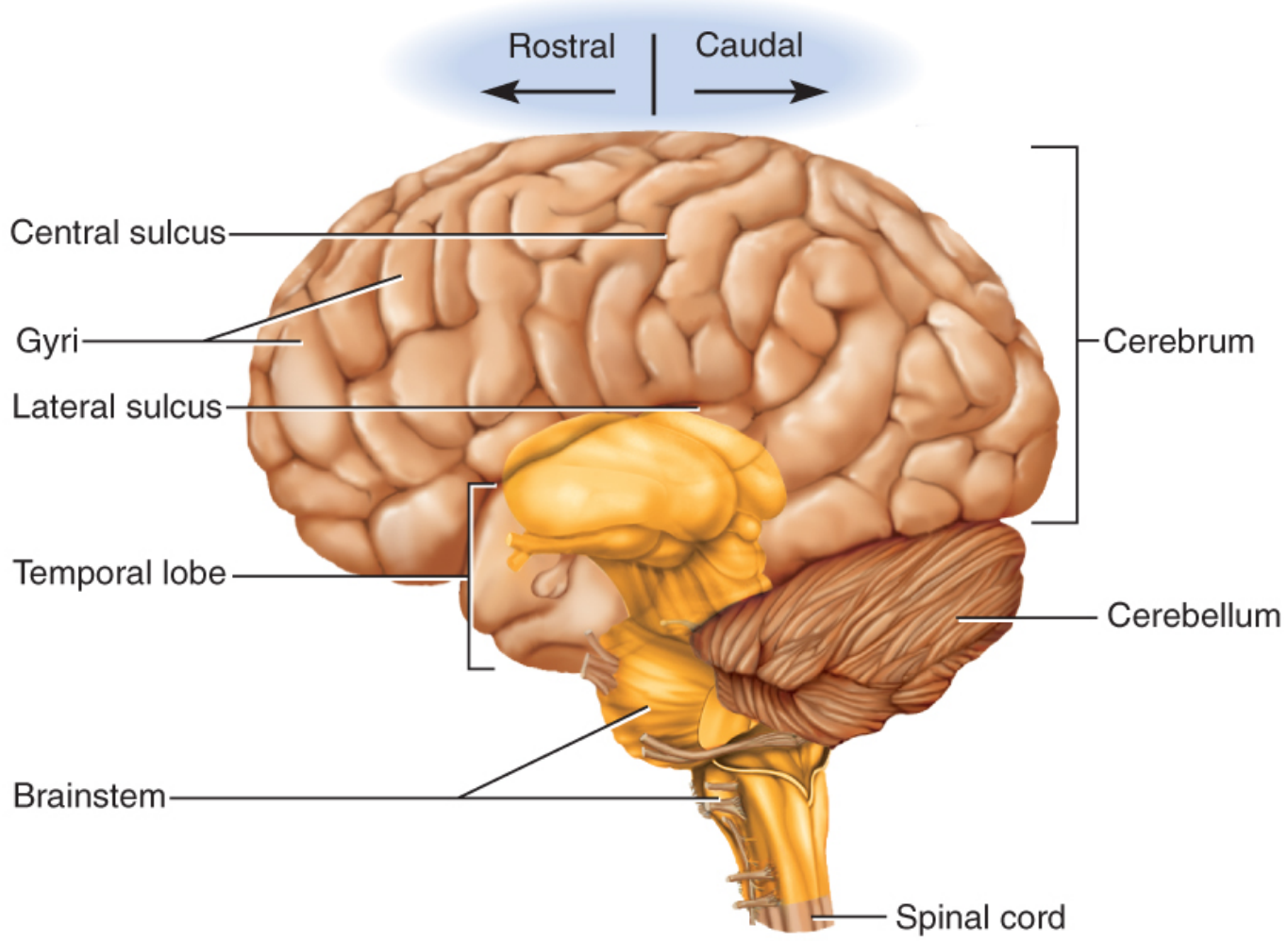
Directional Terms and Landmarks



(b) Lateral view

Cerebrum

- **longitudinal fissure** – deep groove that separates cerebral hemispheres
- **gyri** - thick folds
- **sulci** - shallow grooves
- **corpus callosum** – thick nerve bundle at bottom of longitudinal fissure that connects hemispheres

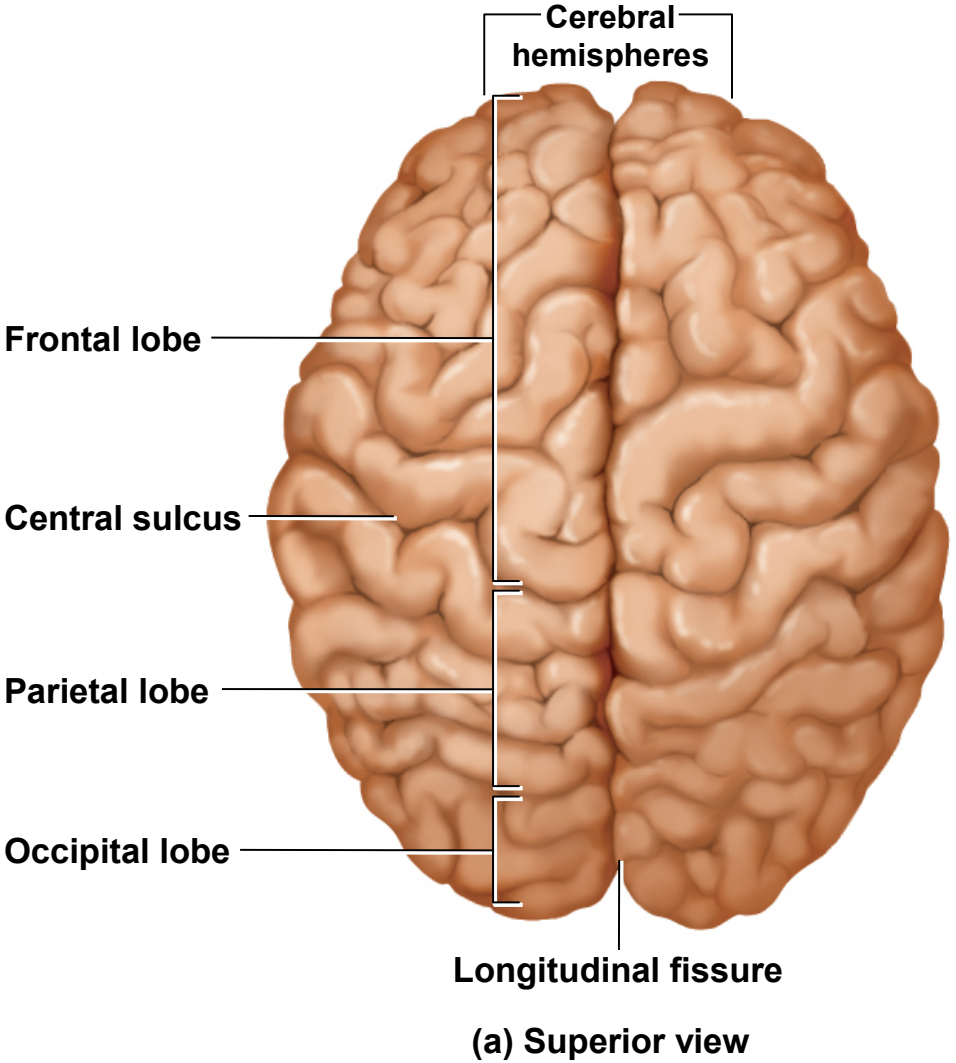
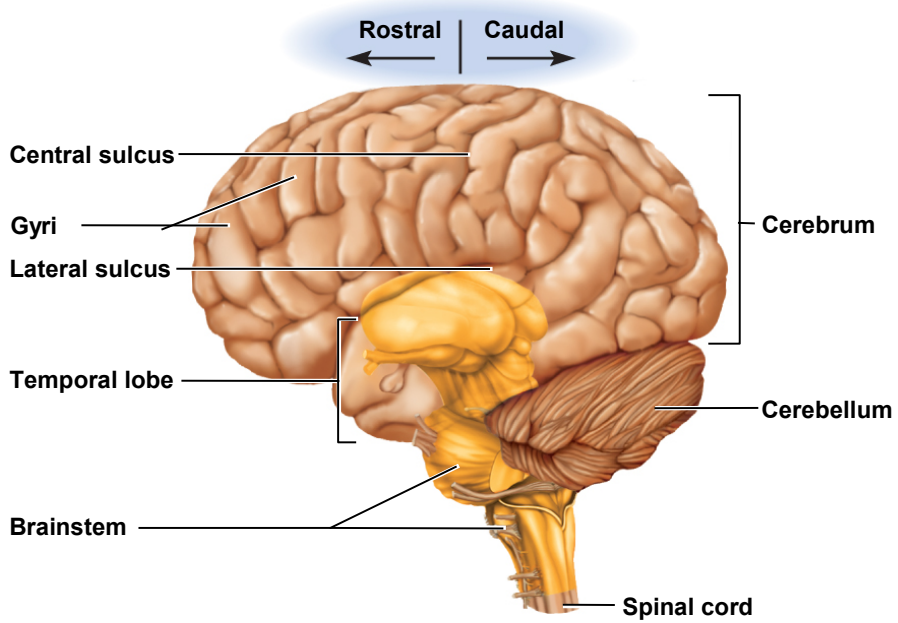


Figure 14.1a

Cerebellum

- occupies **posterior cranial fossa**
- marked by **gyri**, **sulci**, and **fissures**
- about 10% of brain volume
- contains over 50% of brain neurons



