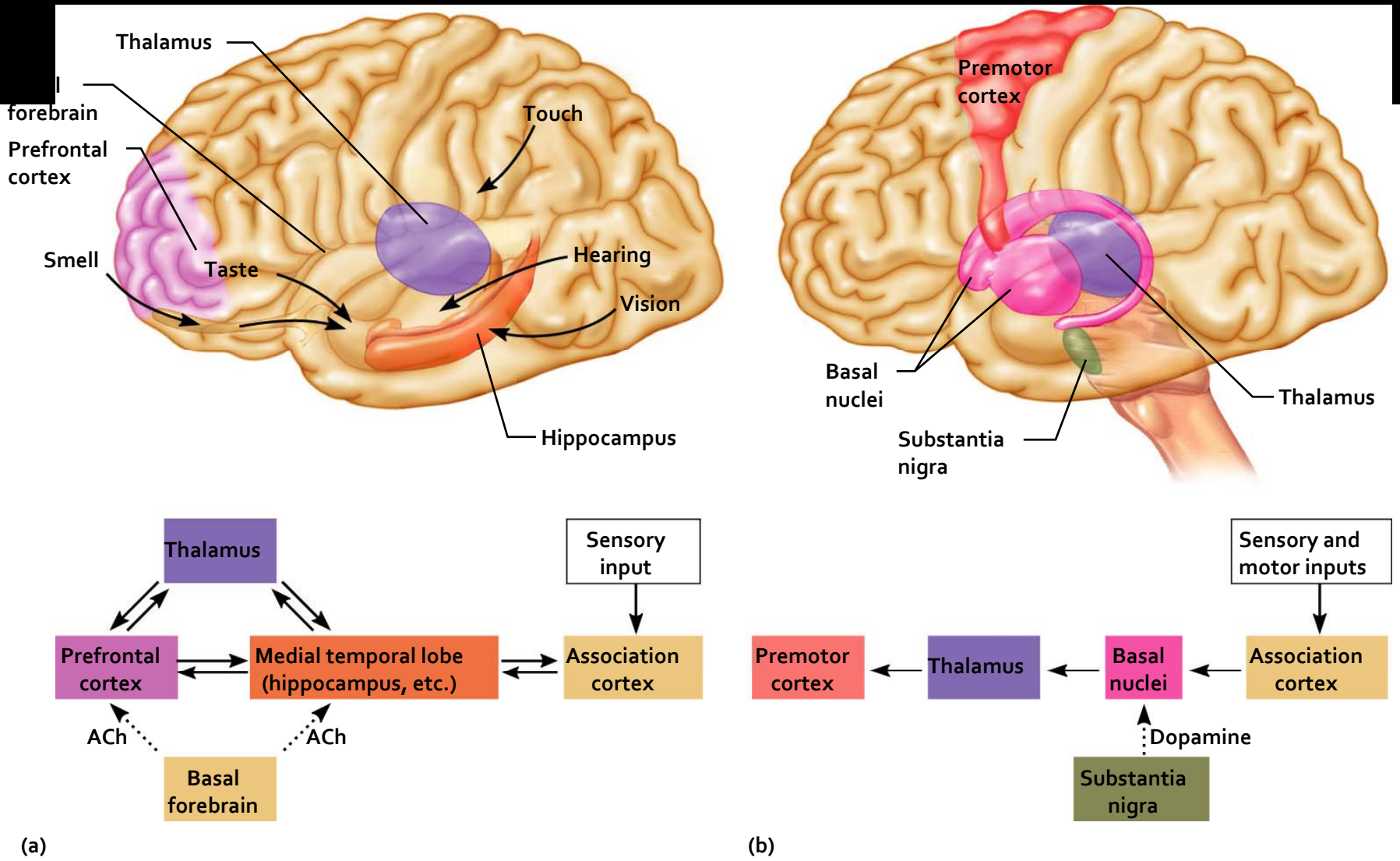
Mechanisms of Memory

- Neuronal RNA content is altered
- Dendritic spines change shape
- Extracellular proteins are deposited at synapses involved in LTM
- Number and size of presynaptic terminals may increase
- More neurotransmitter is released by presynaptic neurons
- New hippocampal neurons appear

Mechanisms of Memory

- Long-term potentiation (LTP) is involved and is mediated by NMDA receptors
- Synaptic events involve the binding of brain-derived neurotropic factor (BDNF)
- BDNF is involved with Na^{+}, Ca^{2+}, and Mg^{2+} influence at synapses

Figure 12.23: Proposed memory circuits, p. 462.



Meninges

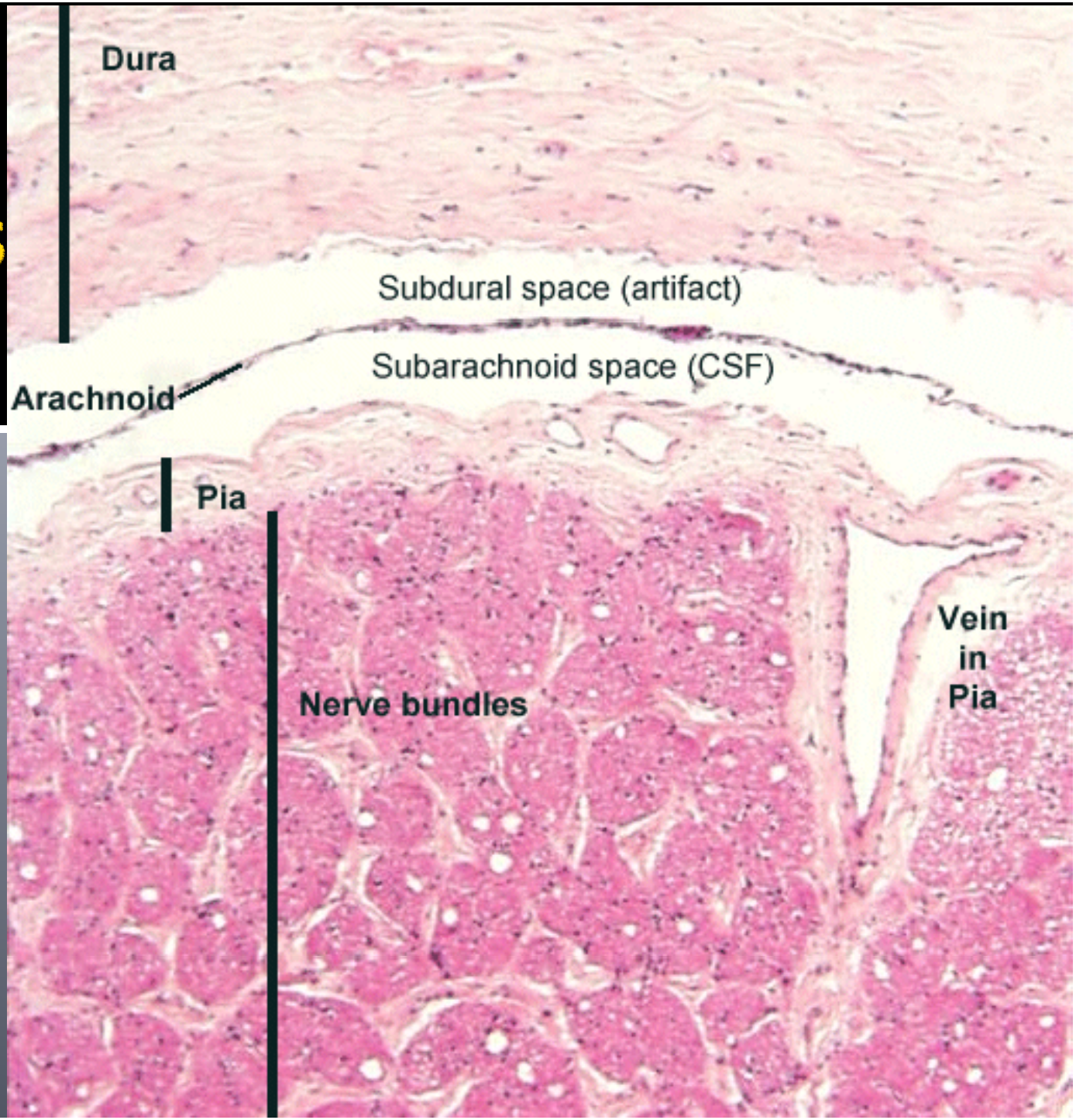
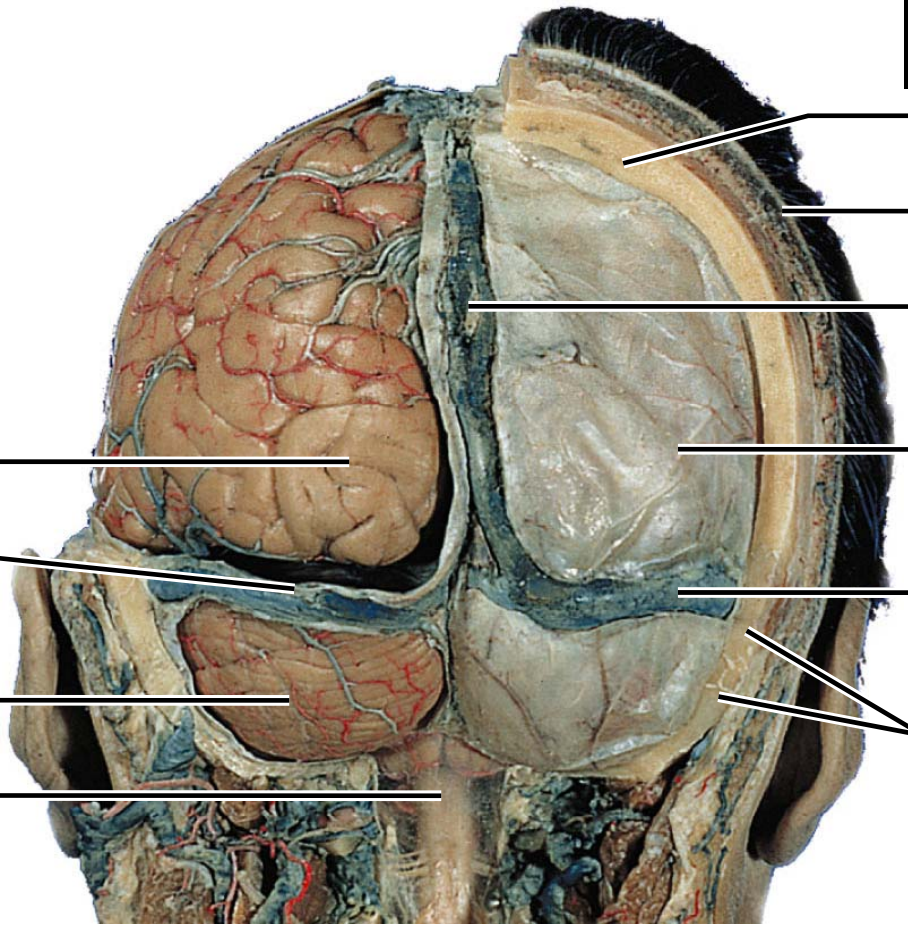
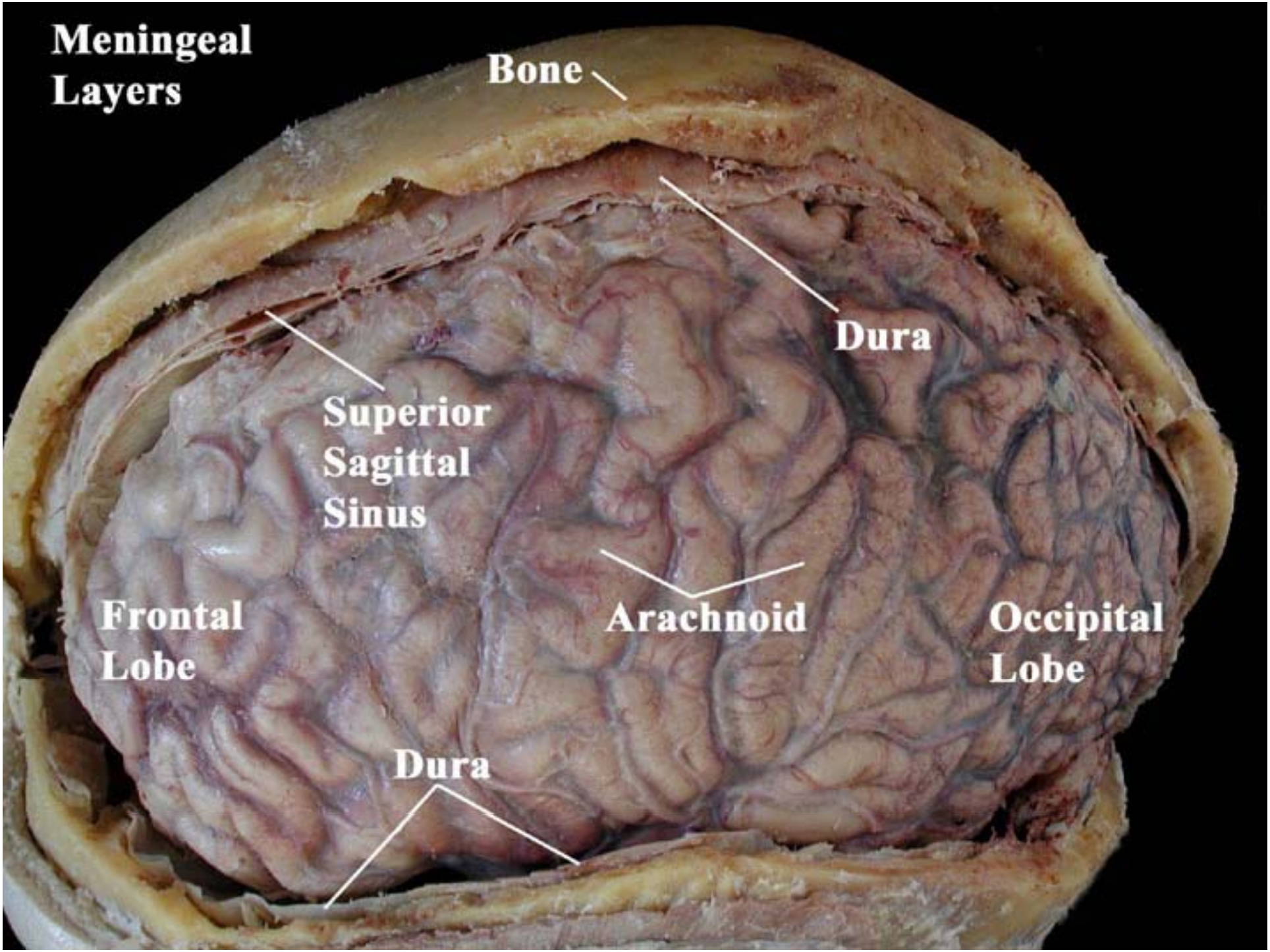

