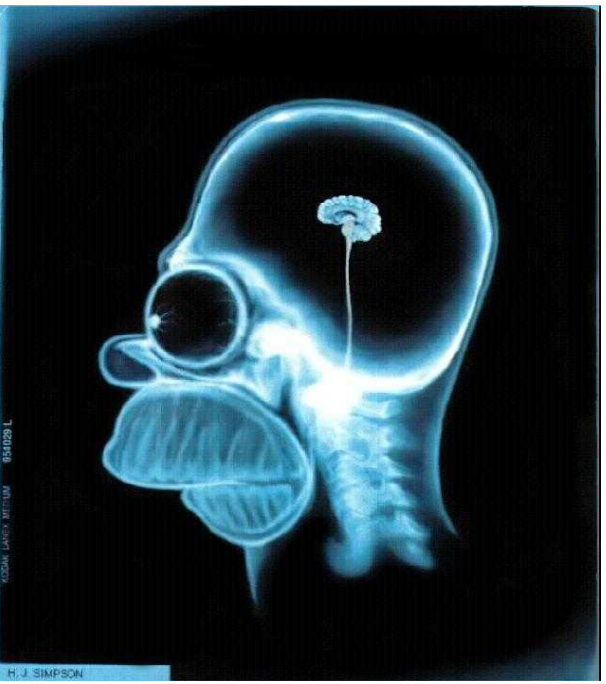
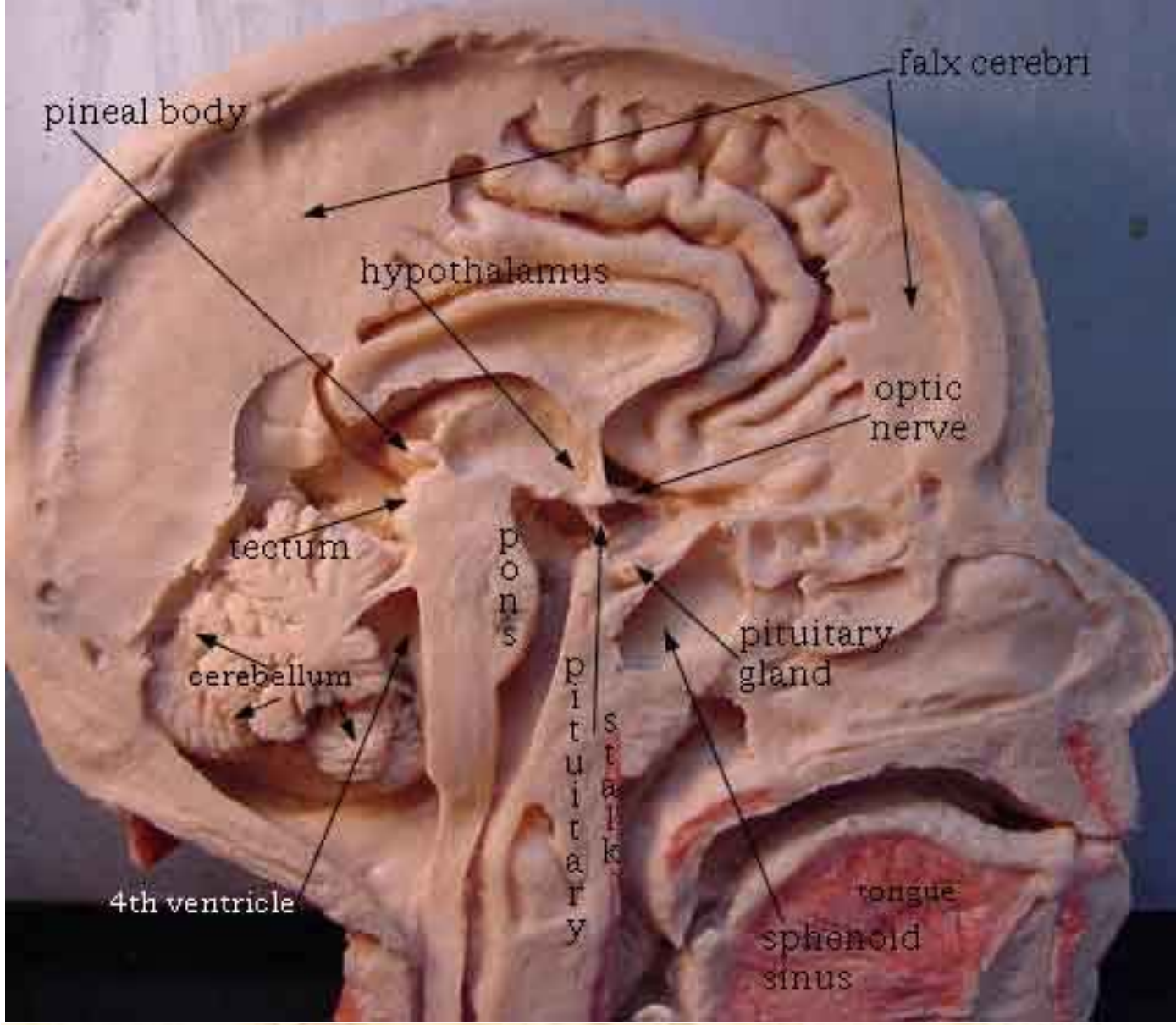
The Brain

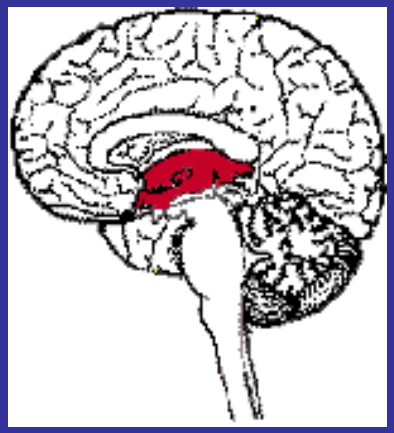


Danil Hammoudi.MD



New Terms:
Brain Division

Telencephalon



Diencephalon

Mesencephalon

Metencephalon

Myelencephalon

Telencephalon

- –Cerebral Cortex
- –Limbic system
- –Basal Ganglia

Pons:

Cerebellum:

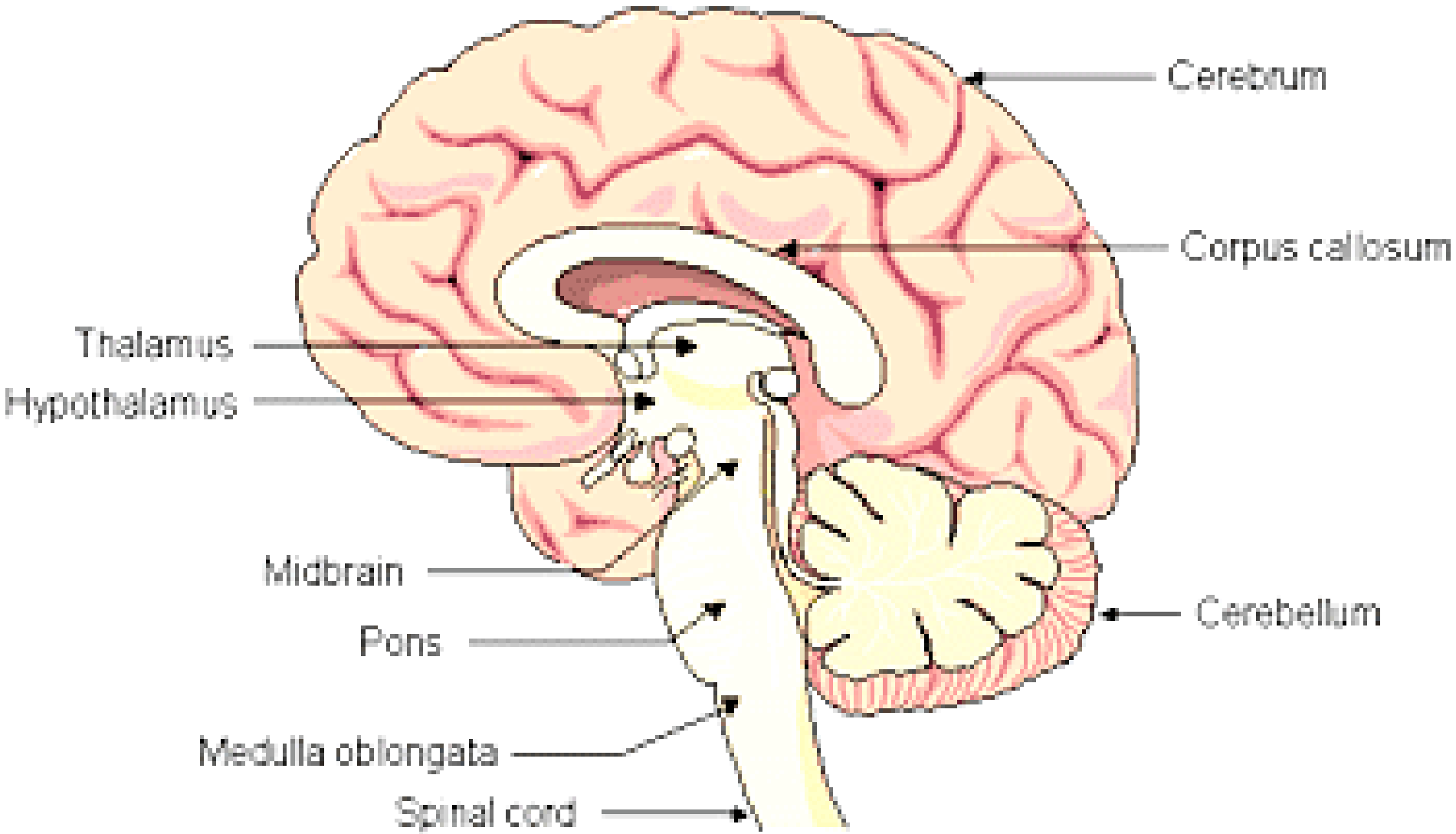
Medulla

Cell bodies in CNS: nuclei

Cell bodies in PNS: ganglia

Nerves: bundles of axons!

Diagram of 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.

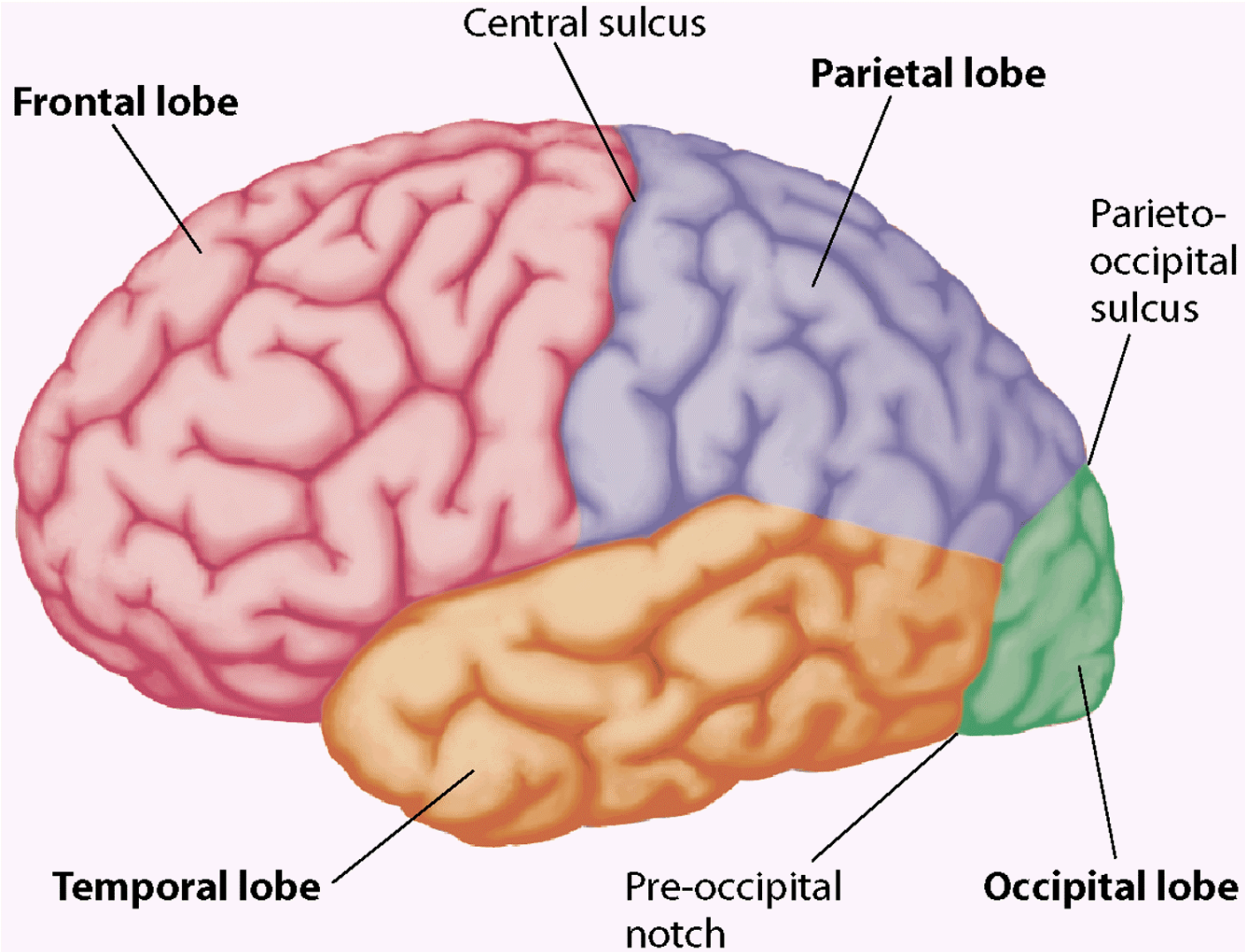
- The right side of the cerebrum controls things such as imagination and 3-D forms.

- 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*

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.

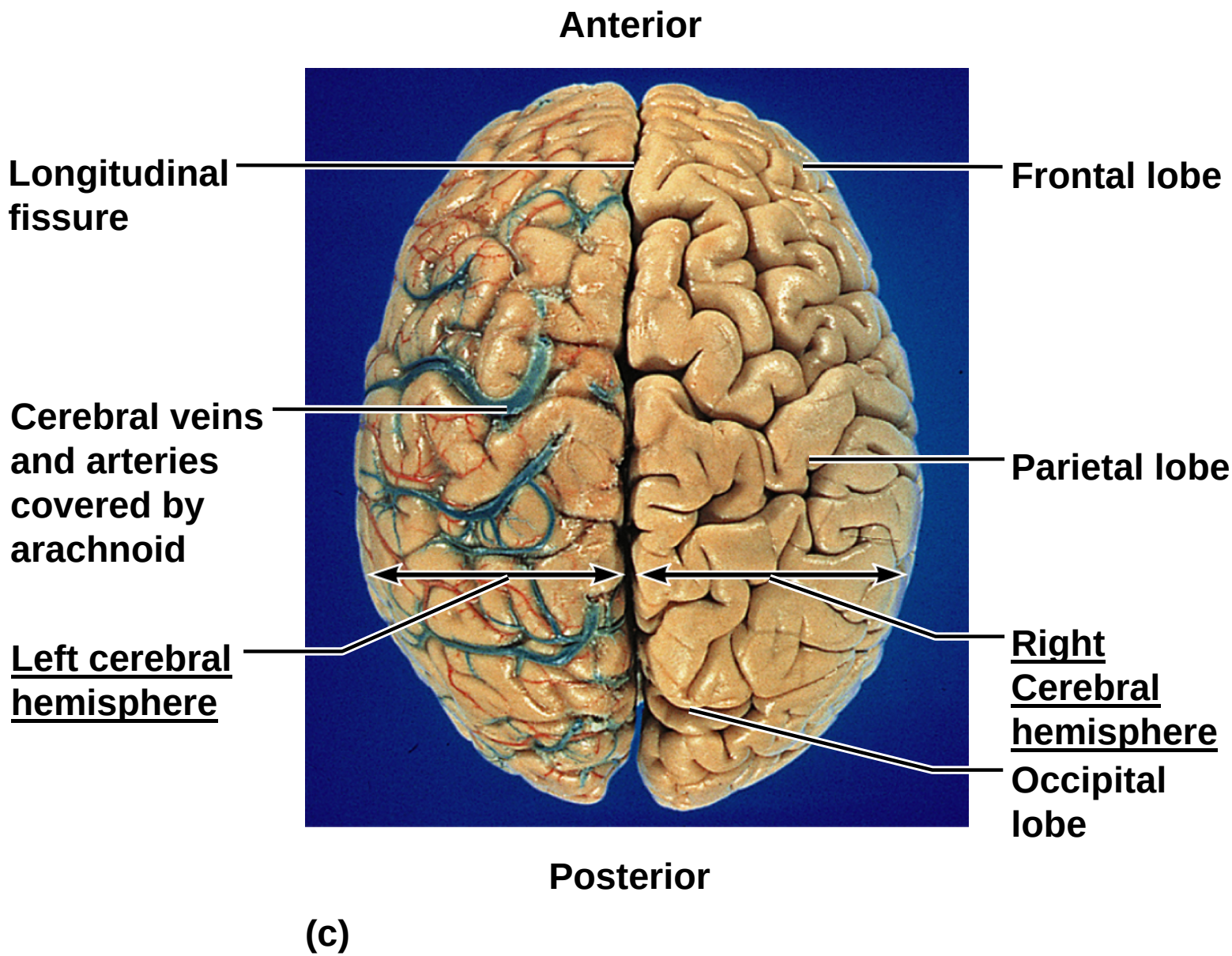
• The hemispheres are linked by the corpus callosum, a very large bundle of nerve fibers, and also by other smaller commissures, including the anterior commissure, posterior commissure, and hippocampal commissure.

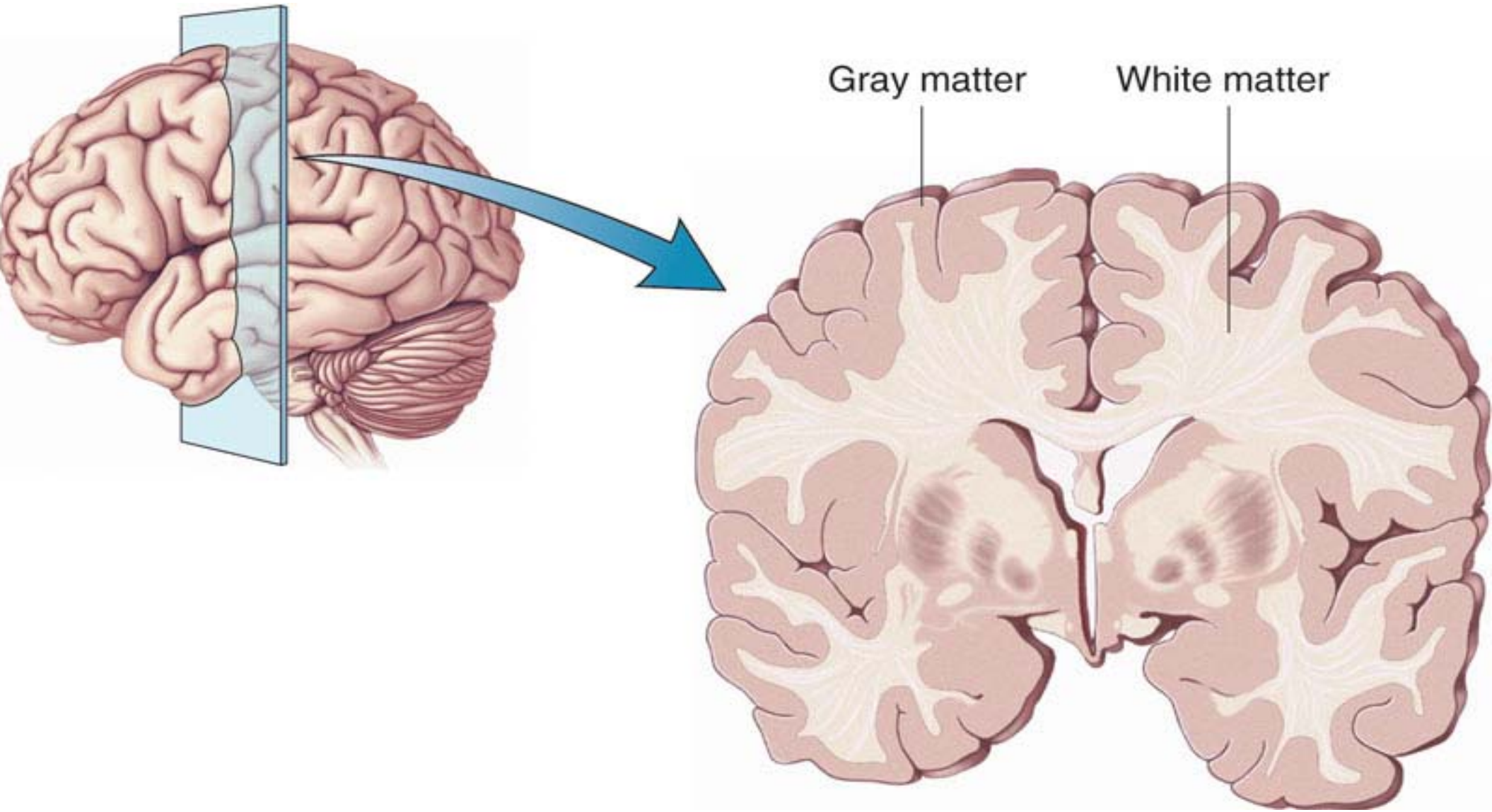
•These commissures transfer information between the two hemispheres to coordinate localized functions.

• 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 12.6c: Lobes and fissures of the cerebral hemispheres, p. 435.




Gray matter
White matter

Cerebral Features:

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

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

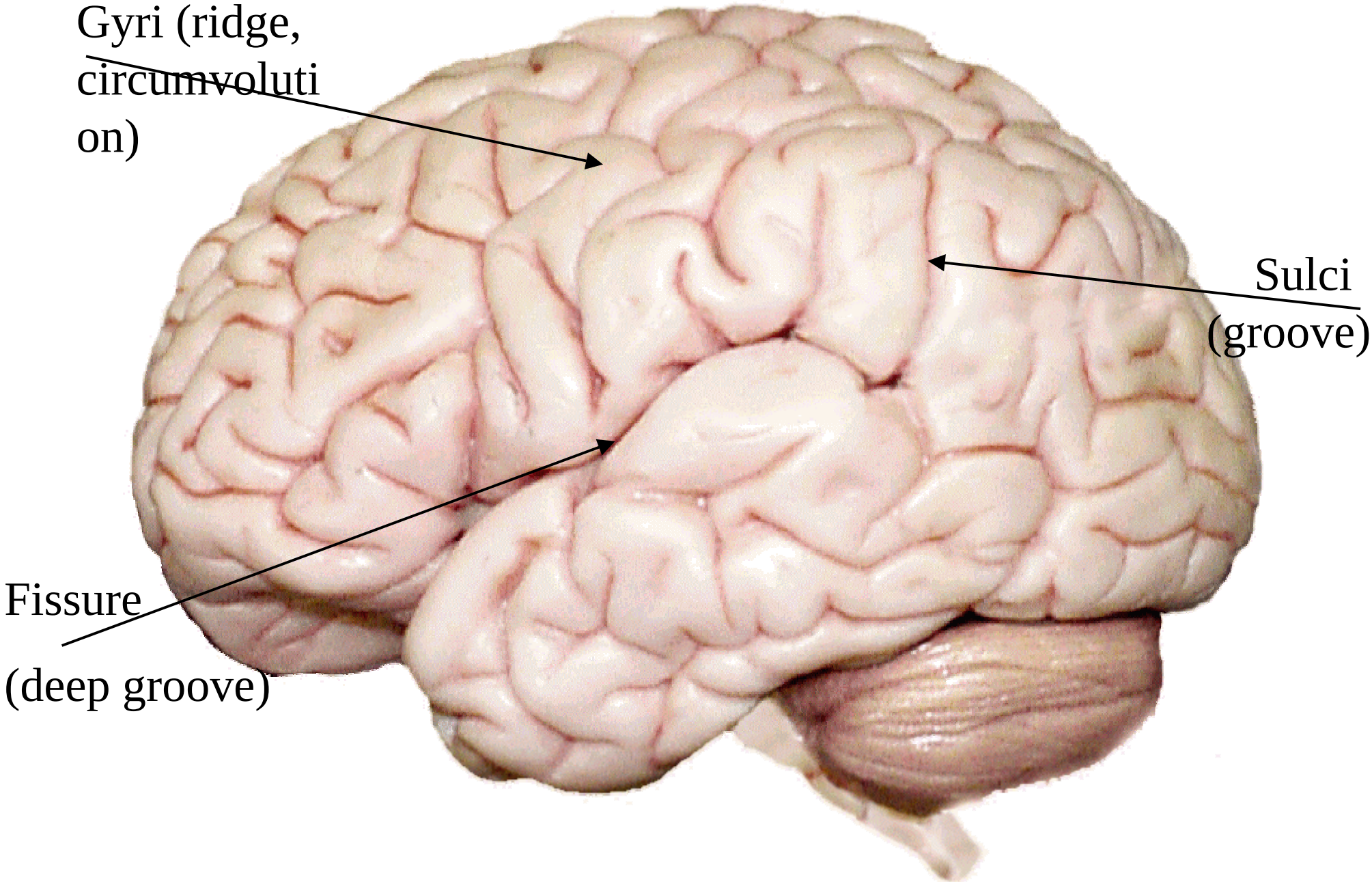
  – **Central Sulcus** – Divides the Frontal Lobe from the Parietal Lobe

- **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

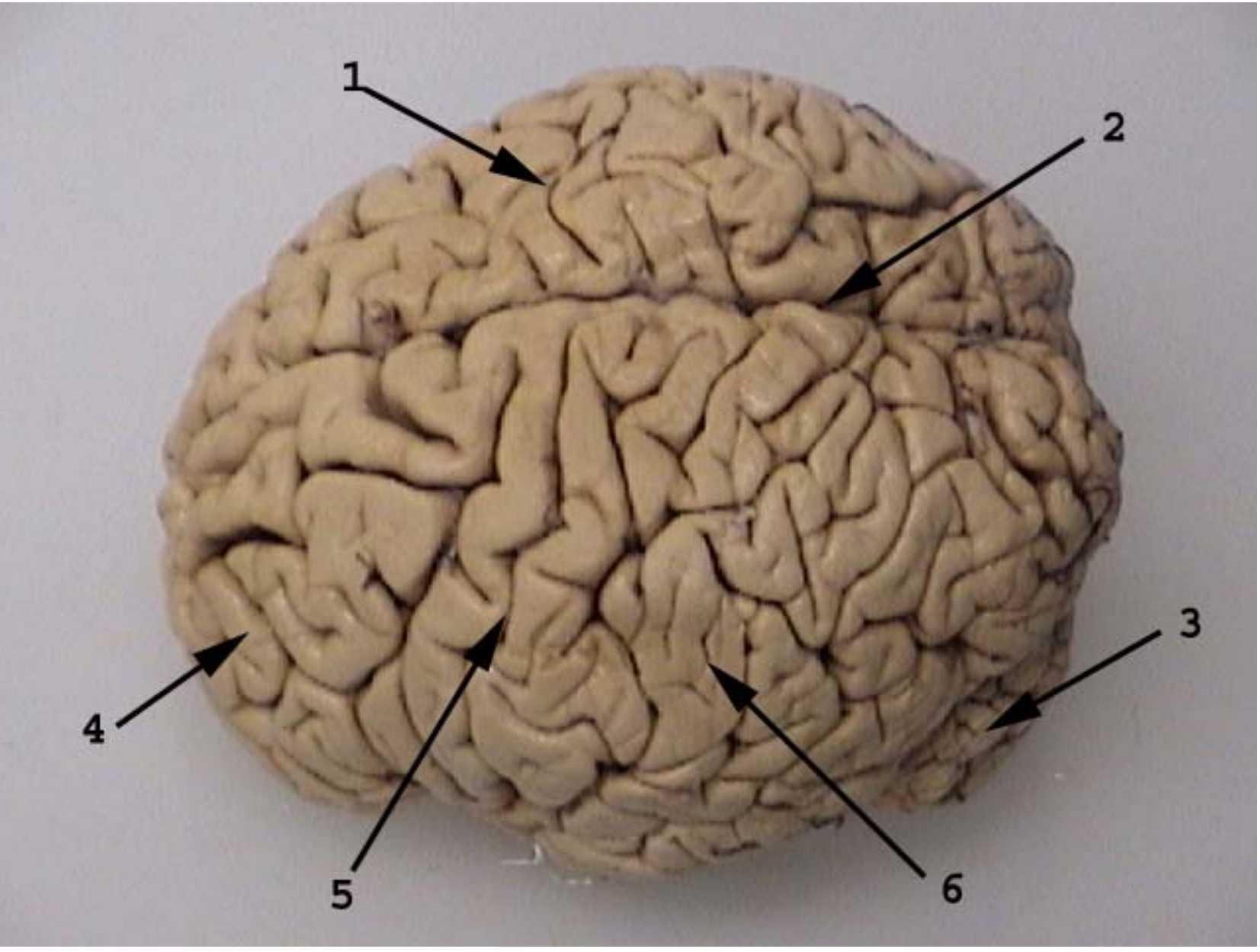
  – **Sylvian / Lateral Fissure** – Divides the Temporal Lobe from the Frontal and Parietal Lobes



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

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

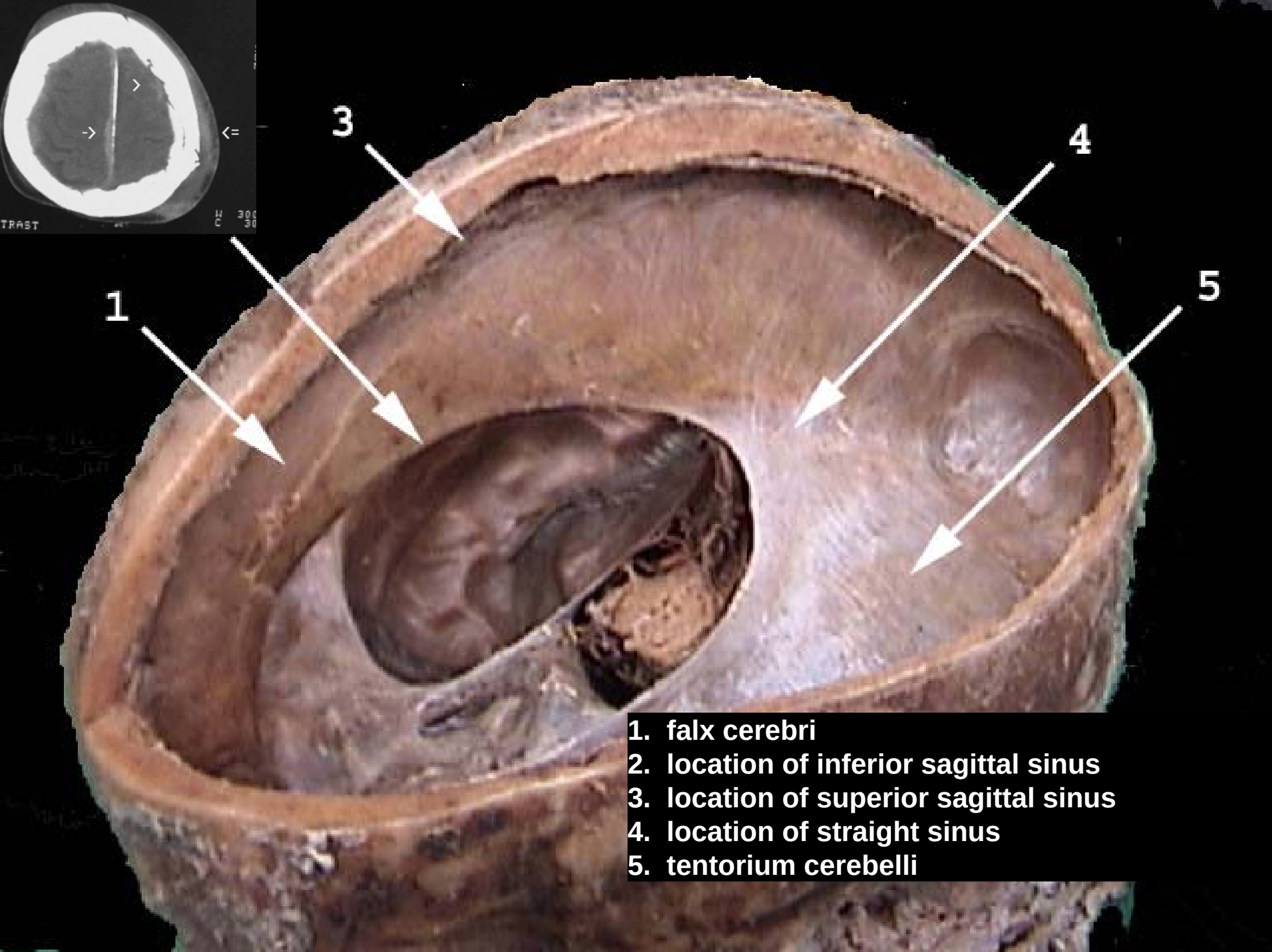
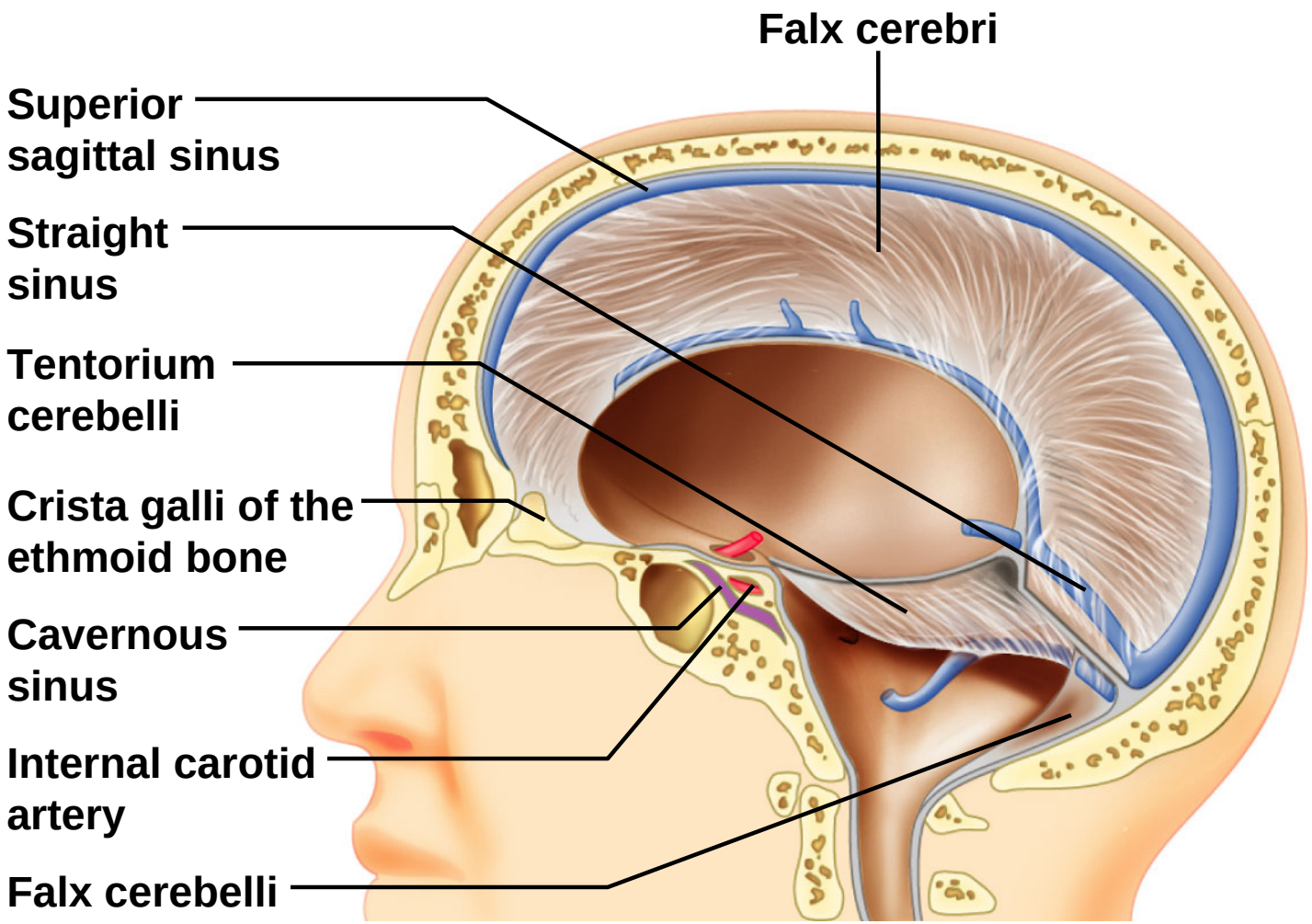
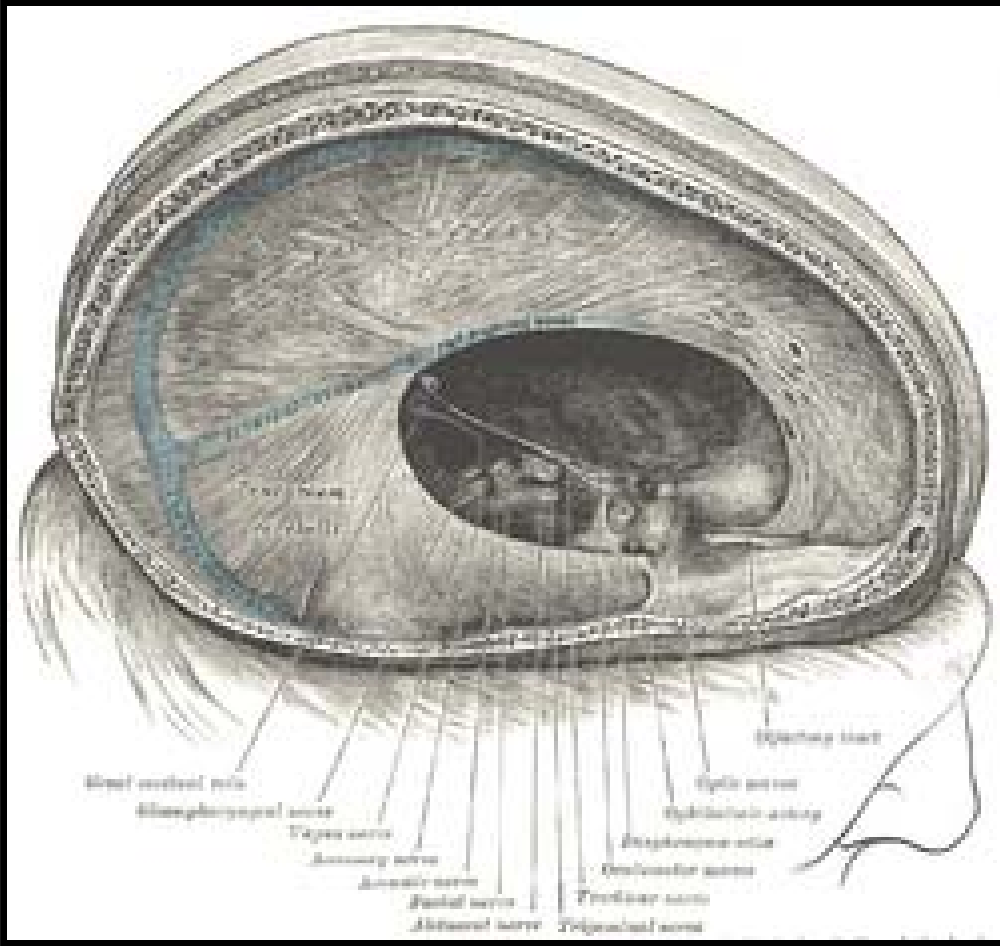

3
4
1
5
1. falx cerebri
2. location of inferior sagittal sinus
3. location of superior sagittal sinus
4. location of straight sinus
5. tentorium cerebelli

Figure 12.25: Partitioning folds of dura mater in the cranial cavity, p. 465.