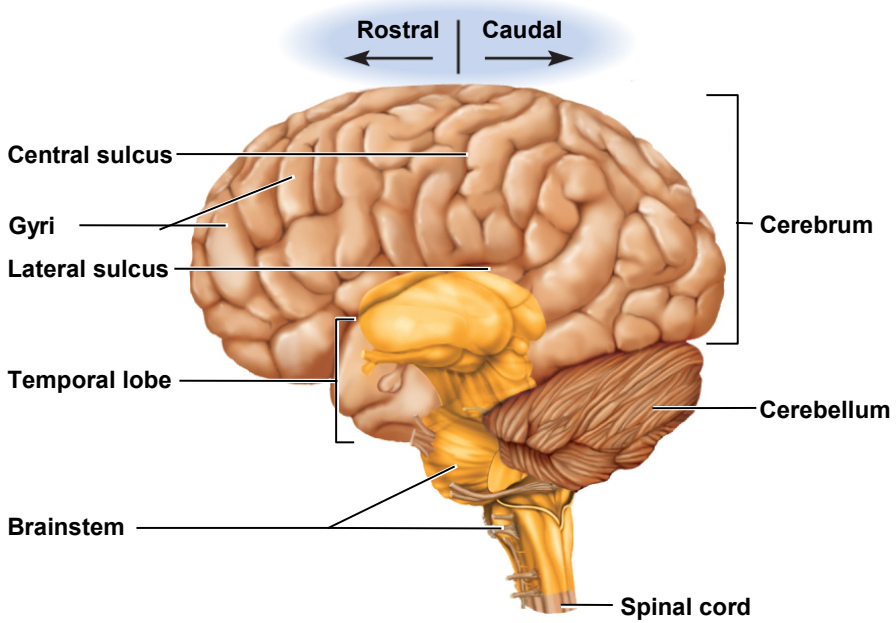
(b) Lateral view

Figure 14.1b

Brainstem

- **brainstem** – what remains of the brain if the cerebrum and cerebellum are removed

- **major components**
  - **diencephalon**
  - **midbrain**
  - **pons**
  - **medulla oblongata**



(b) Lateral view

Figure 14.1b

Median Section of the Brain

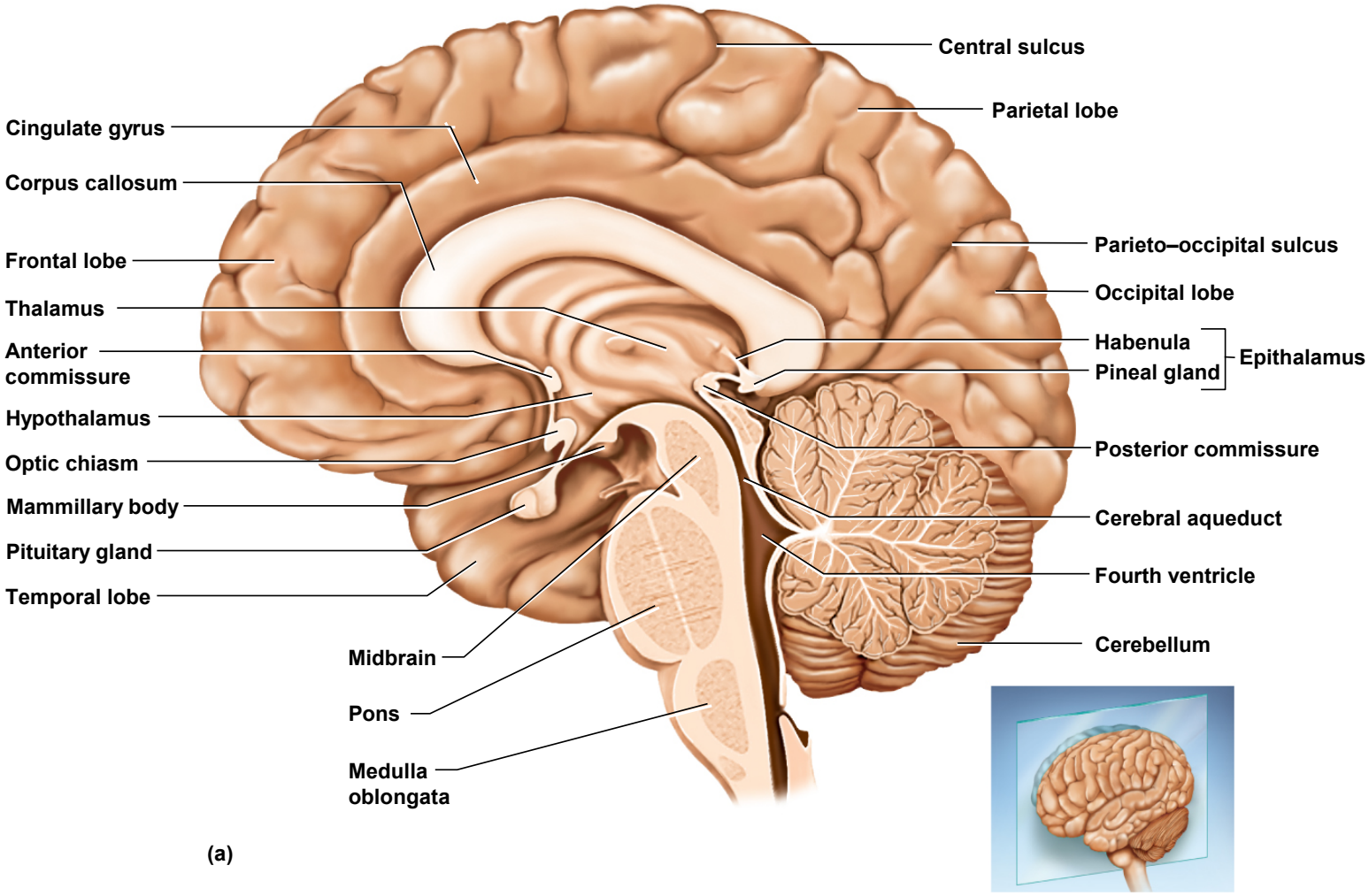


Figure 14.2a

Gray and White Matter

- **gray matter** – the seat of neuron cell bodies, dendrites, and synapses
  - forms surface layer, **cortex,** over cerebrum and cerebellum
  - forms **nuclei** deep within brain
- **white matter -** bundles of axons
  - lies **deep to cortical gray matter**, opposite relationship in the spinal cord
  - composed of **tracts**, bundles of axons, that connect one part of the brain to another, and to the spinal cord