Dura
Subdural space (artifact)
Subarachnoid space (CSF)
Arachnoid
Pia
Nerve bundles
Vein
in
Pia

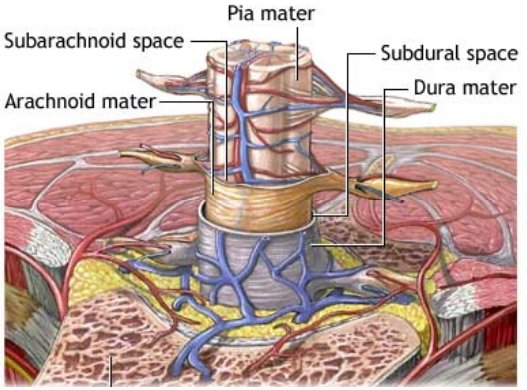
Figure 12.24b: Meninges, p. 464.

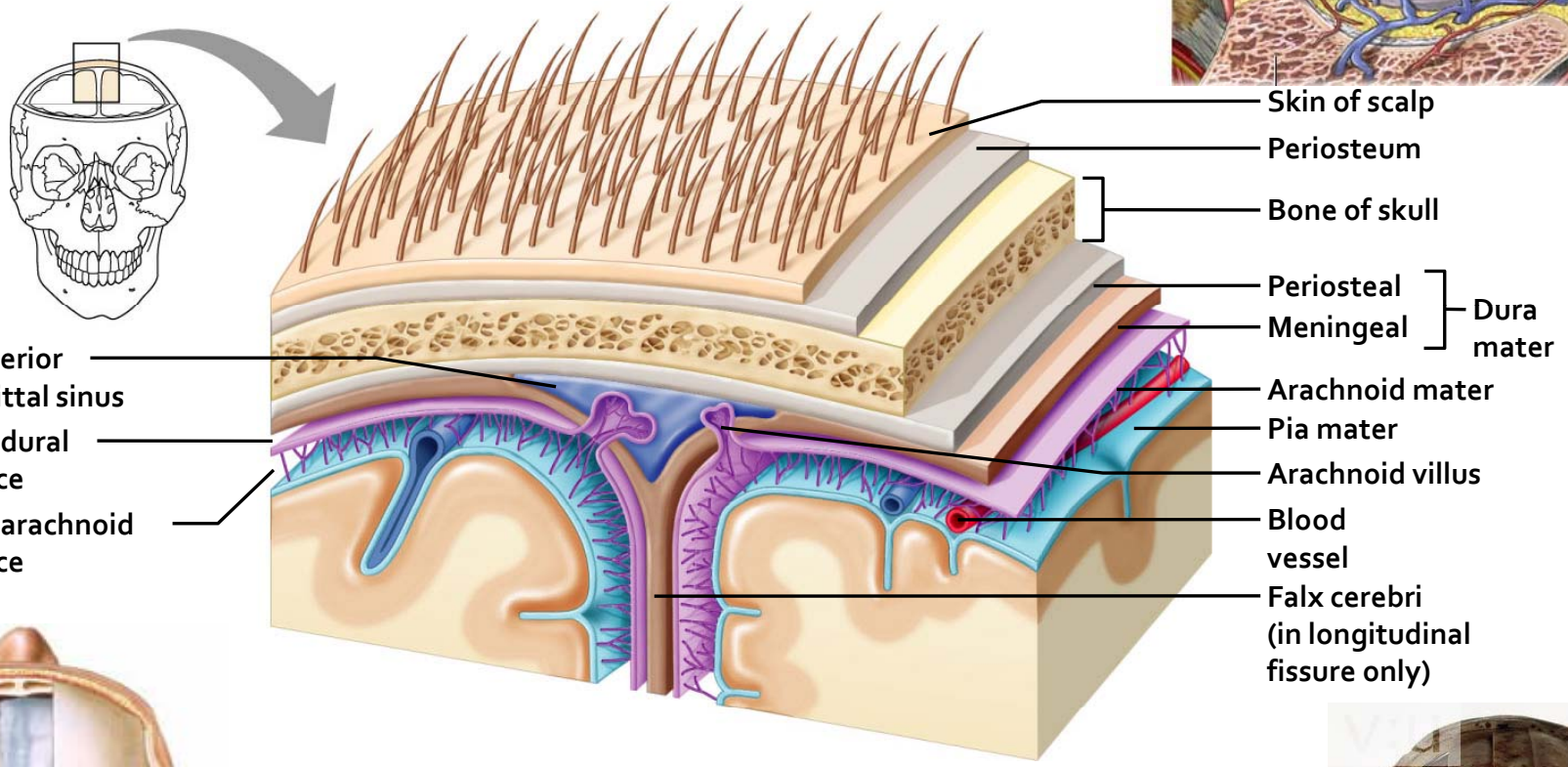


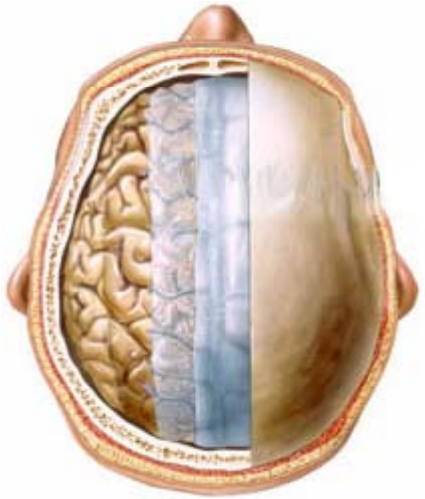
(b)

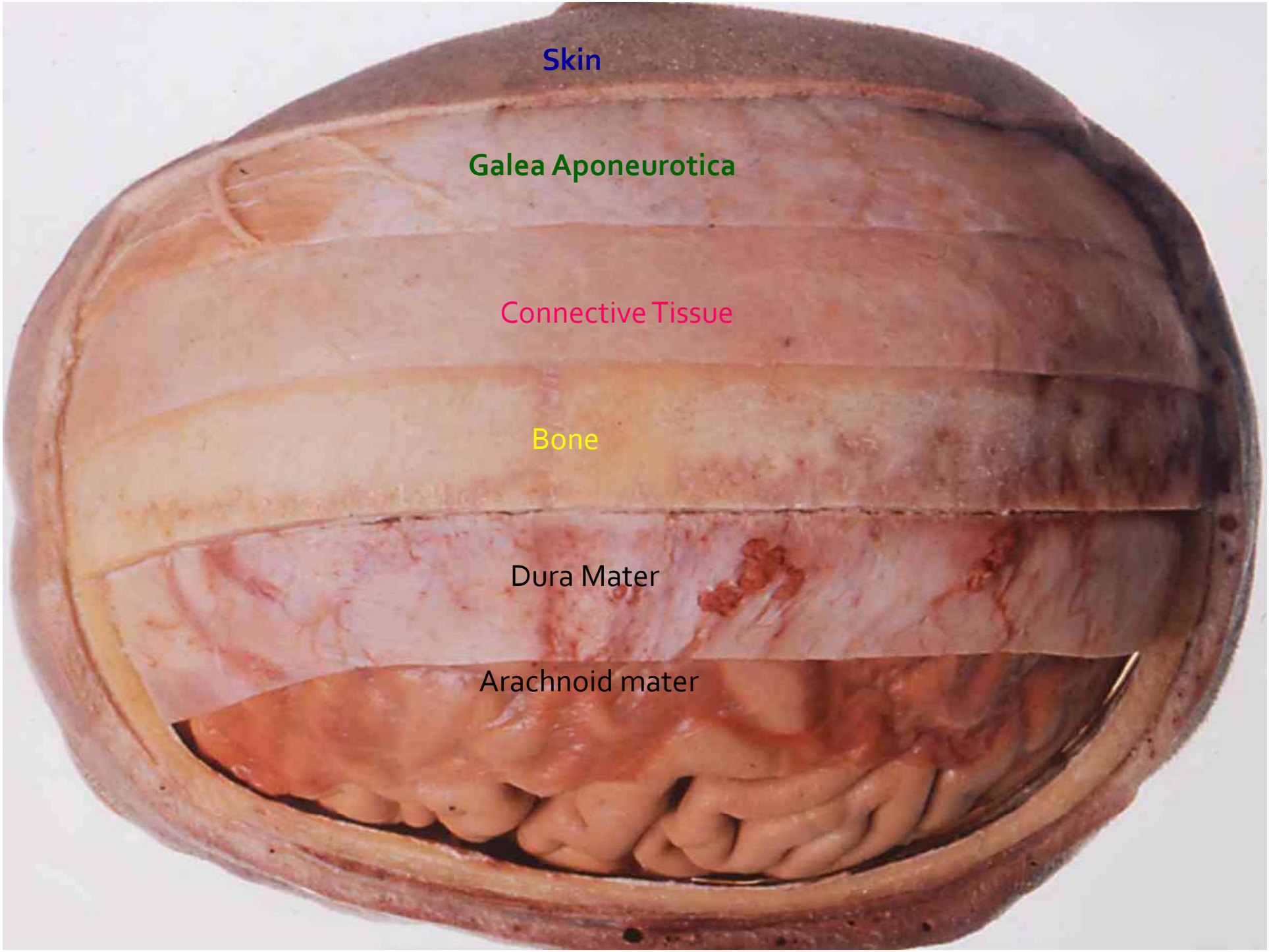

Meningeal Layers
Bone
Dura
Superior Sagittal Sinus
Frontal Lobe
Arachnoid
Occipital Lobe
Dura