Falx cerebri

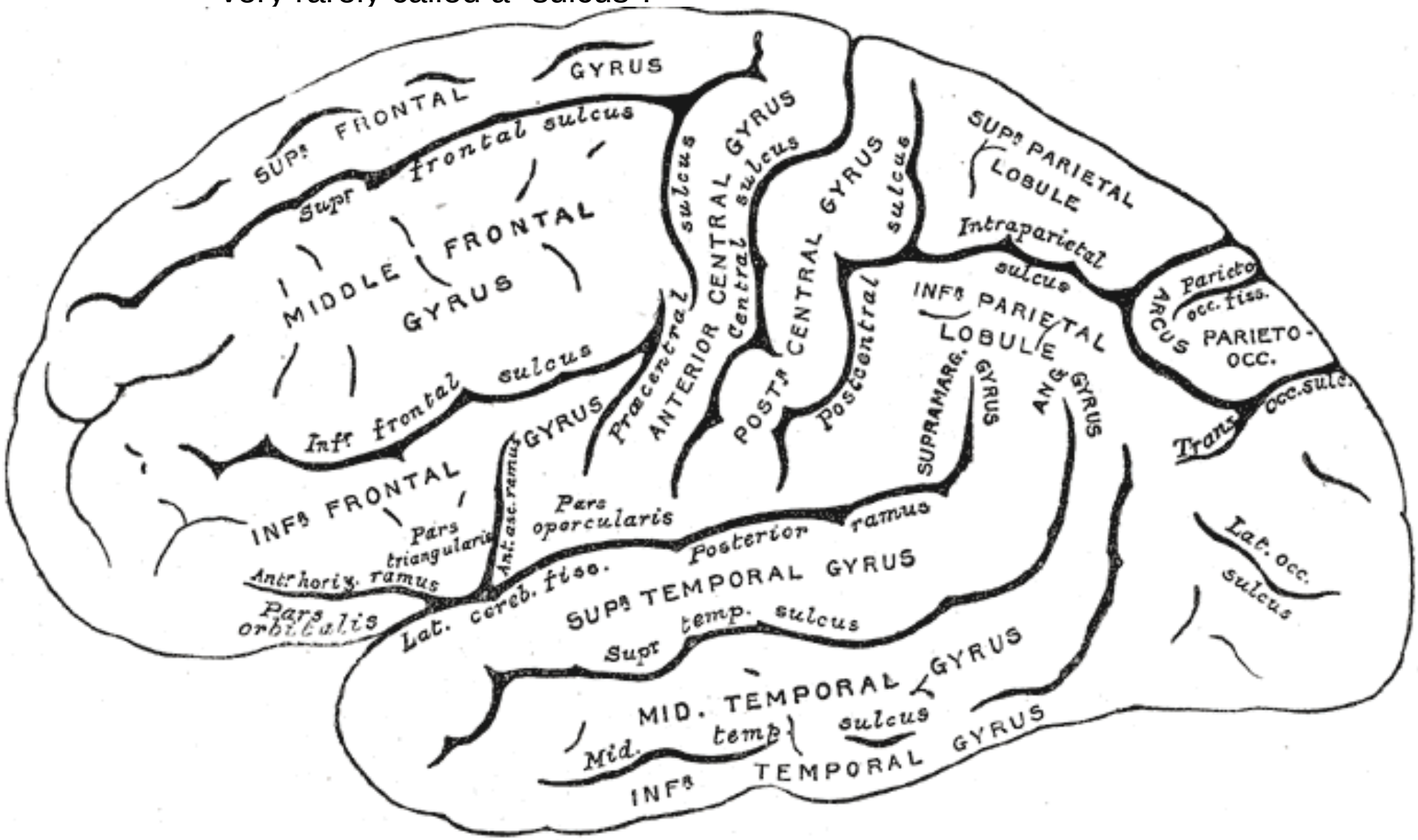


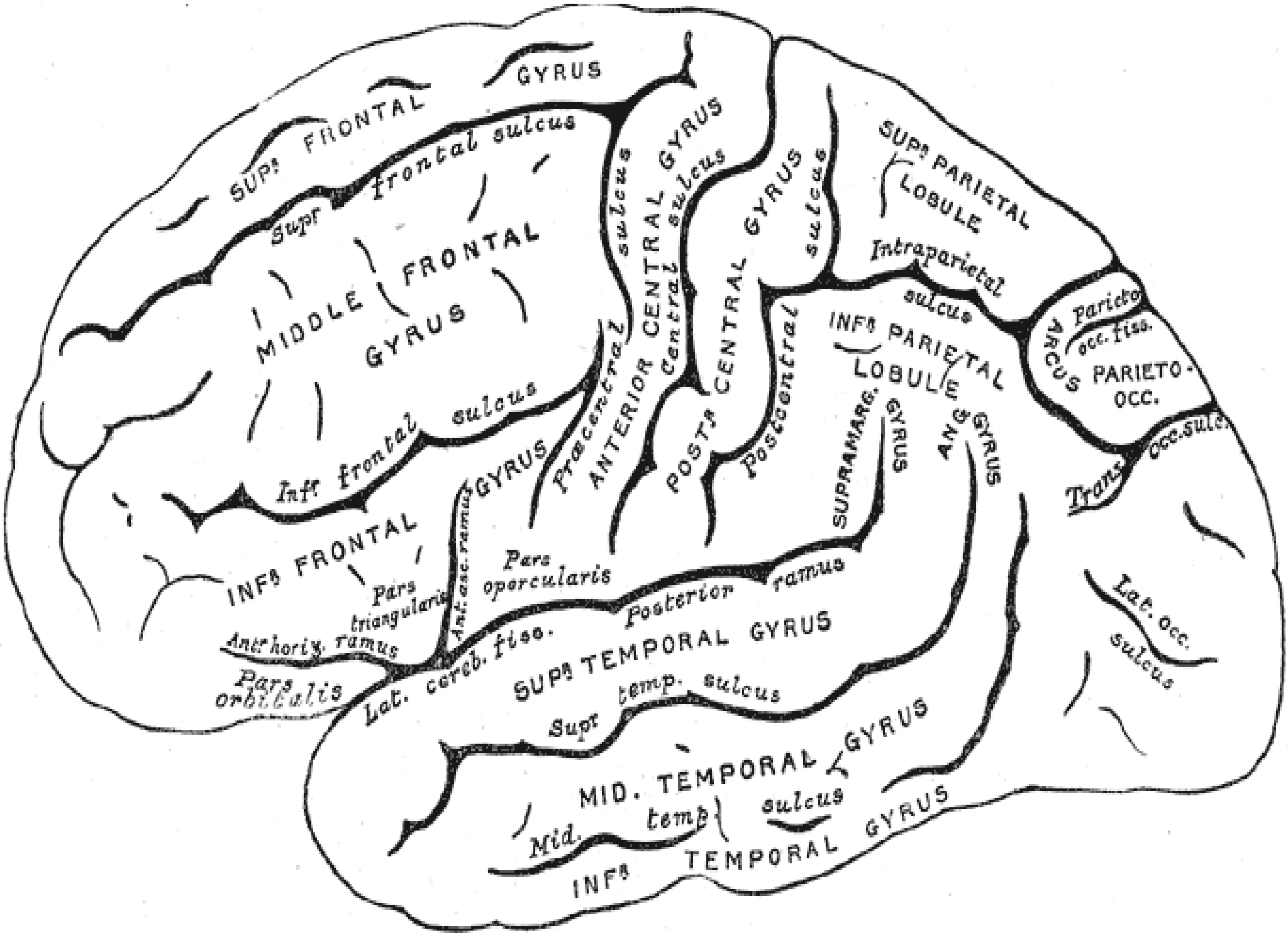
Sulcus

•a **sulcus** is a depression or fissure in the surface of the brain.
• It surrounds the gyri, creating the characteristic appearance of the brain in humans and other large mammals.

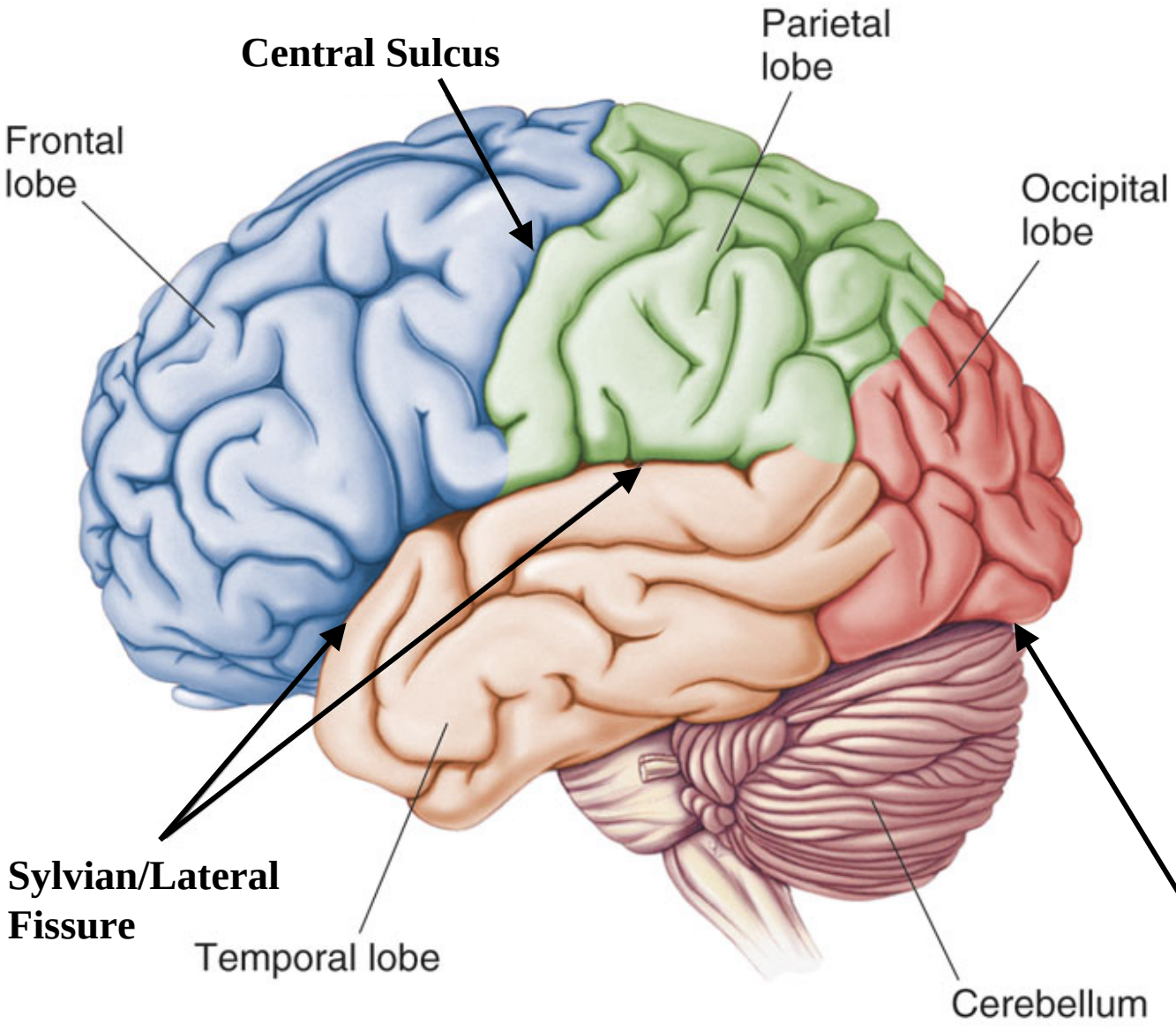
•Large furrows (sulci) that divide the brain into lobes are often called *fissures*.

•The large furrow that divide the two hemispheres - the interhemispheric fissure - is very rarely called a "sulcus".

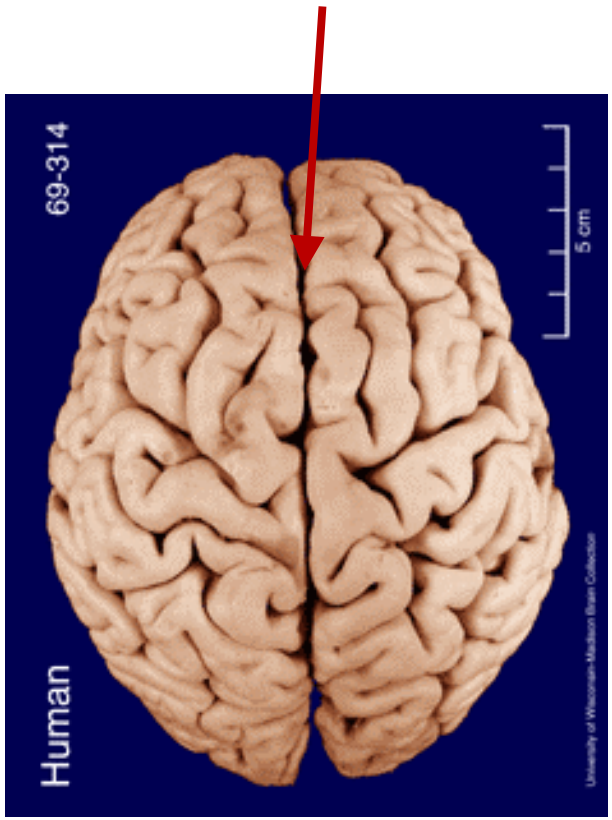



SUP^R FRONTAL GYRUS
Supr frontal sulcus
MIDDLE FRONTAL GYRUS
Inf^r frontal sulcus
INF^R FRONTAL
Pars triangularis
Pars orbitalis
Ant horiz. ramus
Ant. asc. ramus
Lat. cereb. fiss.
GYRUS
Præcentral sulcus
ANTERIOR CENTRAL GYRUS
central sulcus
POST^R CENTRAL GYRUS
Postcentral sulcus
SUP^R PARIETAL LOBULE
Intraparietal sulcus
INF^R PARIETAL LOBULE
SUPRAMARG. GYRUS
ANG^R GYRUS
Pars occ. fiss.
ARCUS PARIETO-OCC.
Trans. occ. sulc.
Pars opercularis
Posterior ramus
SUP^R TEMPORAL GYRUS
Supr temp. sulcus
Lat. occ. sulcus
MID. TEMPORAL GYRUS
Mid. temp. sulcus
INF^R TEMPORAL GYRUS

Specific Sulci/Fissures:



Longitudinal Fissure



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

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

Central sulcus= between frontal and parietal lobes.

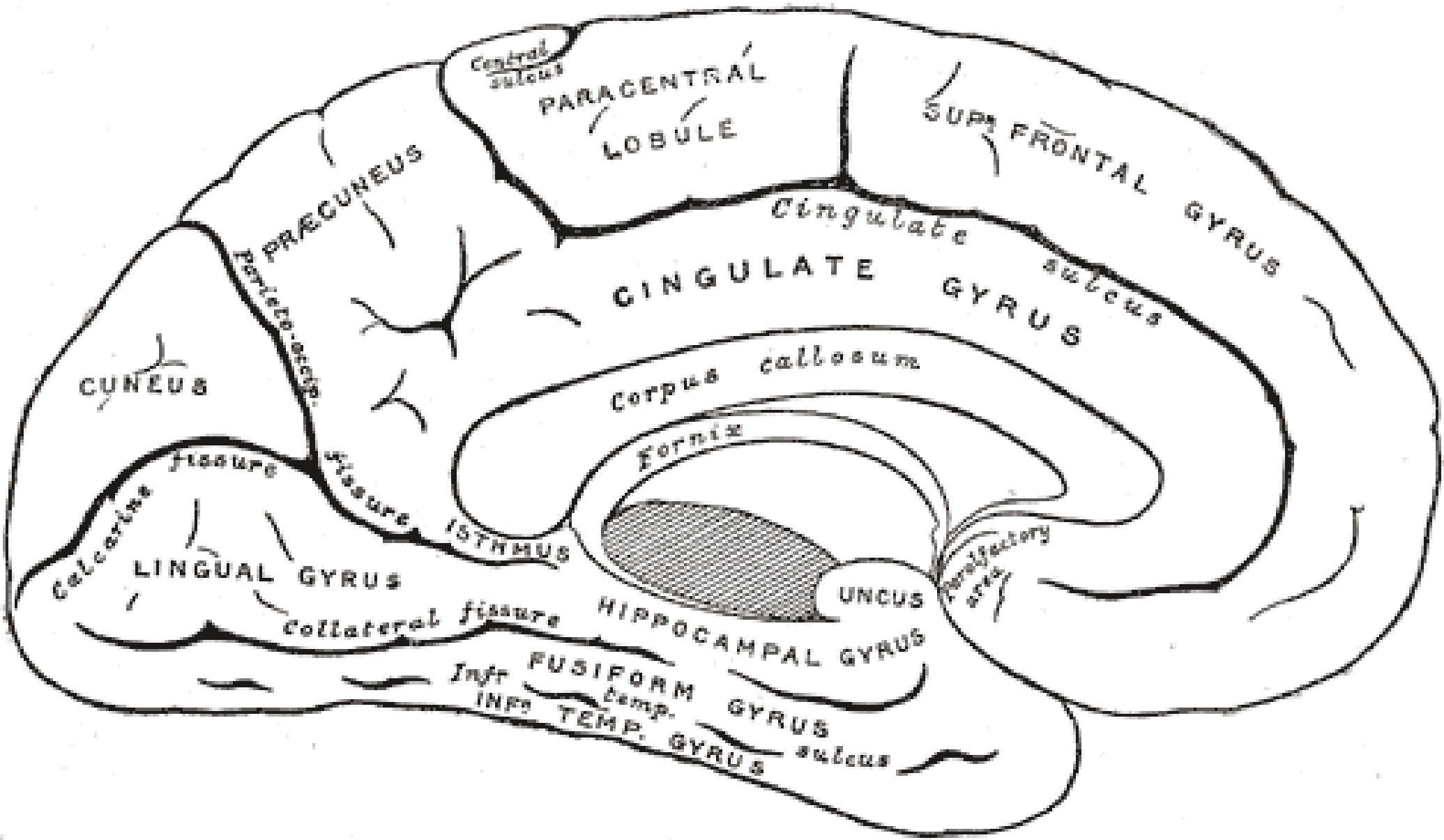
Frontal lobe:

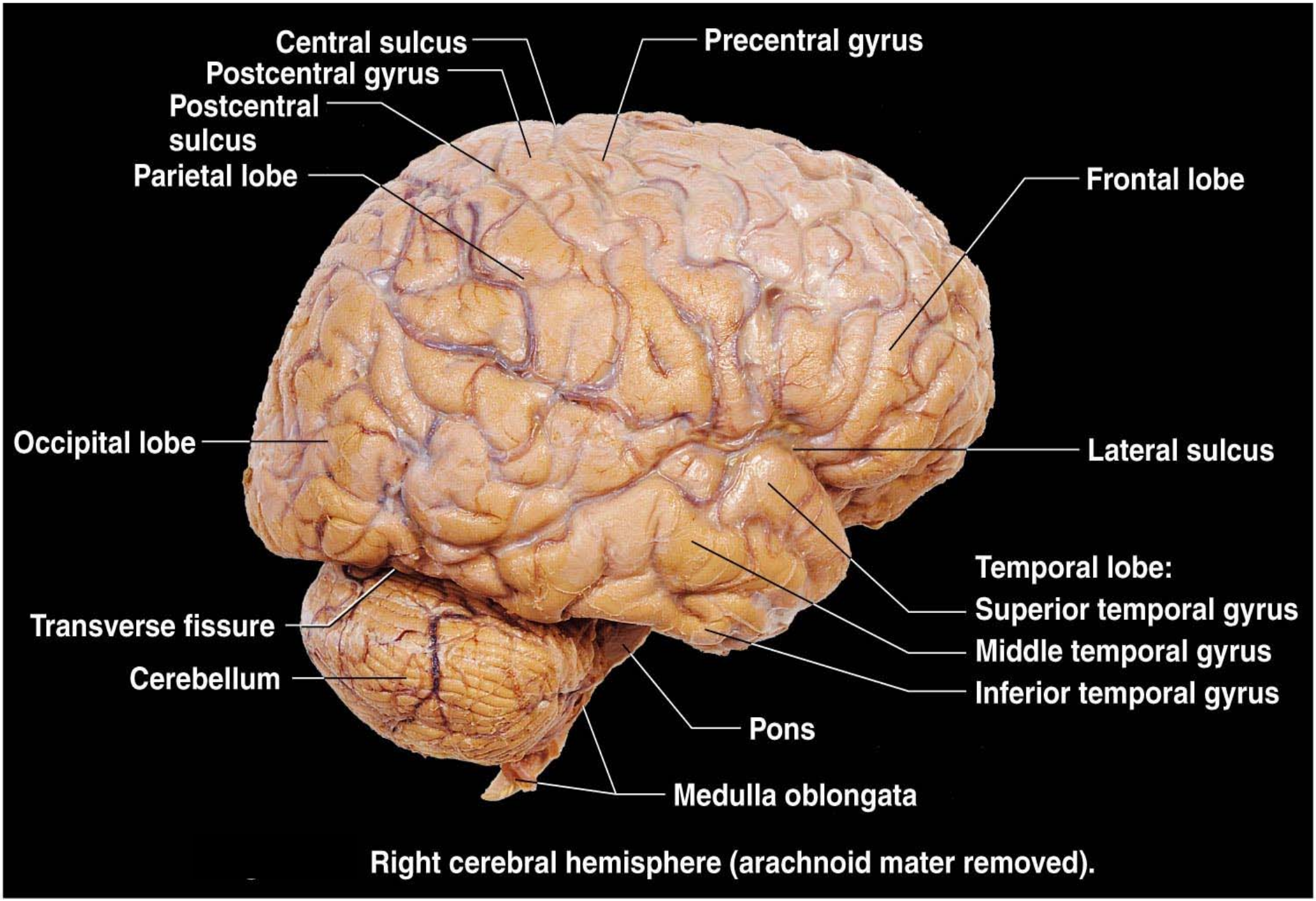
precentral gyrus: motor neurons.

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
Inf^r temp. sulcus
FUSIFORM GYRUS
INF^R TEMP. GYRUS



Right cerebral hemisphere (arachnoid mater removed).

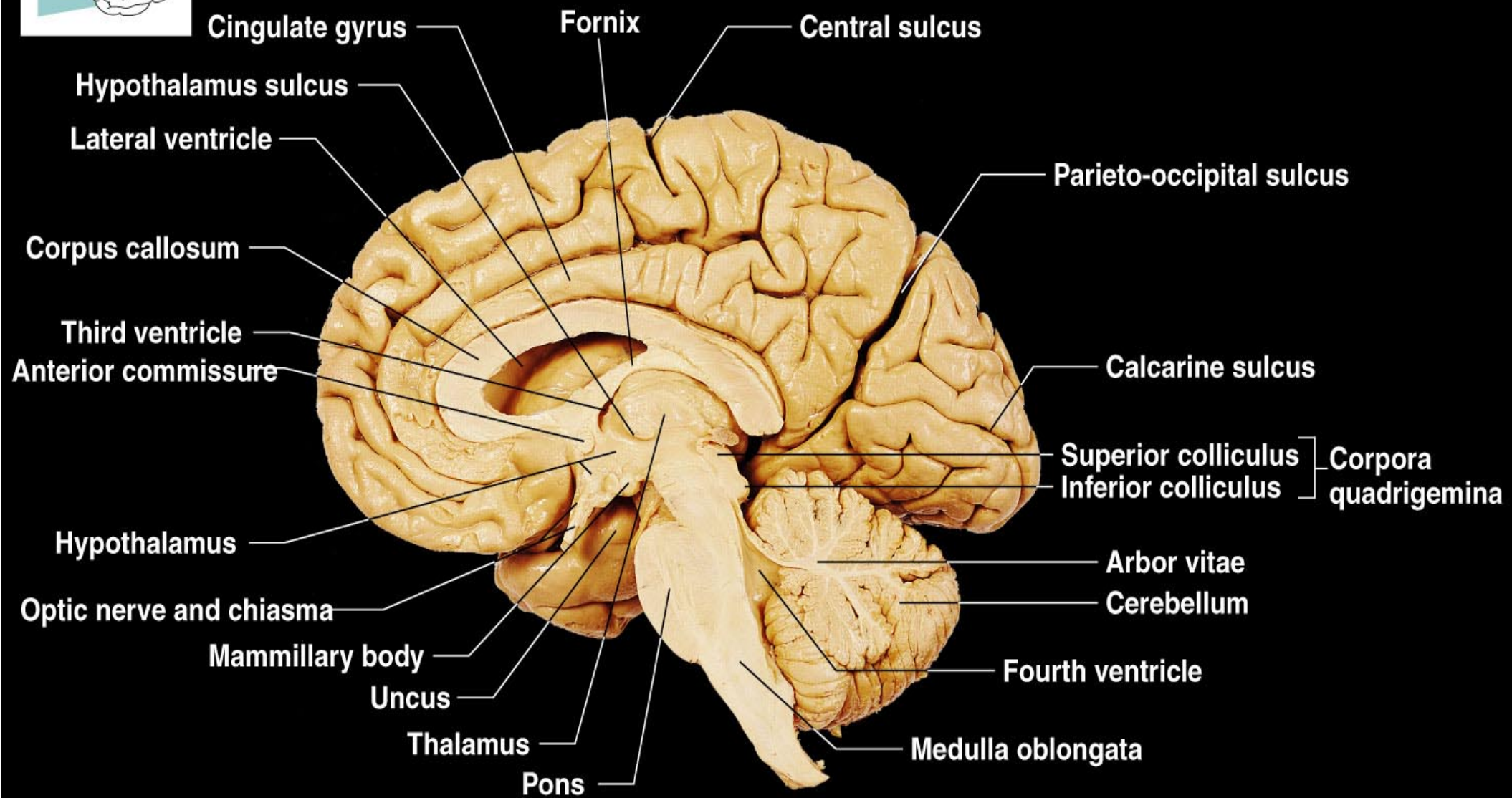


Figure 50 Midsagittal section of the brain.

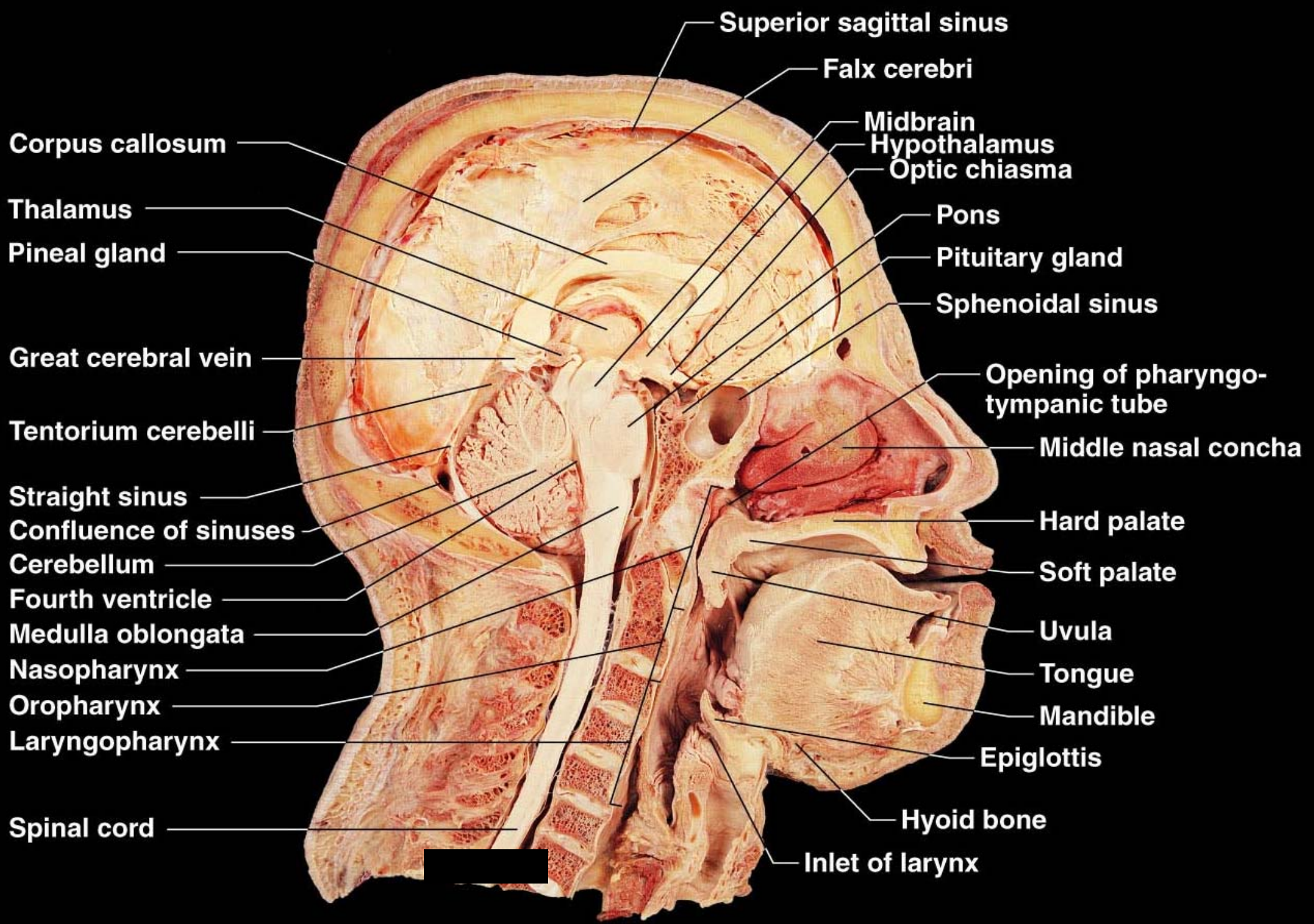
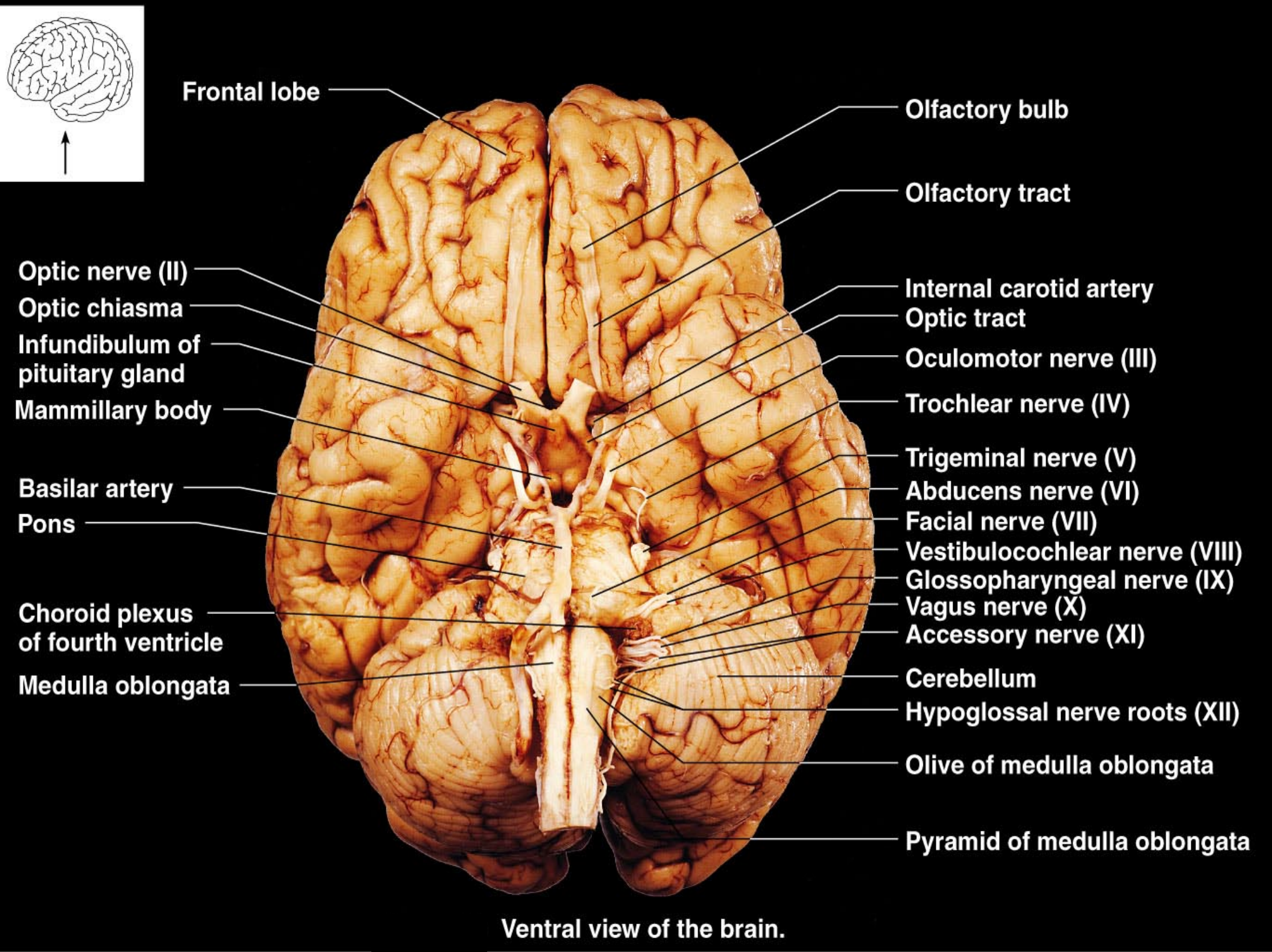


Figure 46 Sagittal section of the head.



Ventral view of the brain.