Embryonic Neural Tube

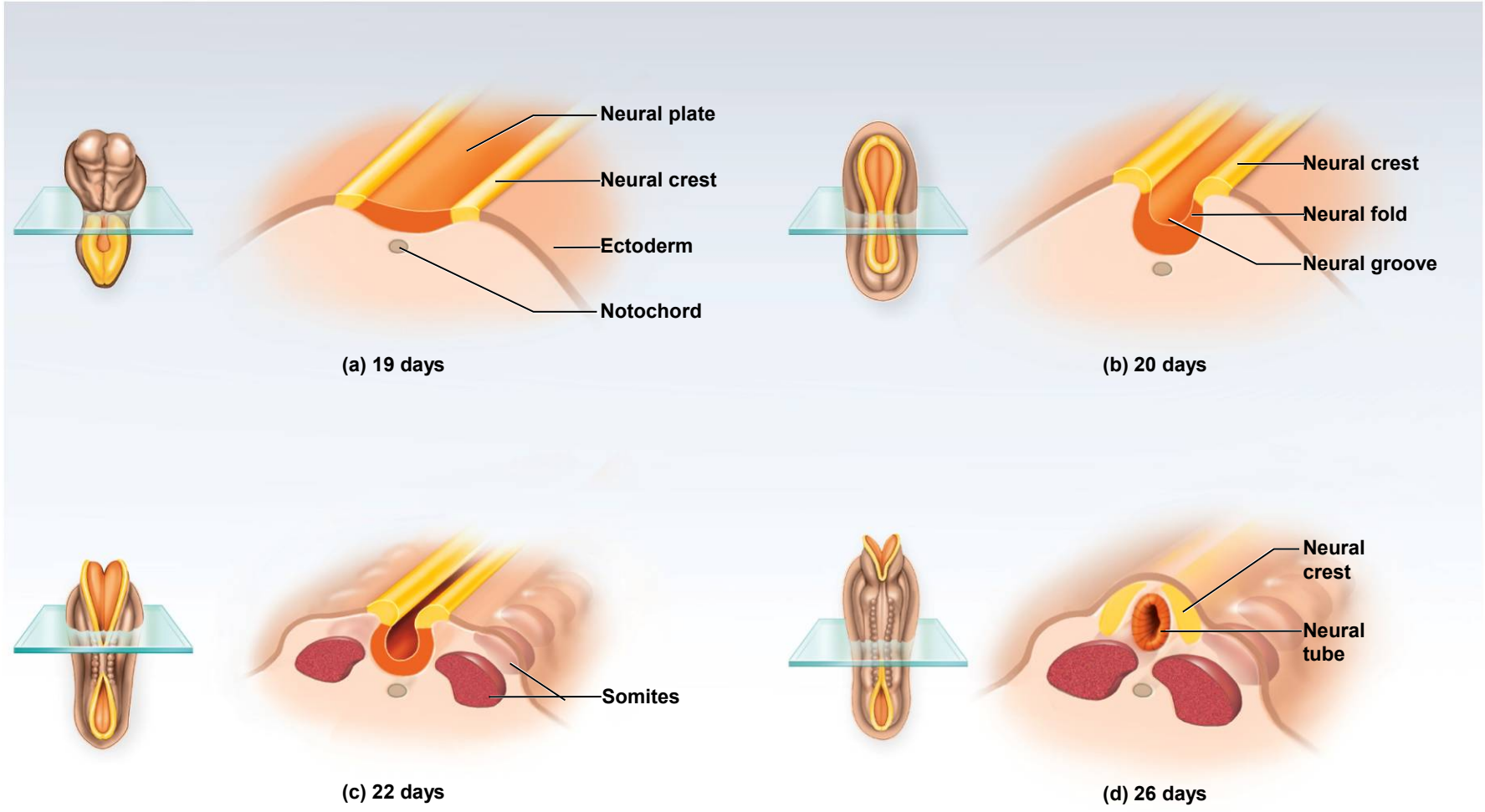


Figure 14.3

Meninges of the Brain

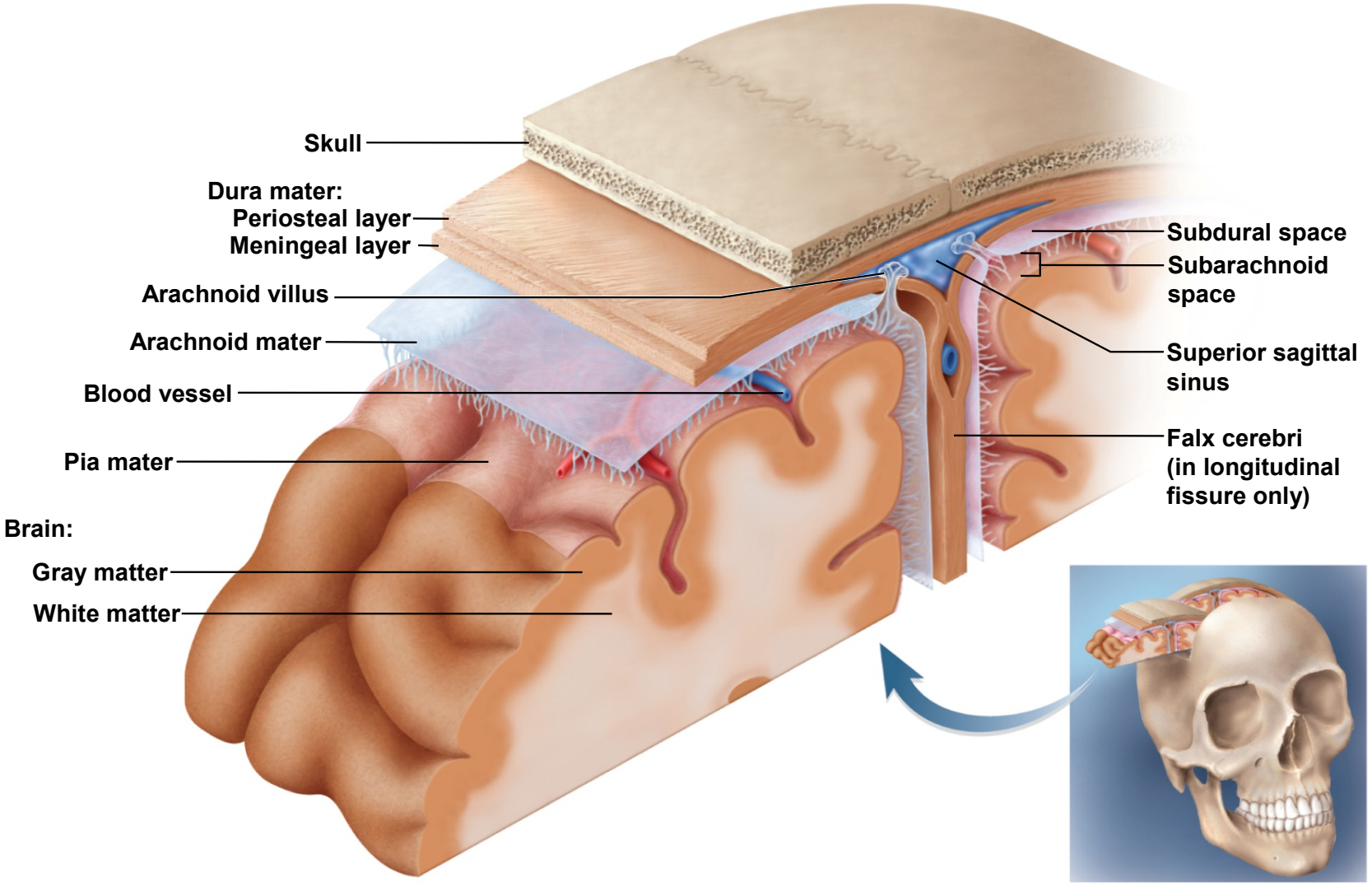


Figure 14.5

Brain Ventricles

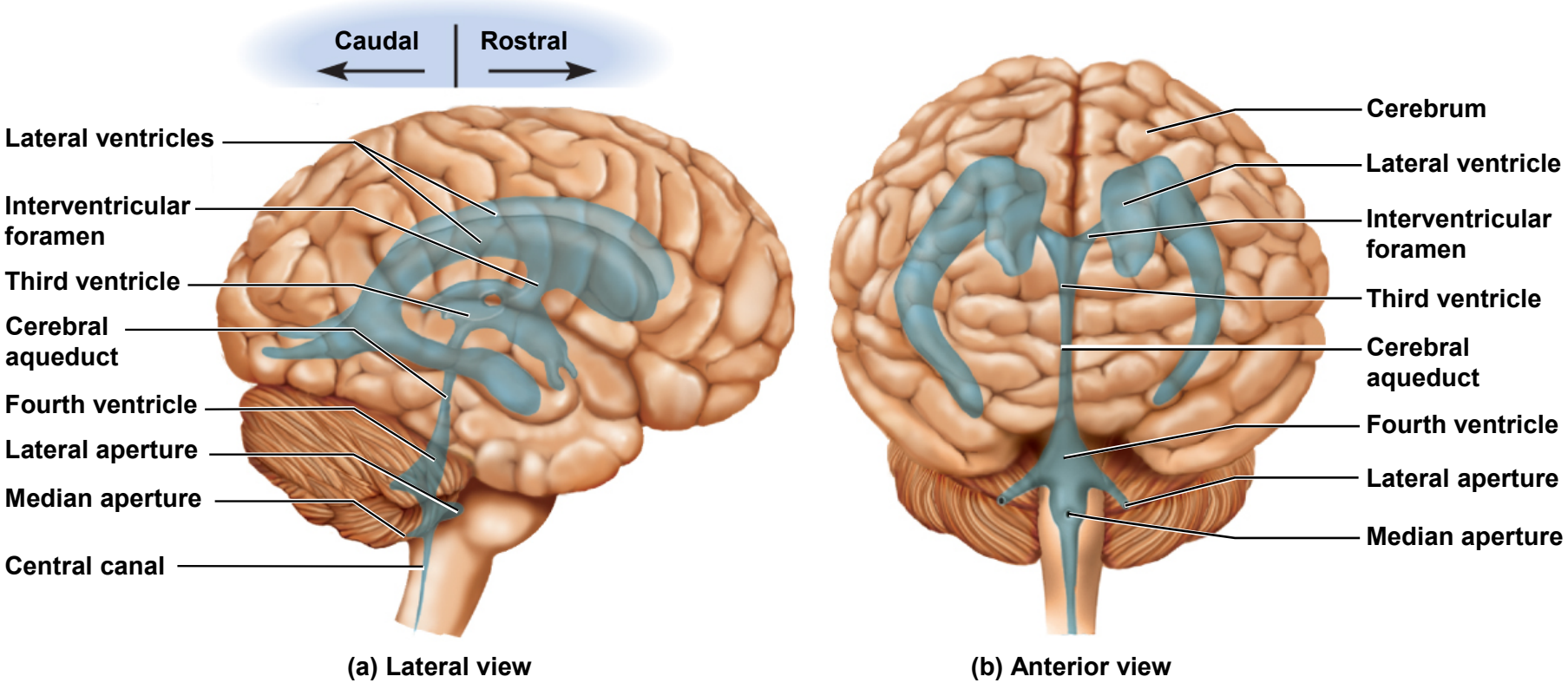


Figure 14.6 a-b

Ventricles and Cerebrospinal Fluid

- **ventricles** – four internal chambers within the brain
  - two **lateral ventricles –** one in each cerebral hemisphere
  - **third ventricle** - single narrow medial space beneath corpus callosum
  - **fourth ventricle** – small triangular chamber between pons and cerebellum
    - connects to **central canal** runs down through spinal cord

Cerebrospinal Fluid (CSF)

choroid plexus – spongy mass of blood capillaries on the floor of each ventricle

Produced cerebrospinal fluid

ependyma – neuroglia that lines the ventricles and covers choroid plexus

produces cerebrospinal fluid

- **cerebrospinal fluid (CSF)** – clear, colorless liquid that fills the ventricles and canals of CNS
  - bathes its external surface
- ependymal cells modify blood filtrate

Functions of CSF

- **buoyancy**
  - allows brain to attain considerable size without being impaired by its own weight
  - if it rested heavily on floor of cranium, the pressure would kill the nervous tissue
- **protection**
  - protects the brain from striking the cranium when the head is jolted
- **chemical stability**
  - flow of CSF rinses away metabolic wastes from nervous tissue and homeostatically regulates its chemical environment