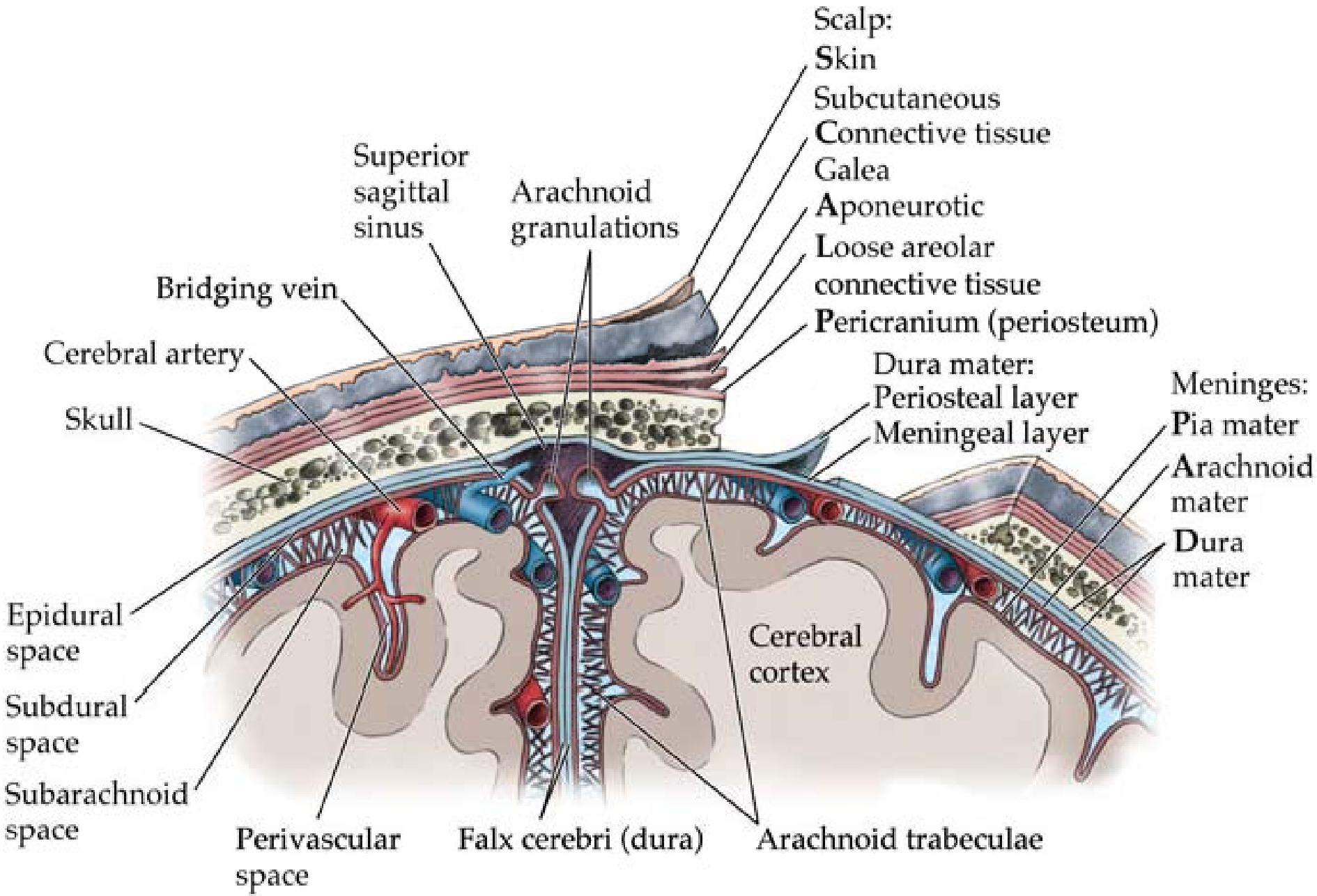
Meninges,


Pia mater
Subarachnoid space
Subdural space
Dura mater
Arachnoid mater


Skin of scalp
Periosteum
Bone of skull
Periosteal
Meningeal
Dura mater
Superior sagittal sinus
Arachnoid mater
Subdural space
Pia mater
Arachnoid villus
Subarachnoid space
Blood vessel
Falx cerebri (in longitudinal fissure only)

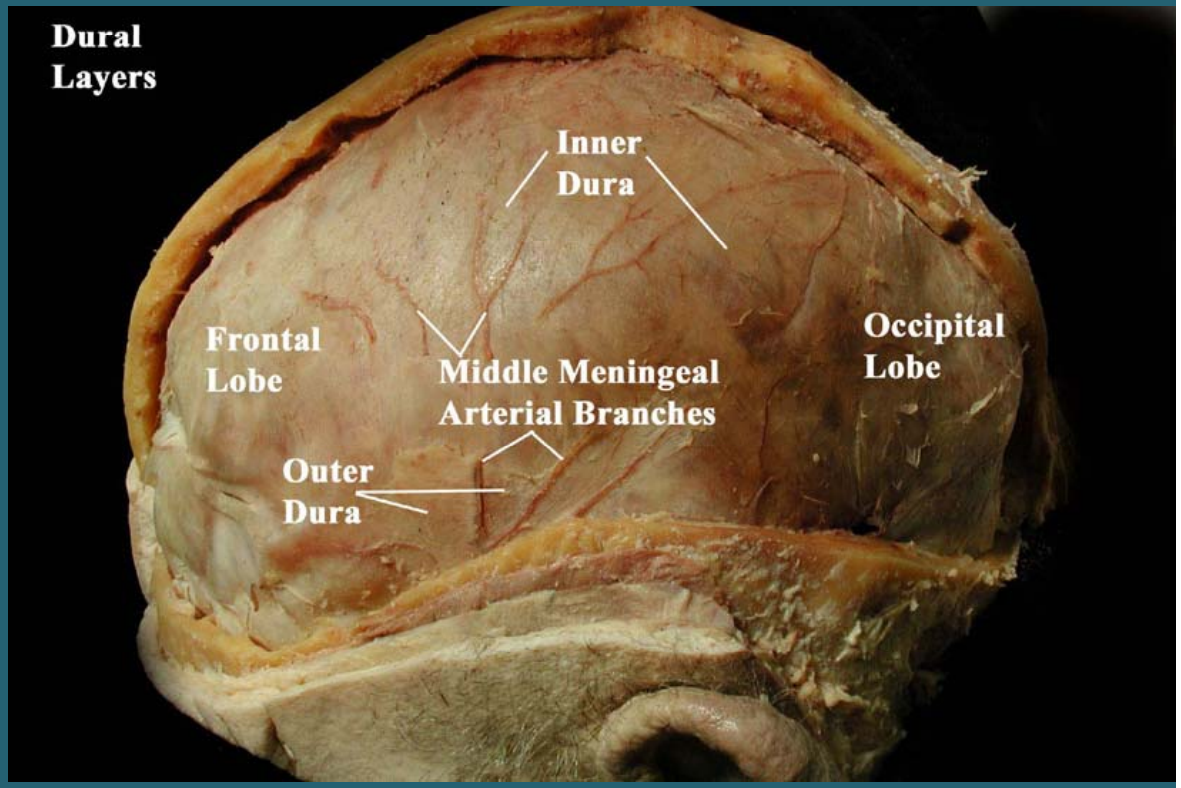



Skin
Galea Aponeurotica
Connective Tissue
Bone
Dura Mater
Arachnoid mater



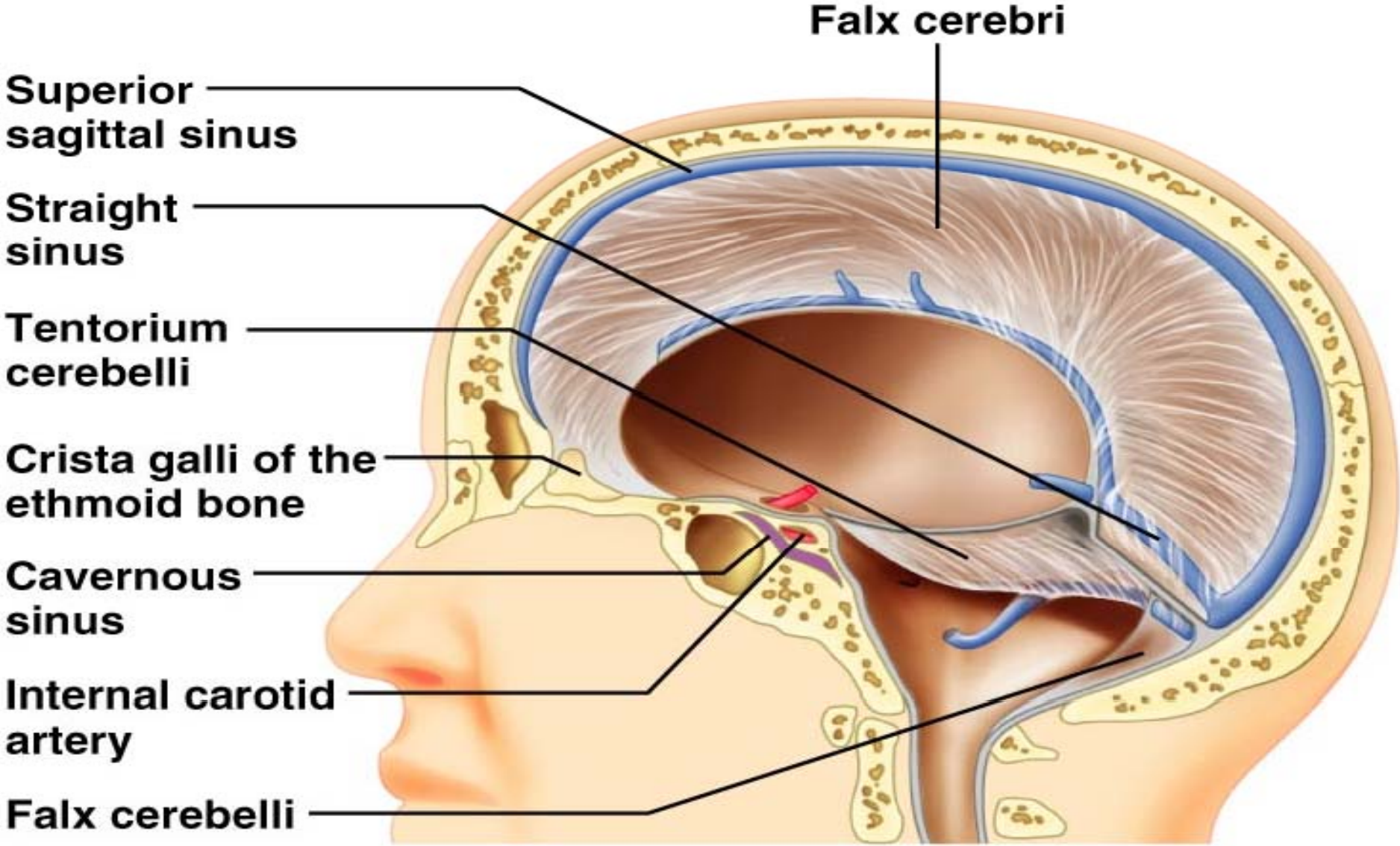
Dura Mater

- Tough and leathery.
- Most superficial.
- 2 layers:
  - Periosteal → attached to the skull
  - Meningeal → true external covering, extends downward and surrounds spinal cord



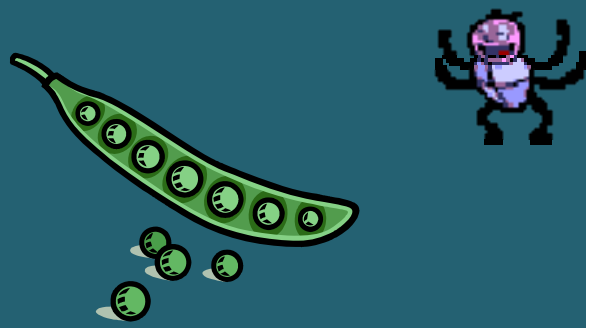
- In several locations, the inner dura mater extends in to the cranial cavity, forming a sheet that dips inward and then returns. These dural folds provide additional support for the brain. Dural sinuses may be found btwn the 2 layers of a dural fold.