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

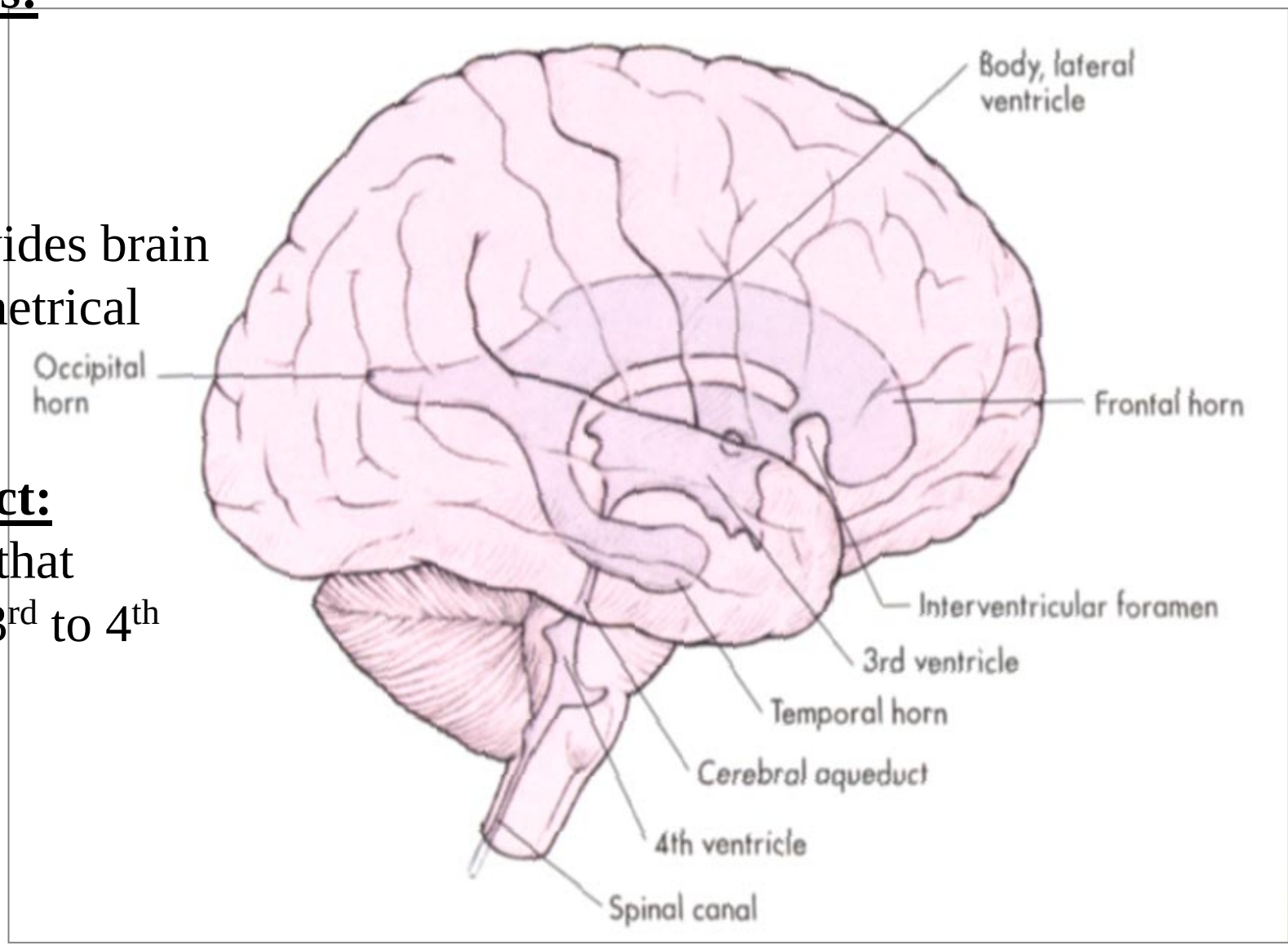
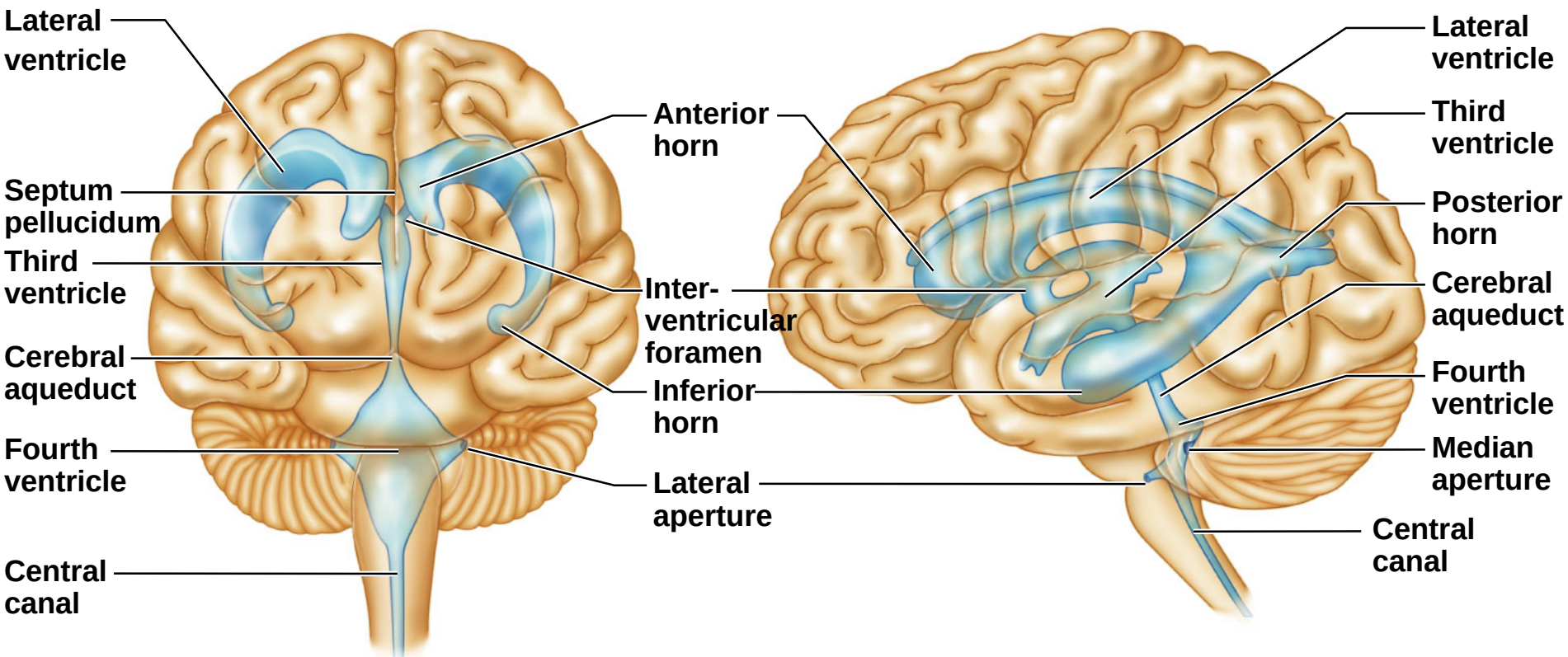
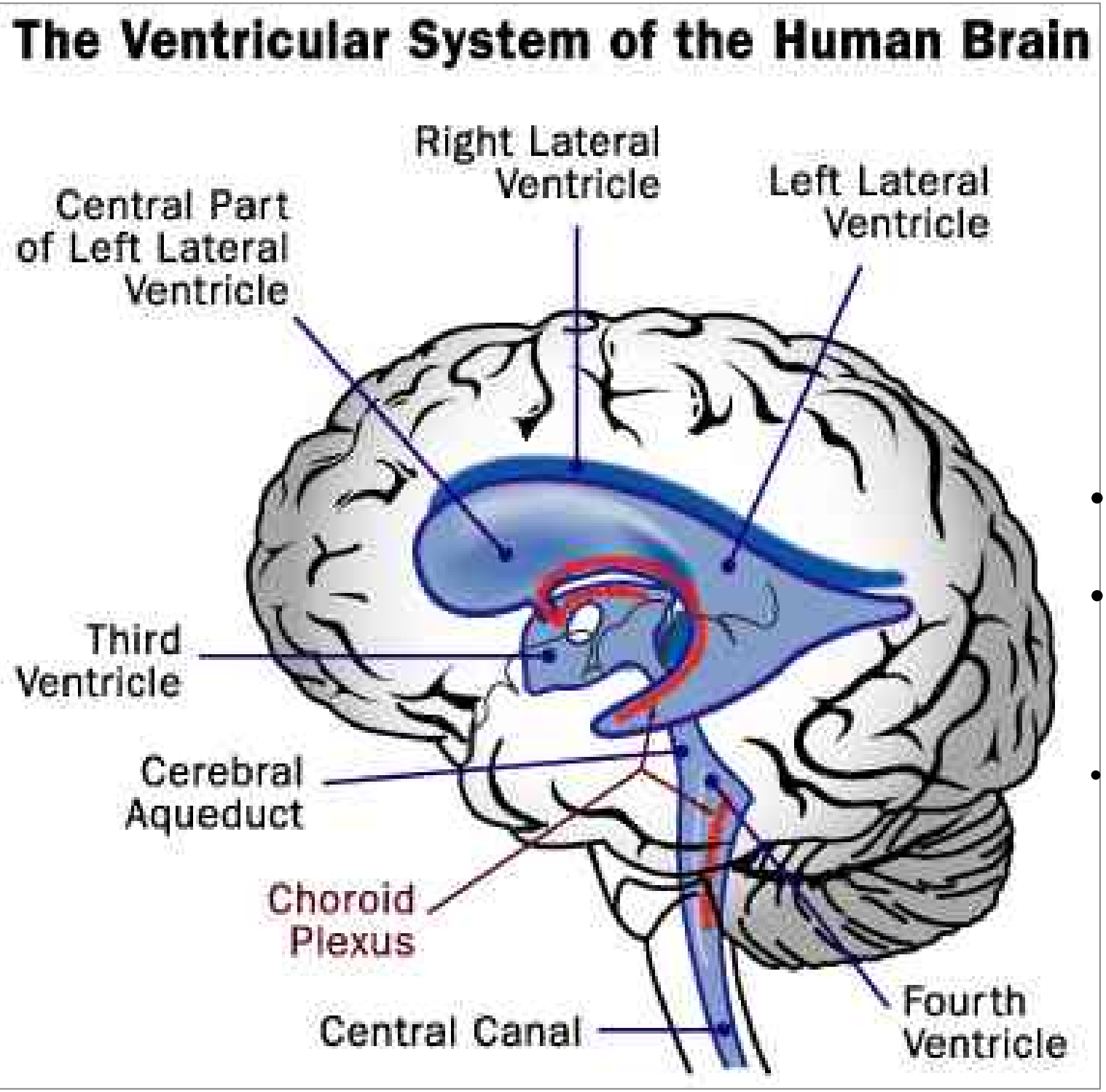


Figure 12.5: Ventricles of the brain, p. 434.



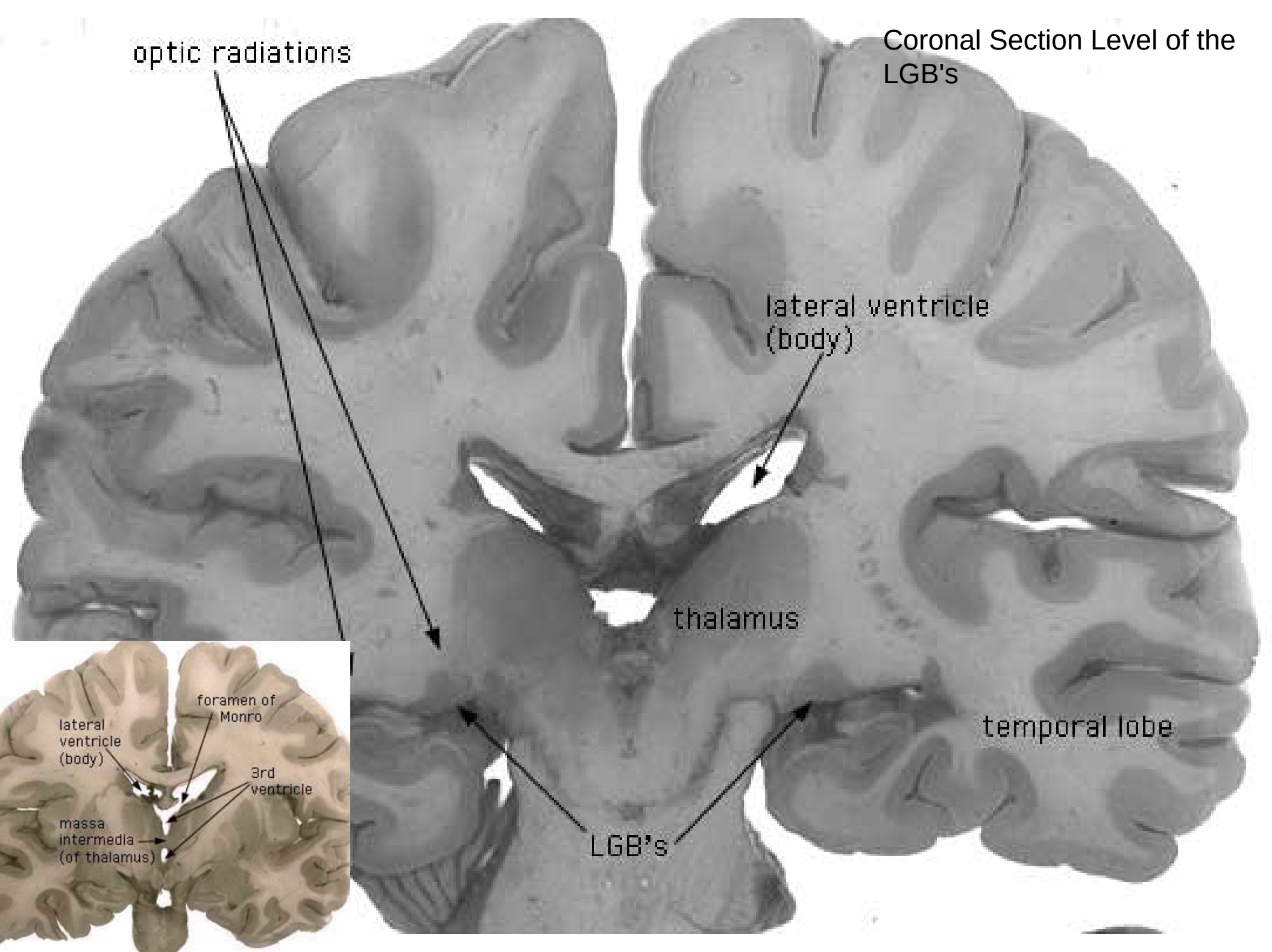
(a) Anterior view

(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)

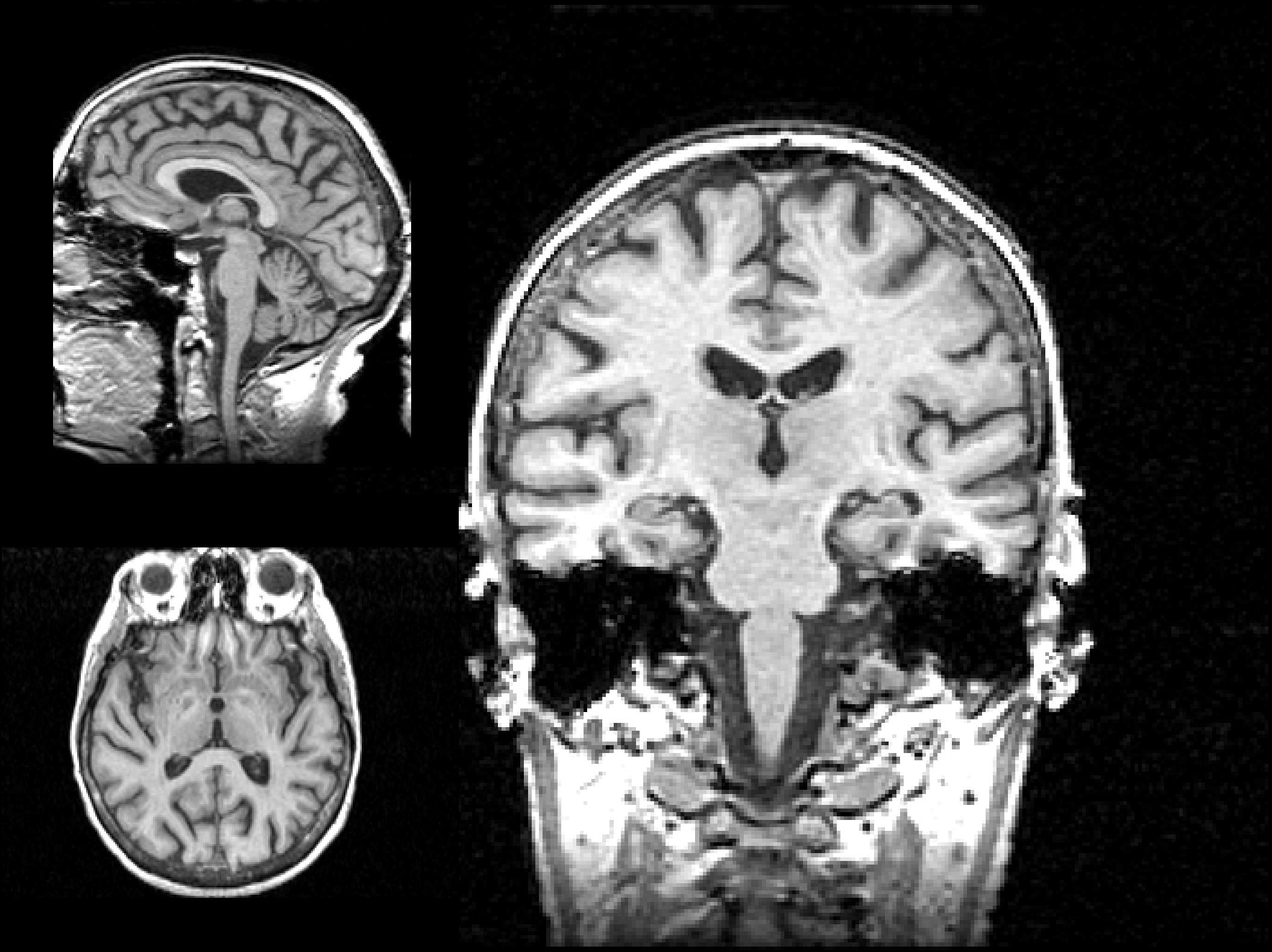
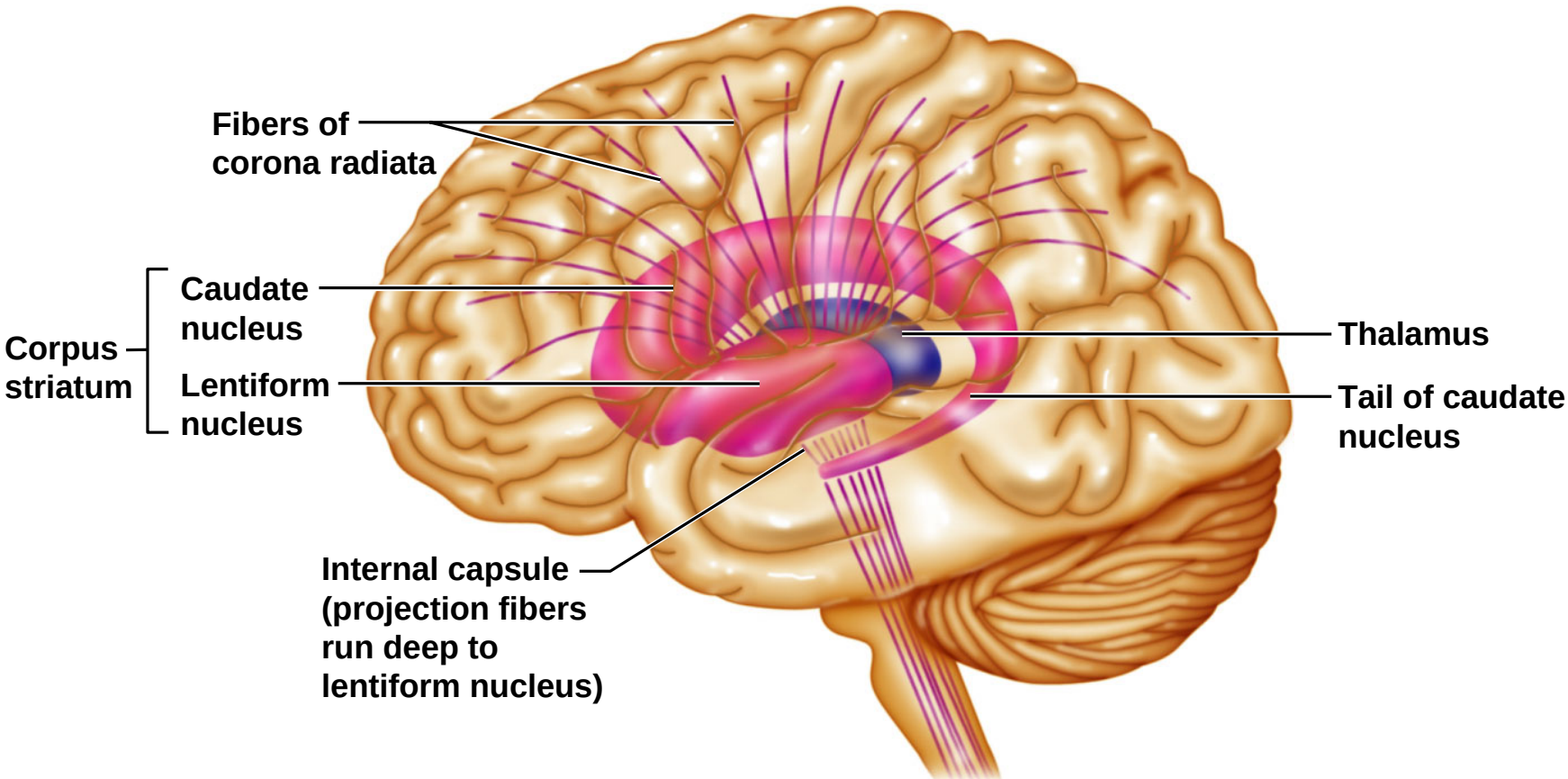


Figure 12.11a: Basal nuclei, p. 444.



(a)

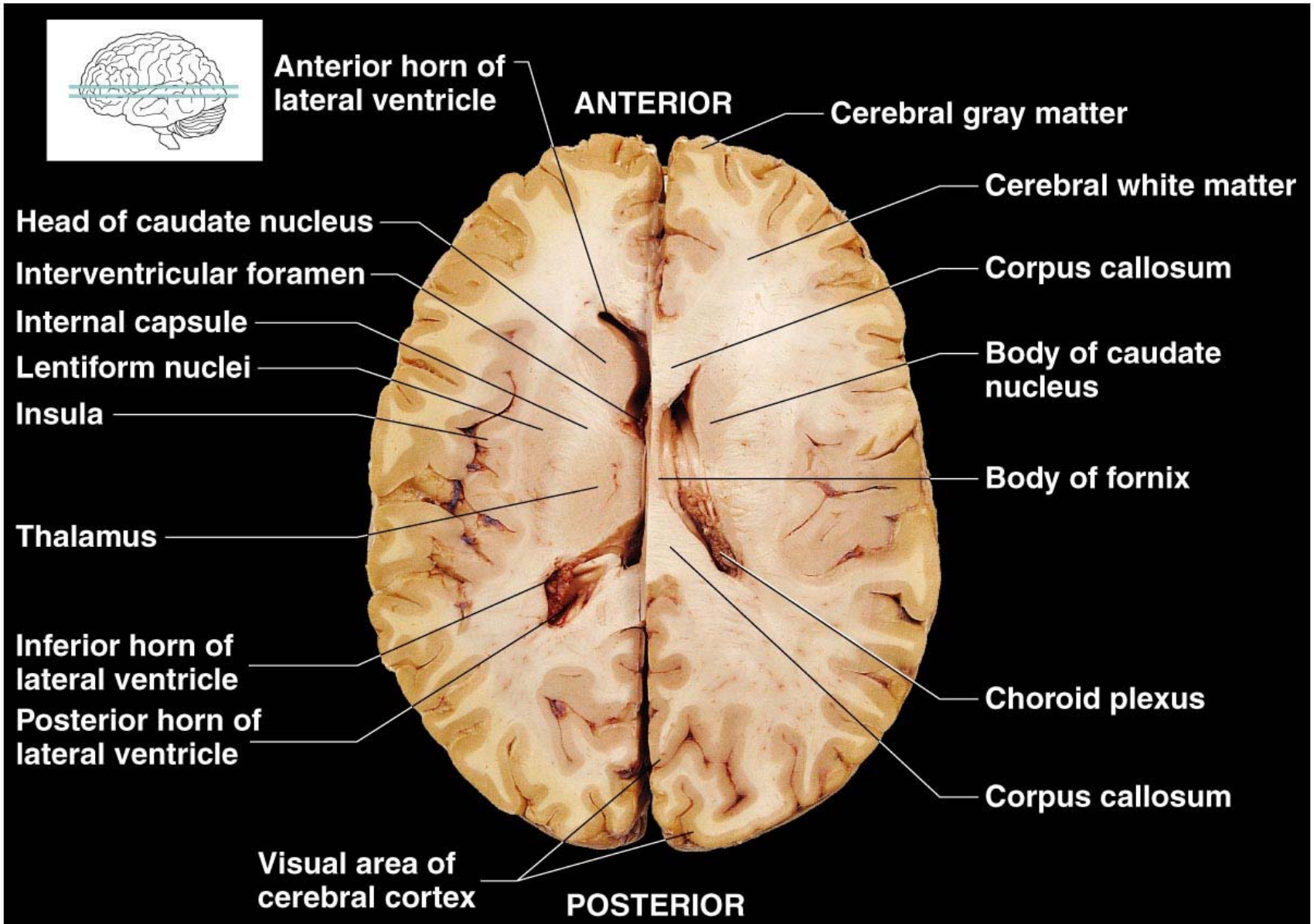
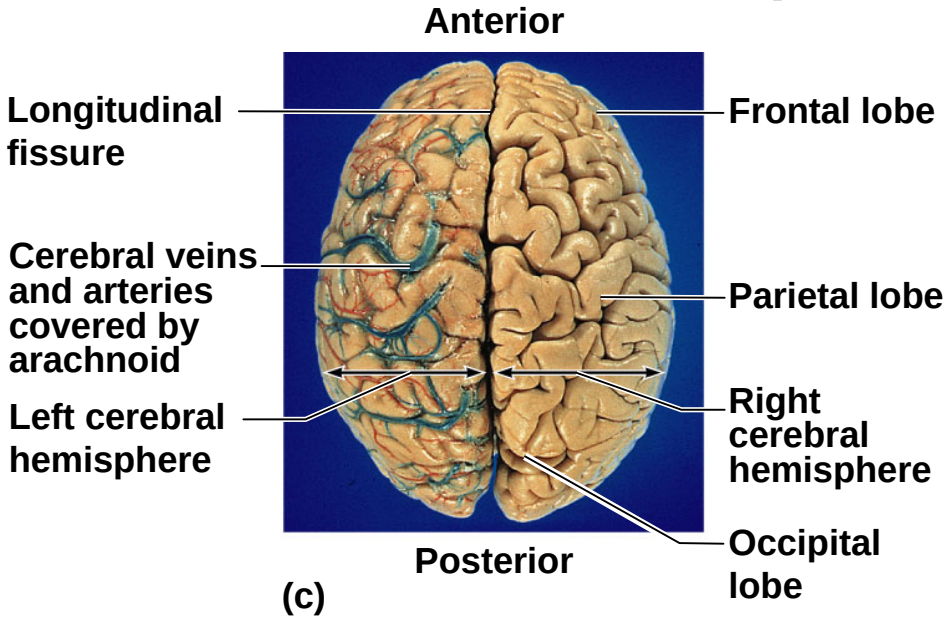
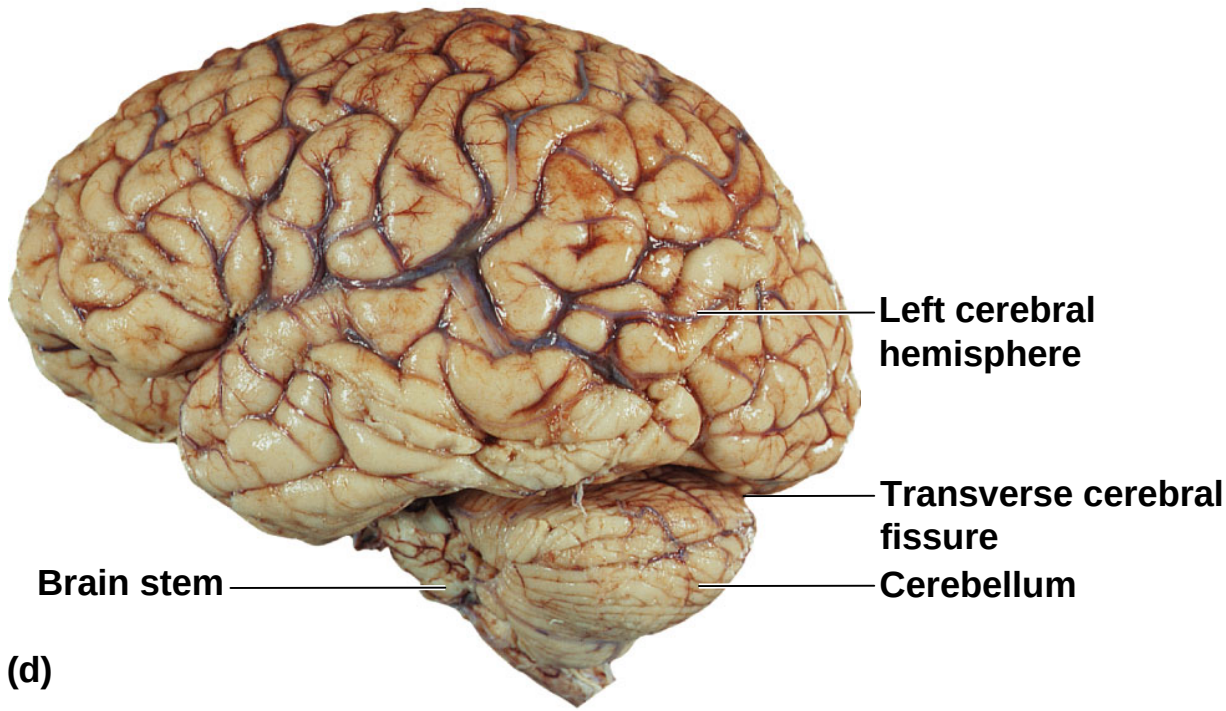


Figure 51 Transverse section of the brain, superior view. Left: on a level with the intraventricular foramen; right: about 1.5 cm higher.

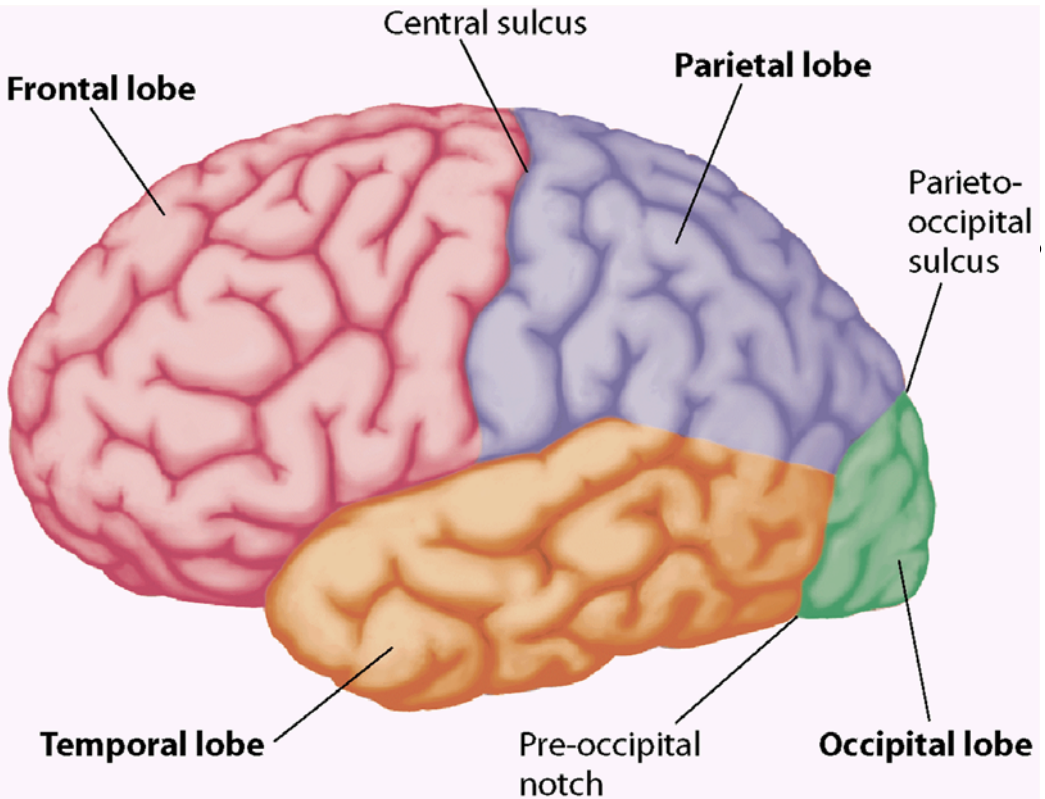
Lobes and fissures of the cerebral hemispheres,



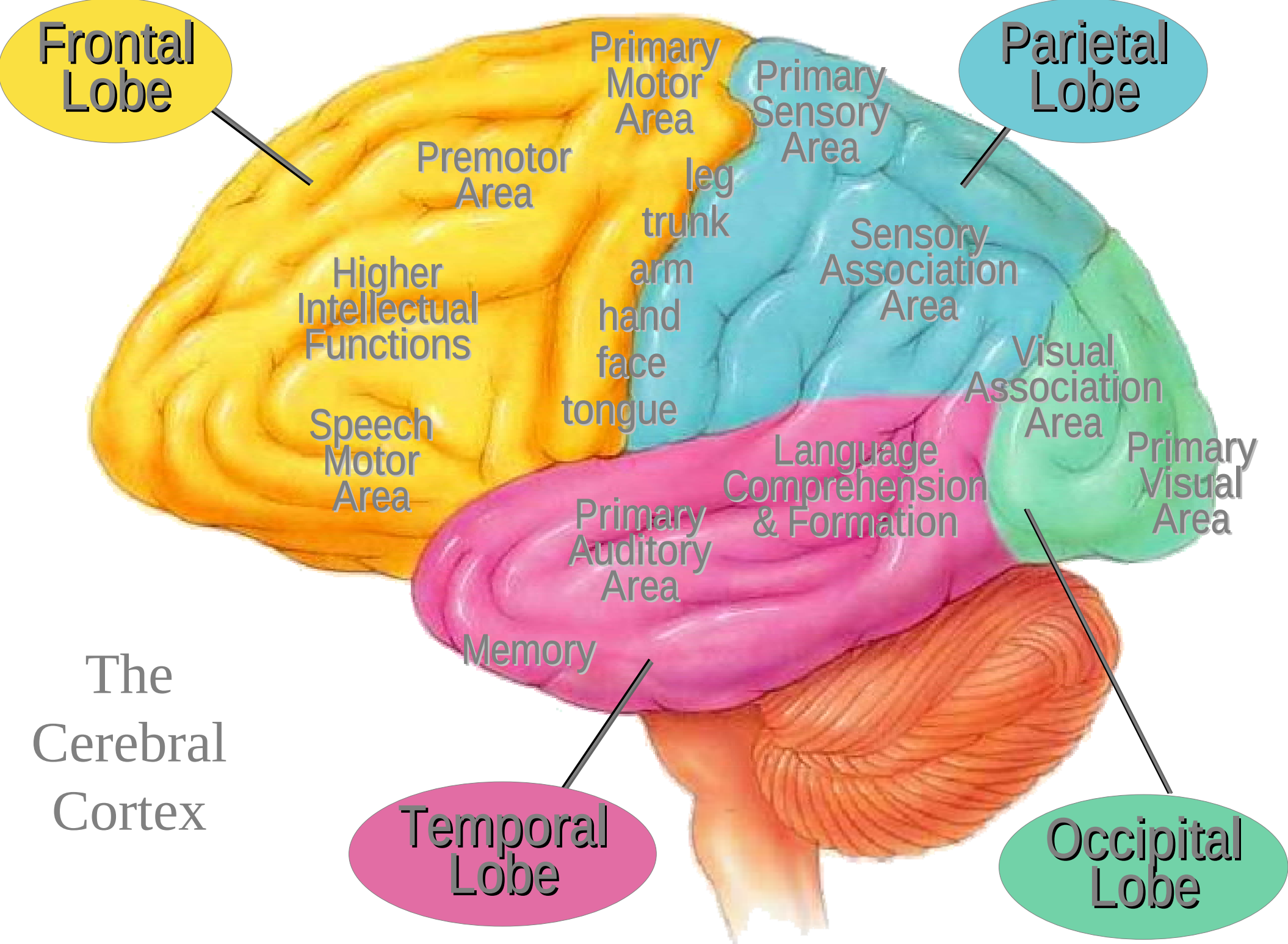


LOBES

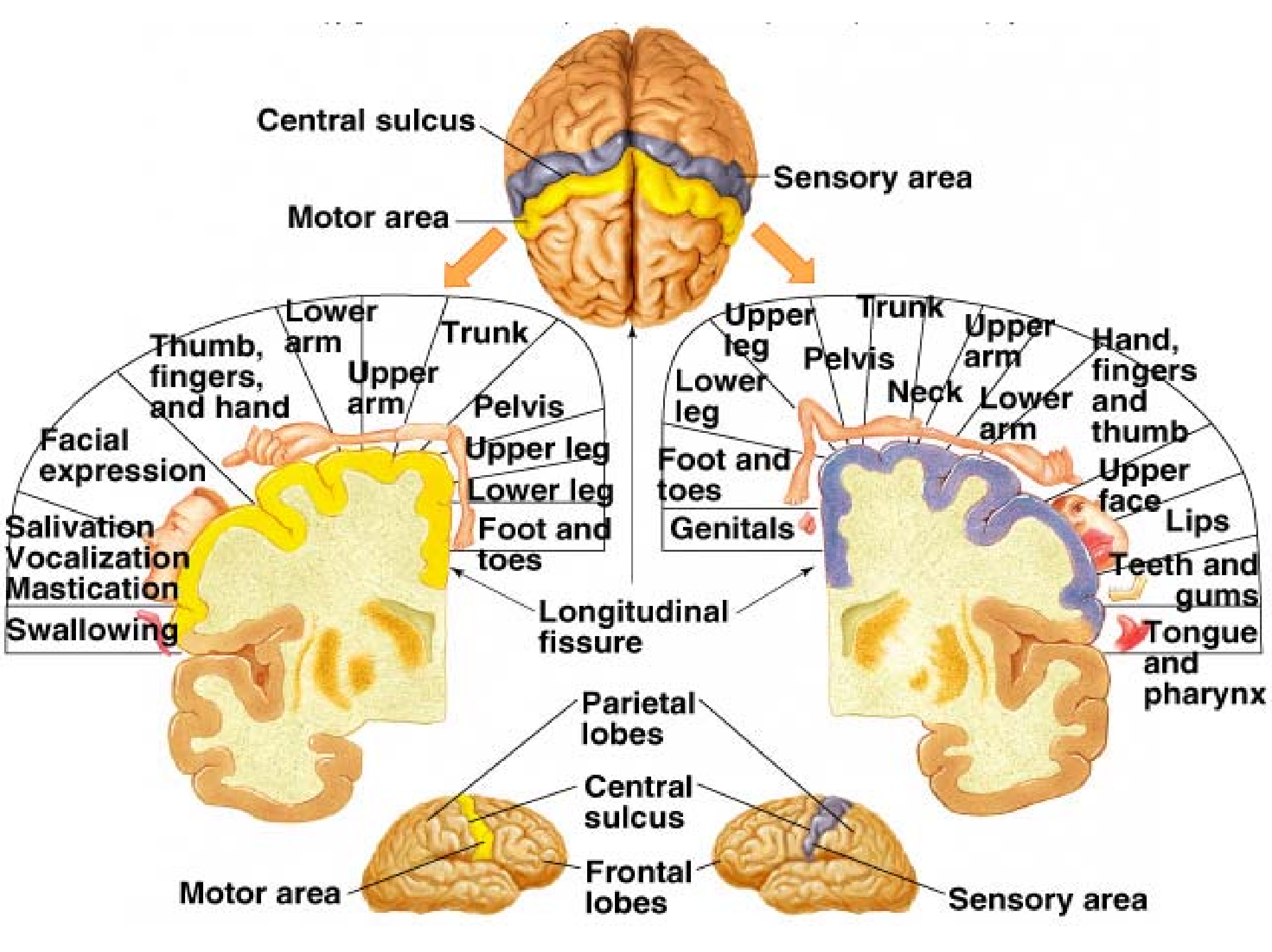
Cortical Function



- 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

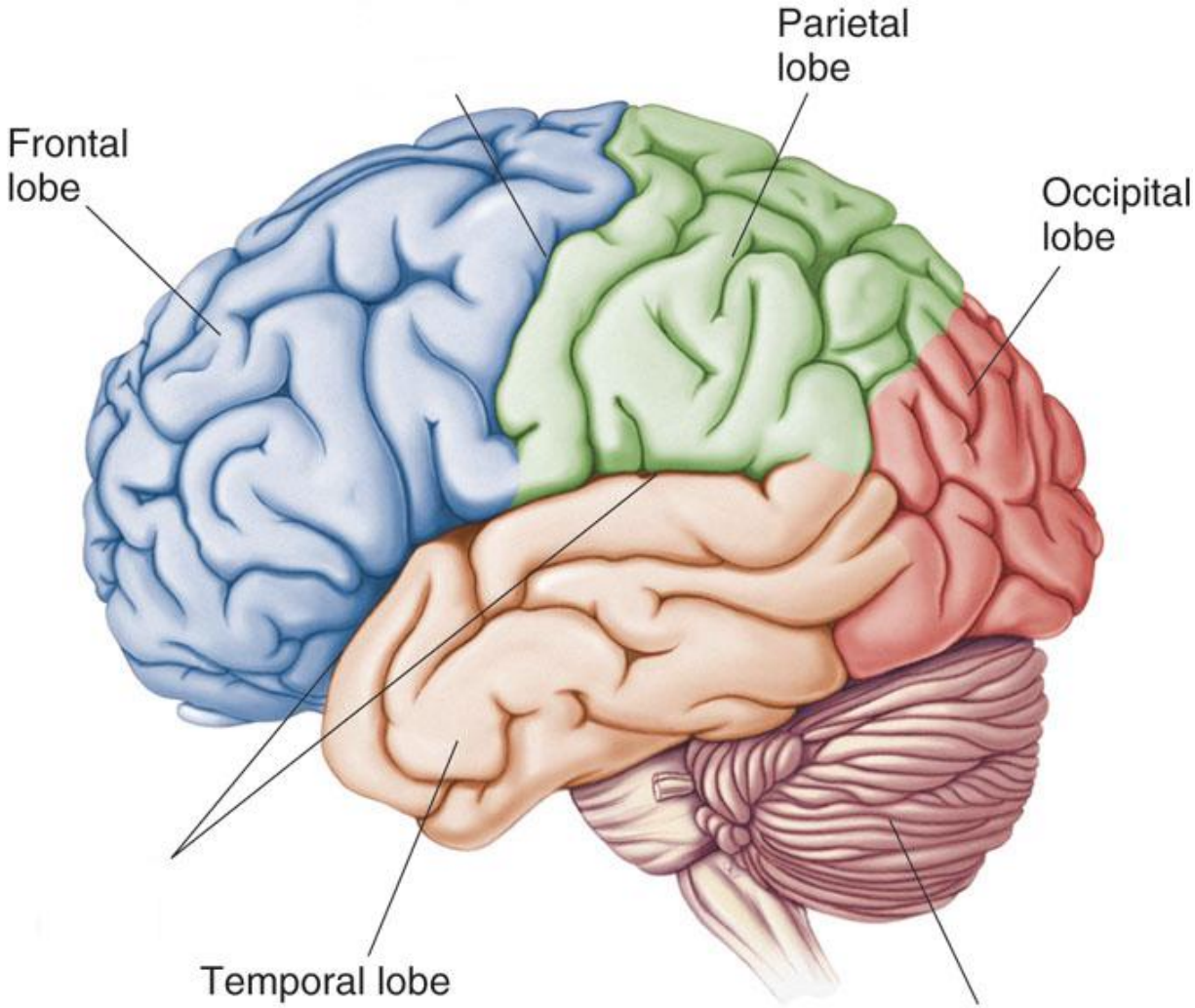


The Cerebral Cortex


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
Longitudinal fissure
Upper leg
Trunk
Pelvis
Upper arm
Hand, fingers and thumb
Neck
Lower arm
Lower leg
Foot and toes
Upper face
Genitals
Lips
Teeth and gums
Tongue and pharynx
Parietal lobes
Central sulcus
Frontal lobes
Motor area
Sensory area

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.