Flow of Cerebrospinal Fluid

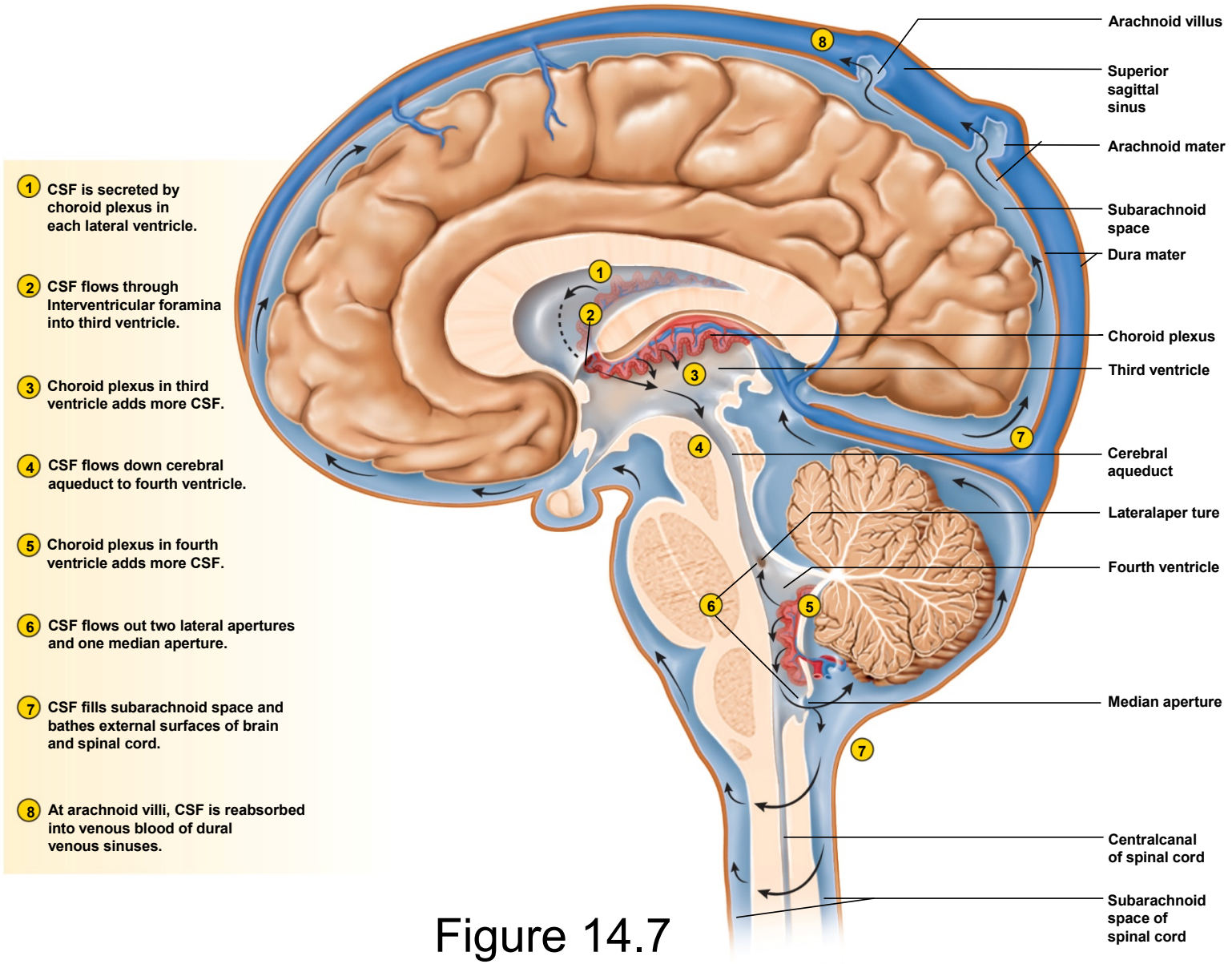


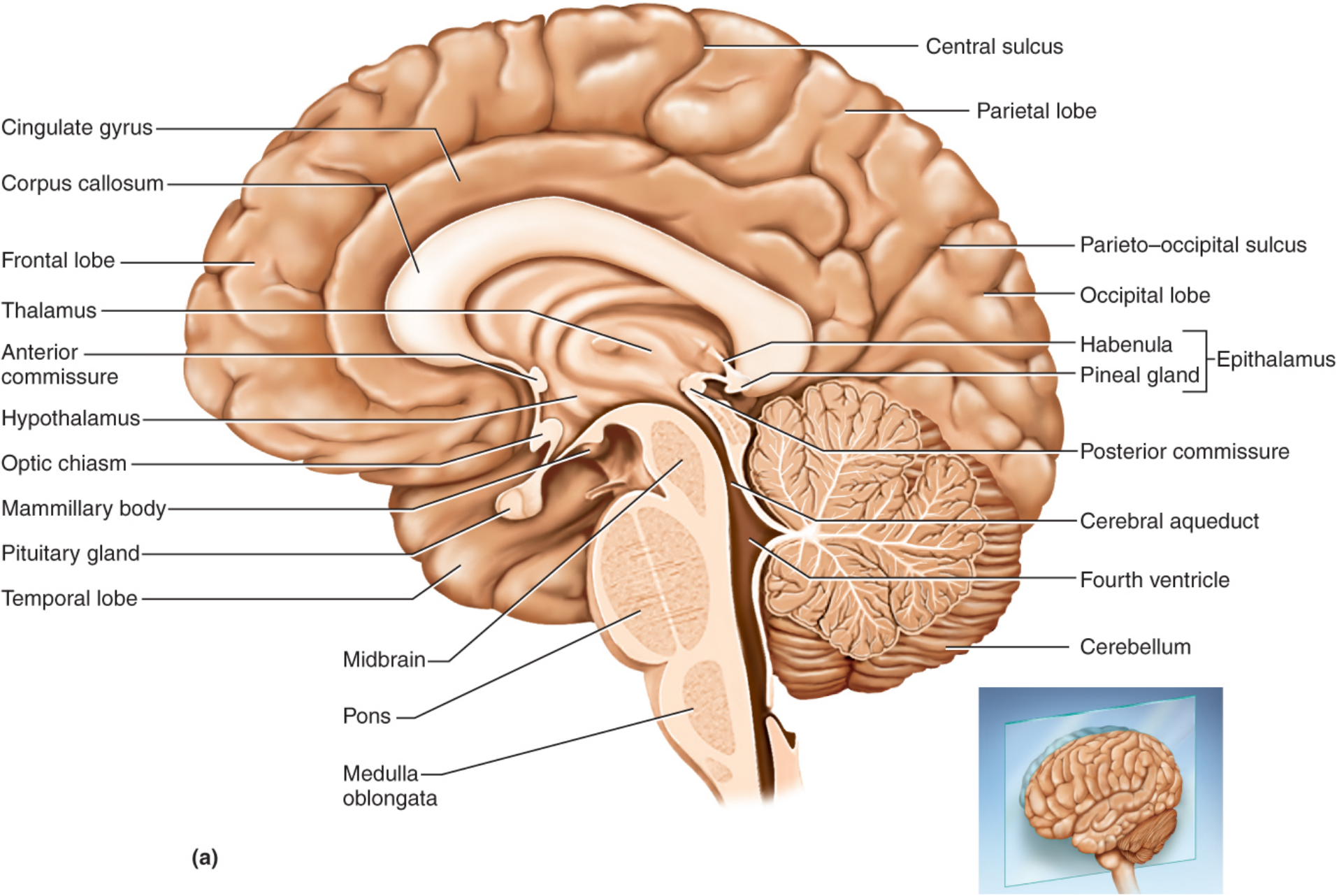
Figure 14.7

Blood Supply to the Brain

- brain is only 2% of the adult body weight, and receives 15% of the blood
- neurons have a high demand for ATP, and therefore, oxygen and glucose, so a constant supply of blood is critical to the nervous system
  - 10 second interruption of blood flow may cause loss of consciousness
  - 1 – 2 minute interruption can cause significant impairment of neural function
  - 4 minutes with out blood causes irreversible brain damage