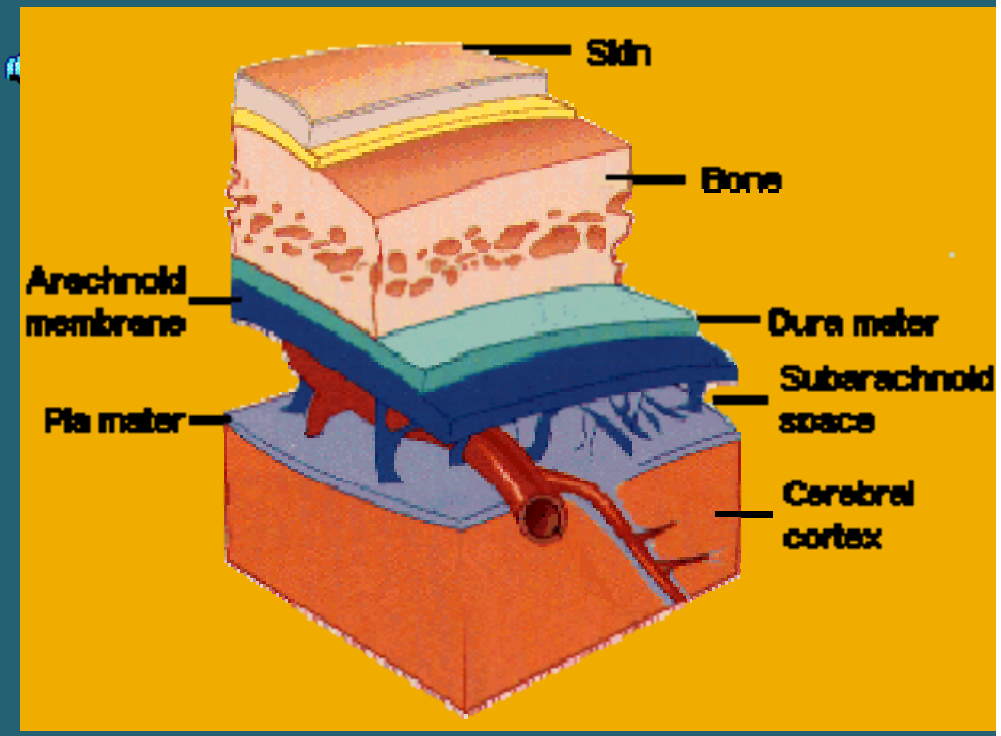
Dura Mater


Falx cerebri
Superior sagittal sinus
Straight sinus
Tentorium cerebelli
Crista galli of the ethmoid bone
Cavernous sinus
Internal carotid artery
Falx cerebelli

Arachnoid and Pia Mater

- Arachnoid:
  - Loose spider-web of connective tissue.
  - Beneath it is the subarachnoid space – filled with blood vessels and CSF
- Pia
  - Deepest and most delicate
  - Covers the brain tissue
  - Follows its every ridge and groove
- What do you call an inflammation of the meninges?





Blood-Brain Barrier

Protective mechanism that helps maintain a stable environment for the brain

Bloodborne substances are separated from neurons by:

Continuous endothelium of capillary walls

Relatively thick basal lamina

Bulbous feet of astrocytes

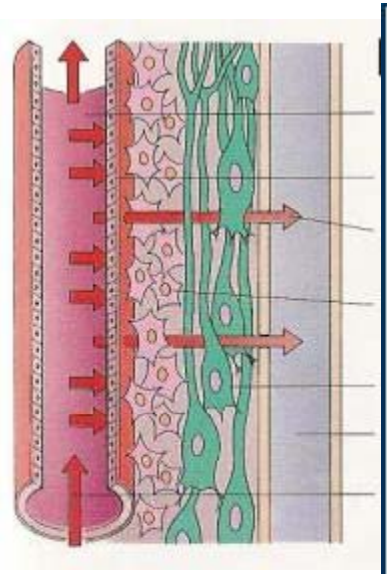
Blood-Brain Barrier: Functions

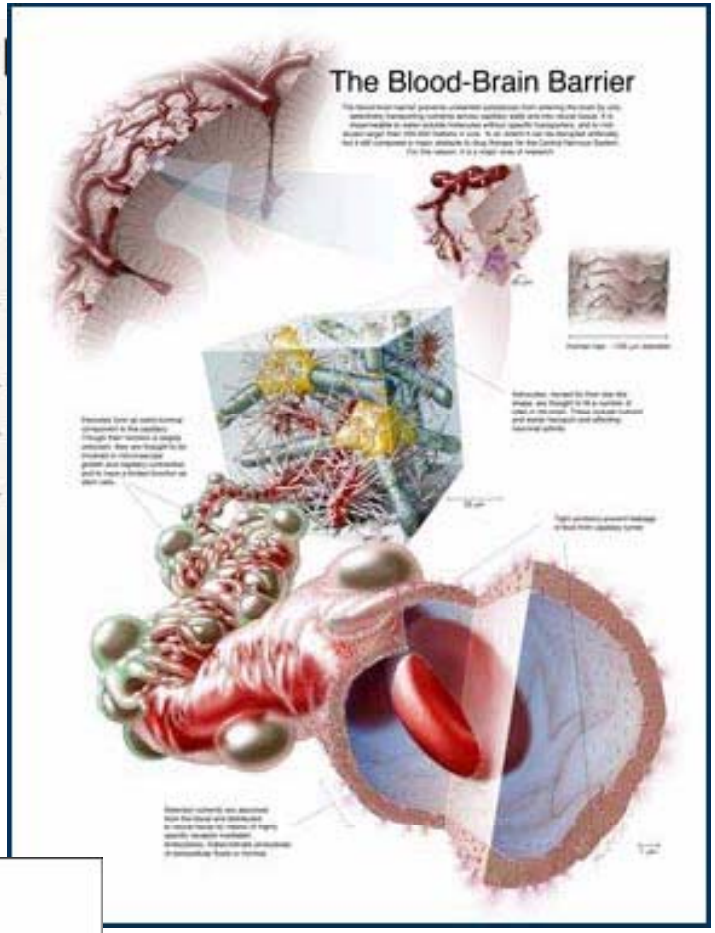
Selective barrier that allows nutrients to pass freely

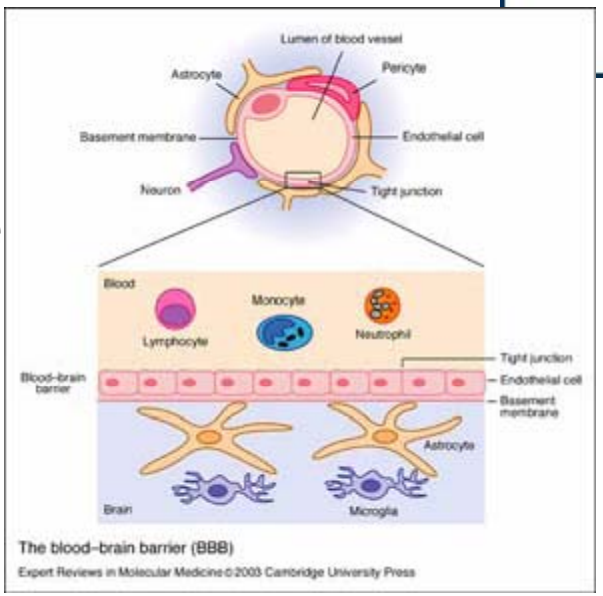
Is ineffective against substances that can diffuse through plasma membranes

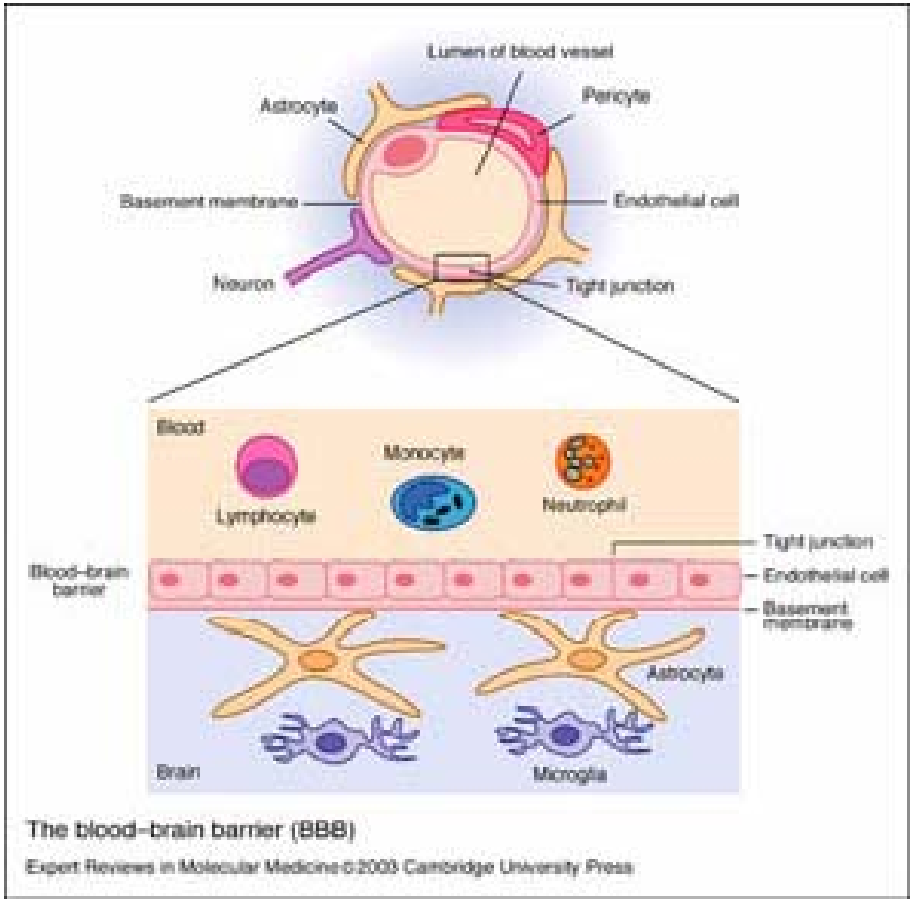
Absent in some areas (vomiting center and the hypothalamus), allowing these areas to monitor the chemical composition of the blood