Figure 12.8a: Functional and structural areas of the cerebral cortex, p. 437.

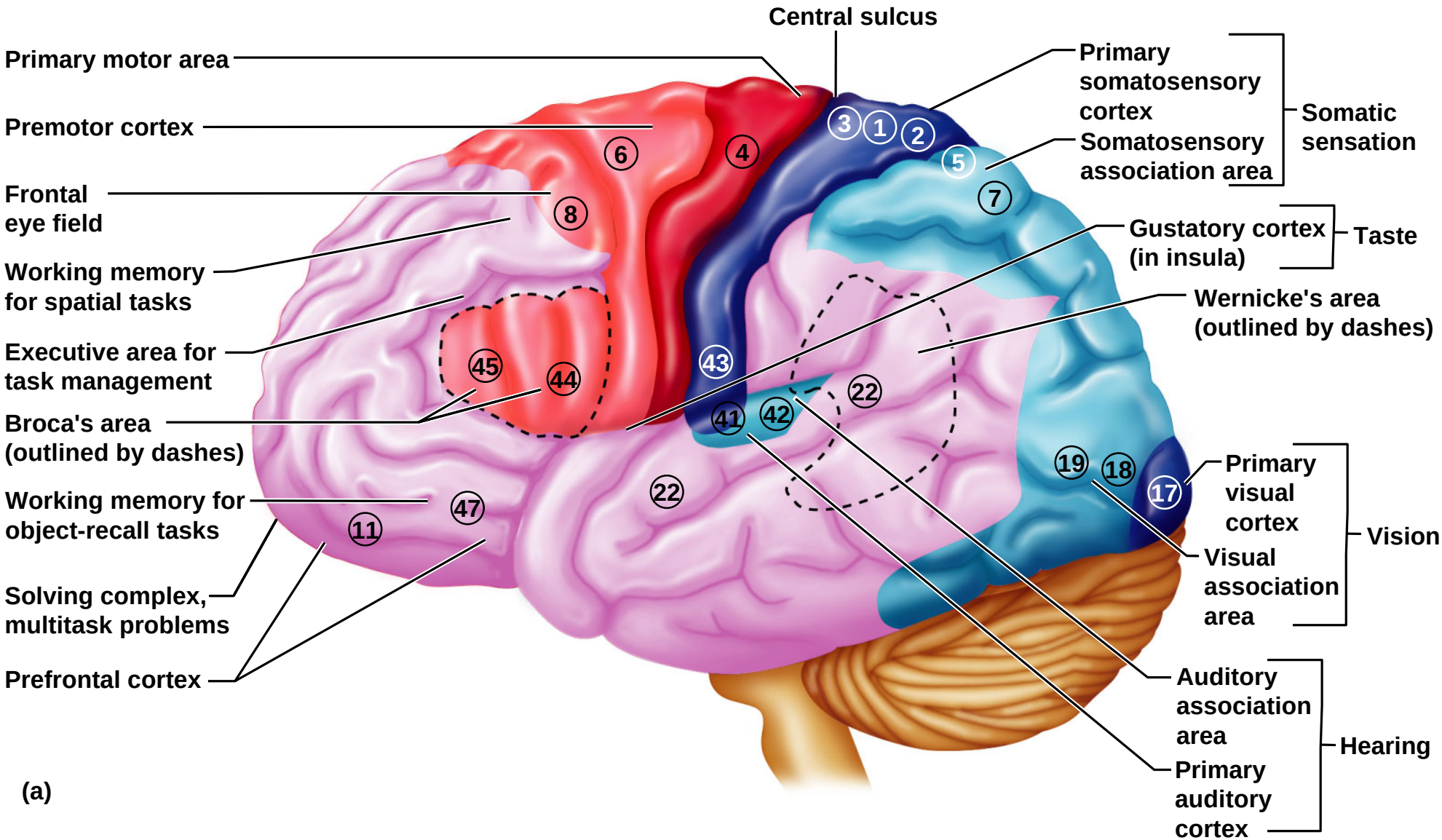
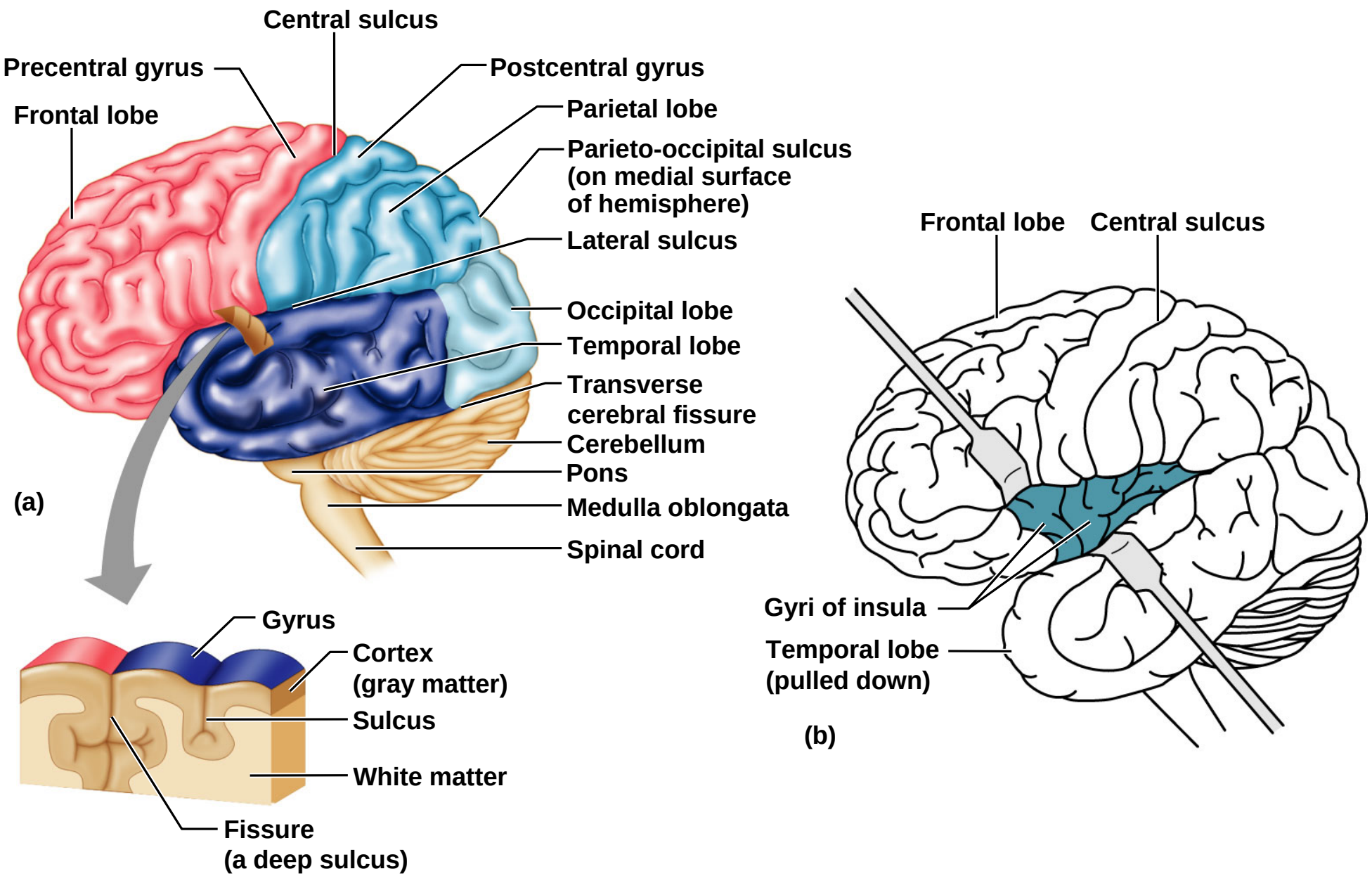


Figure 12.6a-b: Lobes and fissures of the cerebral hemispheres, p. 435.



Lobes and fissures of the cerebral hemispheres, p. 435.

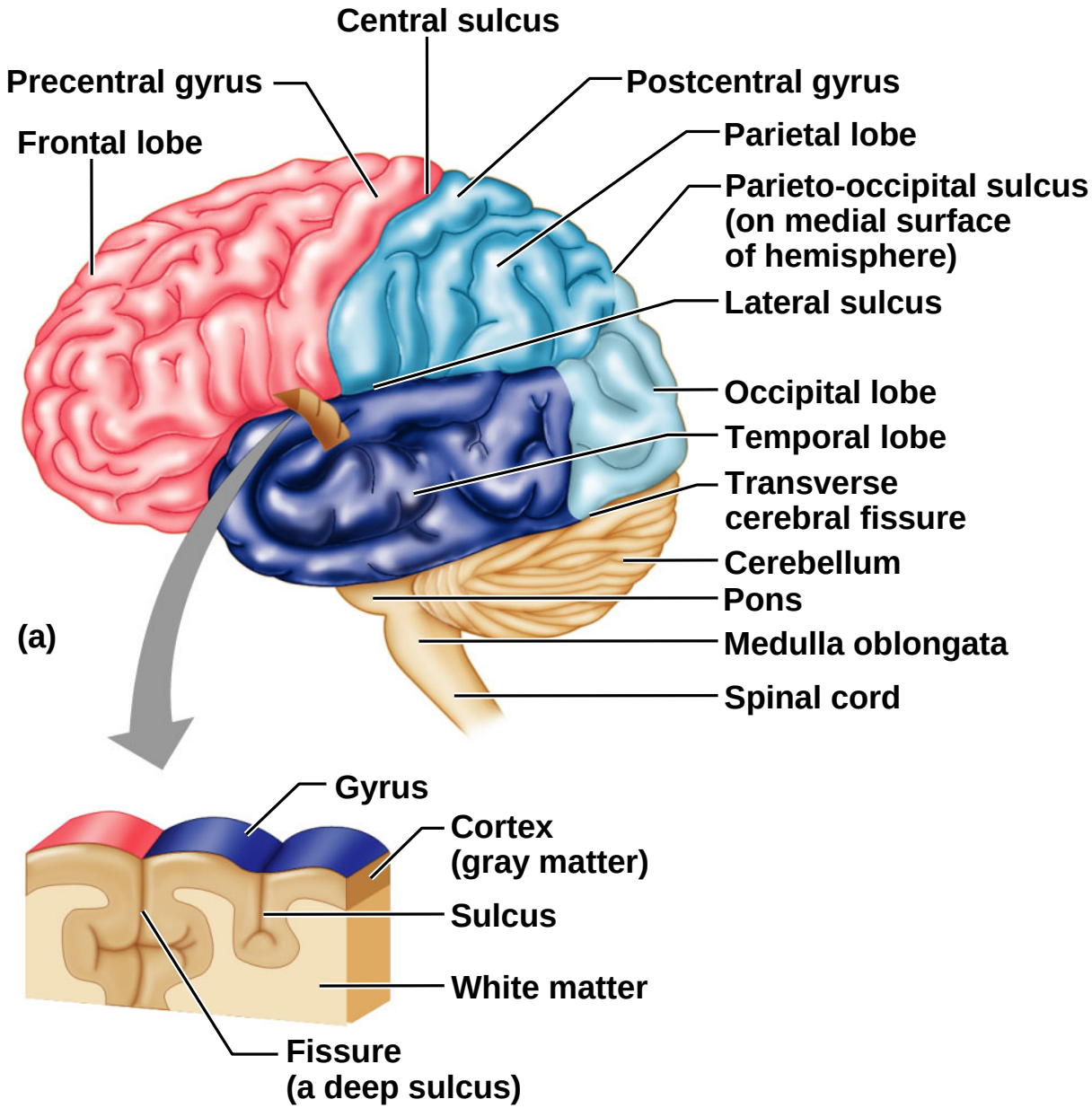
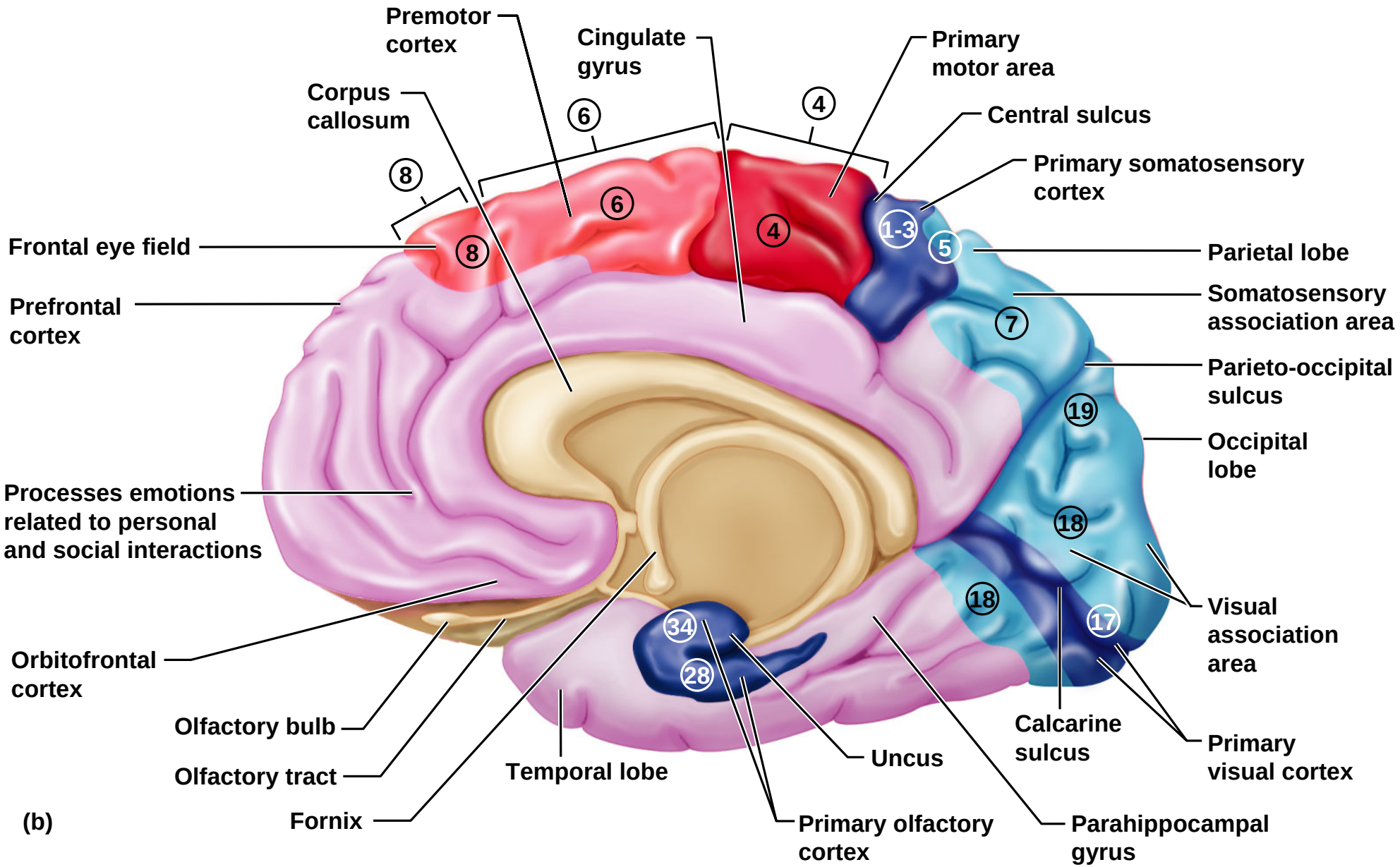


Figure 12.8b: Functional and structural areas of the cerebral cortex, p. 437.

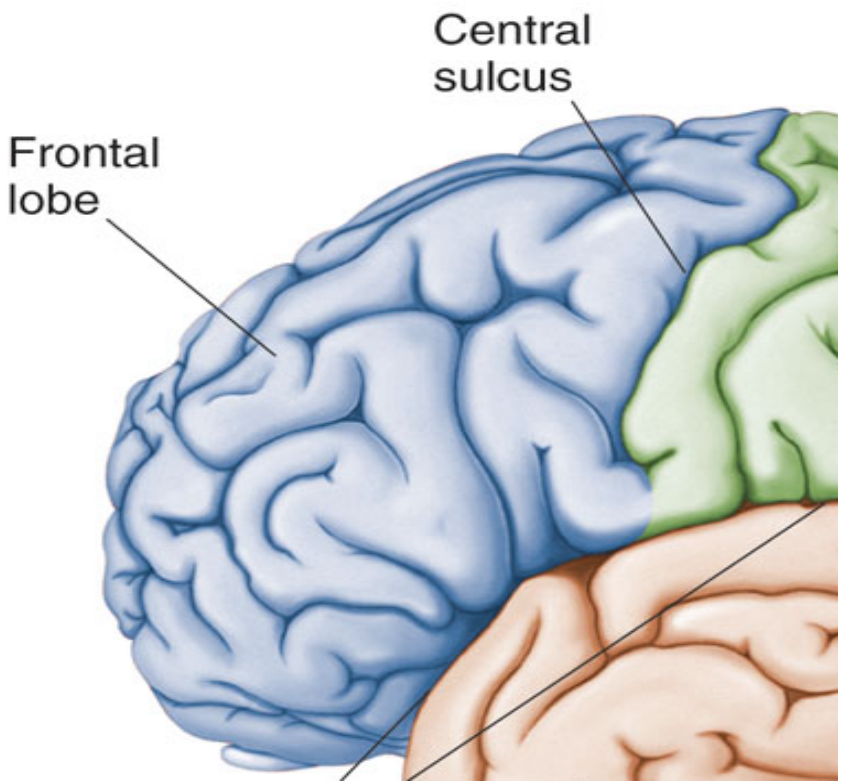


Lobes of the Brain - Frontal

- 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



Investigation (Phineas Gage)

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

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.

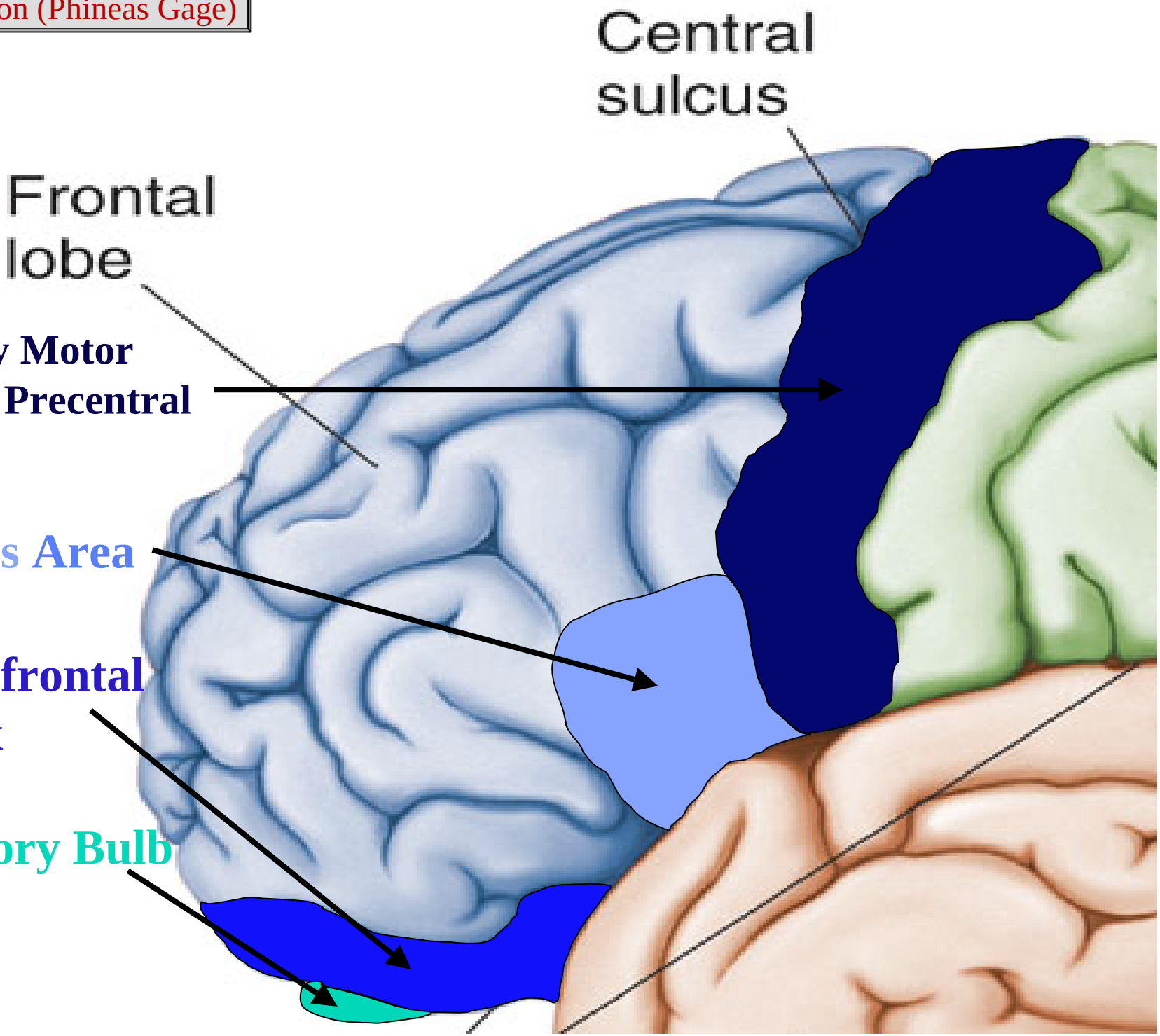
• **Orbitofrontal Cortex** – Site of Frontal Lobotomies

*** 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

Investigation (Phineas Gage)



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.

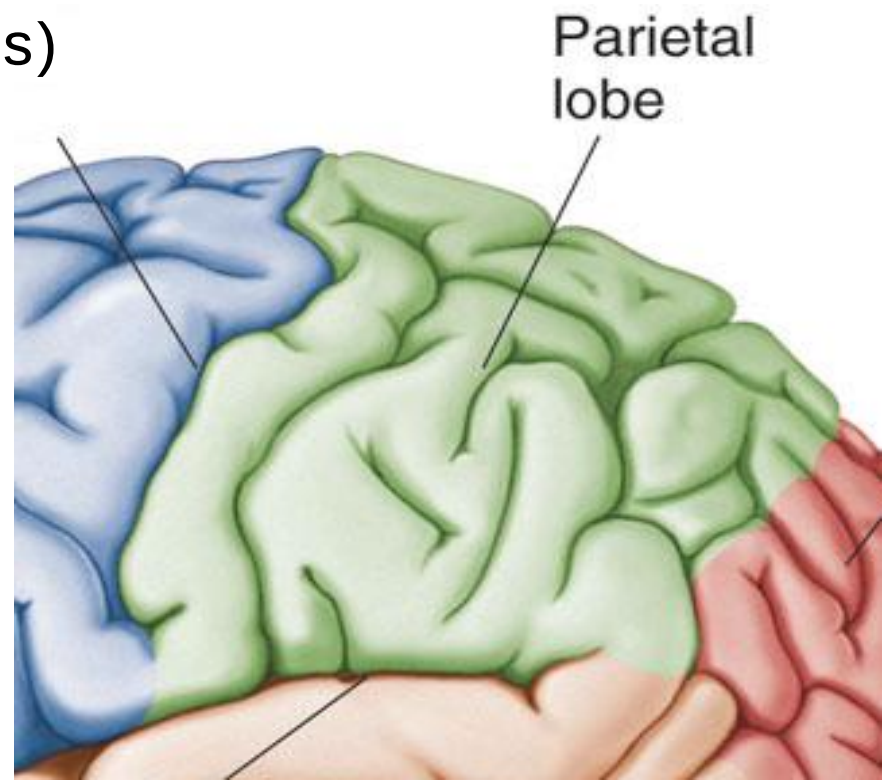
Lobes of the Brain - Parietal Lobe

- 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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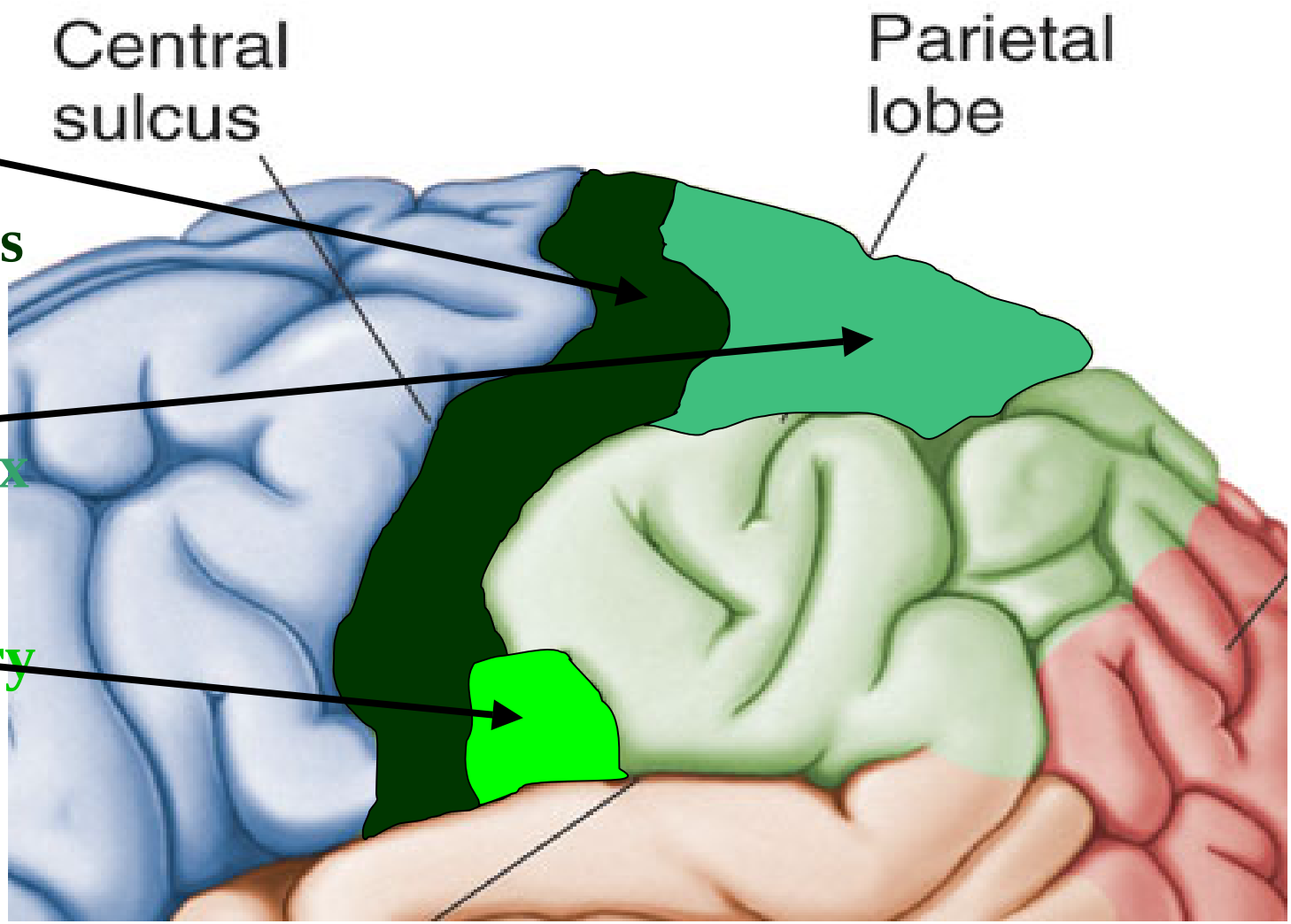
Primary Somatosensory Cortex/ Postcentral Gyrus

Somatosensory Association Cortex

Primary Gustatory Cortex



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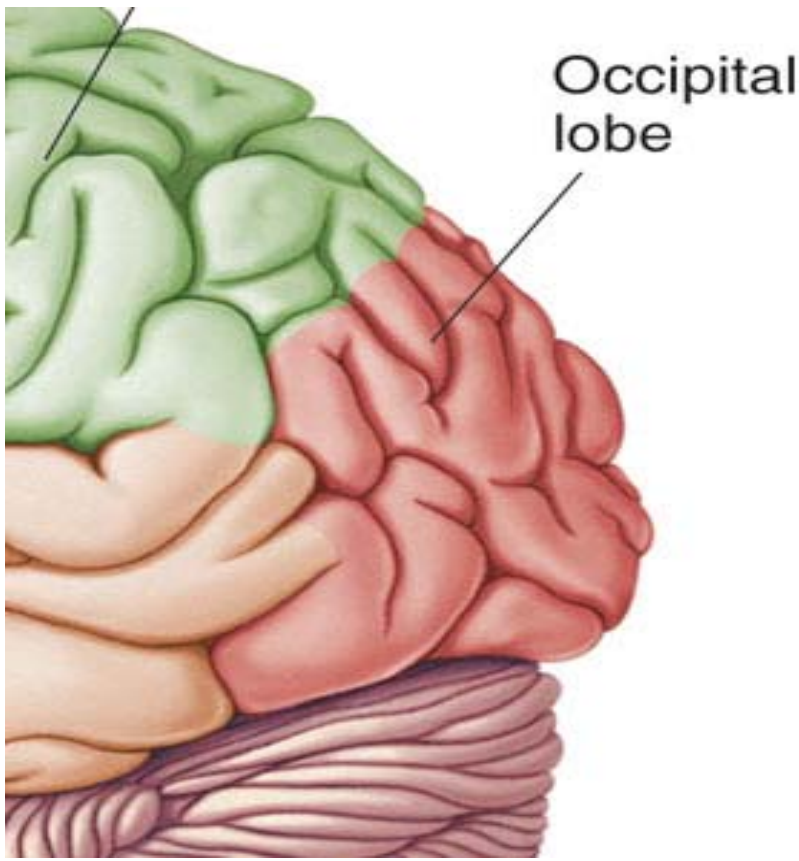
Regions

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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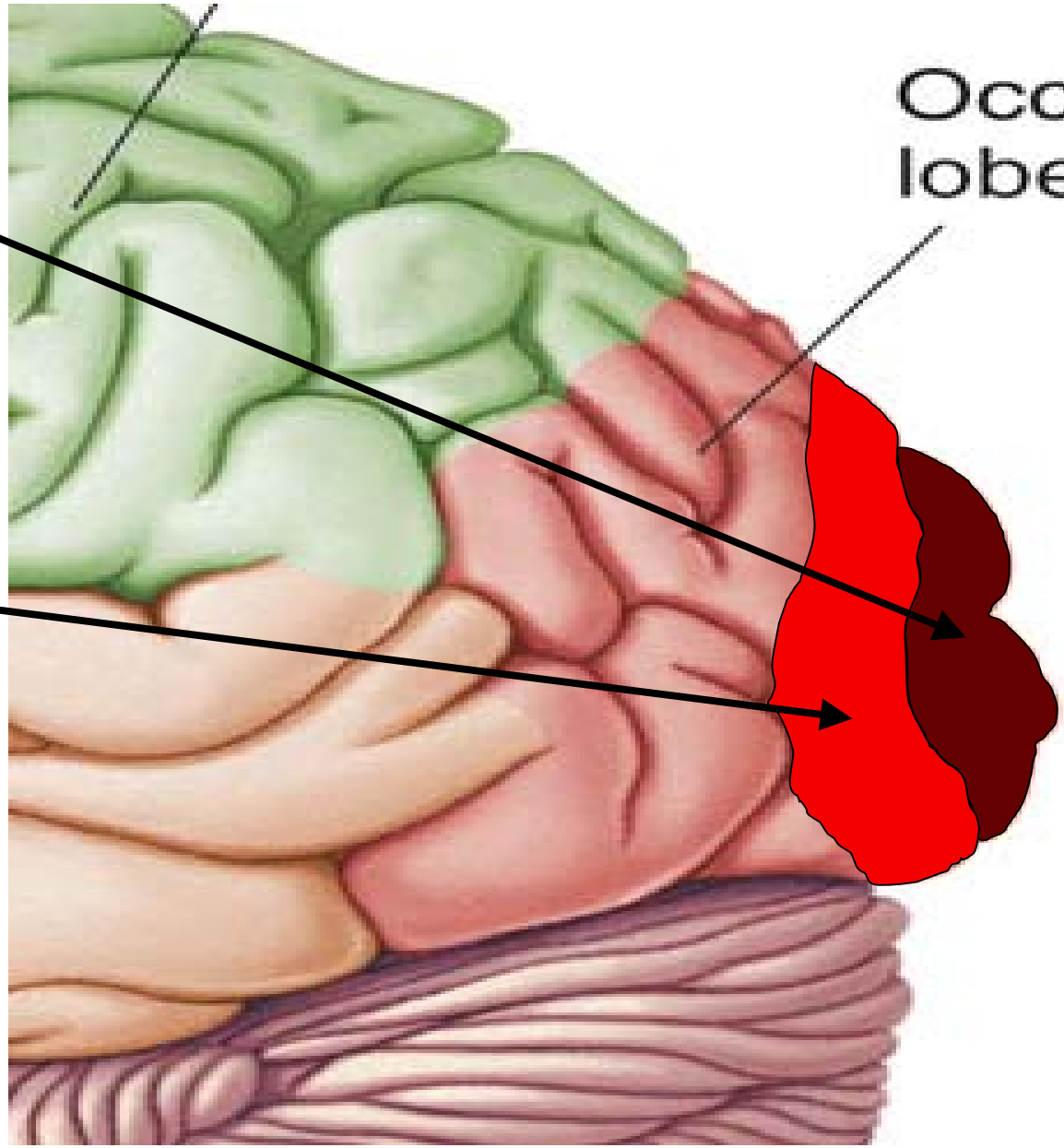
Occipital Lobe – Cortical Regions

- **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

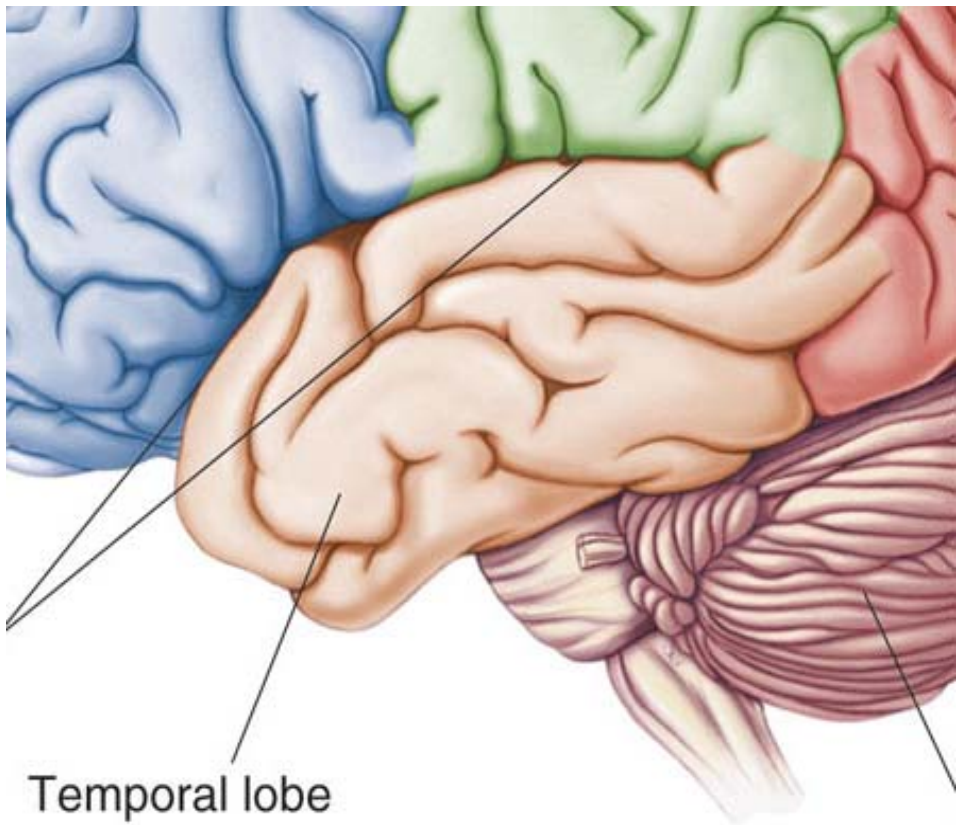
- The Temporal Lobes are located on the sides of the brain, deep to the Temporal Bones of the skull.

- 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.

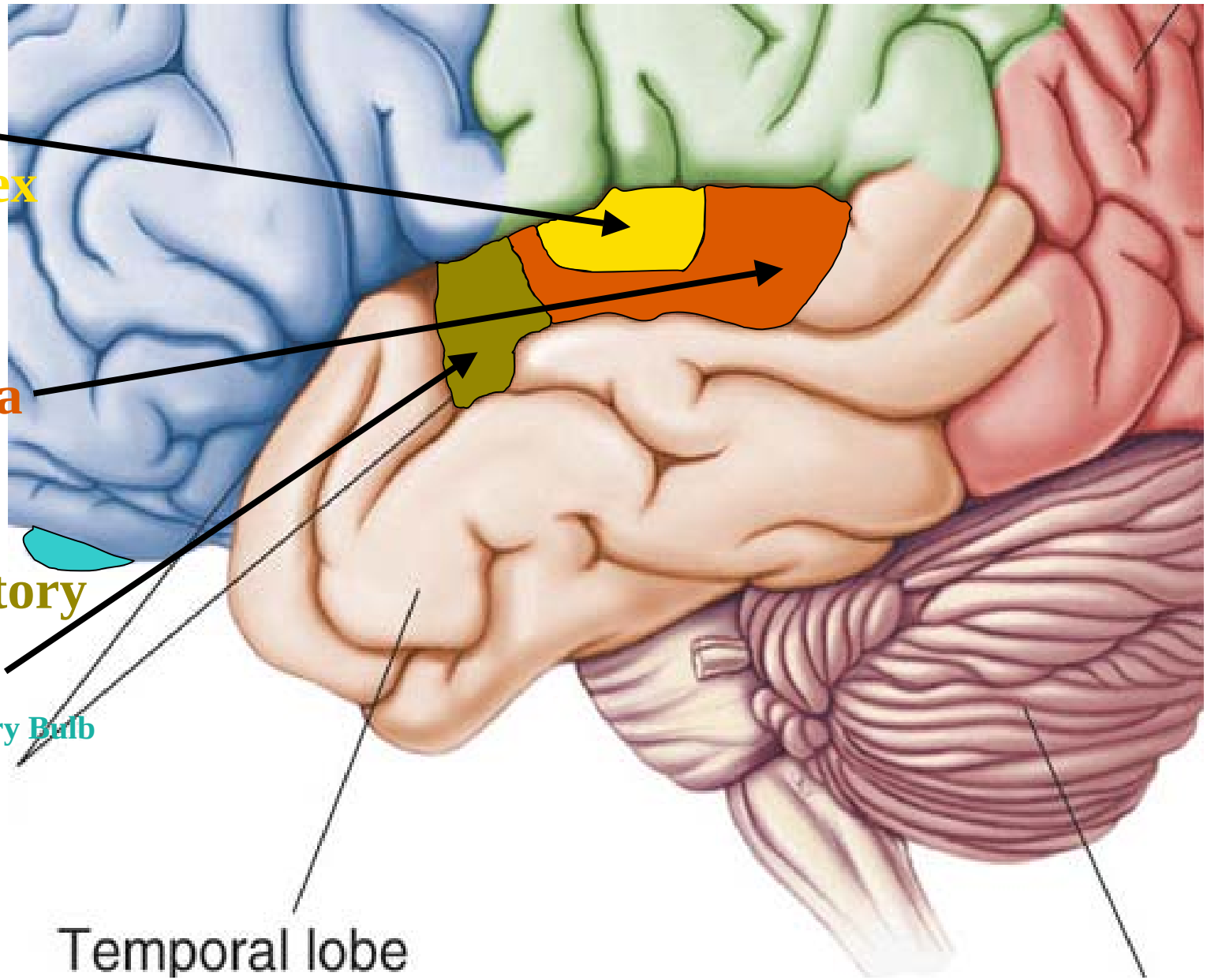
  - Wernicke's Aphasia – Language comprehension is inhibited. Words and sentences are not clearly understood, and sentence formation may be inhibited or non-sensical.