Brain Barrier System

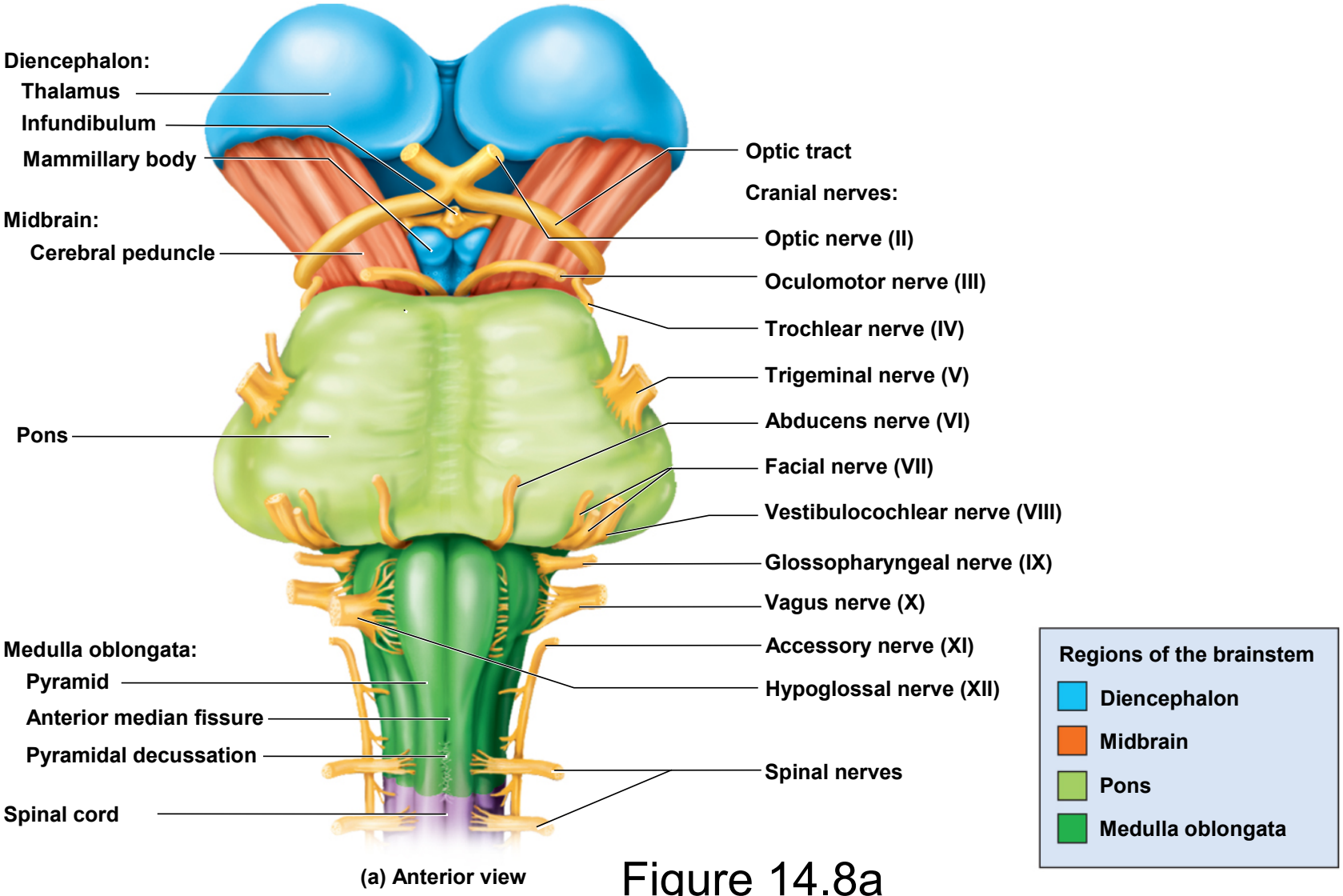
- blood is also a source of antibodies, macrophages, bacterial toxins, and other harmful agents
- **brain barrier system** – strictly regulates what substances can get from the bloodstream into the tissue fluid of the brain
- **blood-brain barrier** - protects blood capillaries throughout brain tissue
  - consists of tight junctions between endothelial cells that form the capillary walls
  - **astrocytes** reach out and contact capillaries with their perivascular feet
  - induce the endothelial cells to form tight junctions that completely seal off gaps between them
  - anything leaving the blood must pass through the cells, and not between them
  - **endothelial cells** can exclude harmful substances from passing to the brain tissue while allowing necessary ones to pass



Medulla Oblongata

- **cardiac center**
  - adjusts rate and force of heart
- **vasomotor center**
  - adjusts blood vessel diameter
- **respiratory centers**
  - control rate and depth of breathing
- **reflex centers**
  - for coughing, sneezing, gagging, swallowing, vomiting, salivation, sweating, movements of tongue and head

Medulla and Pons



(a) Anterior view

Figure 14.8a

Pons

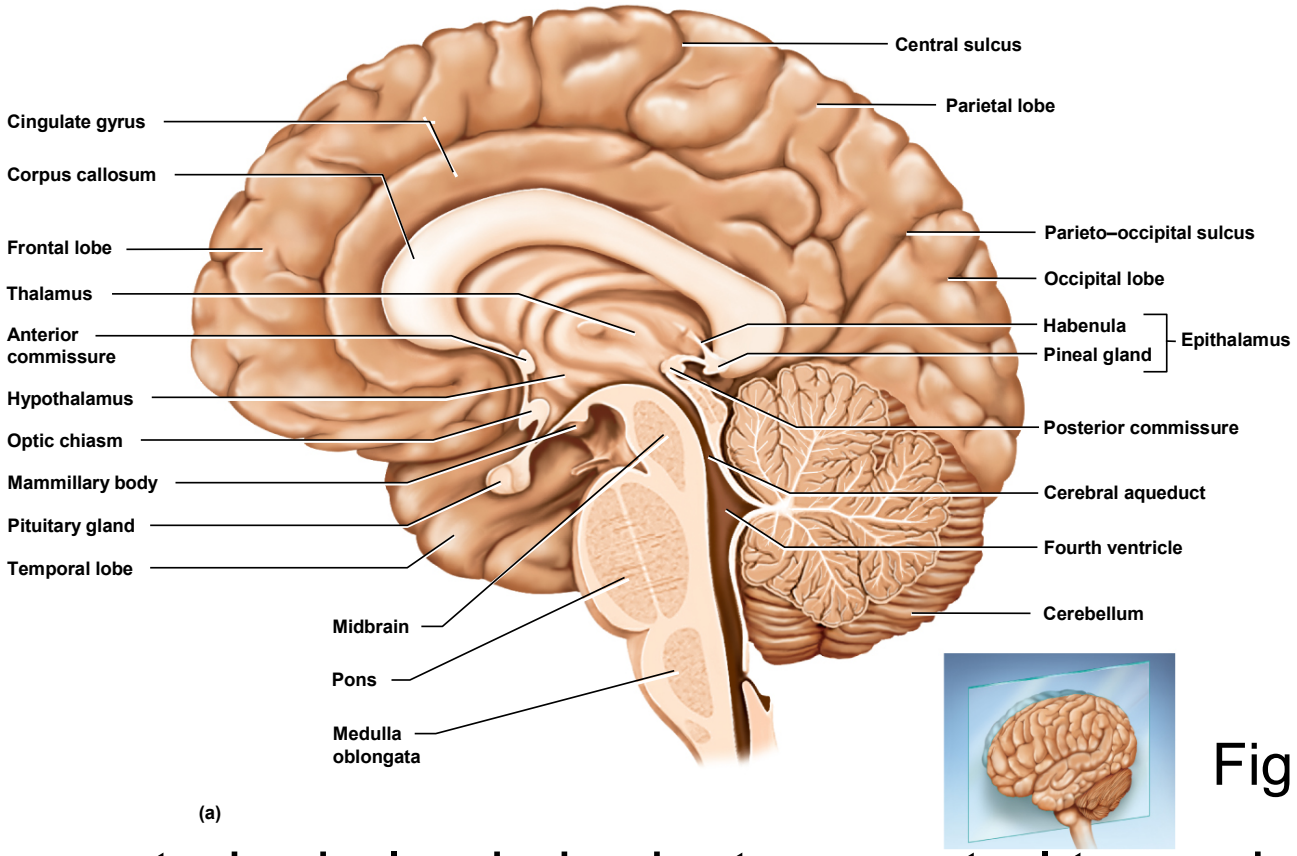


Figure 14.2a

- **pons** – anterior bulge in brainstem, rostral to medulla

Pons

- ascending sensory tracts
- descending motor tracts
- pathways in and out of cerebellum
- **reticular formation** in pons contains additional nuclei concerned with:
  - sleep, respiration, and posture

Reticular Formation

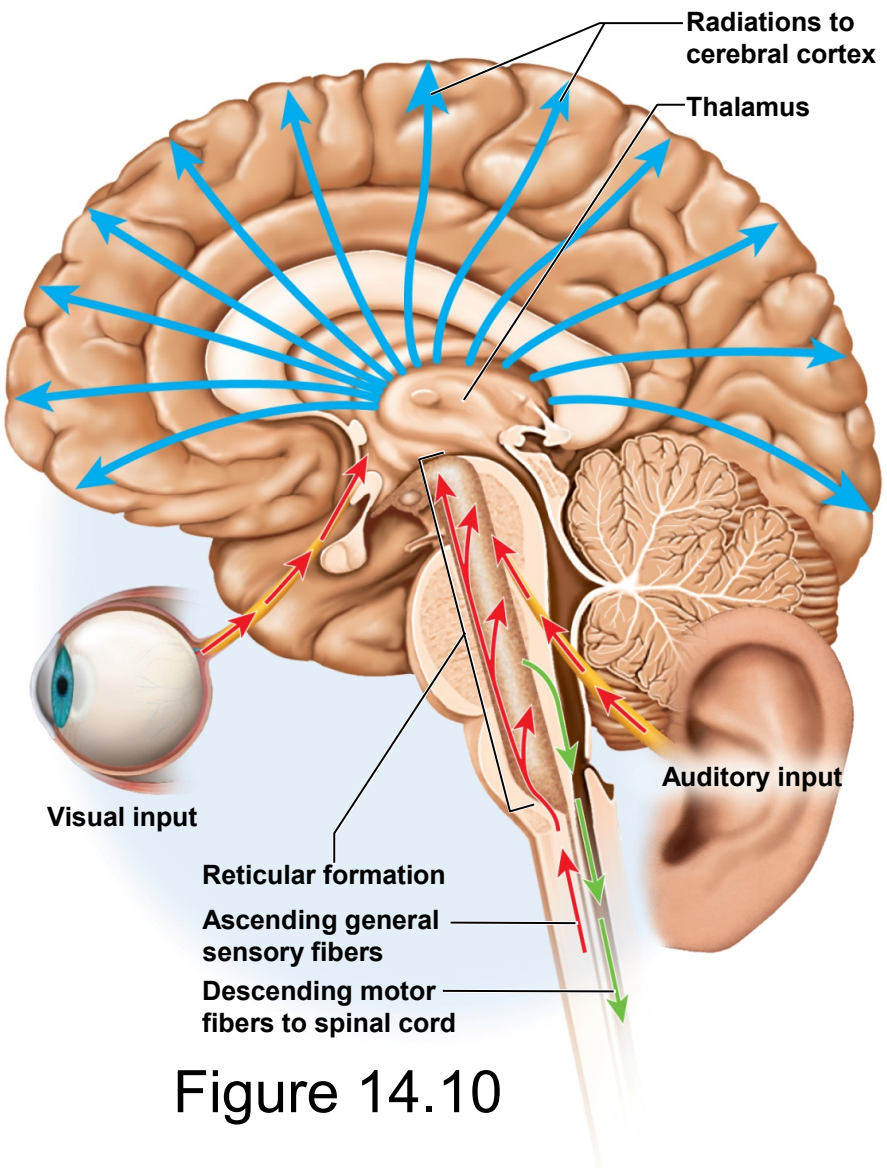


Figure 14.10

- **reticular formation** – loosely organized web of gray matter that runs vertically through all levels of the brainstem
- clusters of gray matter scattered throughout pons, midbrain and medulla
- occupies space between white fiber tracts and brainstem nuclei
- has connections with many areas of cerebrum