Stress increases the ability of chemicals to pass through the blood-brain barrier

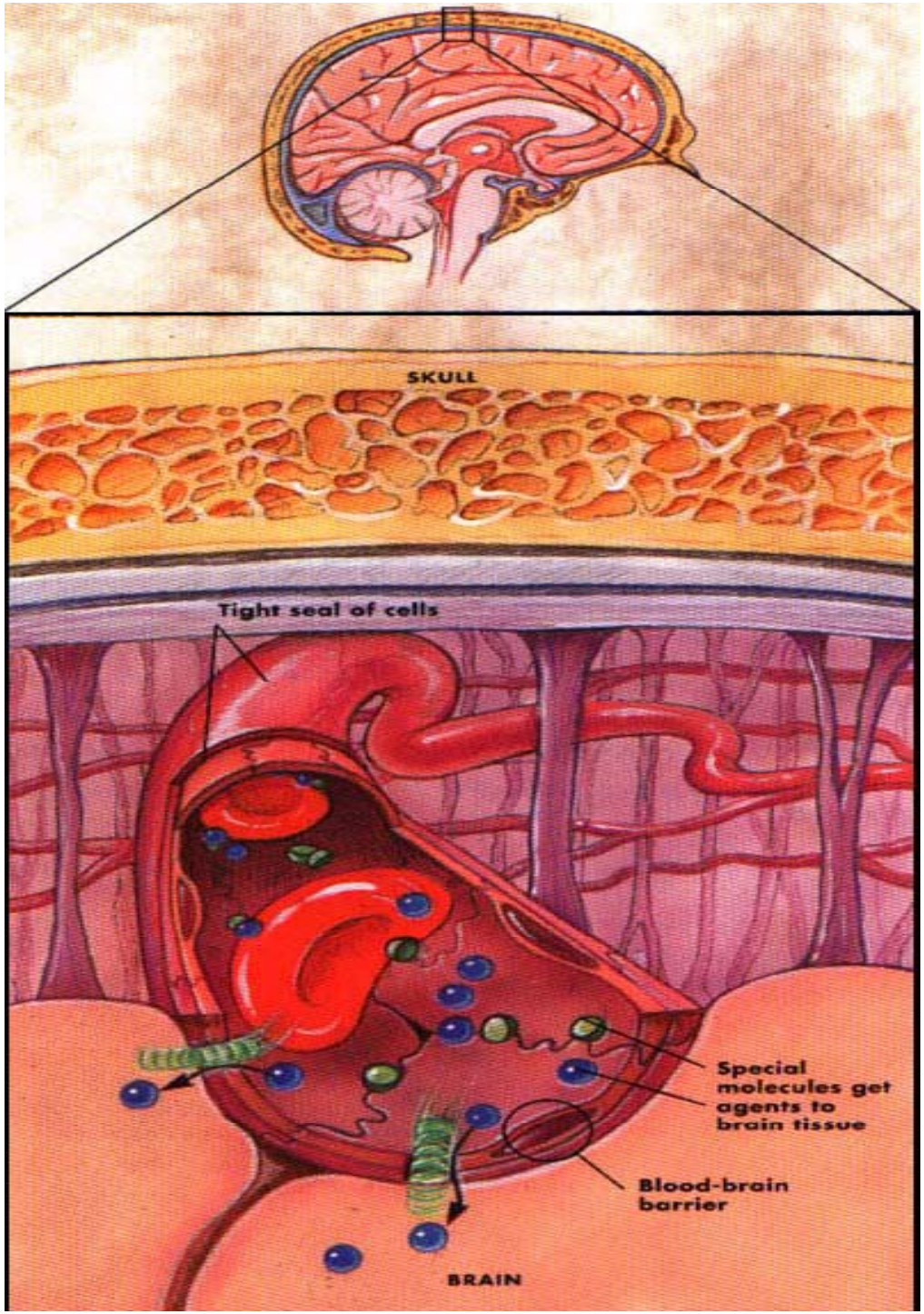








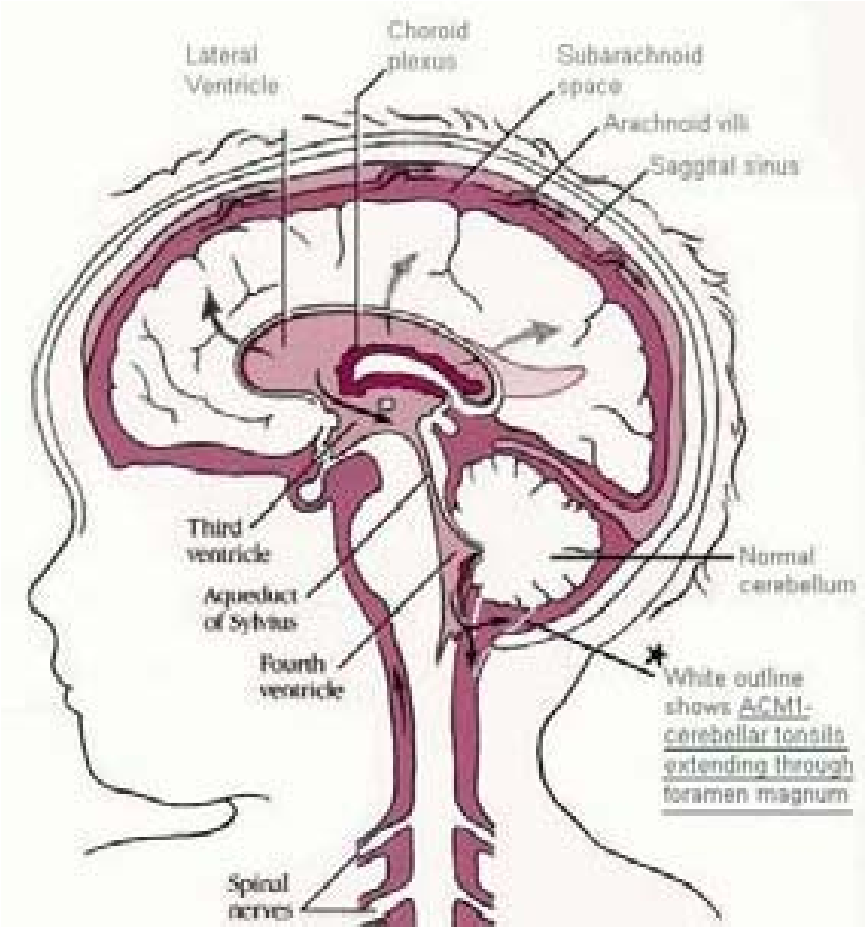
The blood–brain barrier (BBB)



CSF

Cerebrospinal Fluid (CSF)

- Watery solution similar in composition to blood plasma
- Contains less protein and different ion concentrations than plasma
- Forms a liquid cushion that gives buoyancy to the CNS organs
- Prevents the brain from crushing under its own weight
- Protects the CNS from blows and other trauma
- Nourishes the brain and carries chemical signals throughout it
- HYDROCEPHALUS WHEN CSF DO NOT CIRCULATE INCREASING ITS PRESSURE



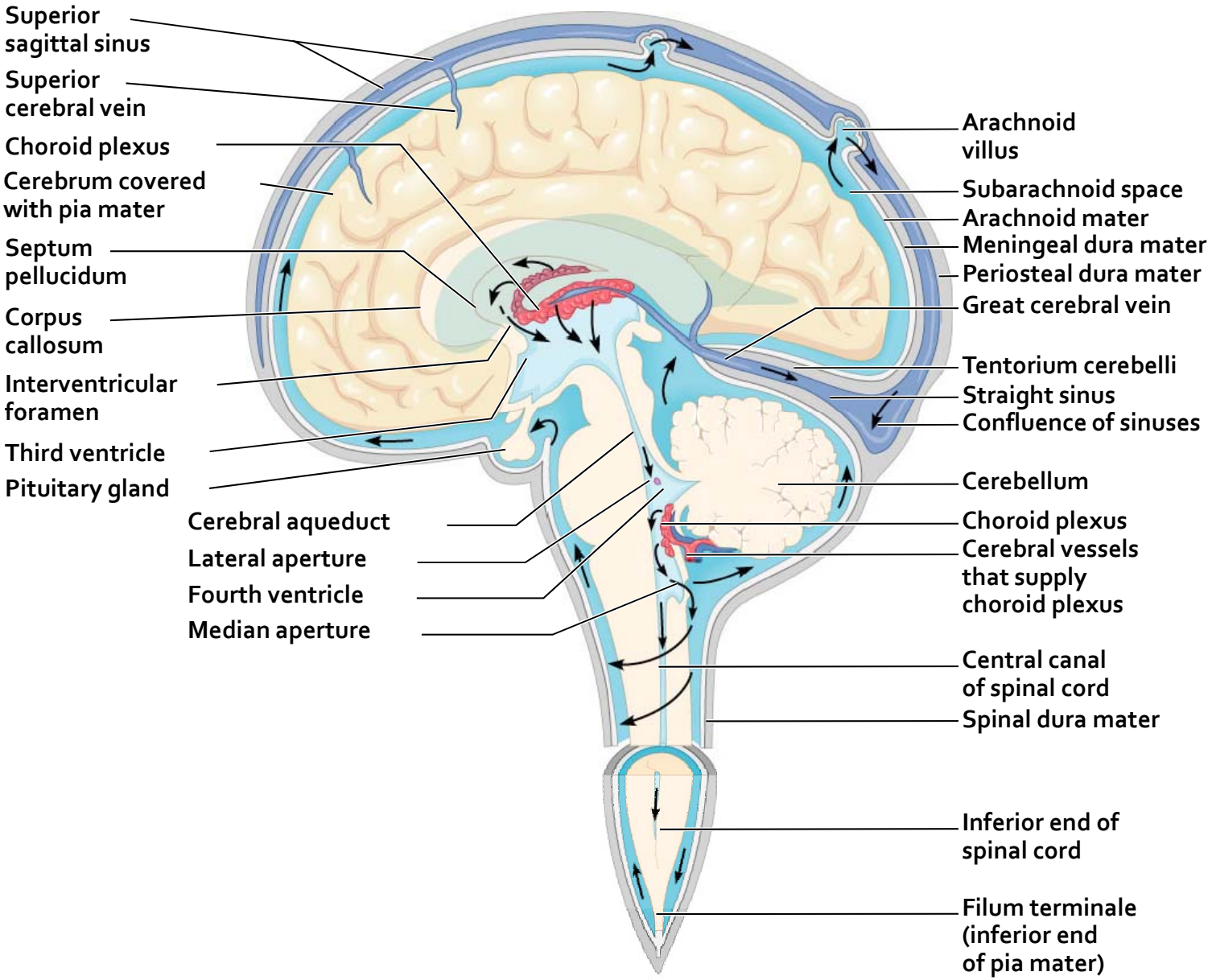
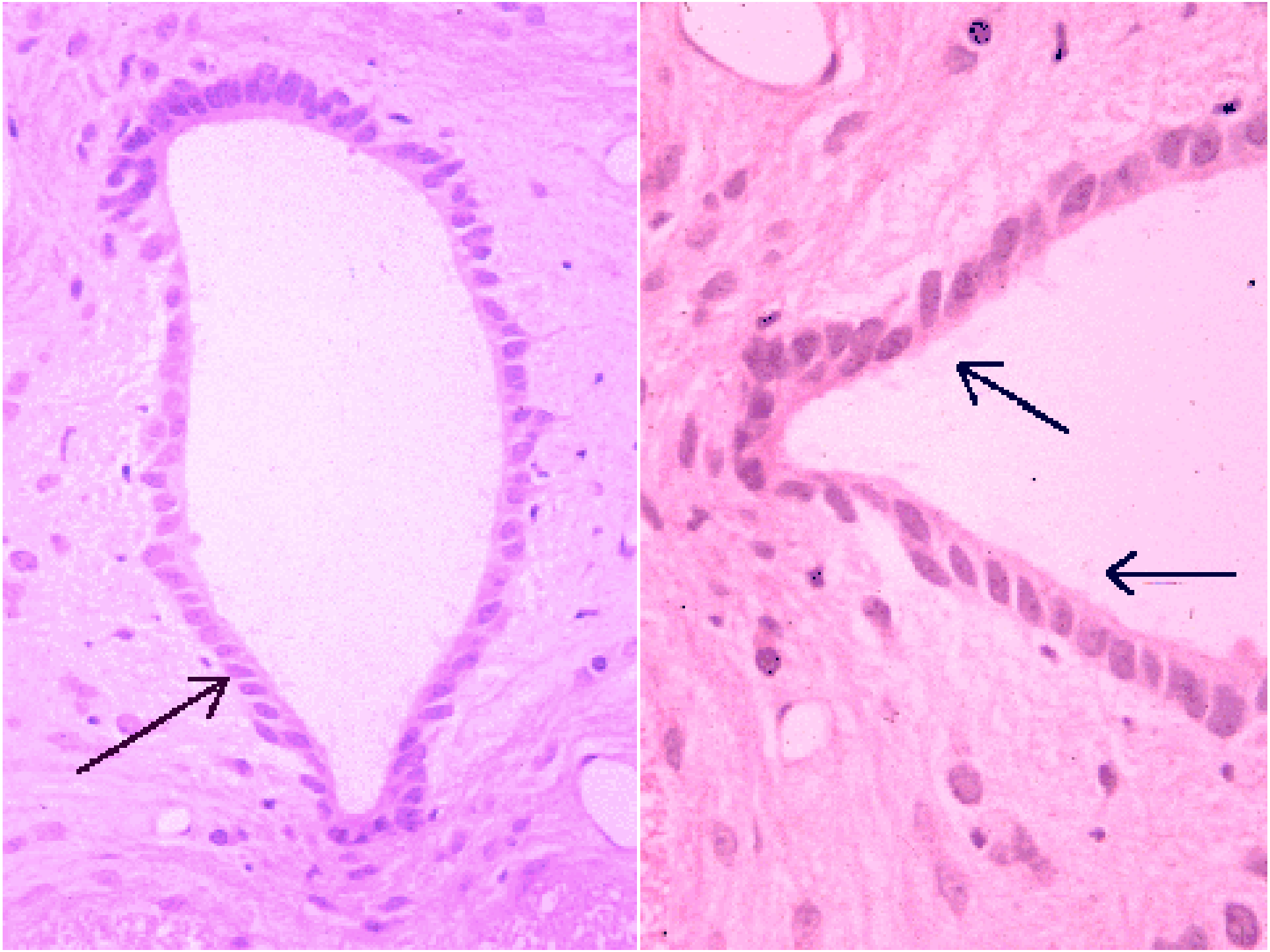