Primary Auditory Cortex

Wernike's Area

Primary Olfactory Cortex (Deep)

Conducted from Olfactory Bulb



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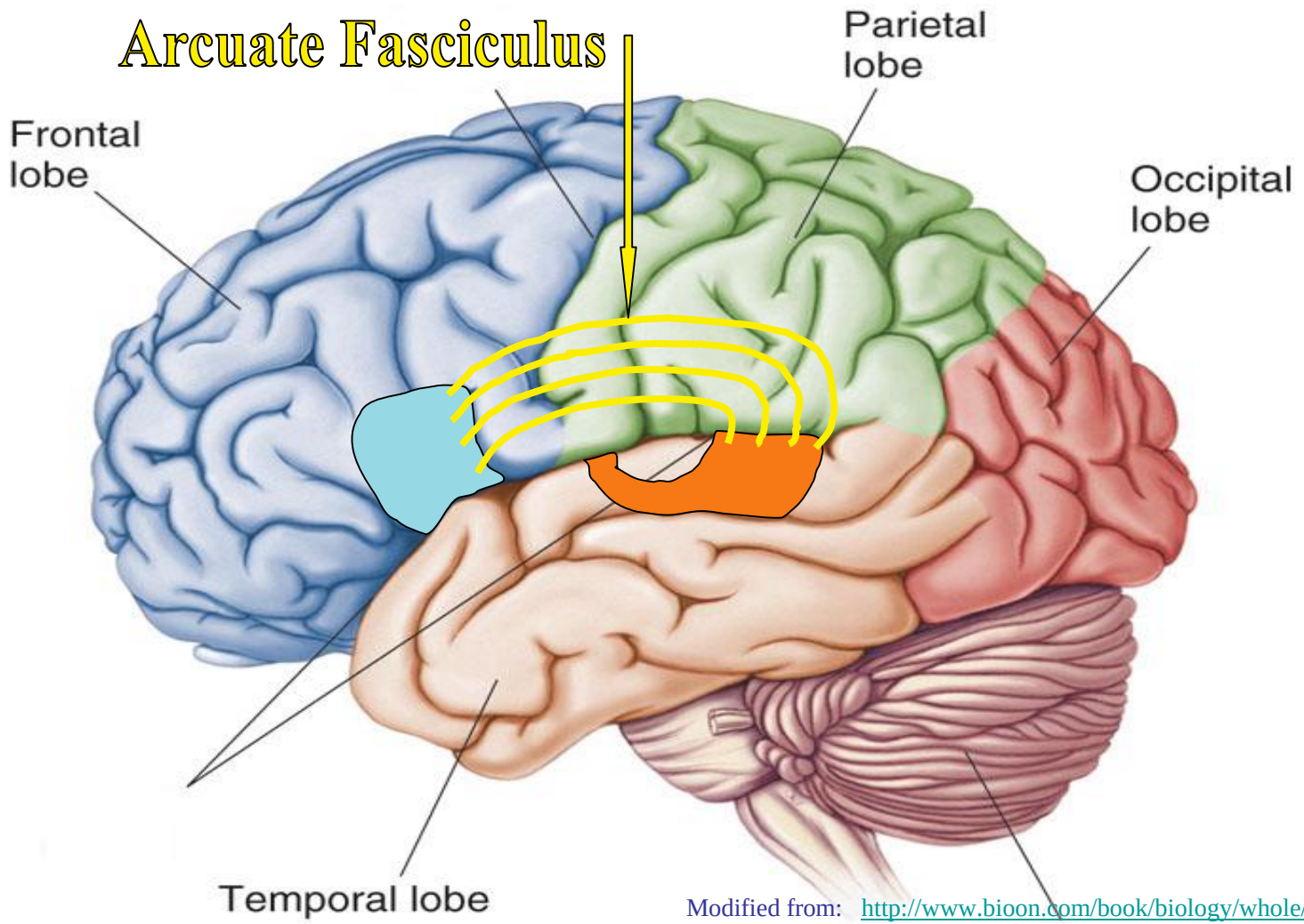
Regions

• **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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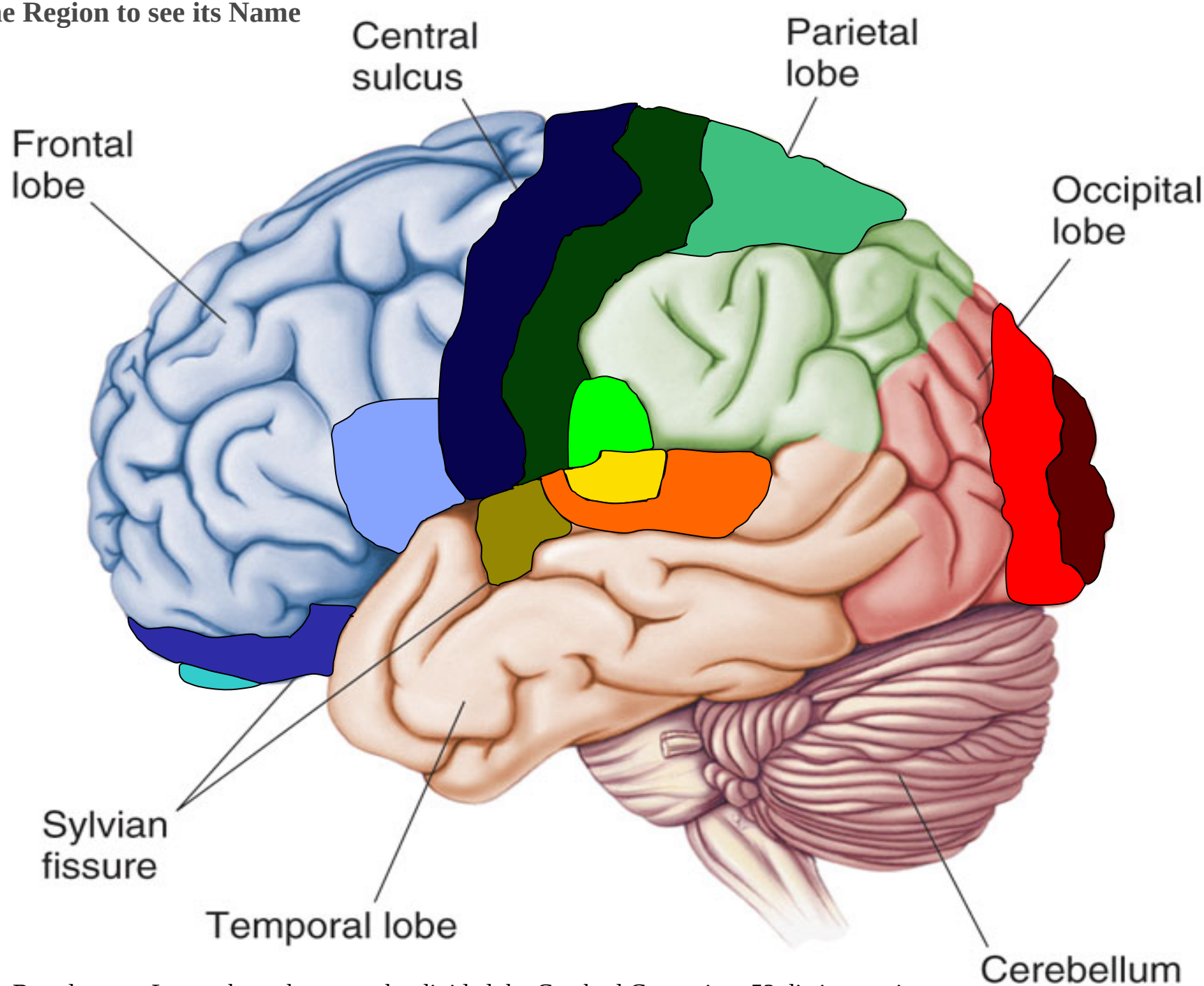
Click the Region to see its Name



Korbinian Broadmann - Learn about the man who divided the Cerebral Cortex into 52 distinct regions:
http://en.wikipedia.org/wiki/Korbinian_Brodmann

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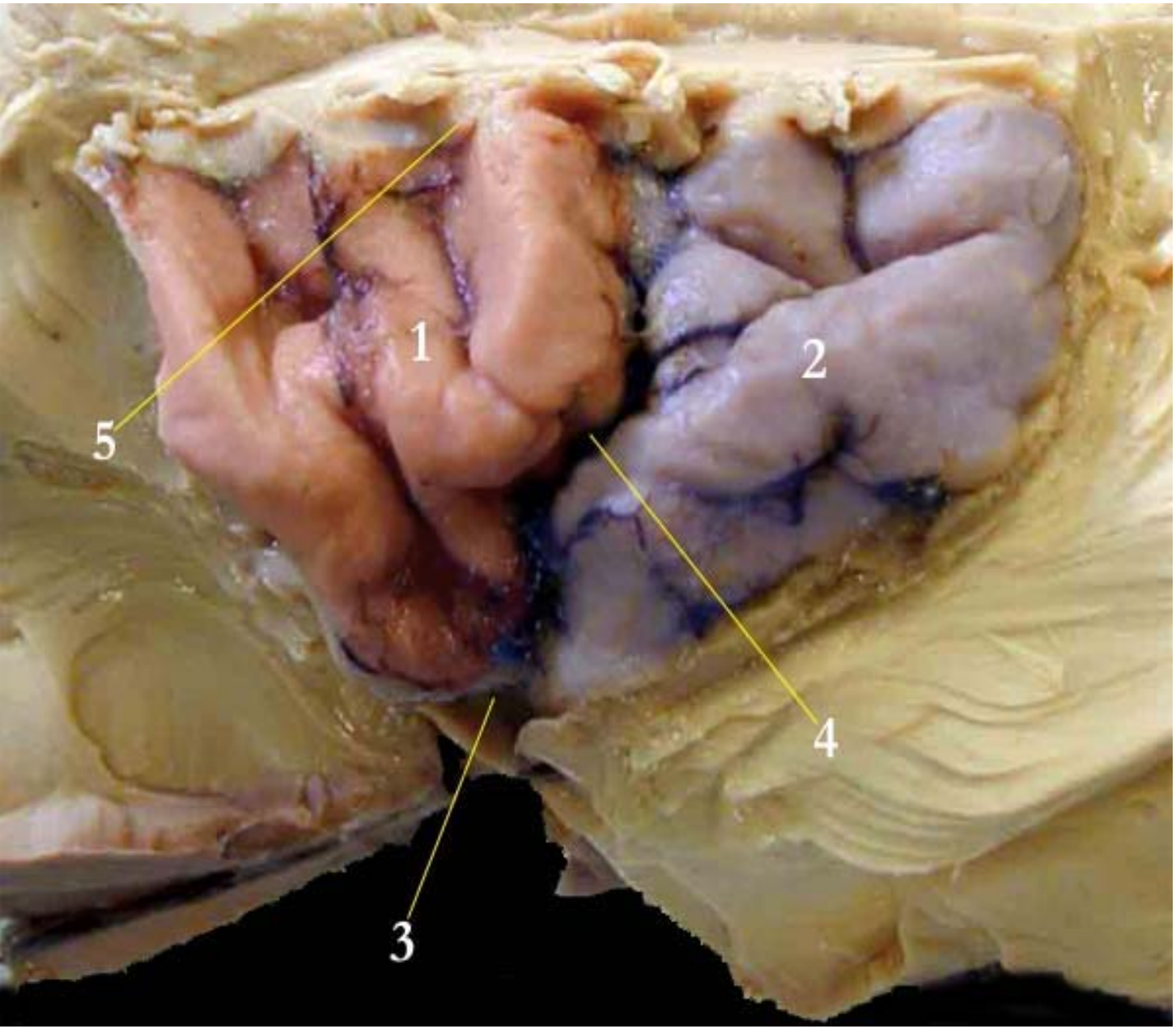
Insular cortex



lies deep to the brain's lateral surface, within the lateral sulcus which separates the temporal lobe and inferior parietal 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.

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

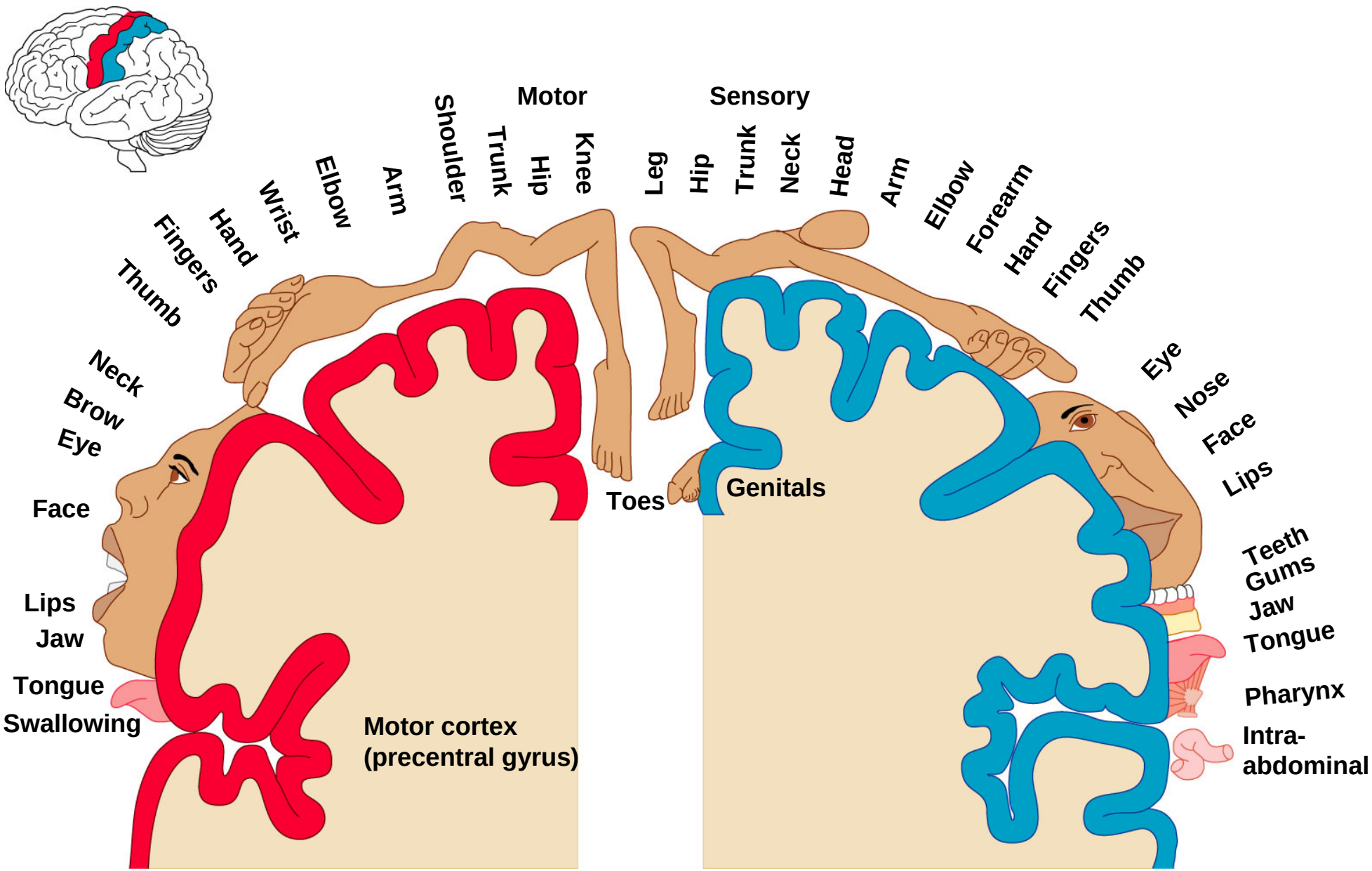
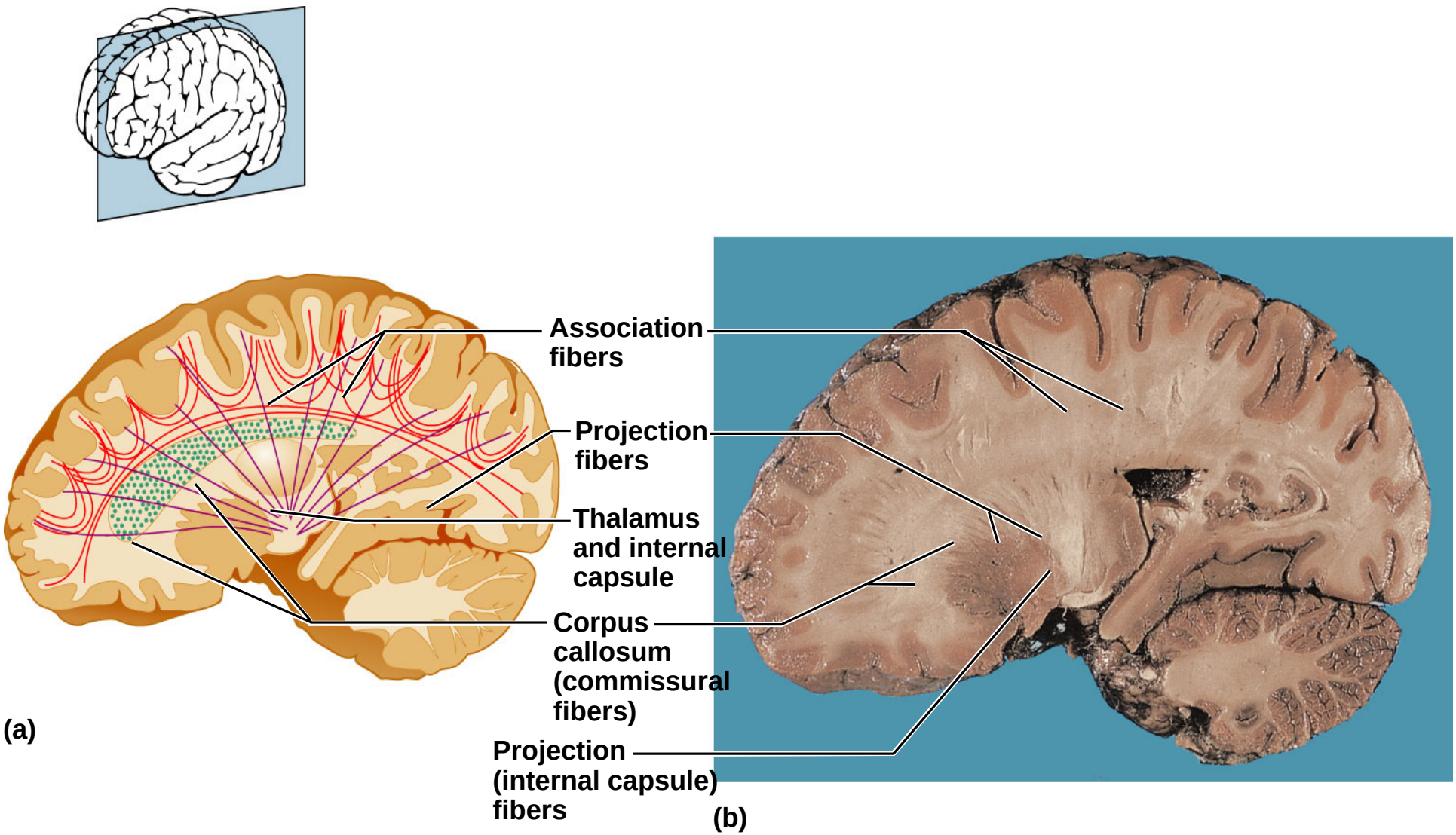
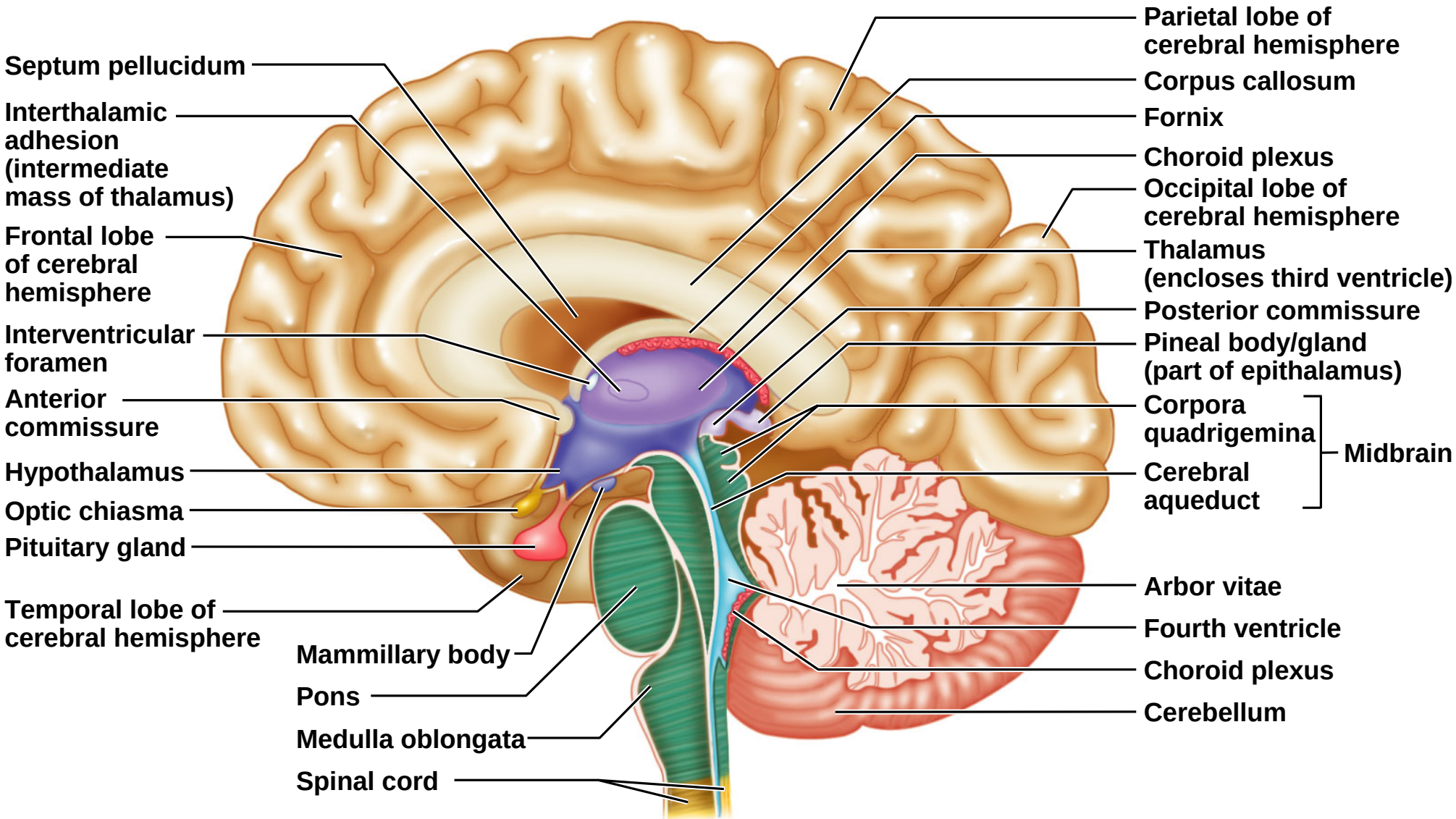


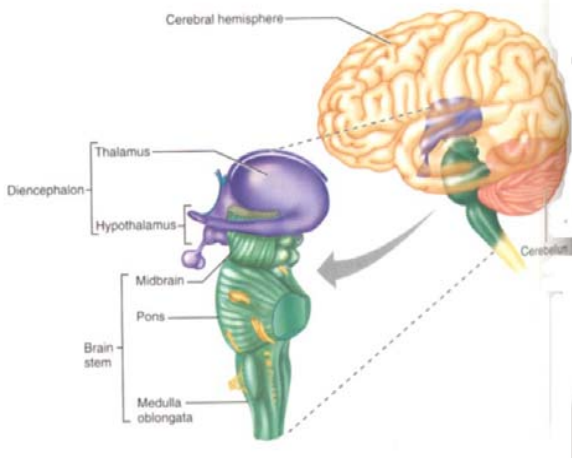
Figure 12.10a-b: Types of fiber tracts in white matter, p. 442.



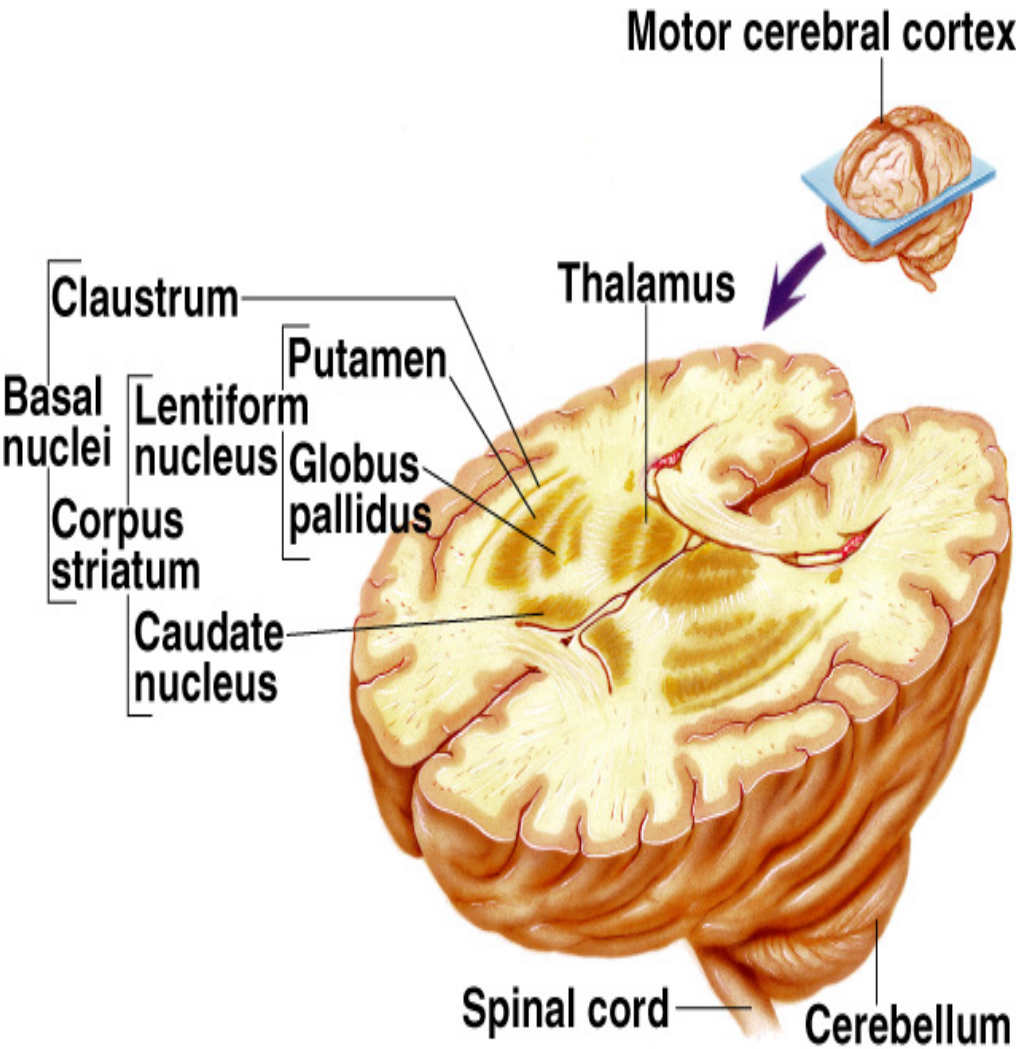
DIENCEPHALON

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



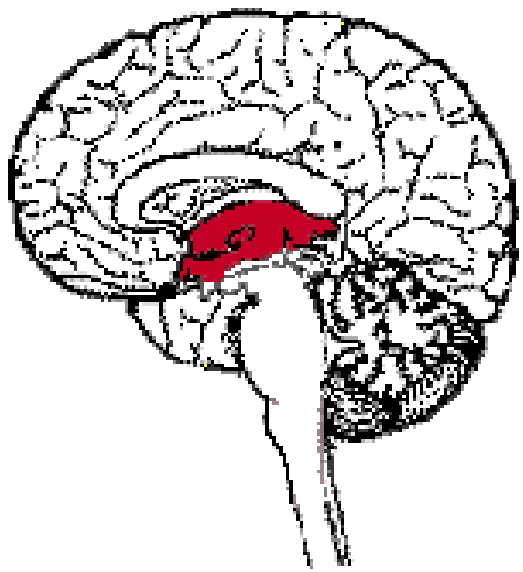


DIENCEPHALON



2 Major Structures

- Thalamus
- Hypothalamus



Selected structures of the diencephalon, p. 445.

Hypothalamus

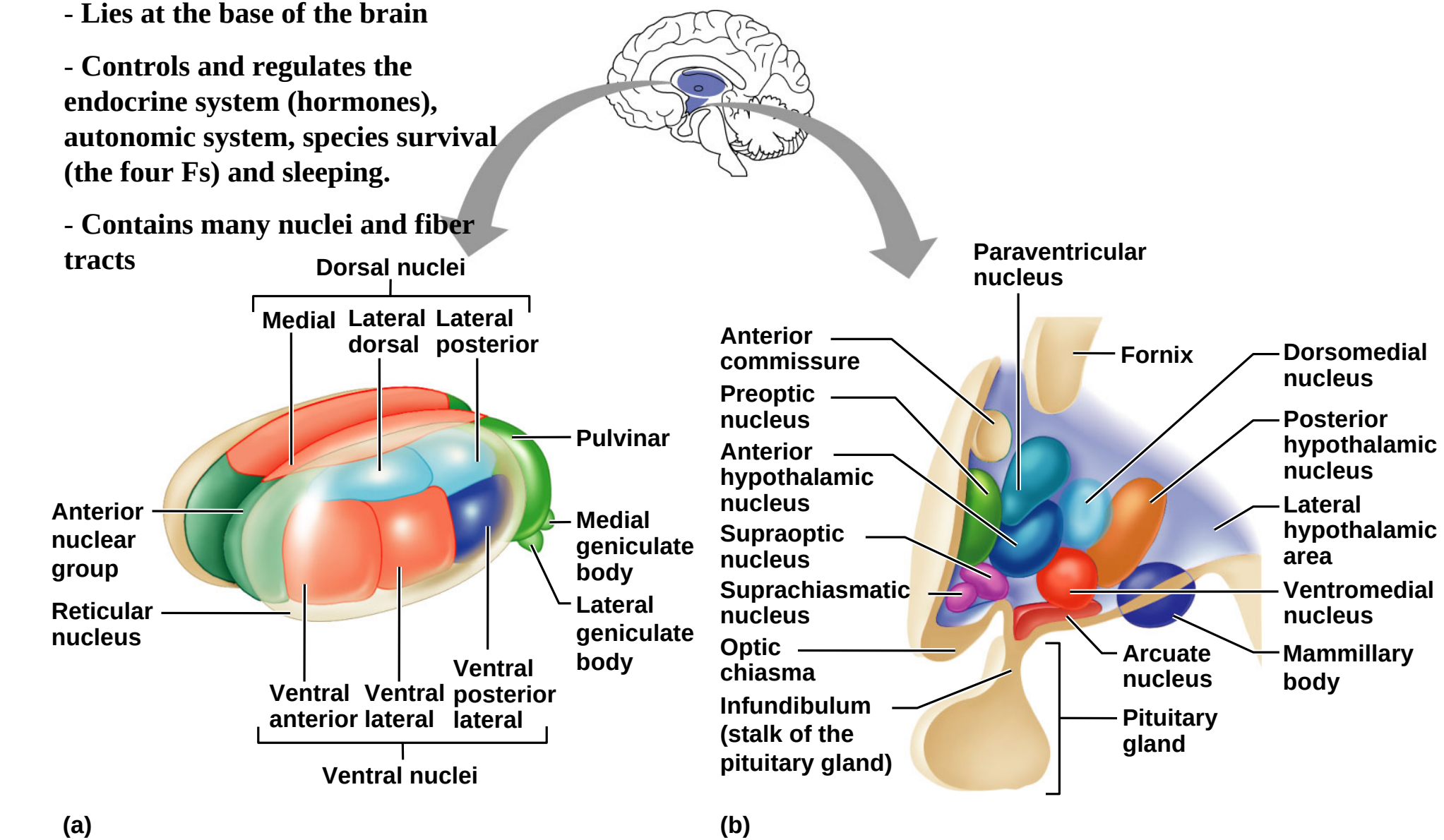
- Lies at the base of the brain

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

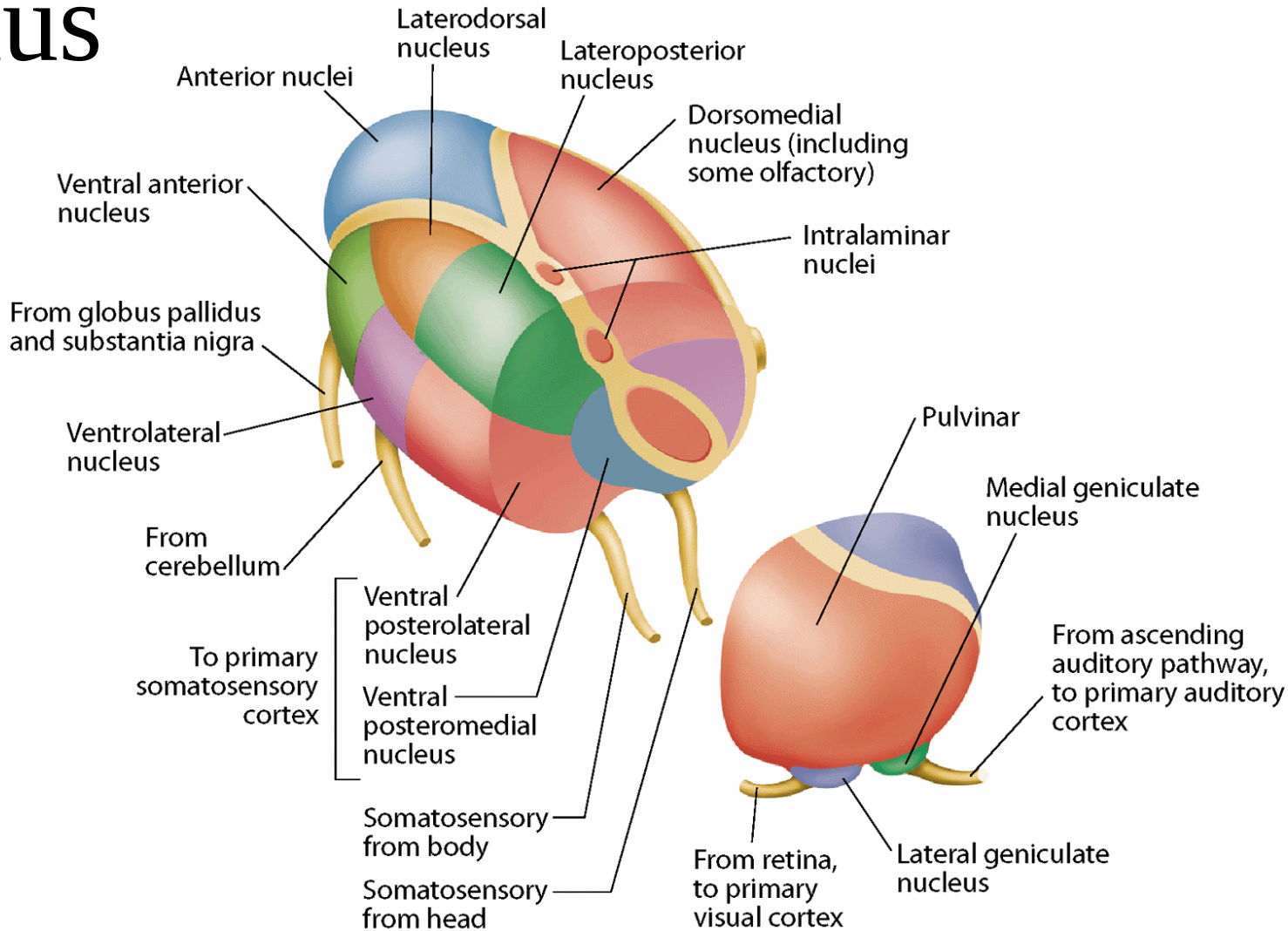
- Contains many nuclei and fiber tracts

Thalamus

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



Thalamus



- *All sensory modalities relay through the thalamus*

Thalamus – “gateway” to the

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

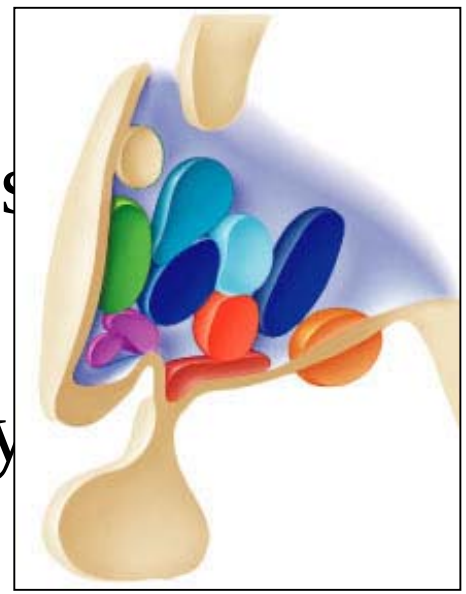
Hypothalamus

Below the thalamus, it caps the brainstem and forms the inferolateral walls of the third ventricle