Functions of Reticular Formation Networks

- somatic motor control
- cardiovascular control
- pain modulation
- sleep and consciousness
- habituation

Cerebellum

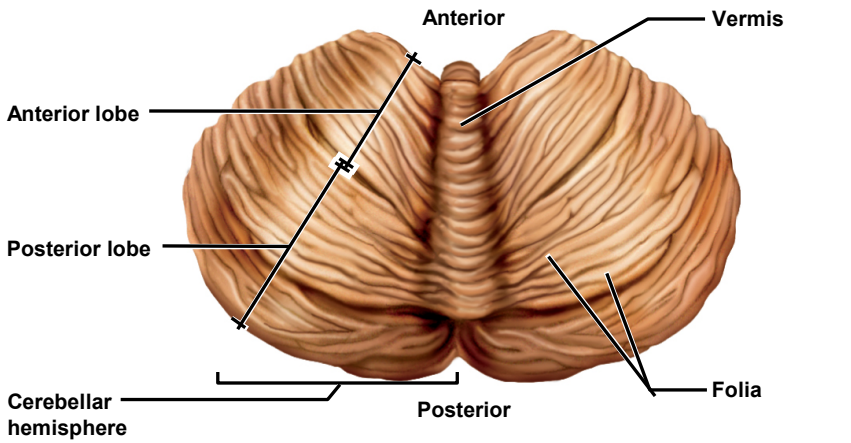


Figure 14.11b

- the largest part of the hindbrain and the second largest part of the brain as a whole
- consists of right and left cerebellar hemispheres connected by **vermis**

Cerebellum

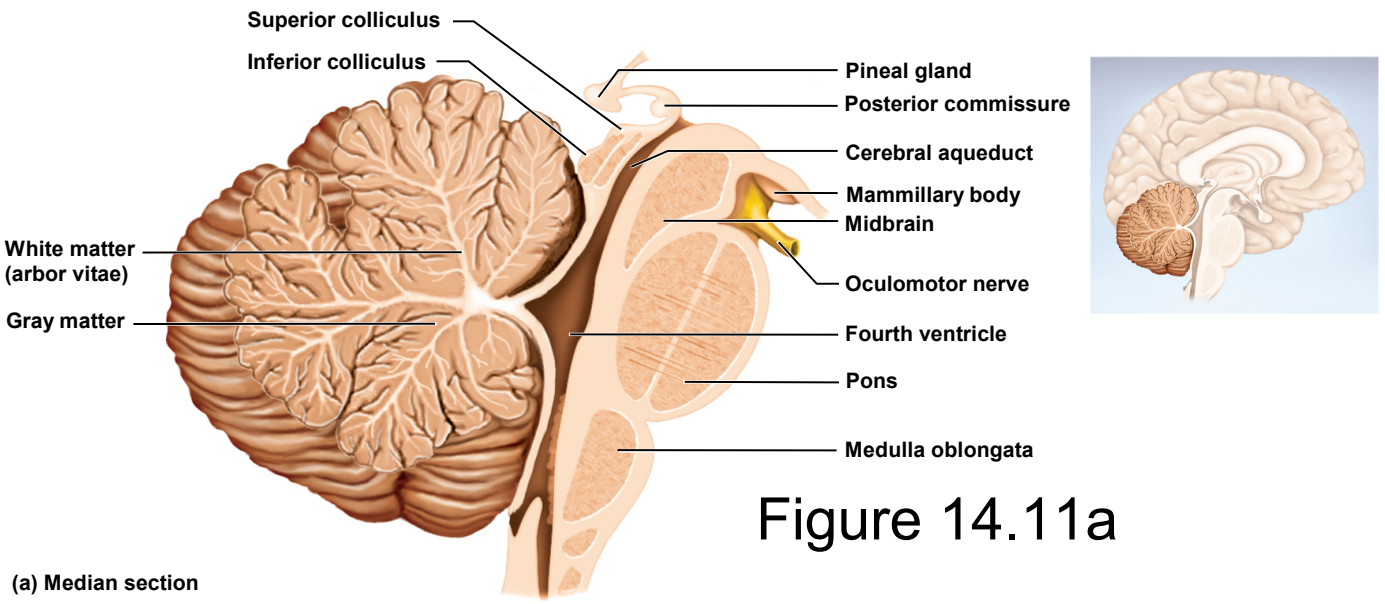
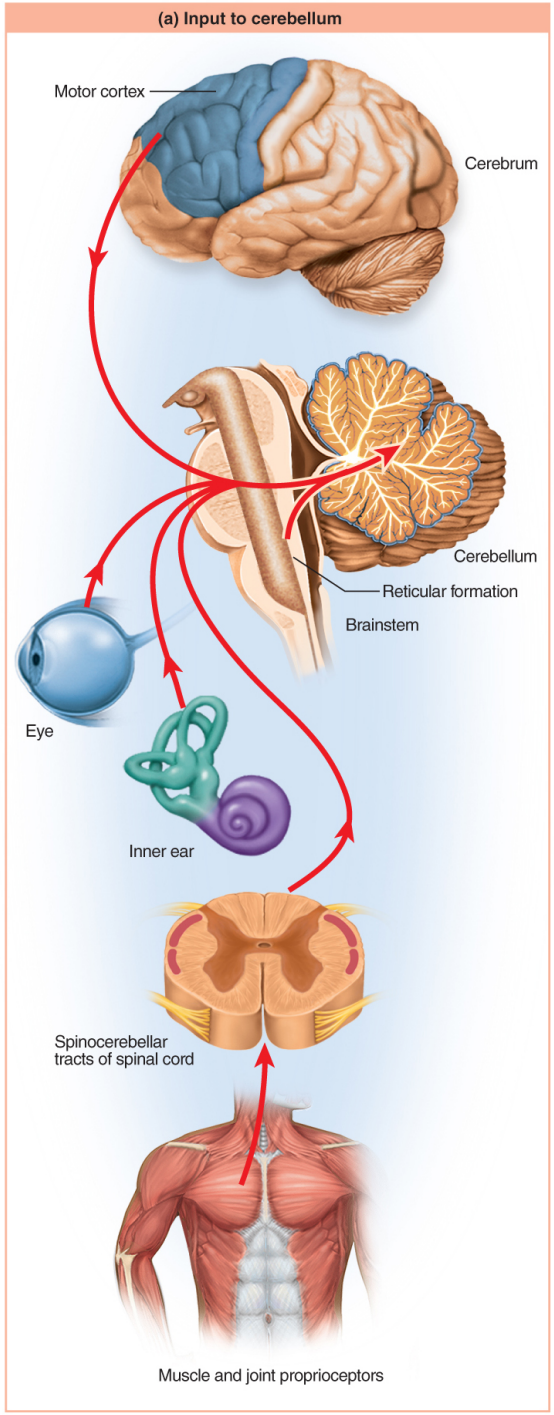
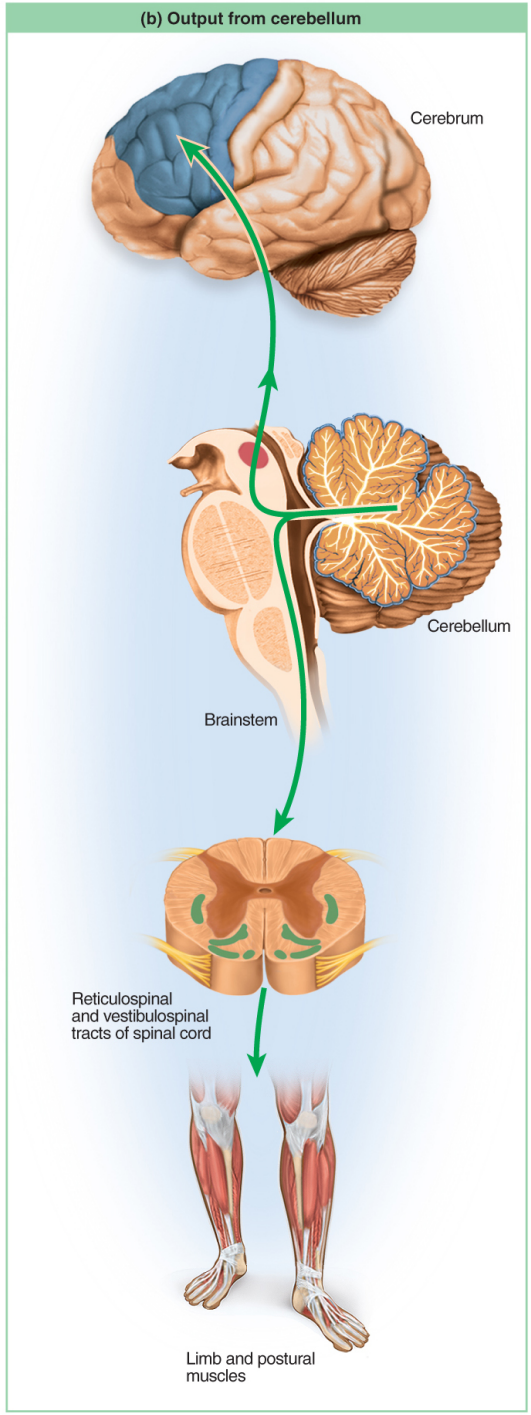