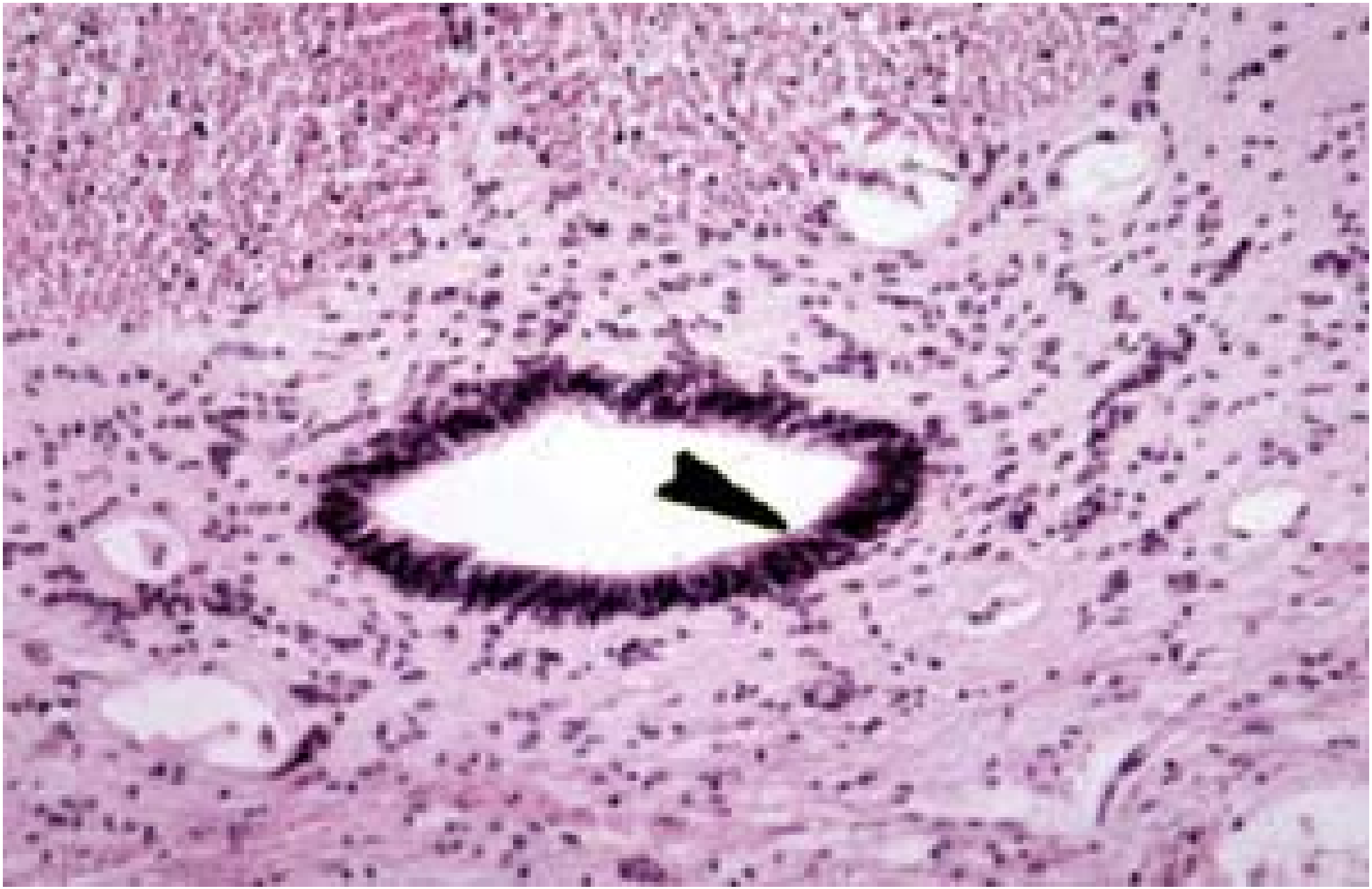
Figure 12.26: Formation, location, and circulation of CSF, p. 466.