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

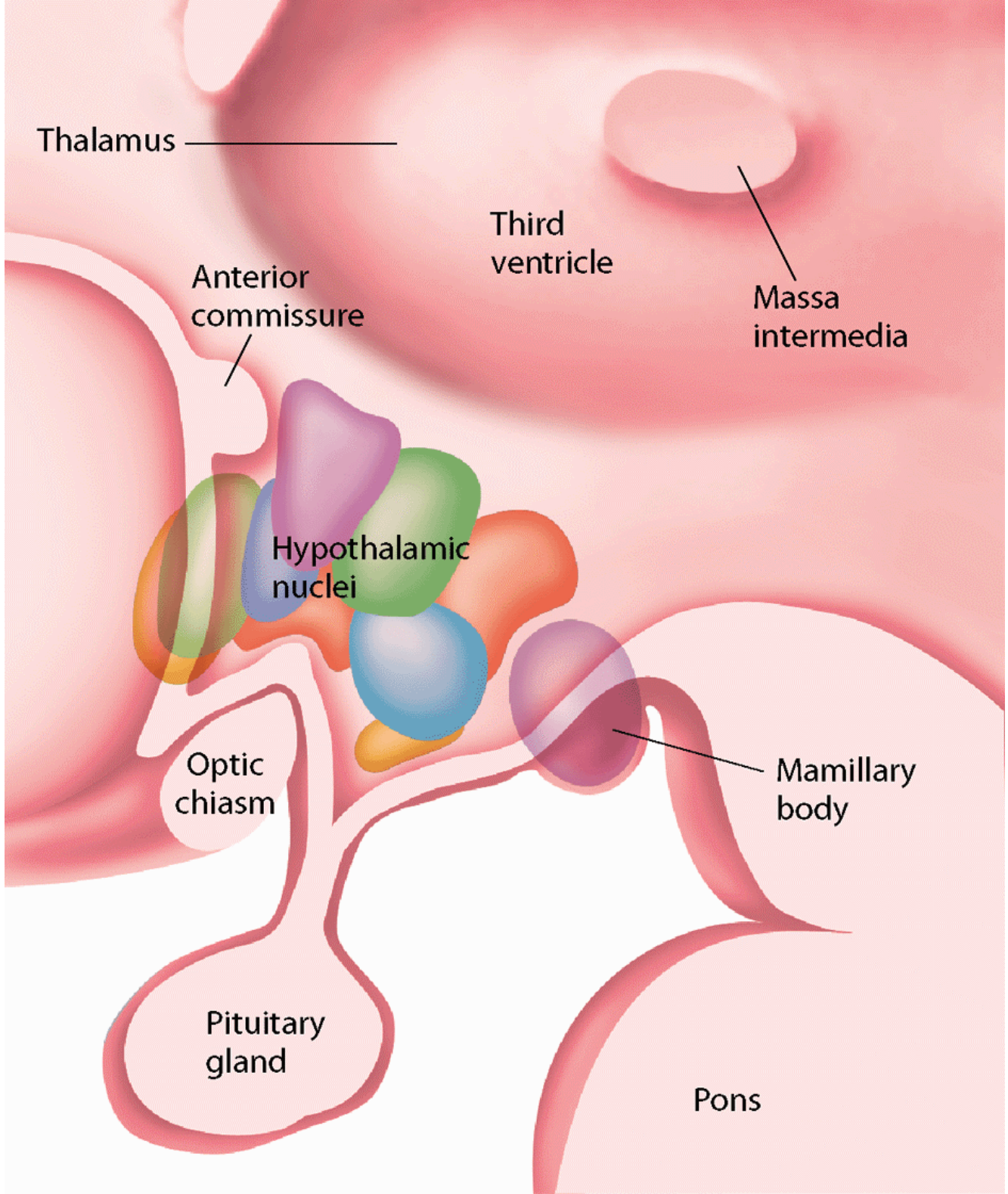
Infundibulum – stalk of the hypothalamus connecting to the pituitary gland

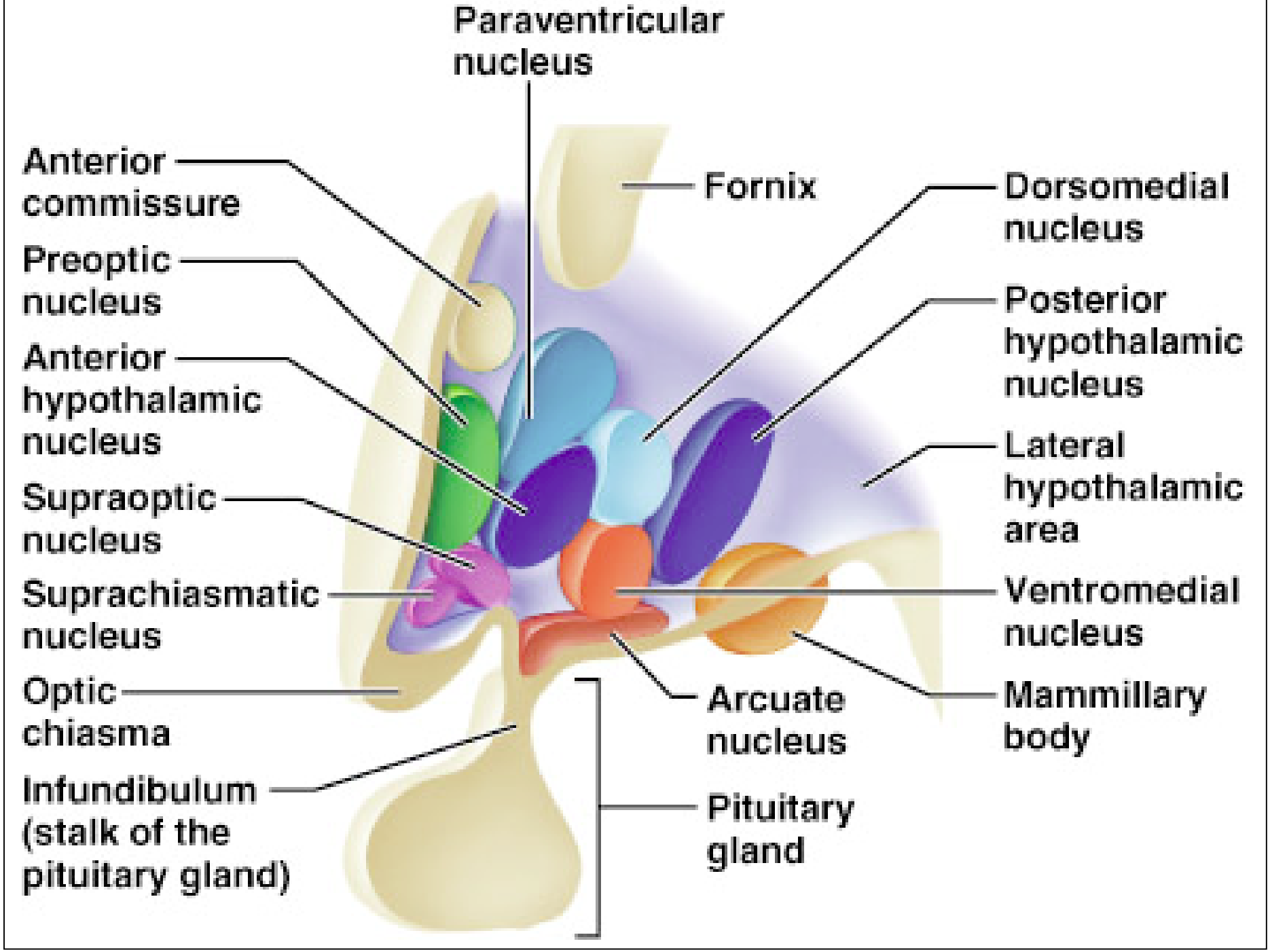
Main visceral control center of the body important to overall body homeostasis



Hypothalamus

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





Hypothalamic Nuclei

Hypothalamic Function

Regulates ANS by controlling activity of centers in brains stem and spinal cord

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

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

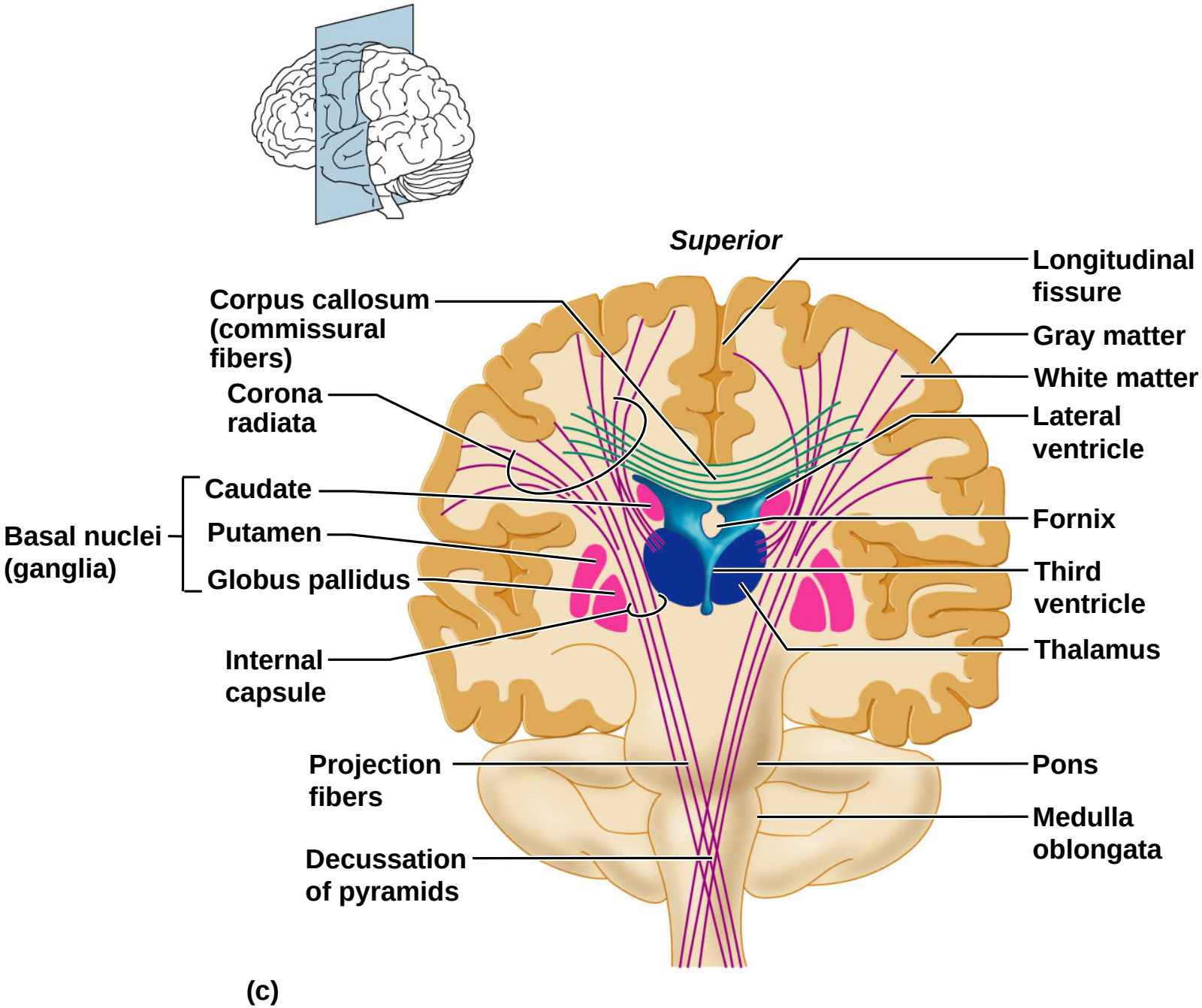


Figure 12.11b: Basal nuclei, p. 444.

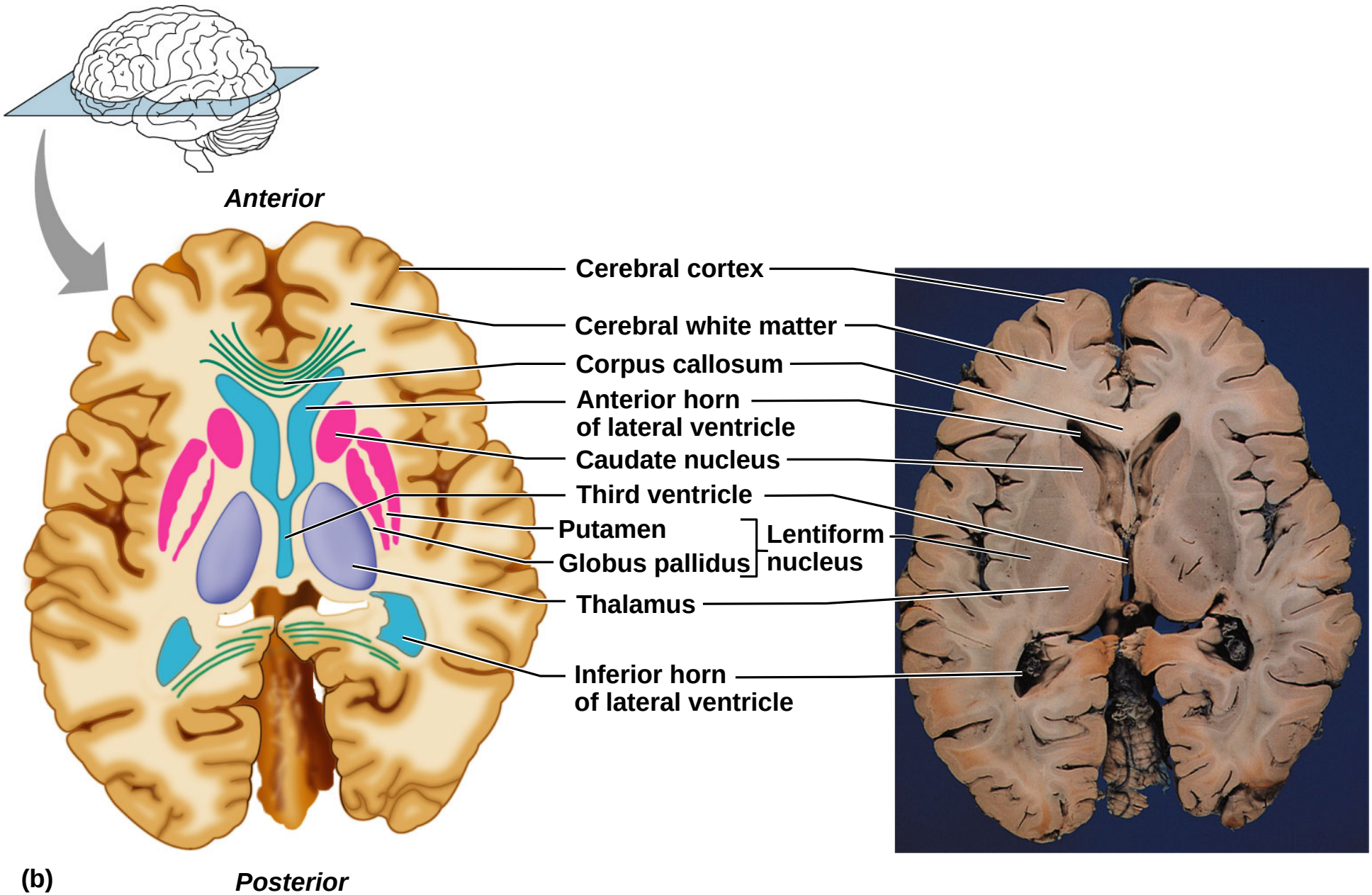


Figure 12.15a: Relationship of the brain stem and the diencephalon, p. 448.

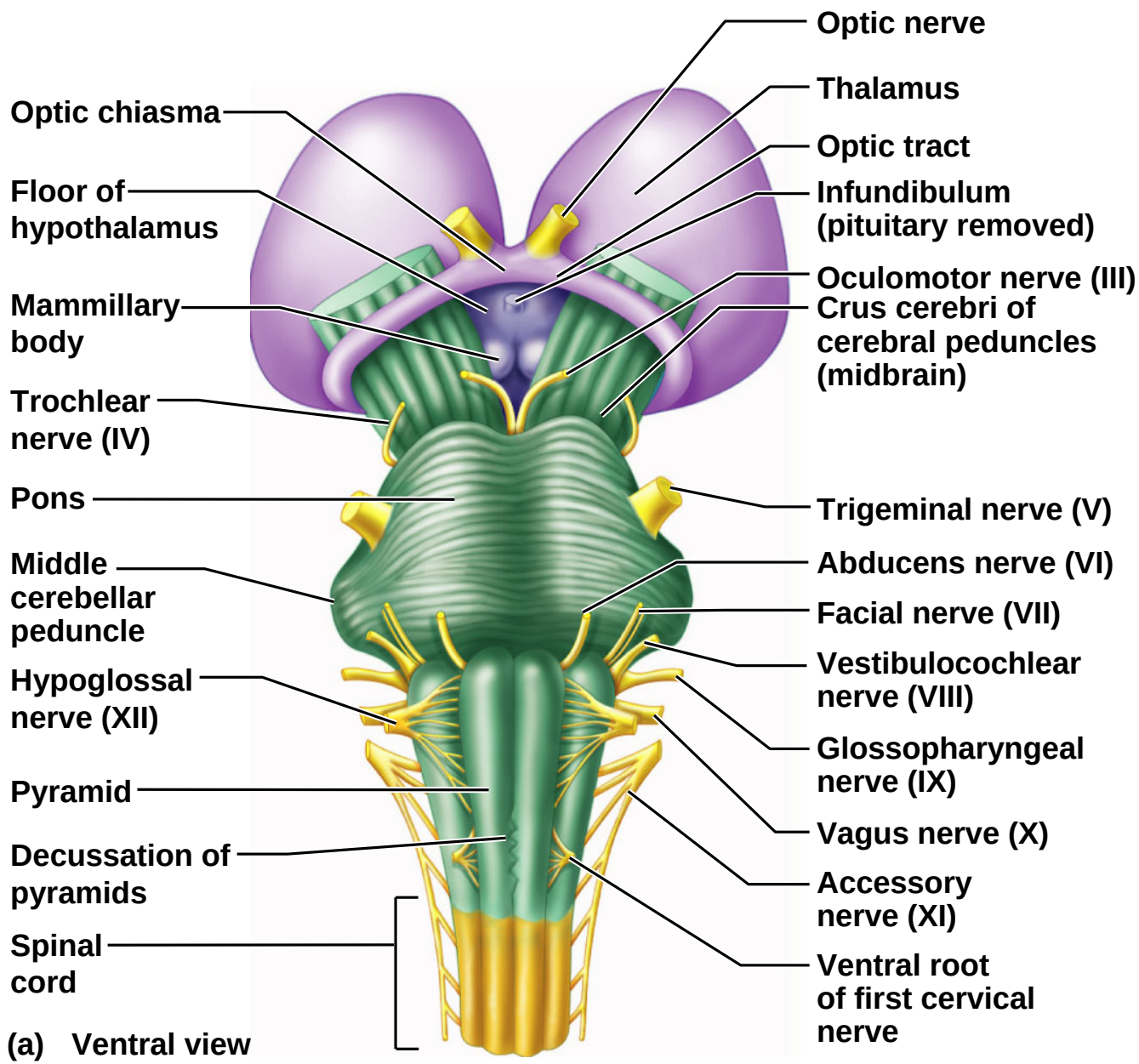


Figure 12.15b: Relationship of the brain stem and the diencephalon, p. 448.

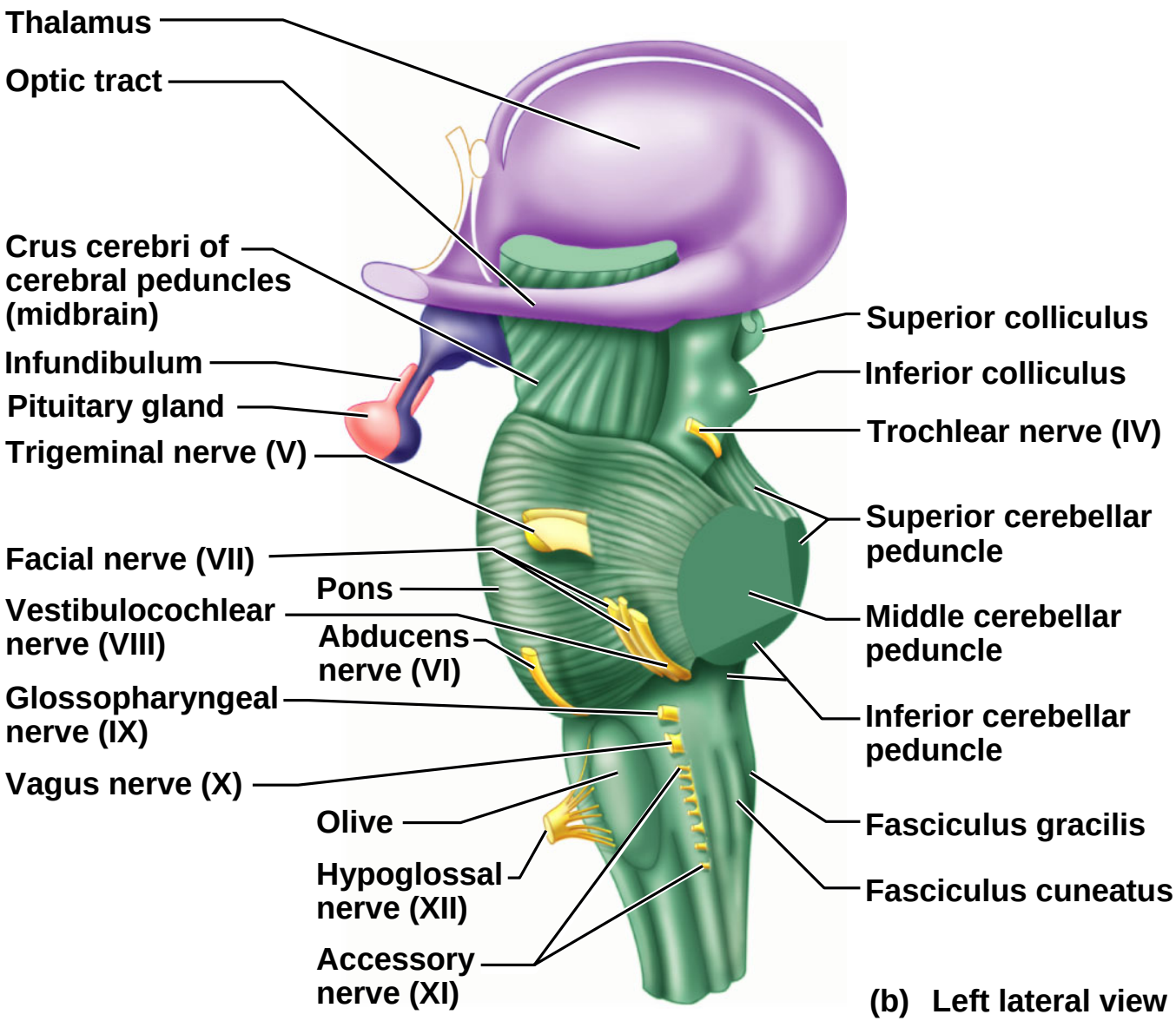
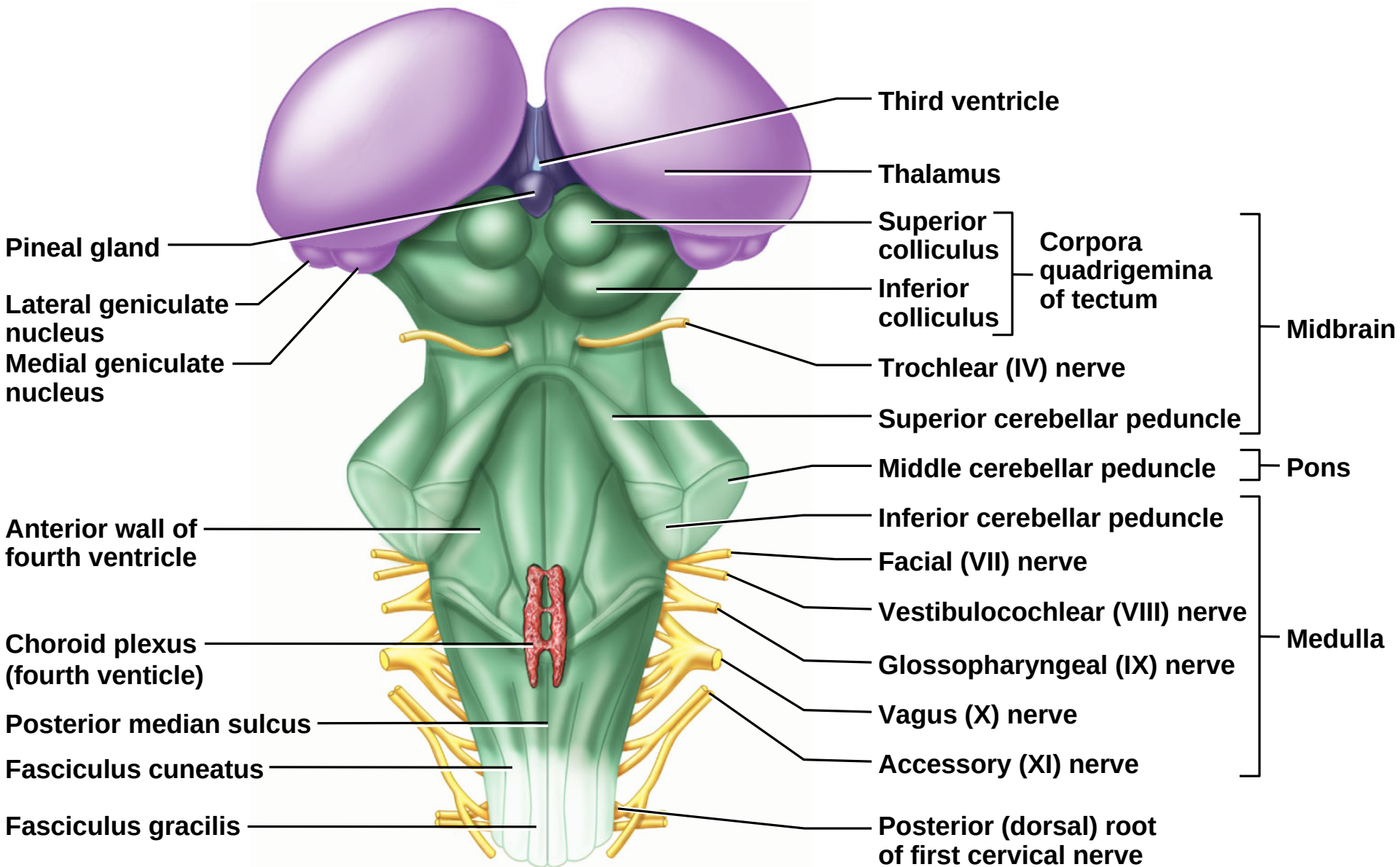


Figure 12.15c: Relationship of the brain stem and the diencephalon, p. 449.

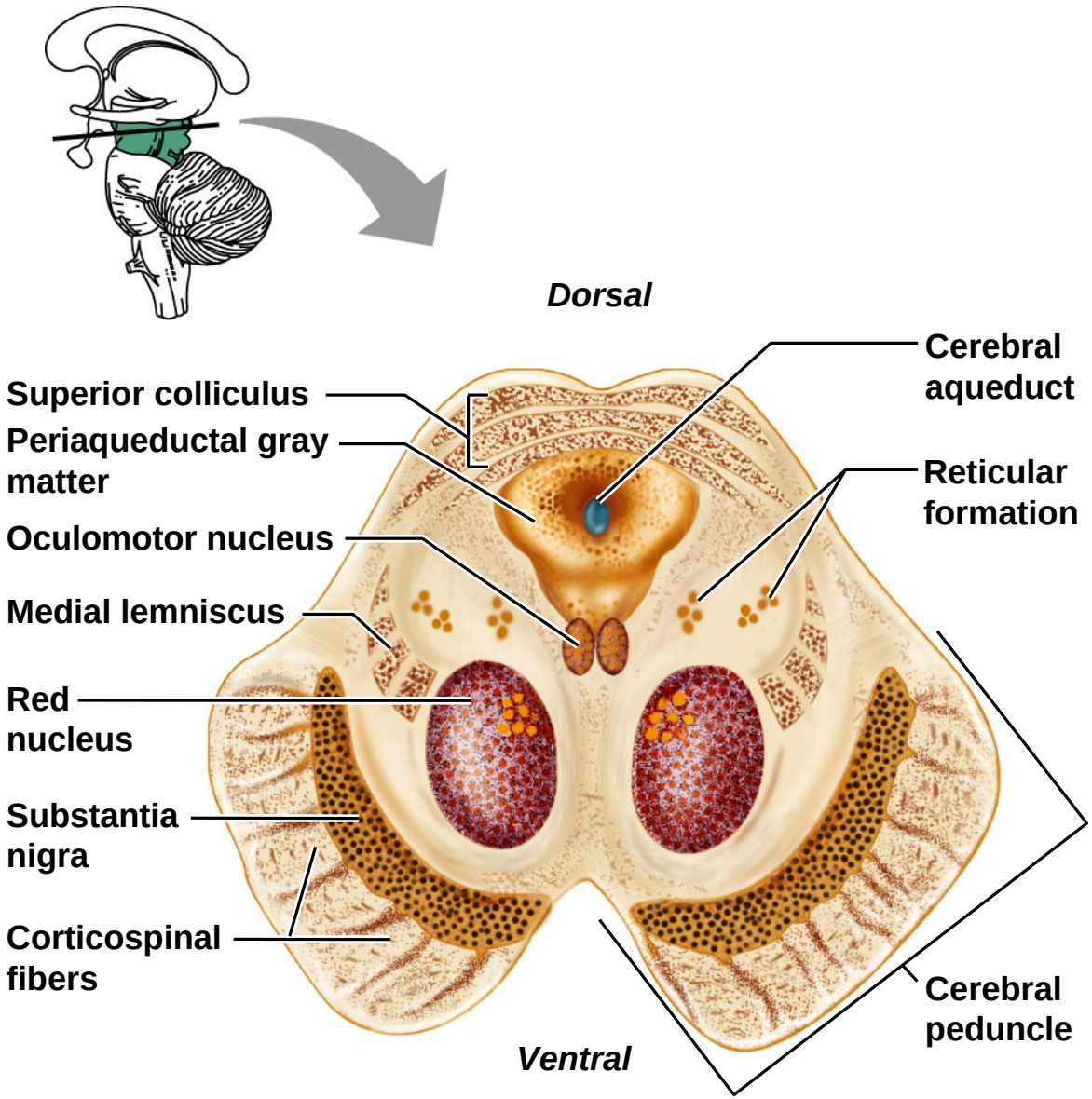


(c) Dorsal view

CRANIAL NERVES: COMPOSITION

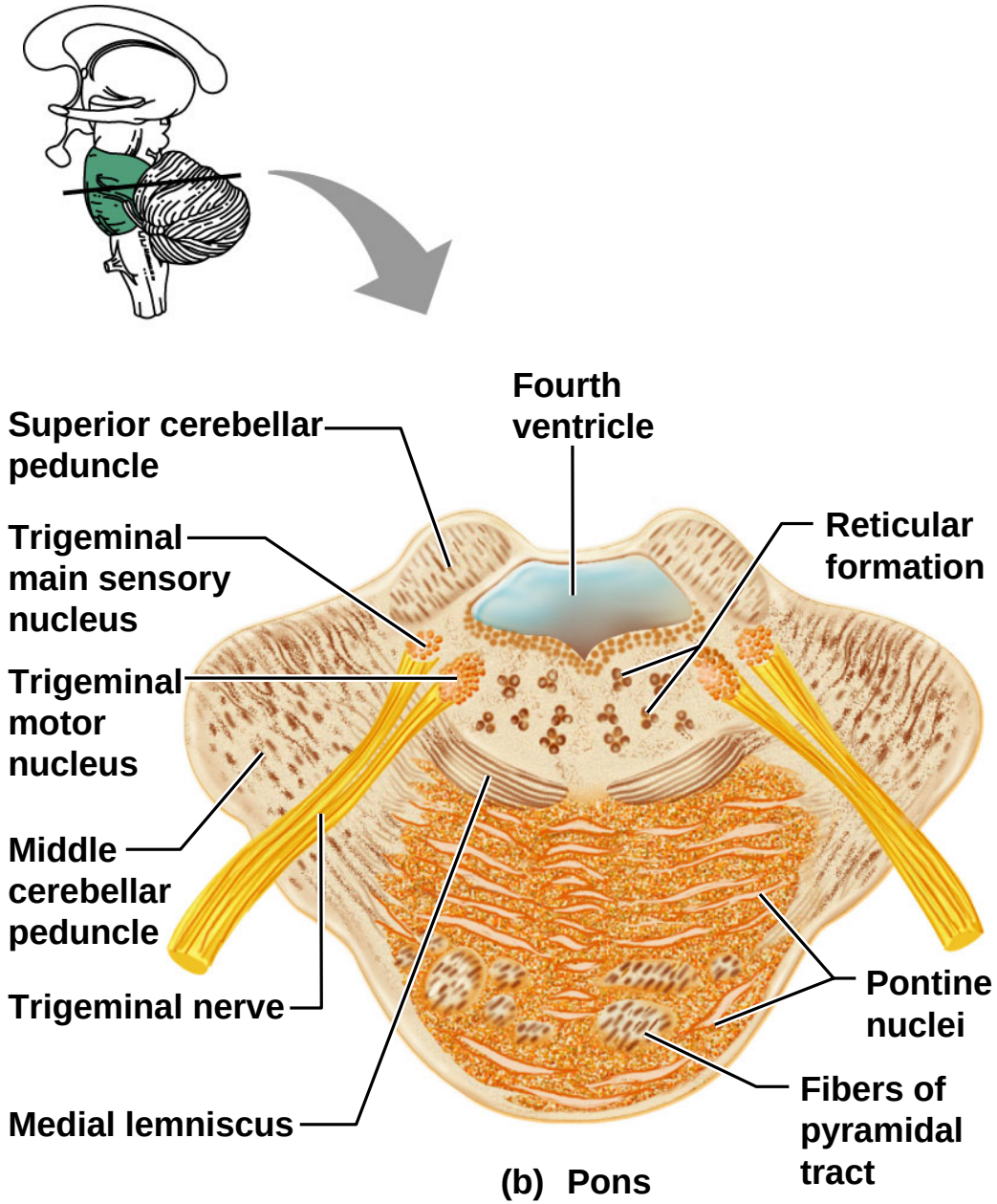
Some are motor nerves	III, IV, VI, XI, XII
Some are sensory nerves	I, II, VIII
Others are mixed nerves	V, VII, IX, X
Some contain autonomic (preganglionic parasympathetic) fibers originating in the brain stem	III, VII, IX, X

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

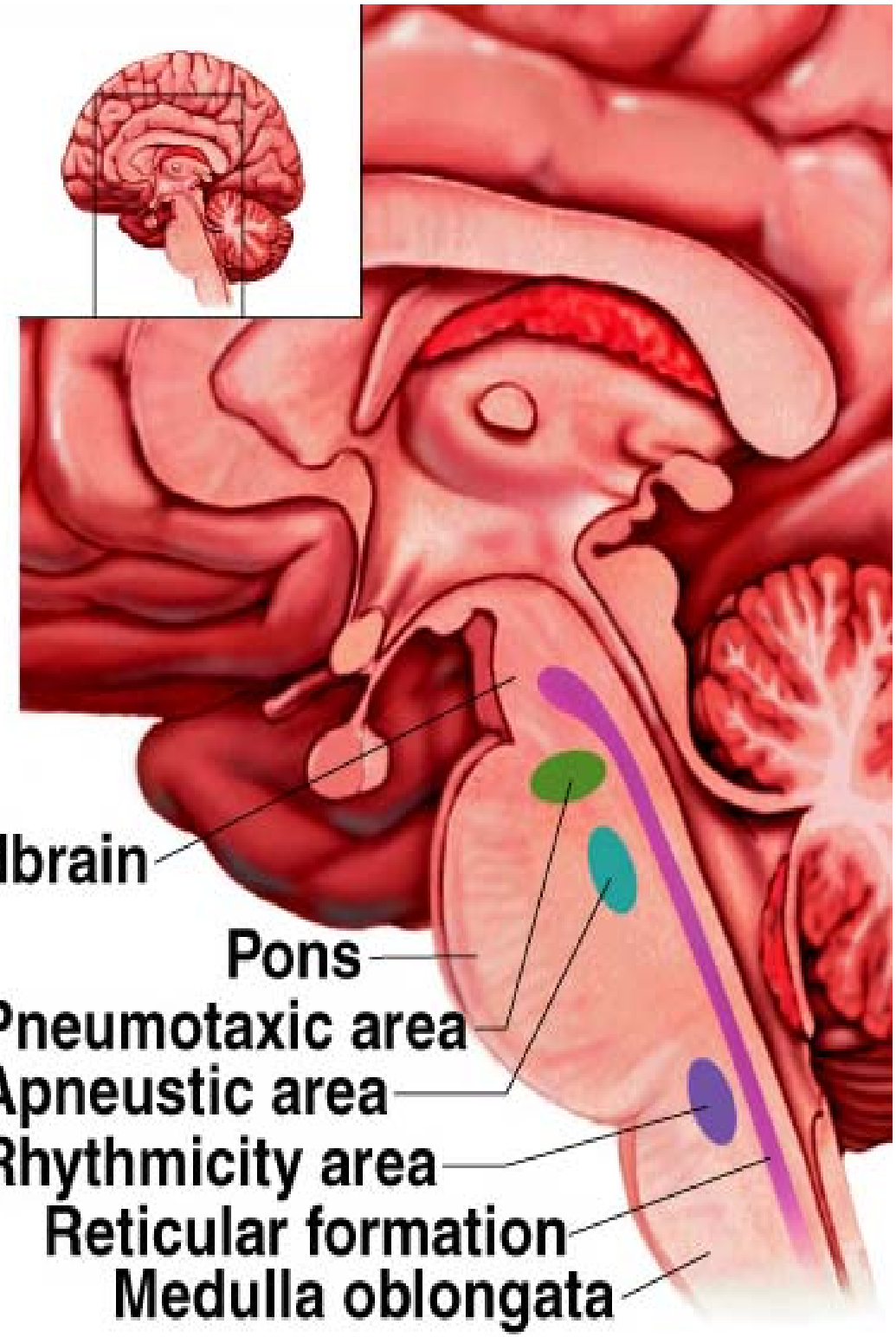
respiratory centers.