Figure 14.11a

- **cerebellar peduncles** – three pairs of stalks that connect the cerebellum to the brainstem
  - **inferior peduncles** – connected to medulla oblongata (input)
  - **middle peduncles** – connected to the pons (input)
  - **superior peduncles** – connected to the midbrain (output)

Input and Output to Cerebellum





Cerebellar Functions

- monitors muscle contractions and aids in motor coordination
- evaluation of sensory input
  - comparing textures without looking at them
  - spatial perception and comprehension of different views of 3D objects belonging to the same object
- timekeeping center
  - predicting movement of objects
  - helps predict how much the eyes must move in order to compensate for head movements and remain fixed on an object
- hearing
  - distinguish pitch and similar sounding words
- planning and scheduling tasks

The Forebrain

- forebrain consists of :
  - **Thalamus**
  - **hypothalamus**
  - **cerebrum**

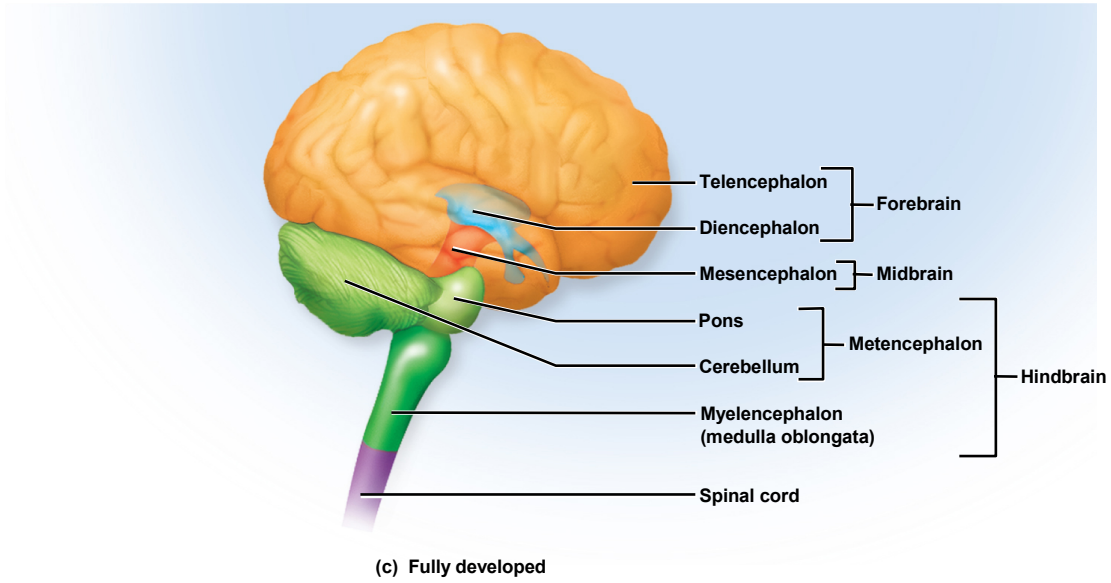


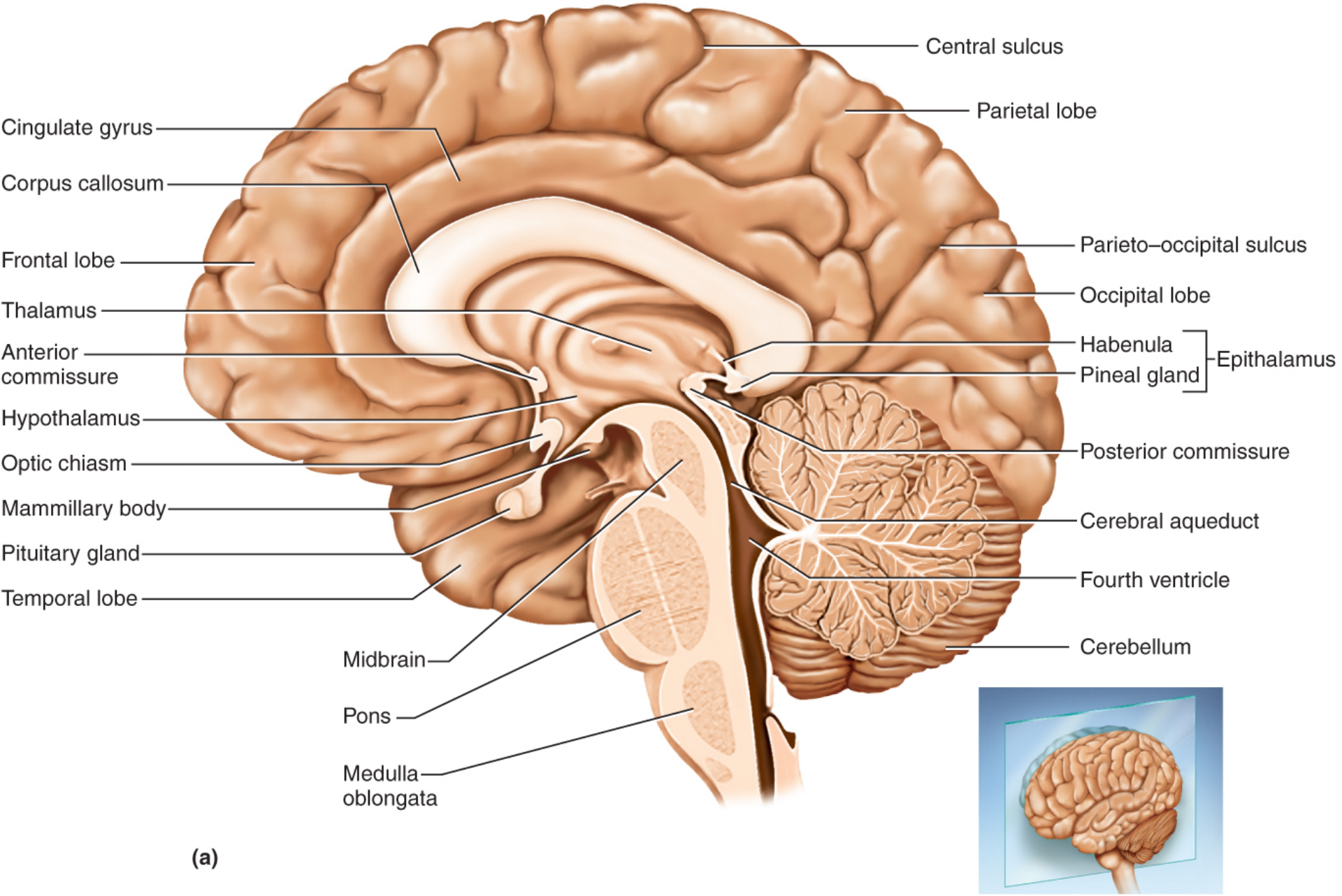
Figure 14.4c

Thalamus

- **Thalamus**
  - nearly all input to the cerebrum passes by way of synapses in the thalamic nuclei, filters information on its way to cerebral cortex
  - **motor control -** relays signals from cerebellum to cerebrum
  - **memory and emotional functions** of the **limbic system** – includes some cerebral cortex of the temporal and frontal lobes and some of the anterior thalamic nuclei

Hypothalamus

- **hypothalamus** – forms part of the walls and floor of the third ventricle
  - relay signals from the limbic system to the thalamus
- **infundibulum** – a stalk that attaches the pituitary gland to the hypothalamus
  - **major control center of autonomic nervous system and endocrine system**
  - plays essential roll in homeostatic regulation of all body systems



Hypothalamus

- functions of hypothalamic nuclei
  - **hormone secretion**
  - **autonomic effects**
  - **thermoregulation**
  - **food and water intake**
  - **rhythm of sleep and waking**
  - **memory**
  - **emotional behavior**