epithelium

lines ventricles & central canal of spinal cord

ciliated - CSF



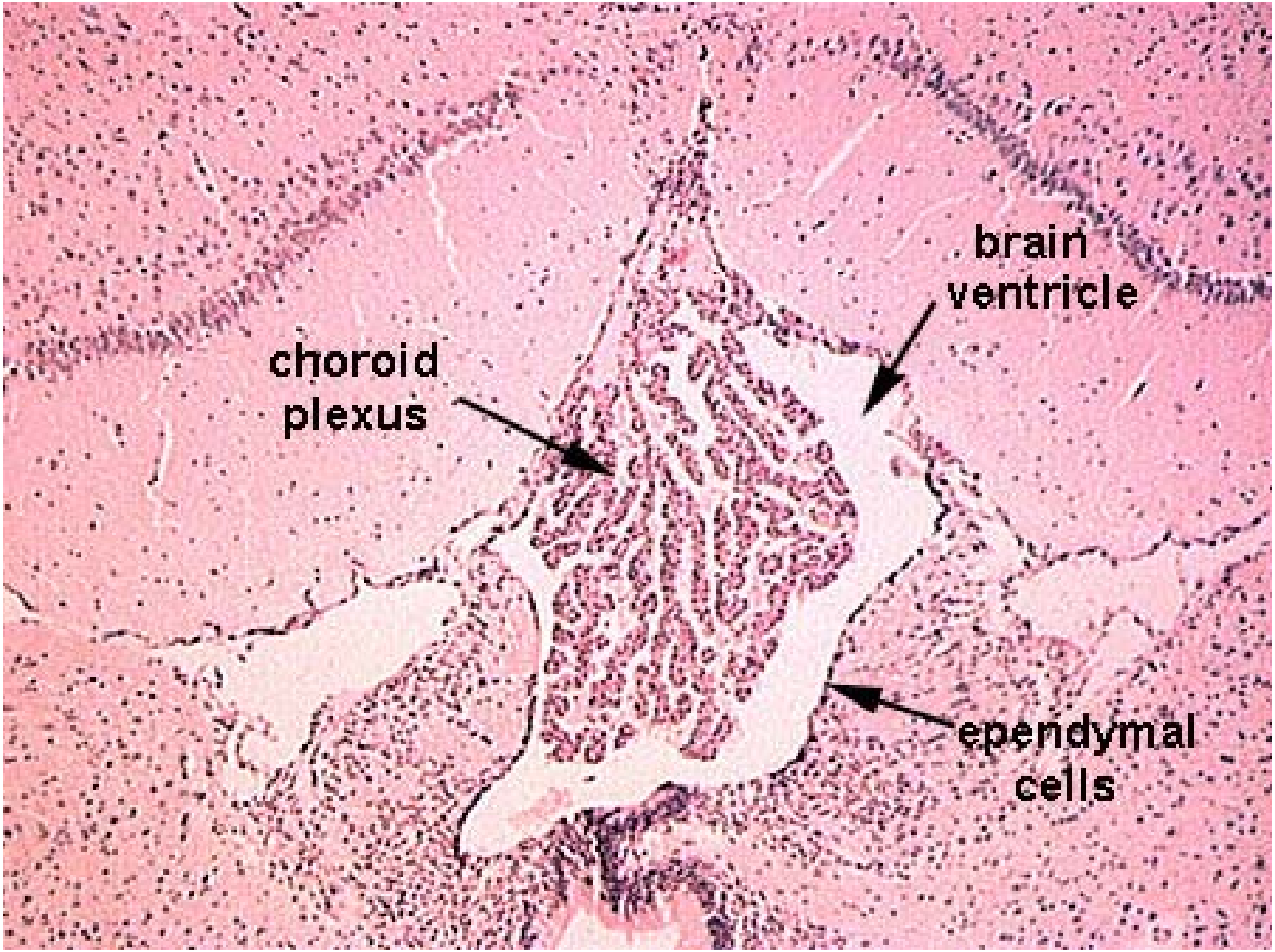


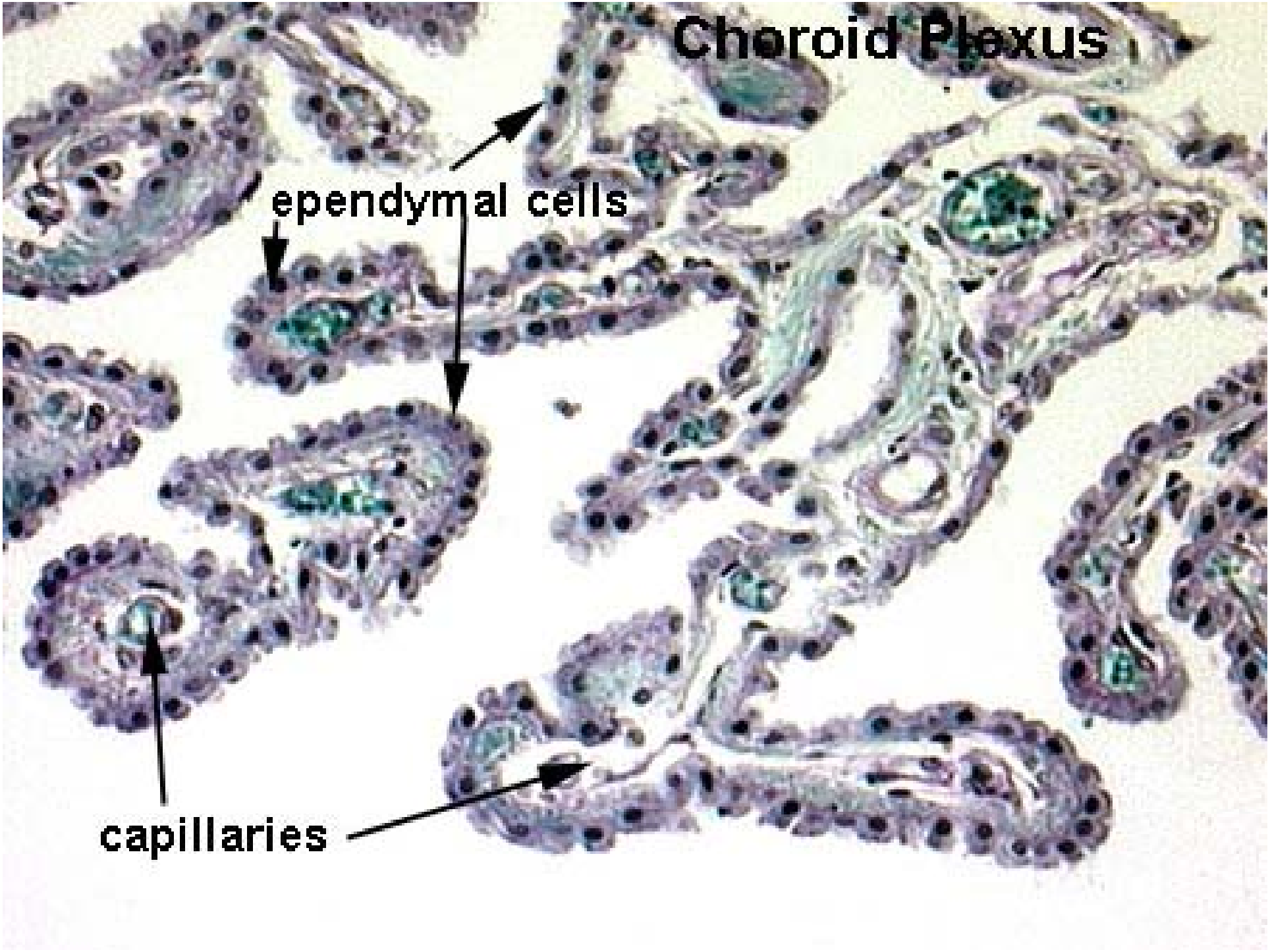
EPENDYMA

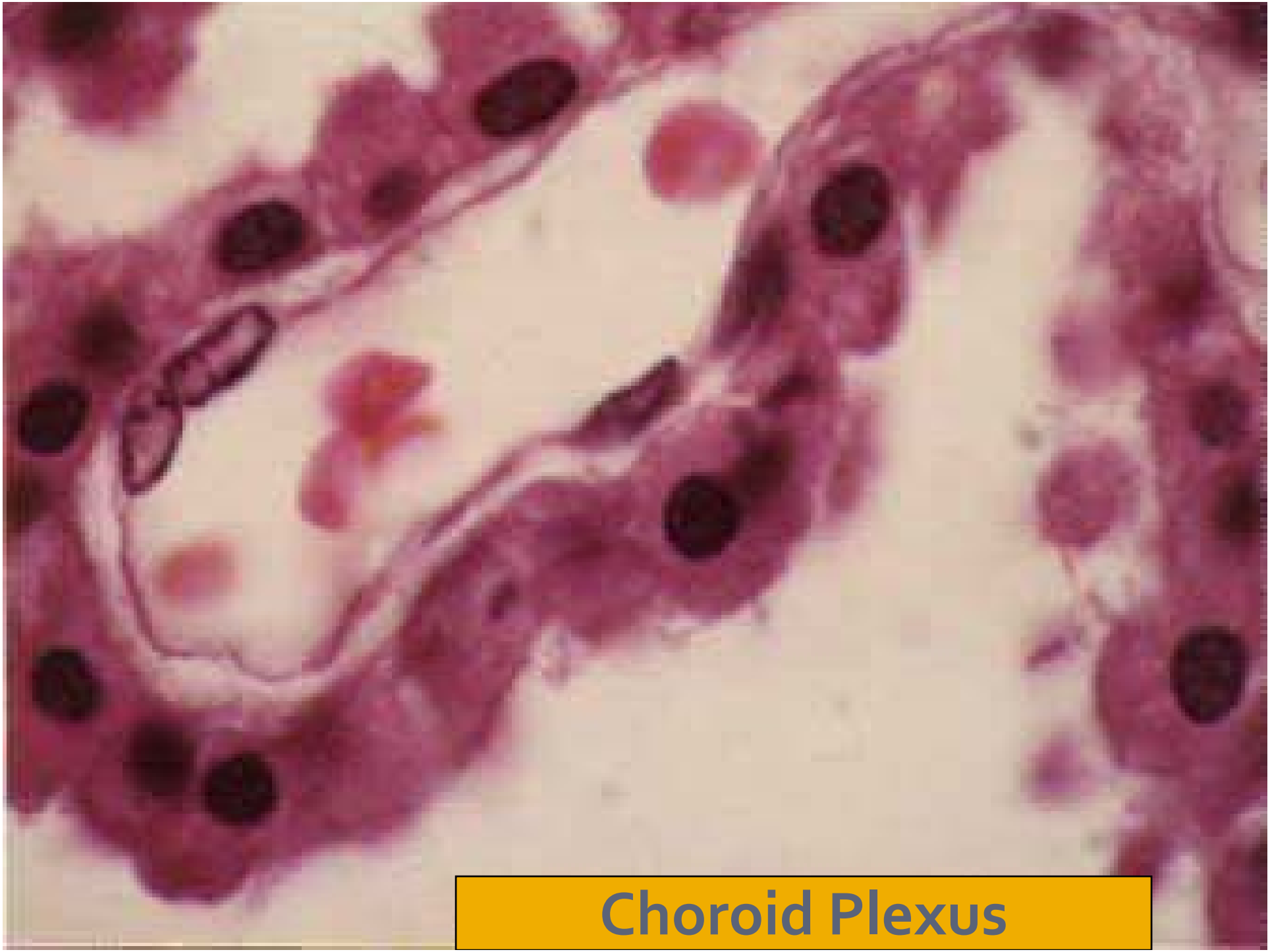
Modified to form choroid plexus

secrete cerebro-spinal fluid (CSF)

SEM of choroid plexus


brain
ventricle
choroid
plexus
ependymal
cells


Choroid Plexus
ependymal cells
capillaries


Choroid Plexus

TANYCYTES

Specialized ependymal cells that extend processes into hypothalamus.

Processes terminate near blood vessels and neurosecretory cells

?Transport CSF or substances in the CSF to neurosecretory cells.

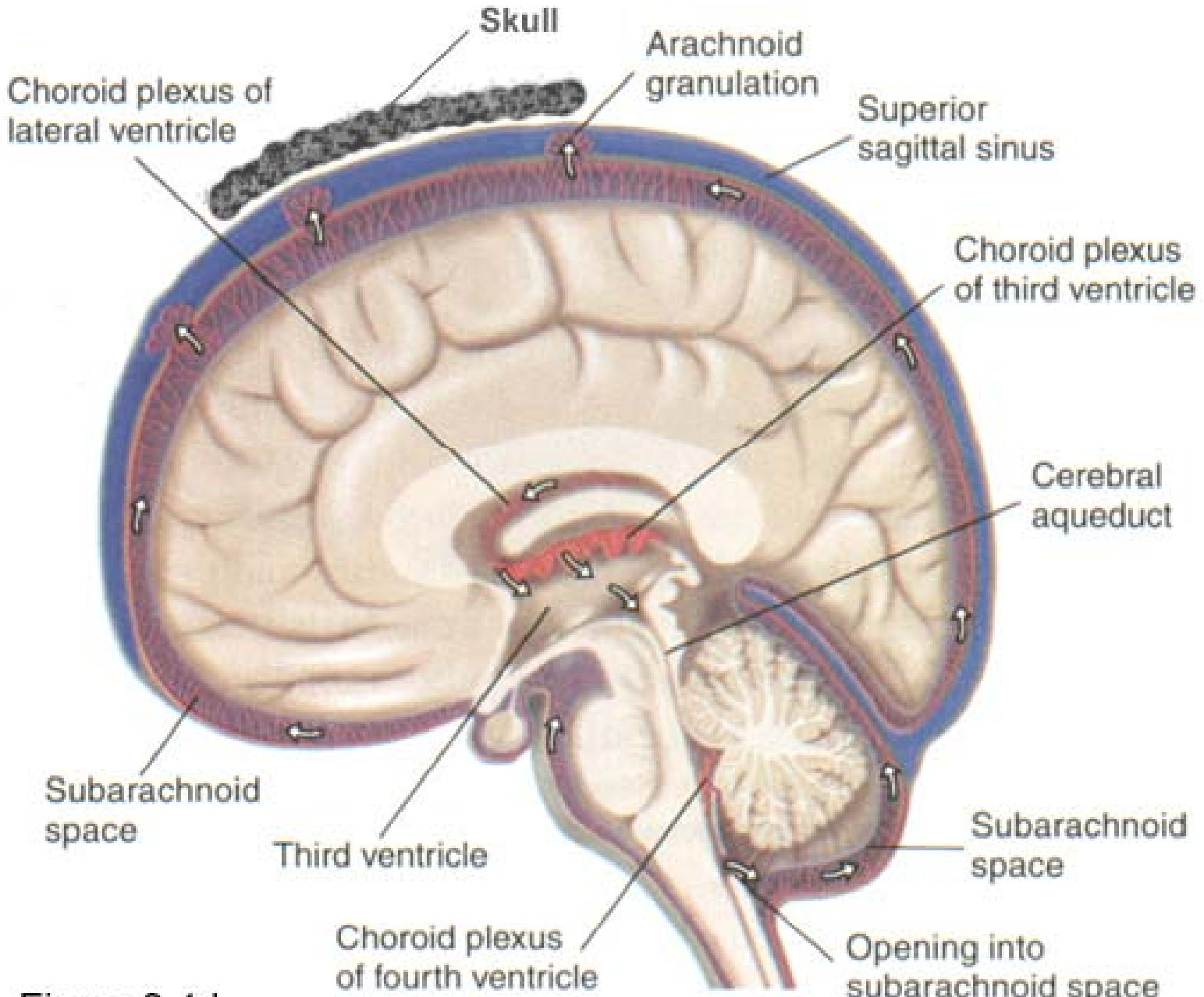
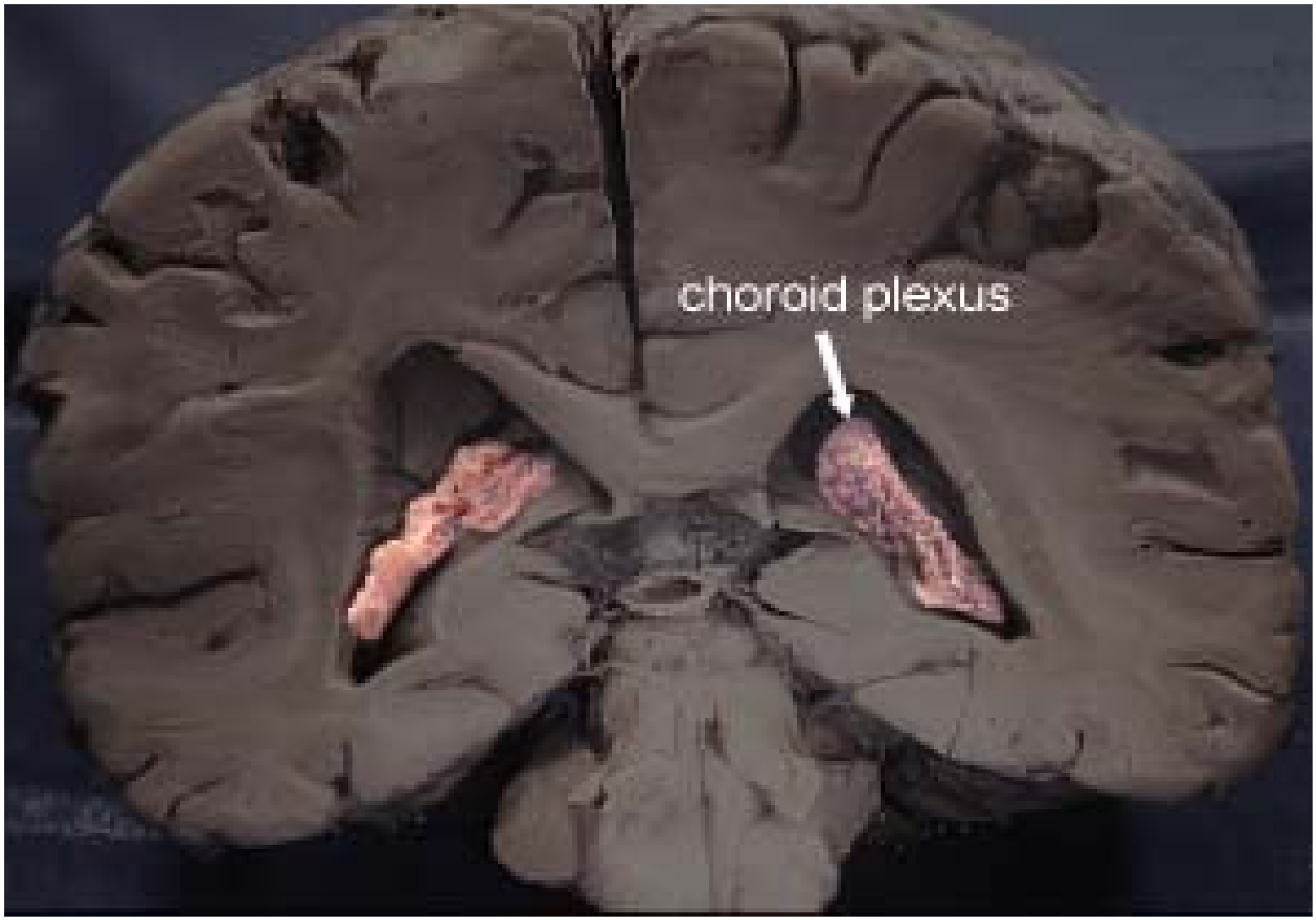