Cerebellum:

"little brain"

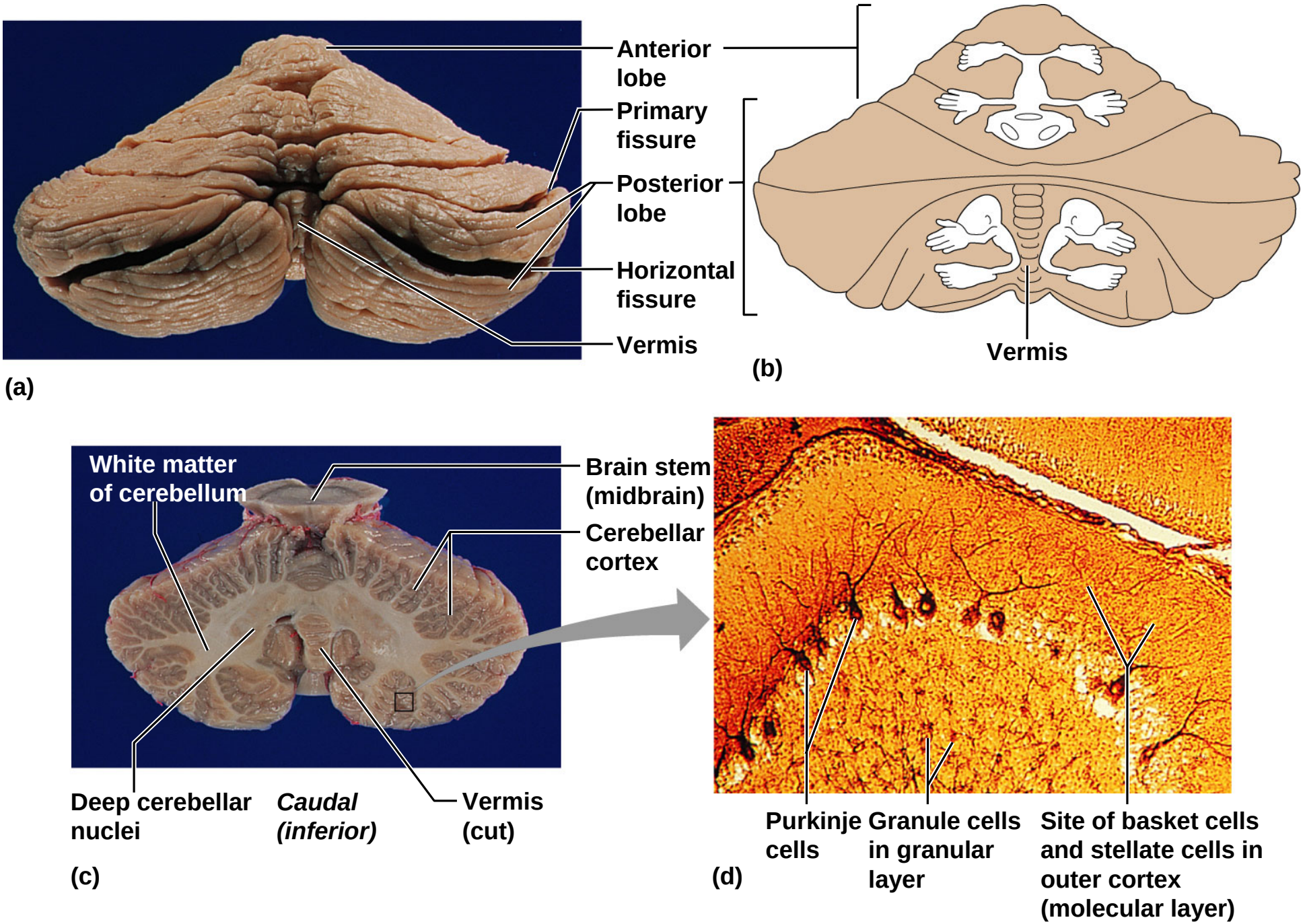
Receives input from proprioceptors (joints, muscles, tendons).

Refinement/coordination of movement.



CEREBELLUM

Figure 12.17: Cerebellum, p. 452.



LIMBIC SYSTEM

Figure 12.18: The limbic system, p. 455.

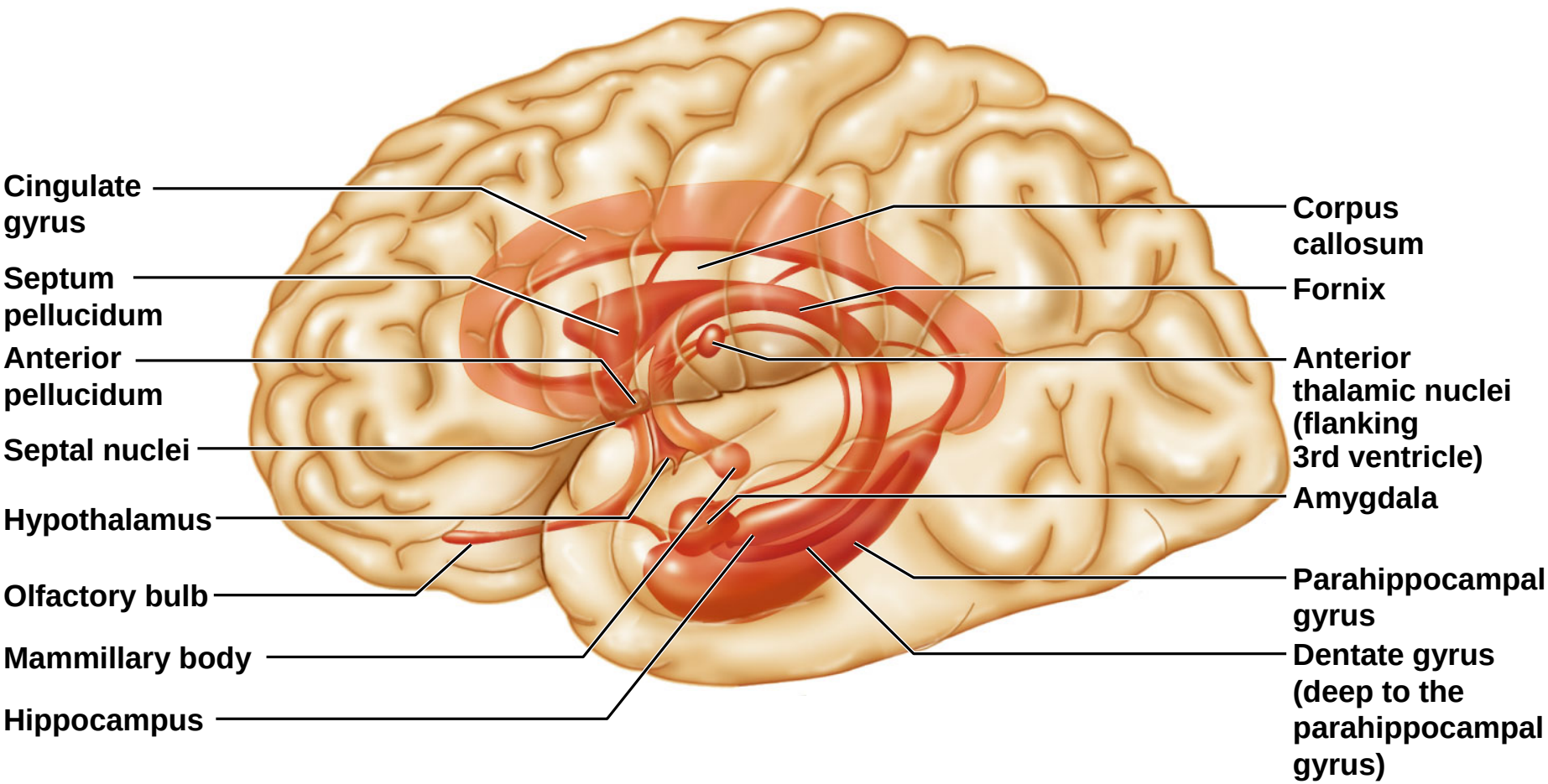


Figure 12.19: The reticular formation, p. 455.

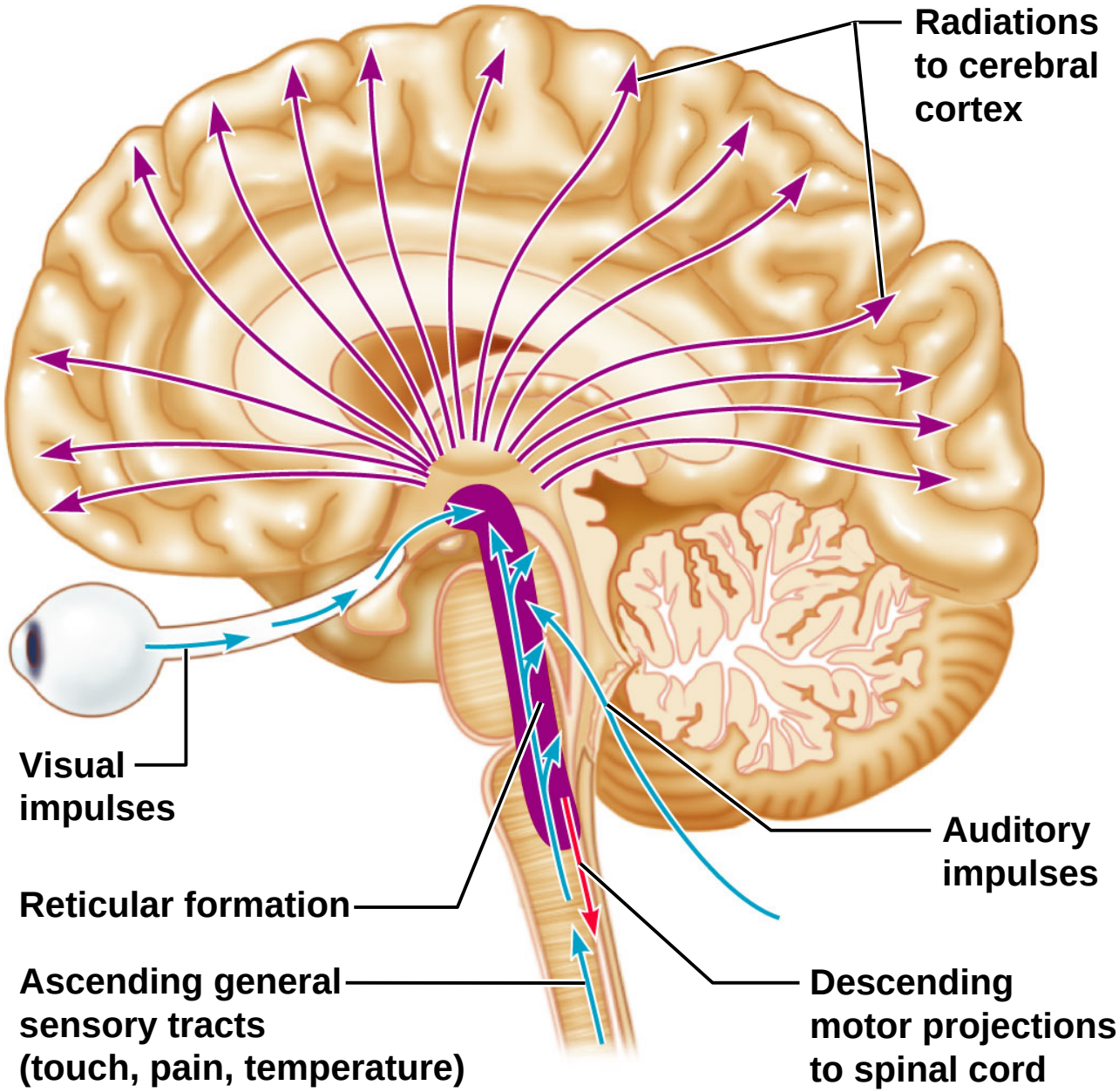


Figure 12.22: Memory processing, p. 461.

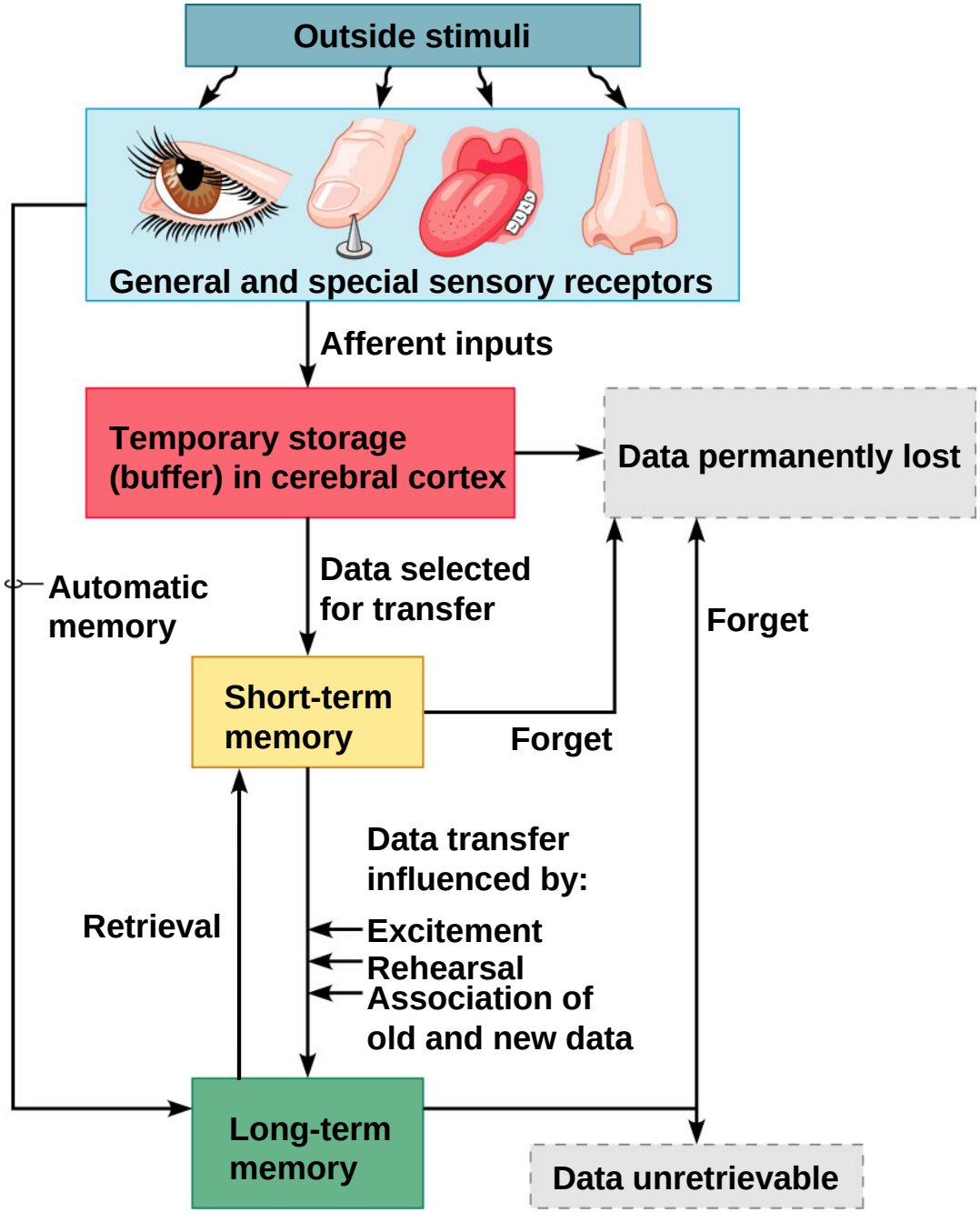
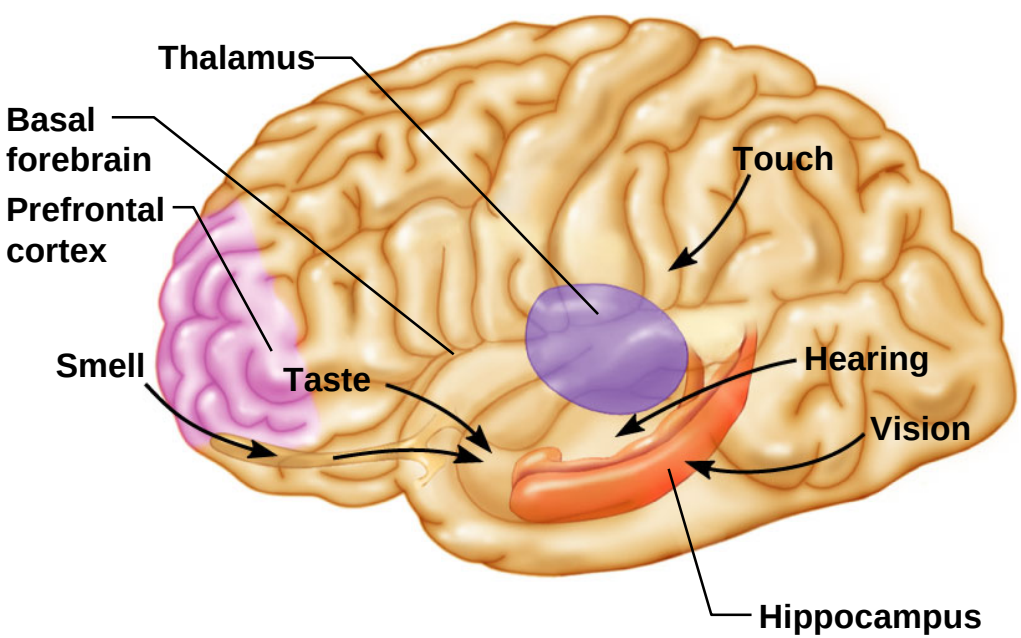
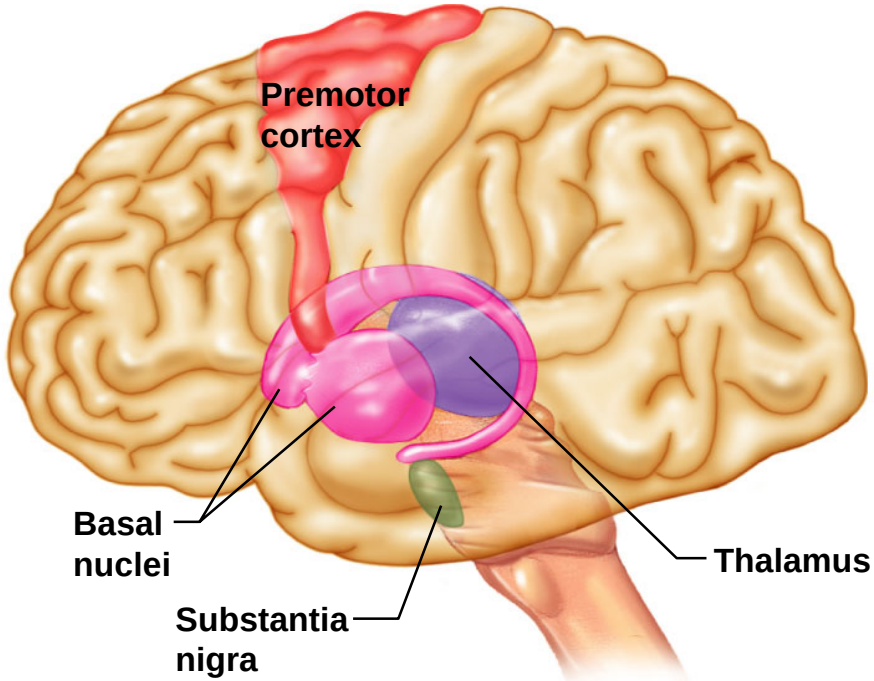
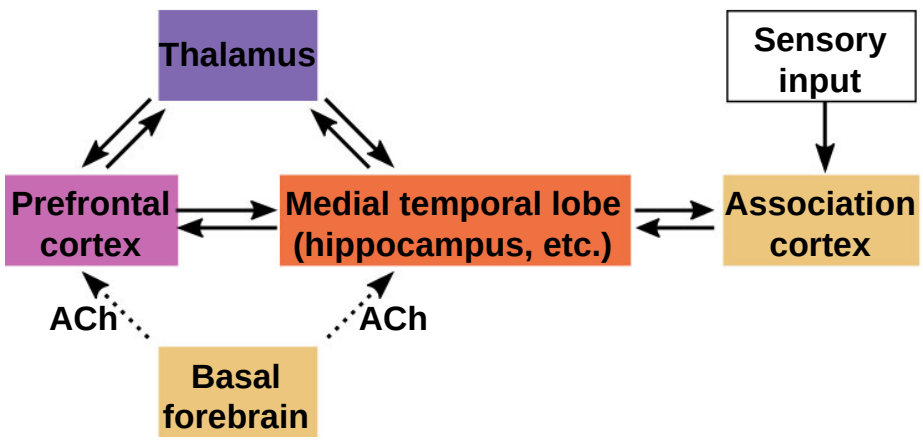


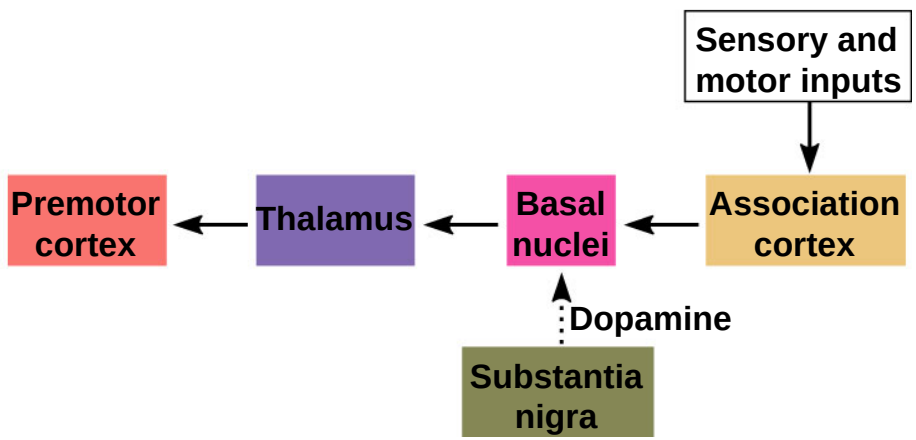
Figure 12.23: Proposed memory circuits, p. 462.







(a)



(b)

Figure 12.24a: Meninges, p. 464.

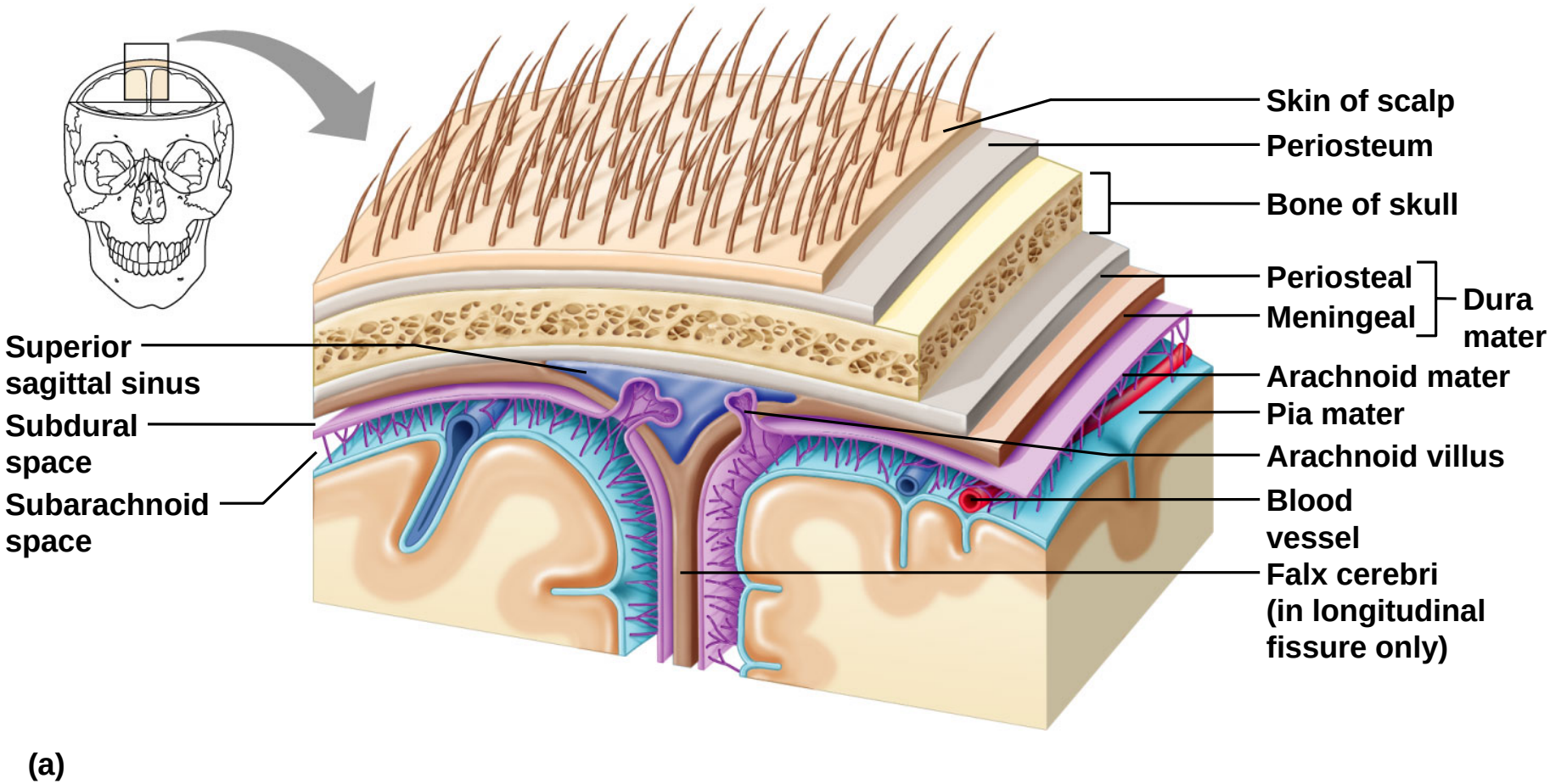
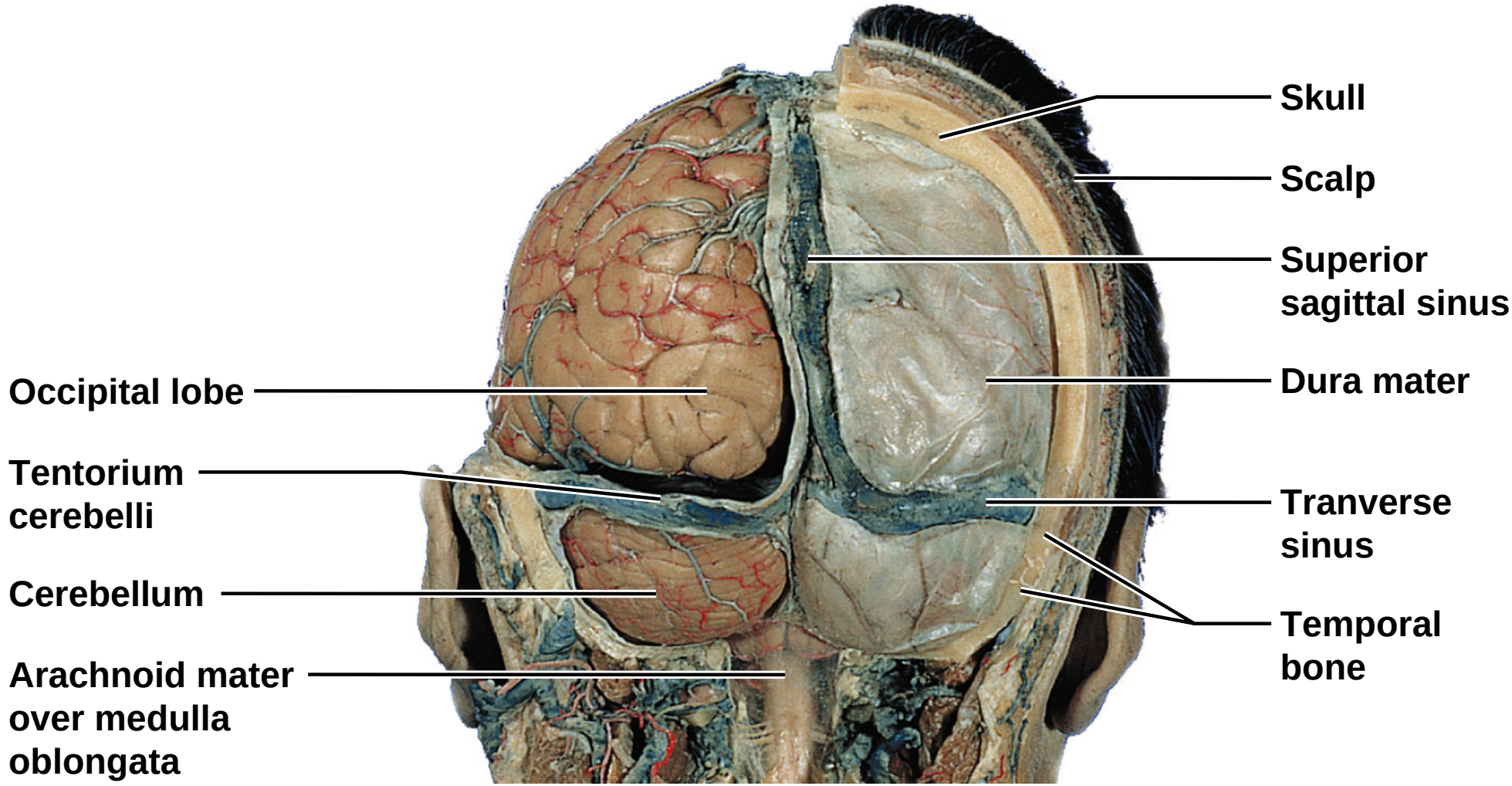


Figure 12.24b: Meninges, p. 464.



(b)

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

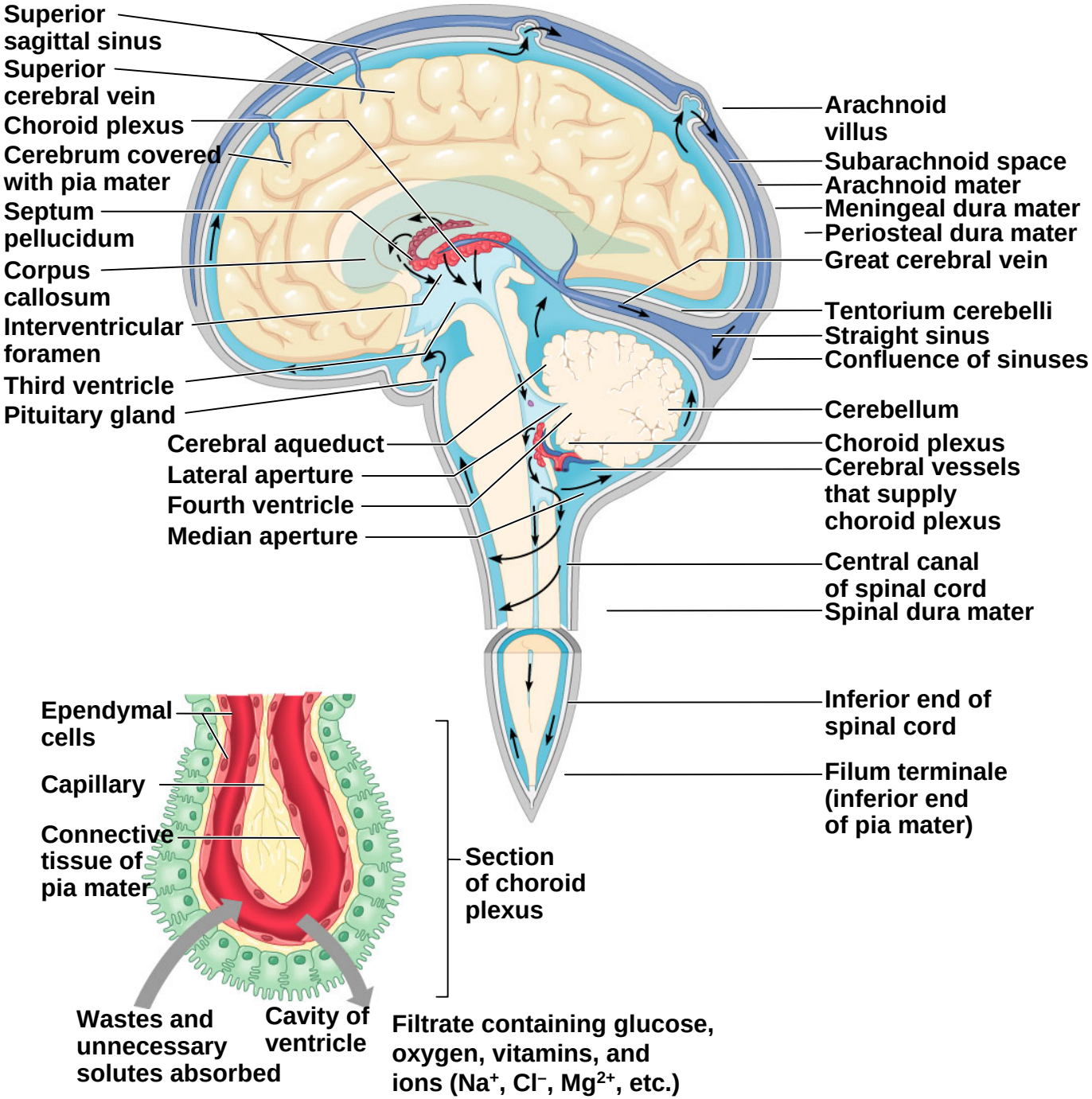
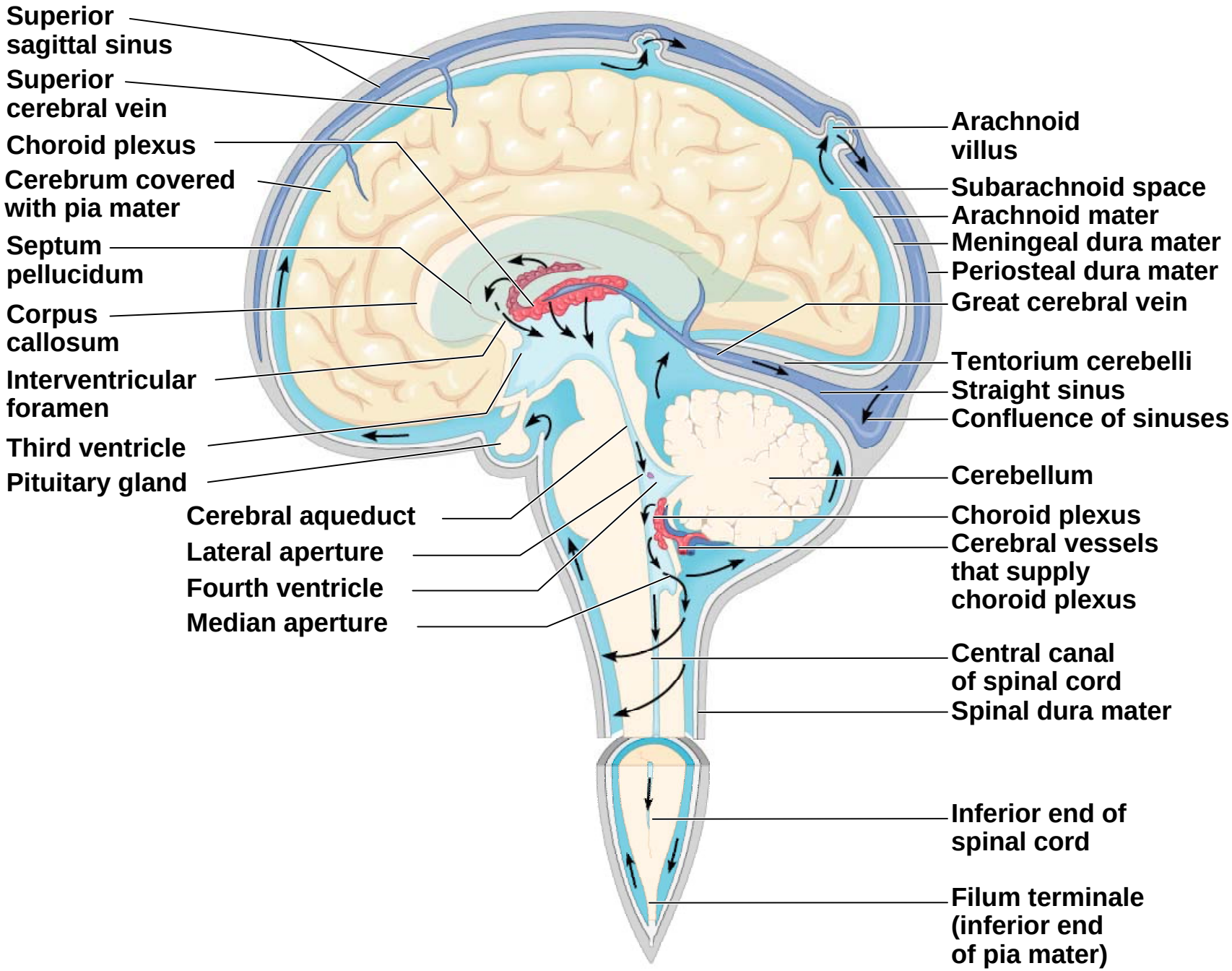
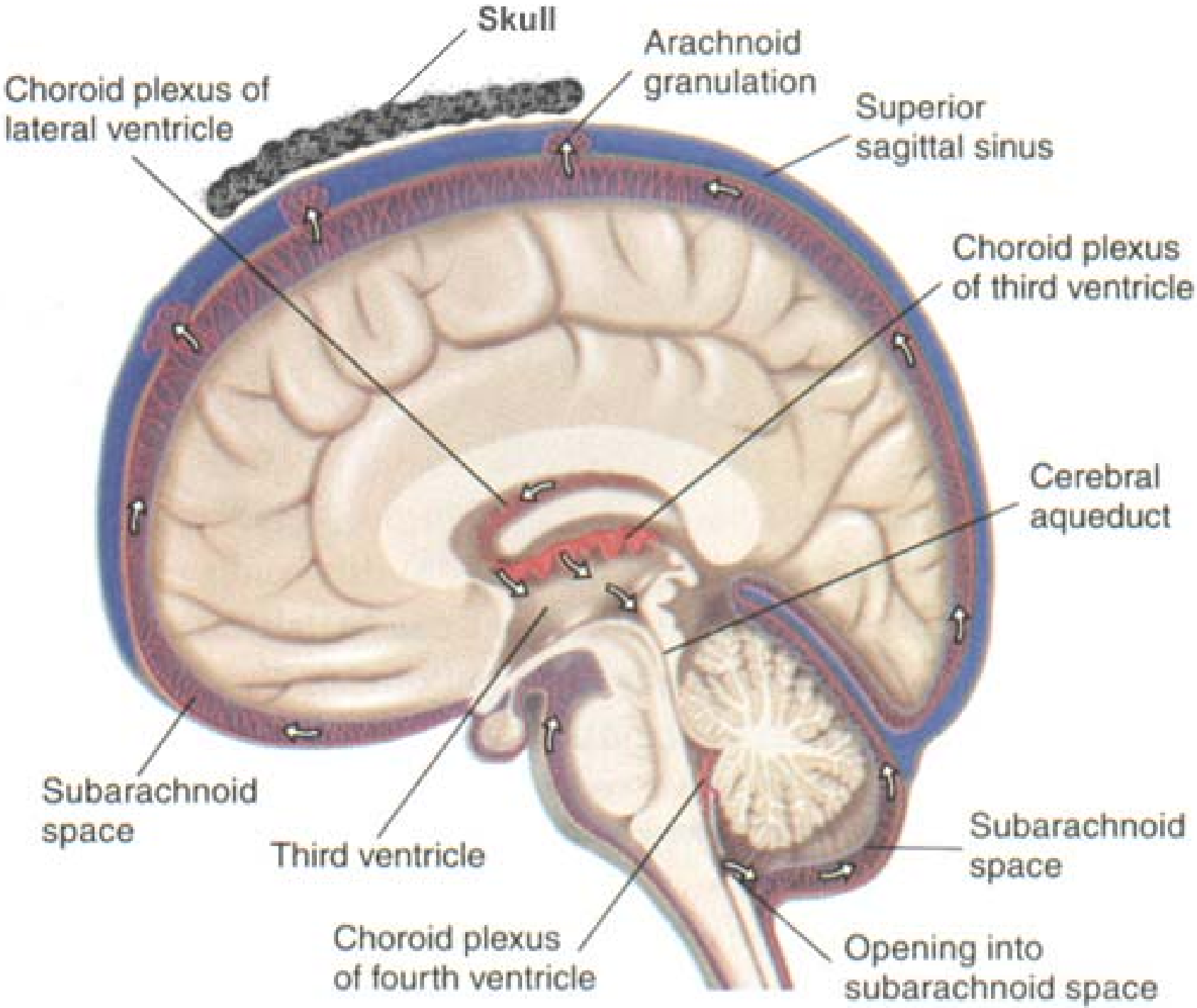
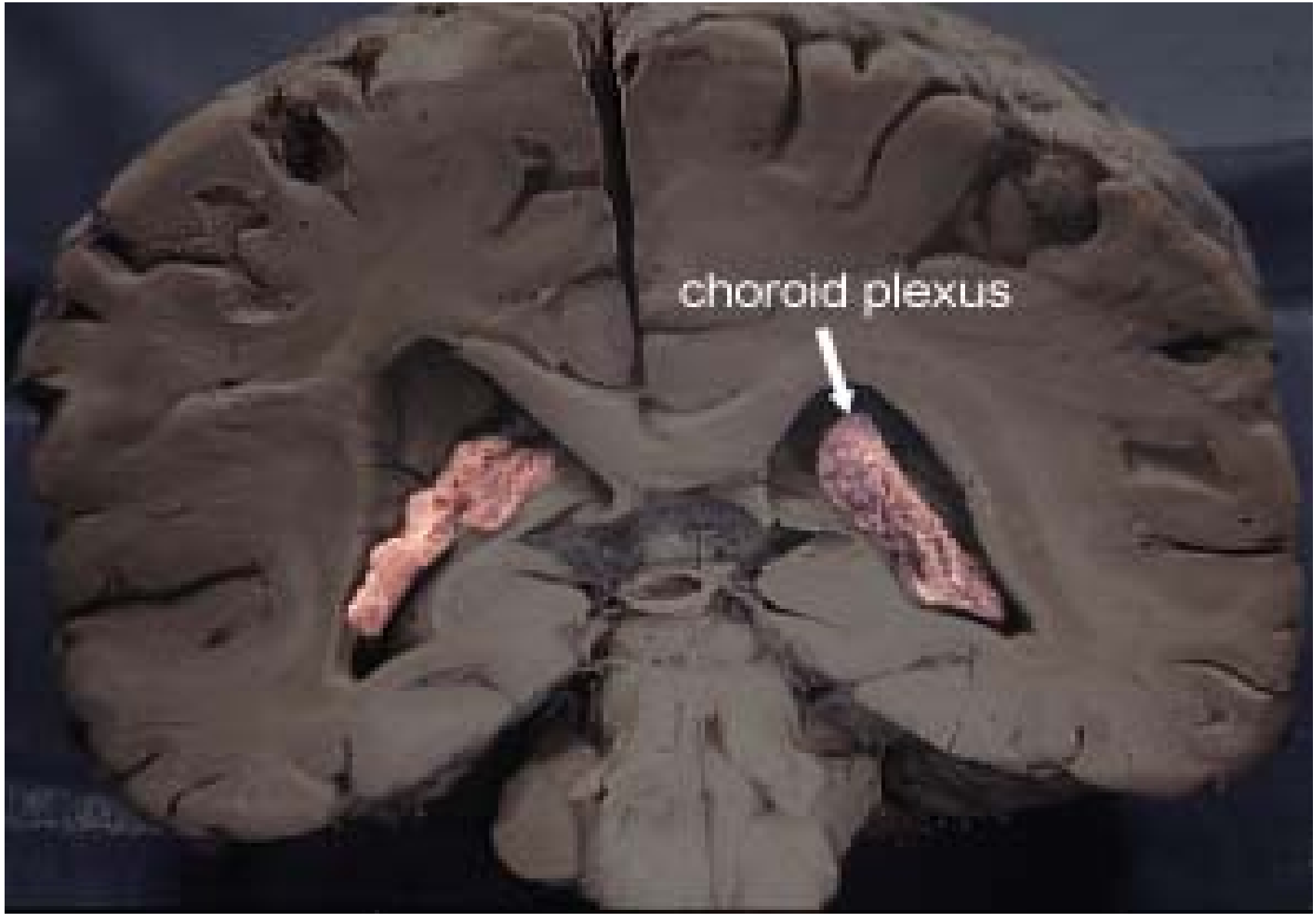


Figure 12.26: Formation, location, and circulation of CSF, p. 466.



(b)


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



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.

Figure 12.29a: Gross structure of the spinal cord, posterior view, p. 471.

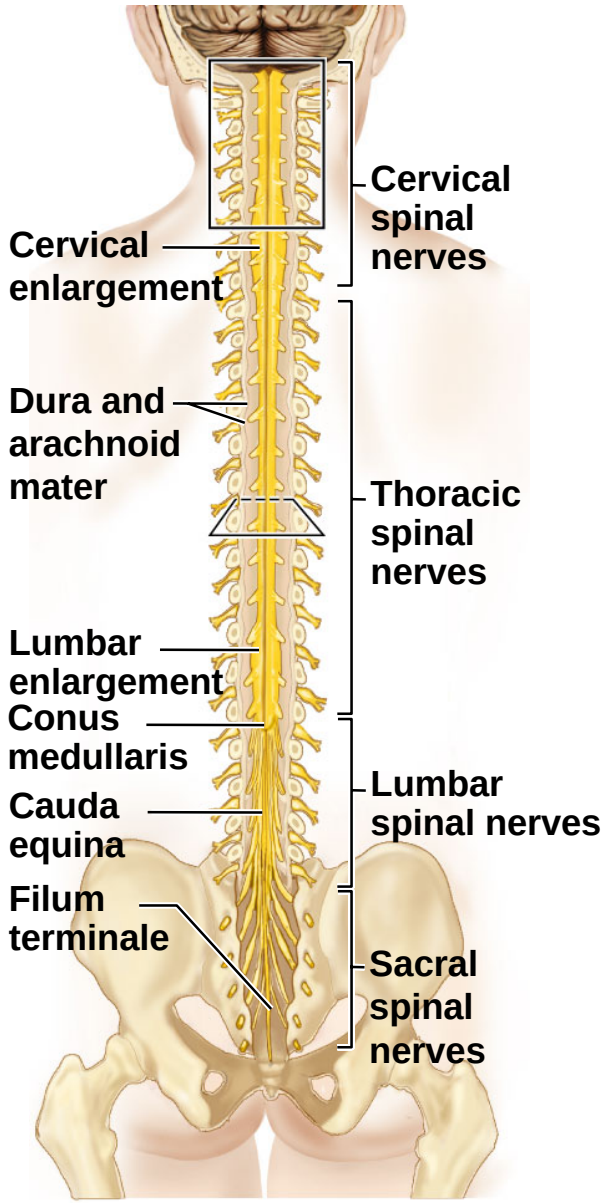


Figure 12.29b: Gross structure of the spinal cord, posterior view, p. 471.

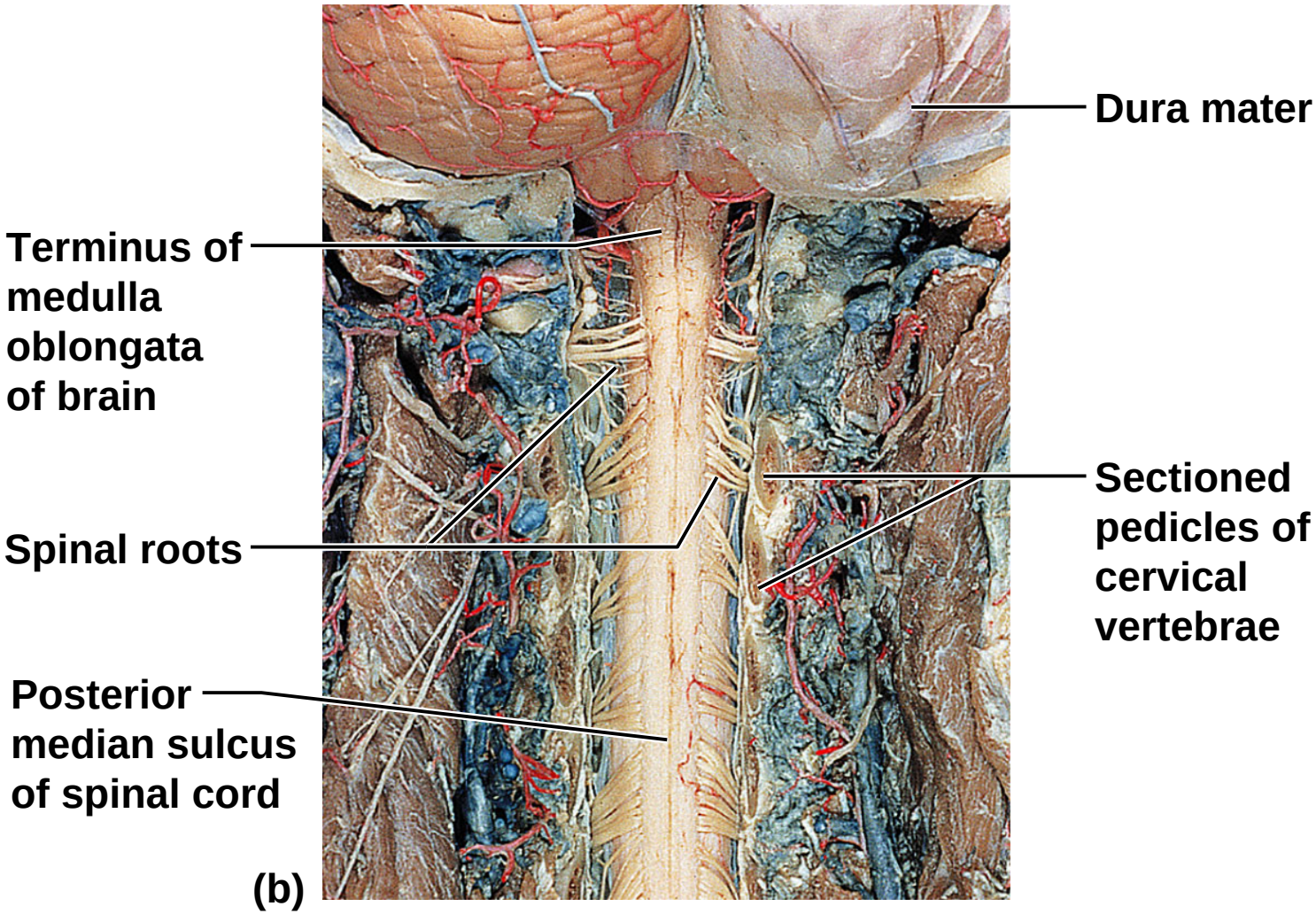


Figure 12.29c: Gross structure of the spinal cord, posterior view, p. 471.

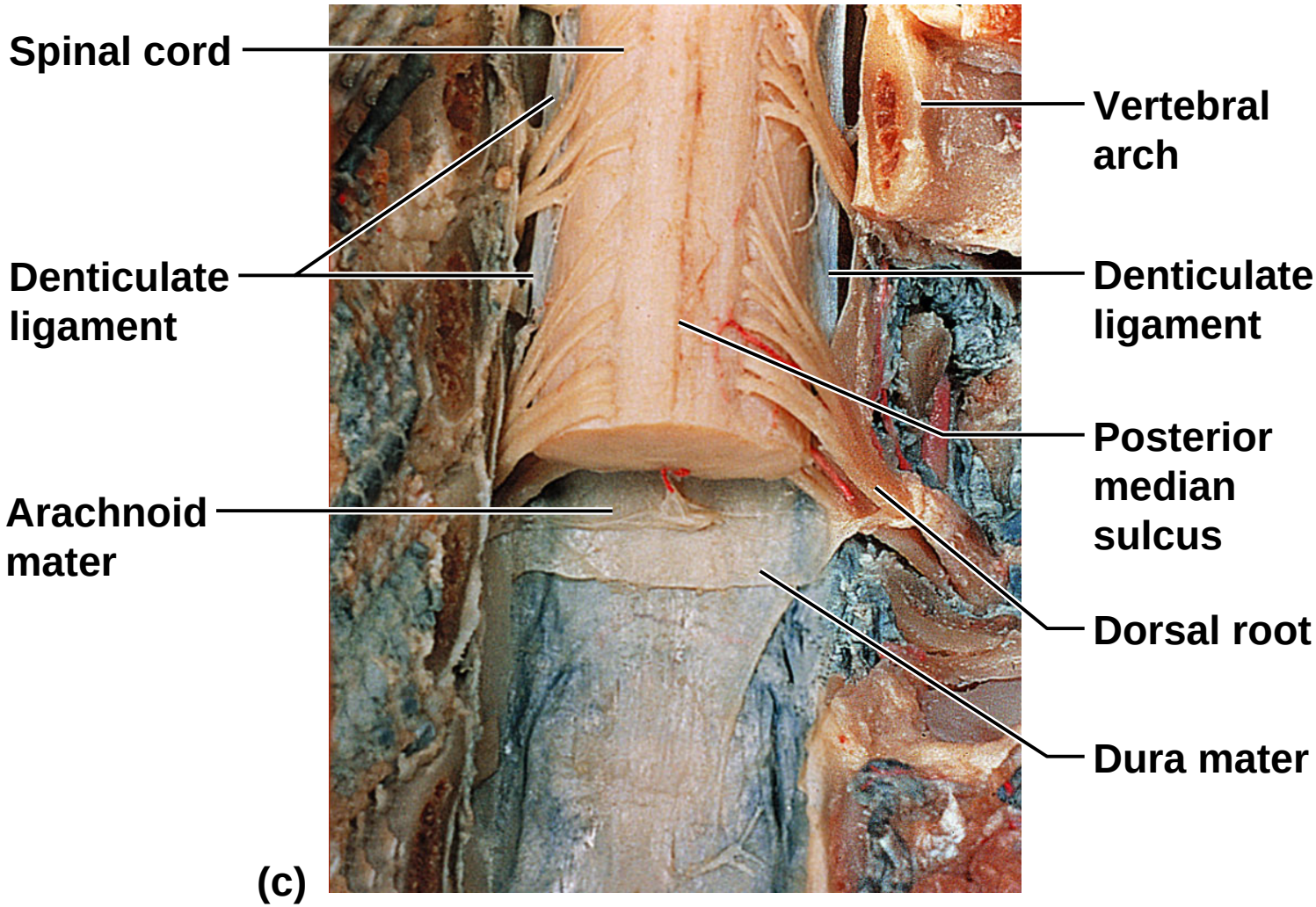


Figure 12.29d: Gross structure of the spinal cord, posterior view, p. 471.

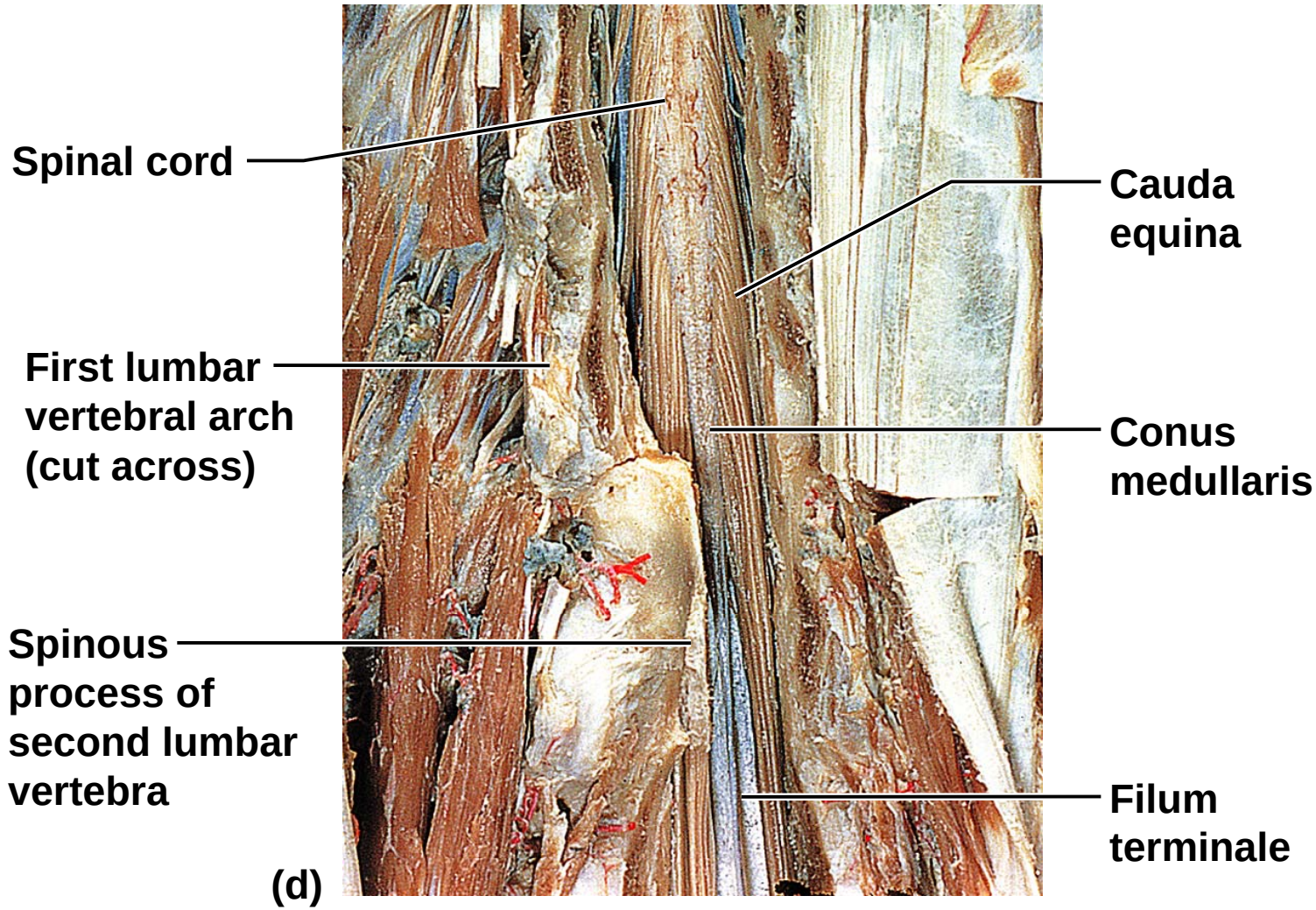


Figure 12.30: Diagrammatic view of a lumbar tap, p. 472.

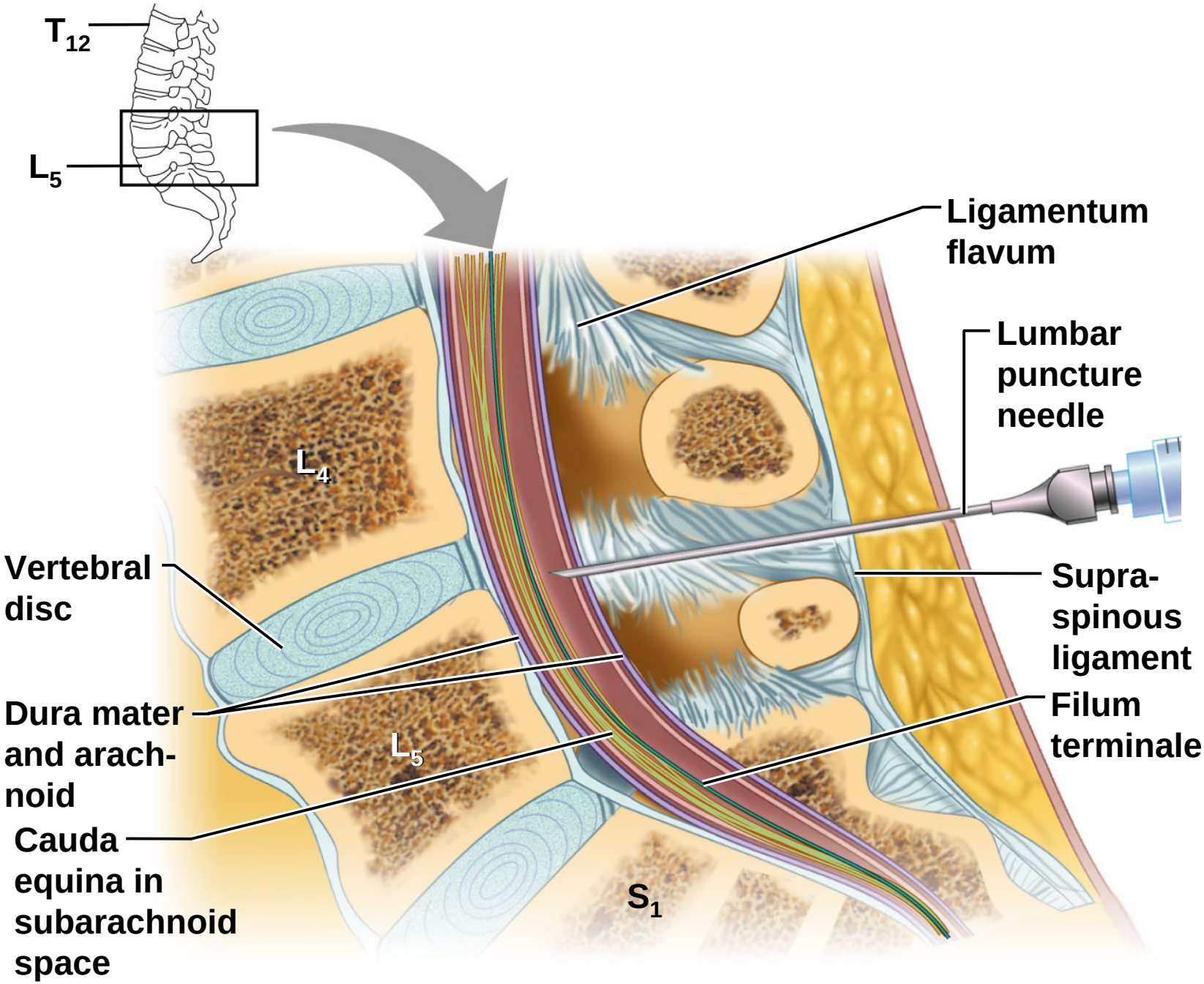


Figure 12.31a: Anatomy of the spinal cord, p. 473.

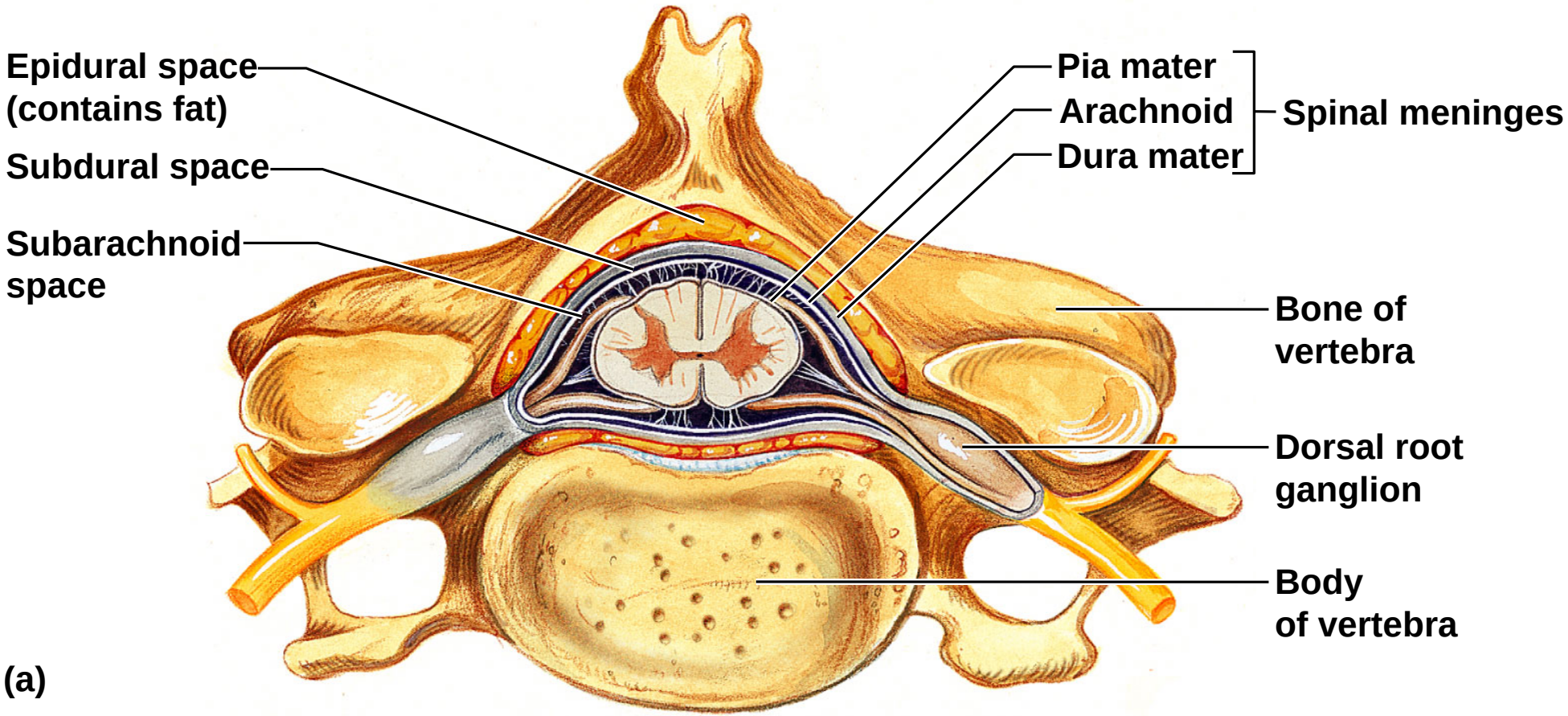


Figure 12.31b: Anatomy of the spinal cord, p. 473.

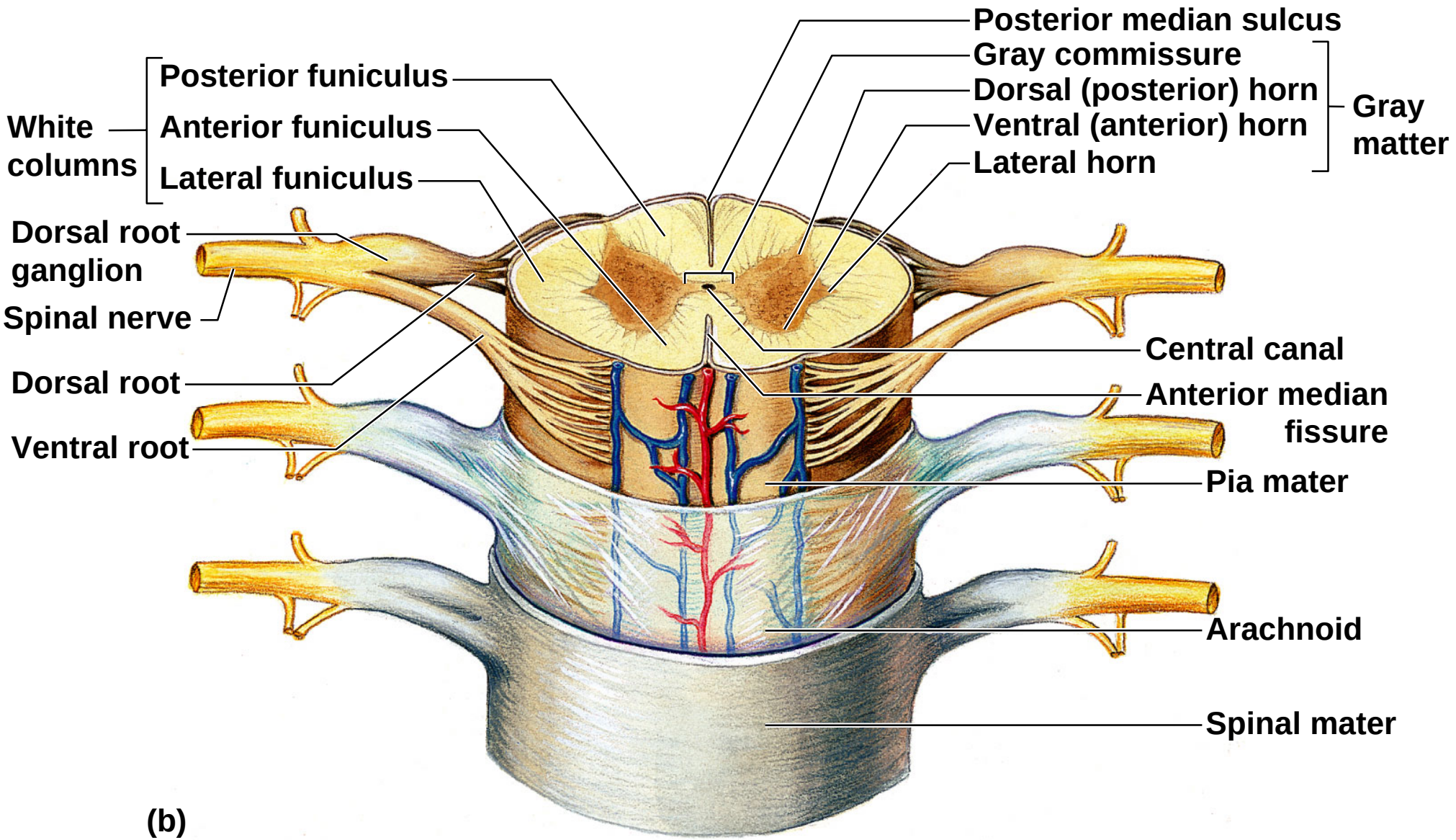


Figure 12.32: Organization of the gray matter of the spinal cord, p. 474.

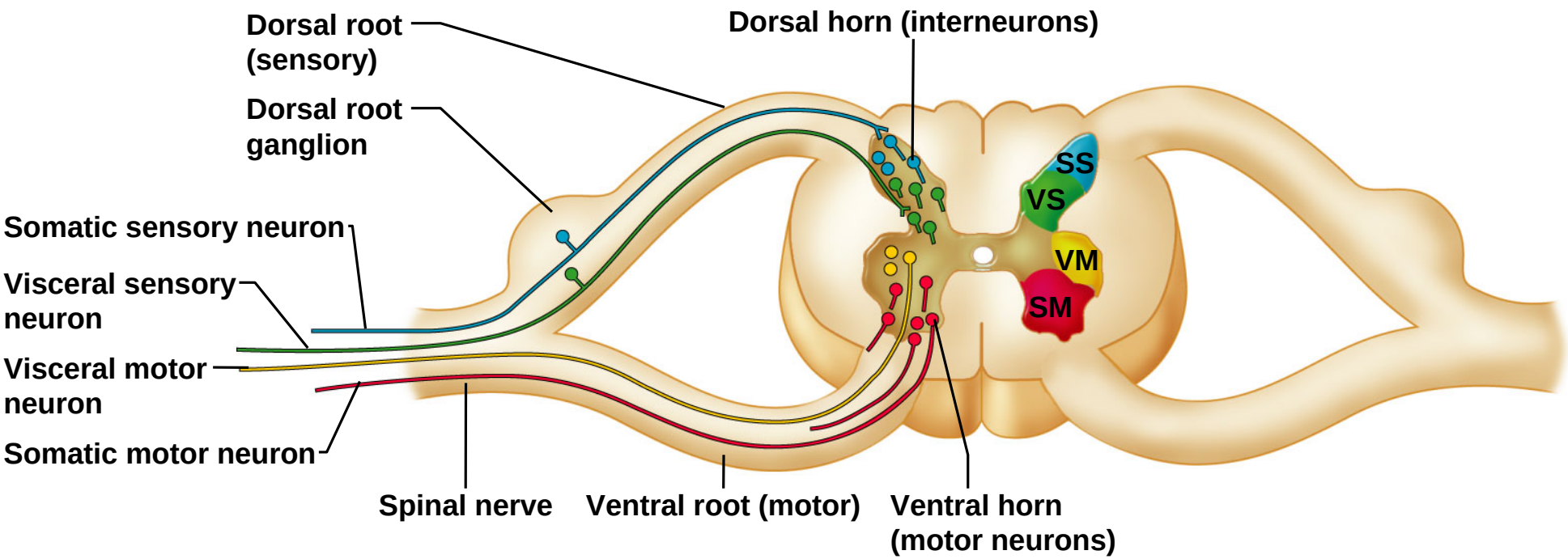


Figure 12.33: Major ascending (sensory) and descending (motor) tracts of the spinal cord, cross-sectional view, p. 475.

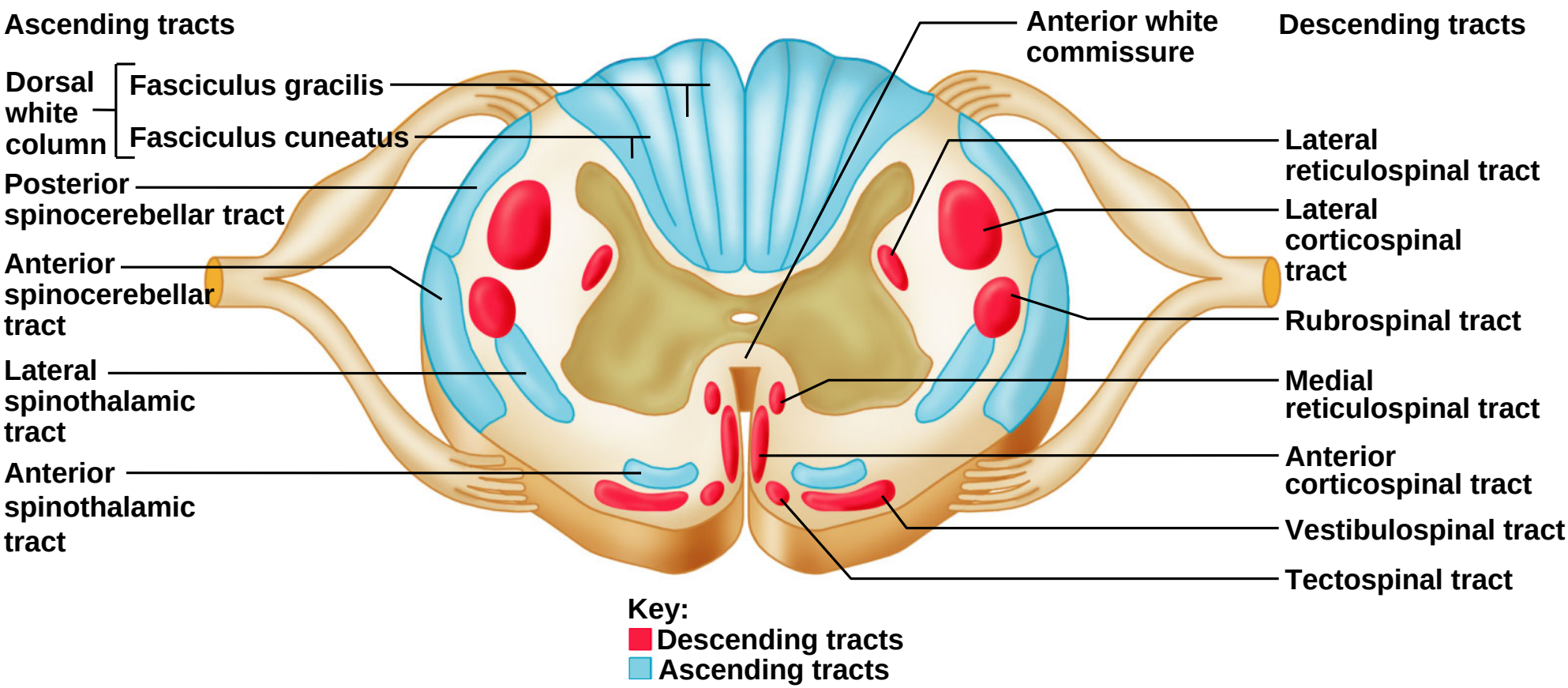


Figure 12.34: Pathways of selected ascending spinal cord tracts, p. 476.

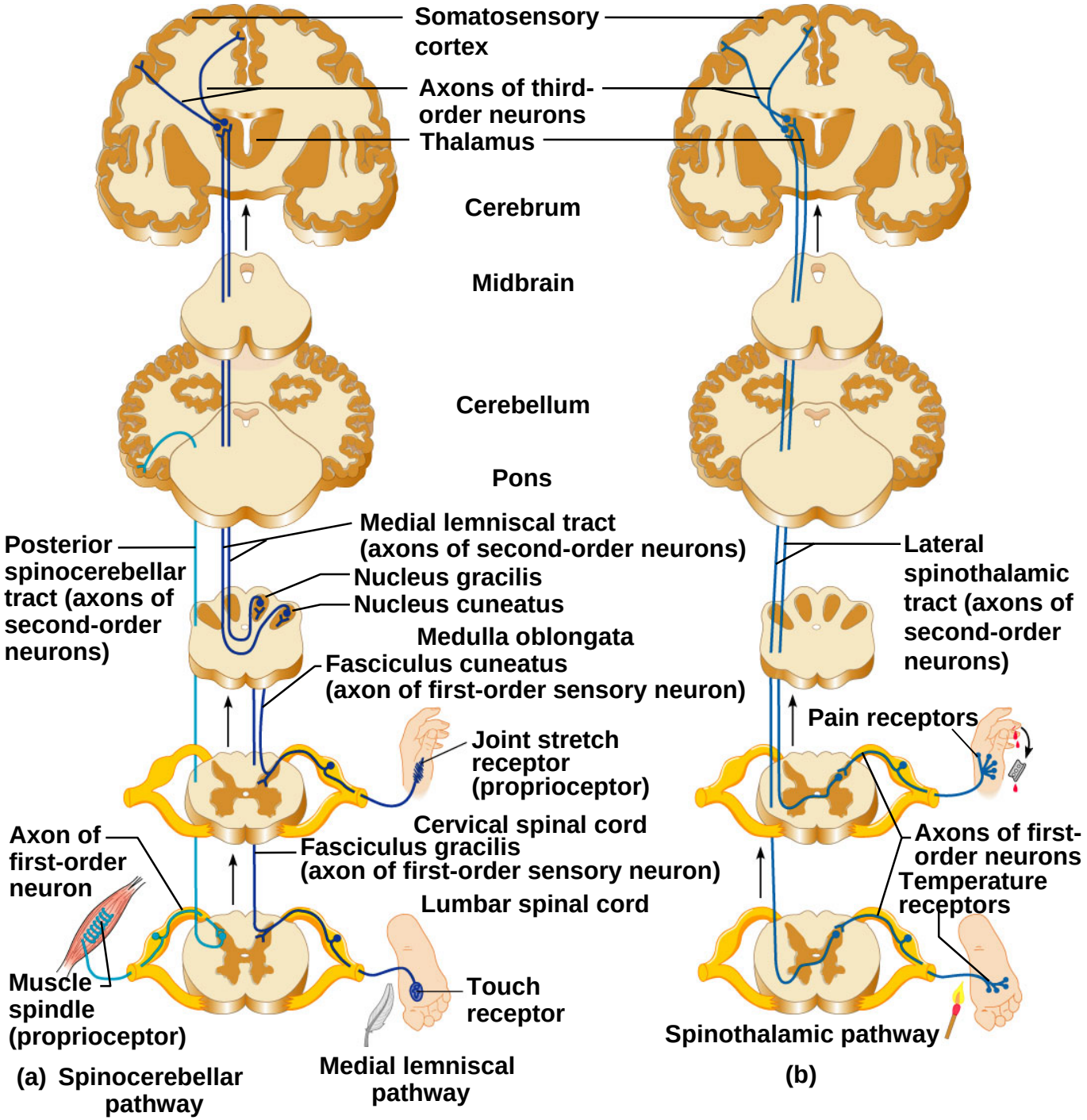


Figure 12.35: Pathways of selected descending spinal cord tracts, p. 480.