Skull
Arachnoid granulation
Choroid plexus of lateral ventricle
Superior sagittal sinus
Choroid plexus of third ventricle
Cerebral aqueduct
Subarachnoid space
Third ventricle
Subarachnoid space
Choroid plexus of fourth ventricle
Opening into subarachnoid space

Figure 3.4d



choroid plexus

- It produces the cerebrospinal fluid (CSF) which is found within the ventricles of the brain and in the subarachnoid space around the brain and spinal cord.
- It is comprised of a rich capillary bed, pia mater, and choroid epithelial cells.
- It is located in certain parts of the ventricular system of the brain.

Types of Sleep

- There are two major types of sleep:
  - Non-rapid eye movement (NREM)
  - Rapid eye movement (REM)
- One passes through four stages of NREM during the first 30-45 minutes of sleep
- REM sleep occurs after the fourth NREM stage has been achieved

Types and Stages of Sleep: NREM

- NREM stages include:
  - Stage 1 – eyes are closed and relaxation begins; the EEG shows alpha waves; one can be easily aroused
  - Stage 2 – EEG pattern is irregular with sleep spindles (high-voltage wave bursts); arousal is more difficult
  - Stage 3 – sleep deepens; theta and delta waves appear; vital signs decline; dreaming is common
  - Stage 4 – EEG pattern is dominated by delta waves; skeletal muscles are relaxed; arousal is difficult

Types and Stages of Sleep: REM

- Characteristics of REM sleep
  - EEG pattern reverts through the NREM stages to the stage 1 pattern
  - Vital signs increase
  - Skeletal muscles (except ocular muscles) are inhibited
  - Most dreaming takes place

Sleep

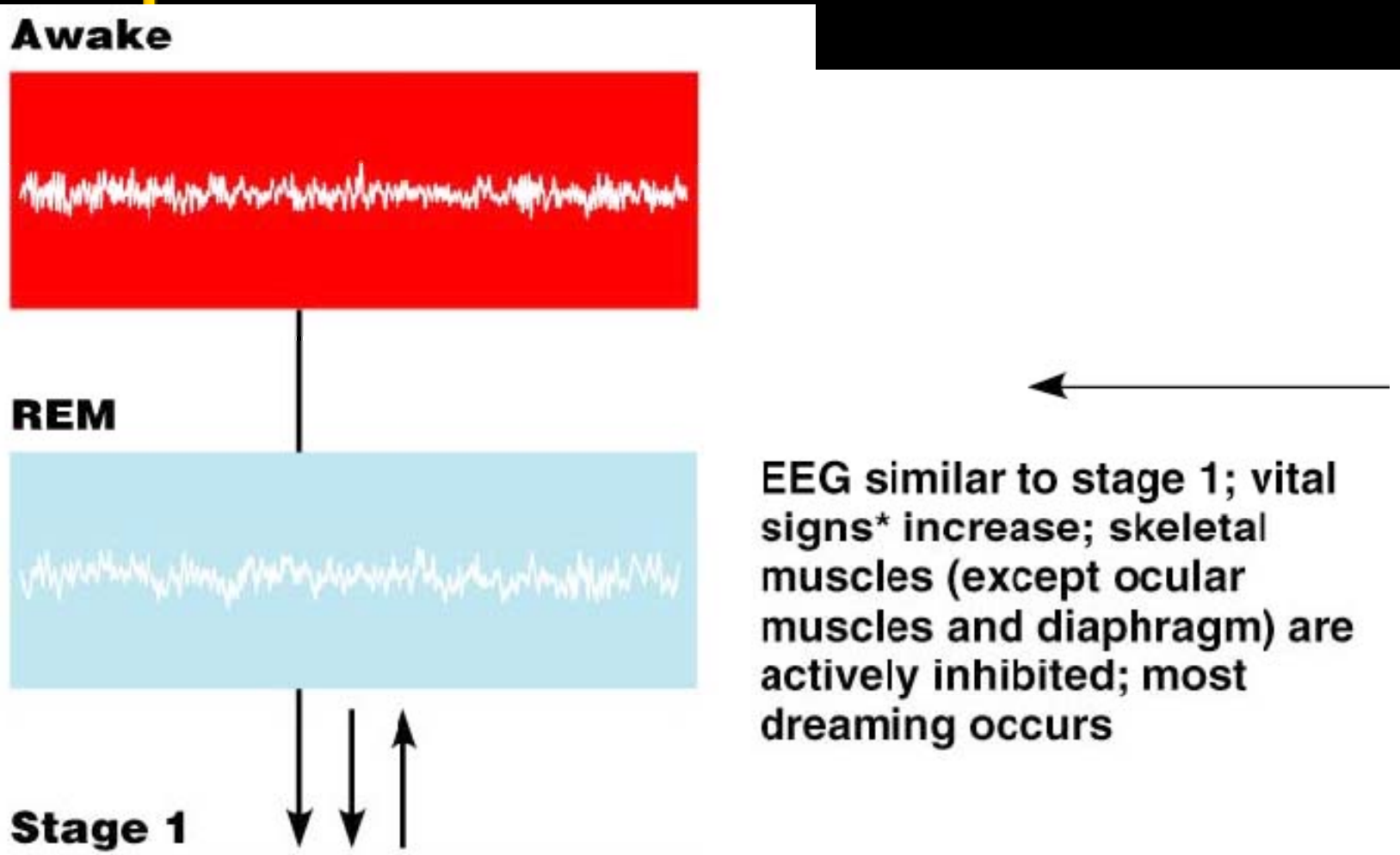
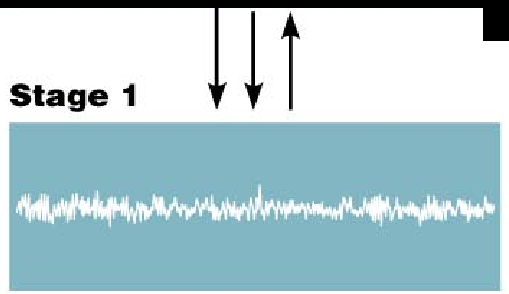


Figure 12.21a.1

Sleep

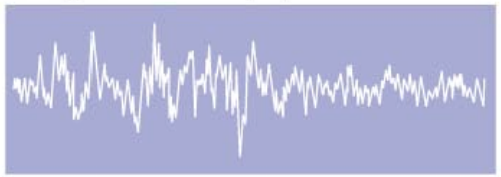


Stage 1

Eyes closed, relaxation begins; a drifting sensation occurs; vital signs* normal; EEG shows alpha waves; arousal is easy

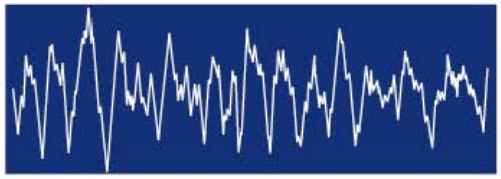
Stage 2

EEG more irregular; sleep spindles appear (short, high-amplitude bursts, 12–14 Hz); arousal is more difficult



Stage 3

Sleep deepens; theta and delta waves appear; vital signs* decline; reached about 20 min after the onset of stage 1



Stage 4

Slow-wave sleep; EEG dominated by delta waves; vital signs* at lowest normal level; arousal difficult; bed-wetting, night terrors, and sleep-walking may occur

(a)

Figure 12.21a.2

Sleep Patterns

- Alternating cycles of sleep and wakefulness reflect a natural circadian rhythm
- Although RAS activity declines in sleep, sleep is more than turning off RAS
- The brain is actively guided into sleep
- The suprachiasmatic and preoptic nuclei of the hypothalamus regulate the sleep cycle
- A typical sleep pattern alternates between REM and NREM sleep

Importance of Sleep

- Slow-wave sleep is presumed to be the restorative stage
- Those deprived of REM sleep become moody and depressed
- REM sleep may be a reverse learning process where superfluous information is purged from the brain
- Daily sleep requirements decline with age

Sleep Disorders

- **Narcolepsy** – lapsing abruptly into sleep from the awake state
- **Insomnia** – chronic inability to obtain the amount or quality of sleep needed
- **Sleep apnea** – temporary cessation of breathing during sleep