Cerebrum

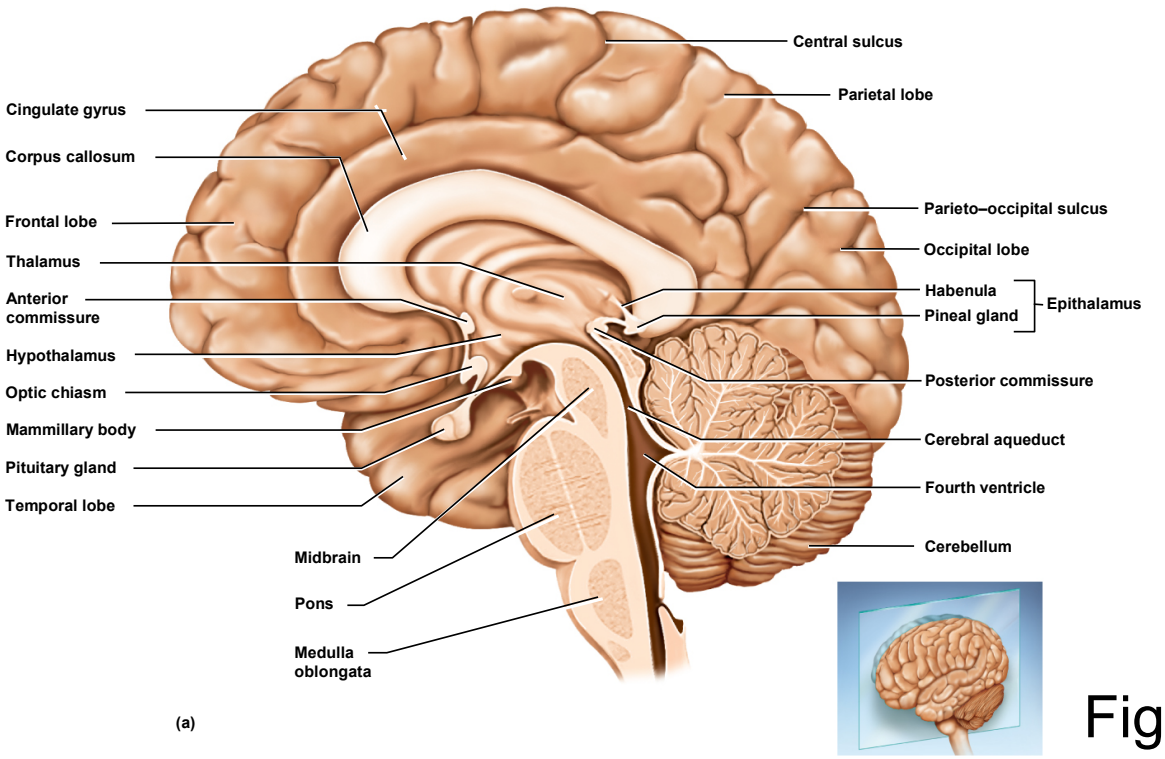


Figure 14.2a

- **cerebrum** – largest and most conspicuous part of the human brain
  - seat of sensory perception, memory, thought, judgment, and voluntary motor actions

Cerebrum - Gross Anatomy

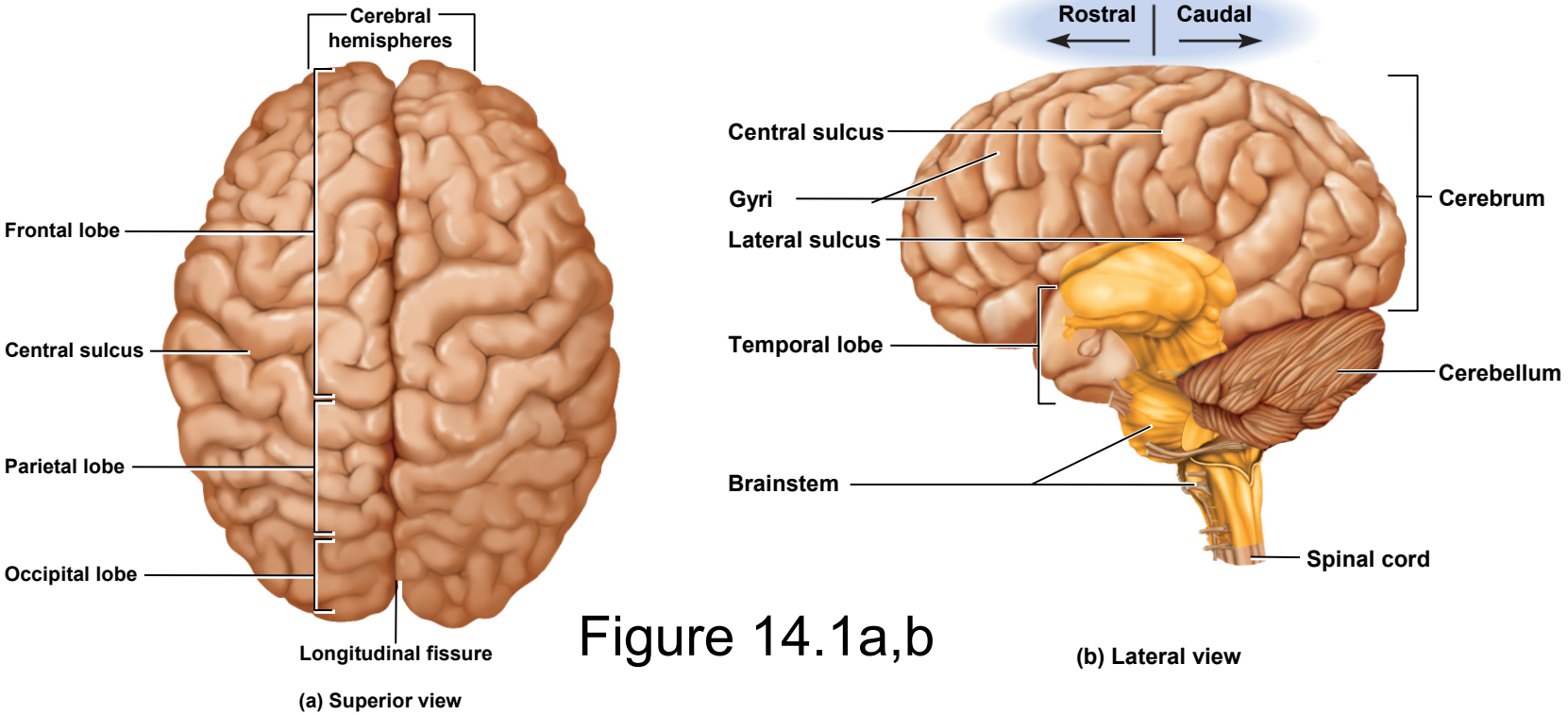
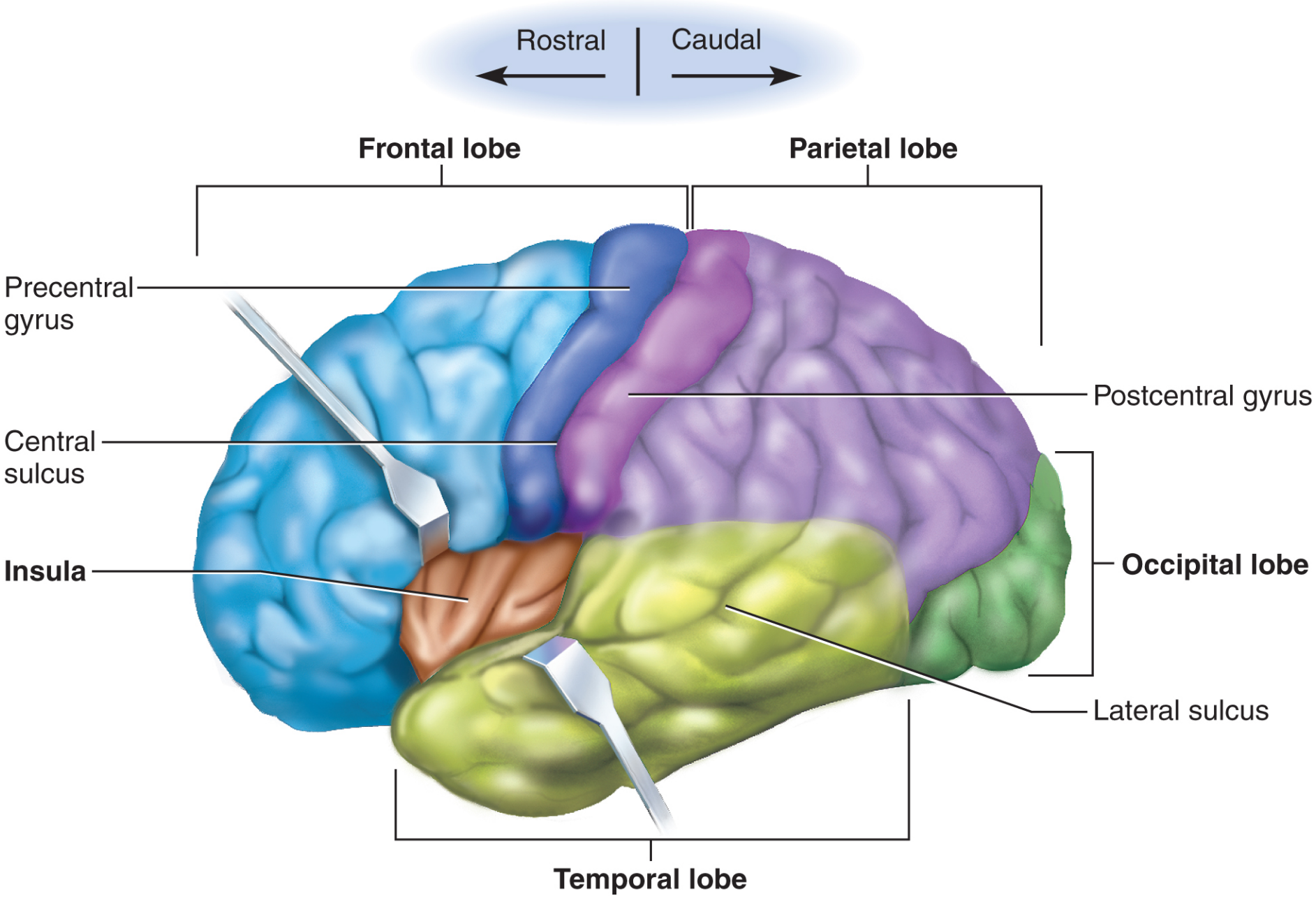


Figure 14.1a,b

- two **cerebral hemispheres** divided by **longitudinal fissure**
  - connected by white fibrous tract the **corpus callosum**
  - **gyri** and **sulci** – increases amount of cortex in the cranial cavity
  - gyri increases surface area for information processing capability
  - some sulci divide each hemisphere into **five lobes** named for the cranial bones that overly them

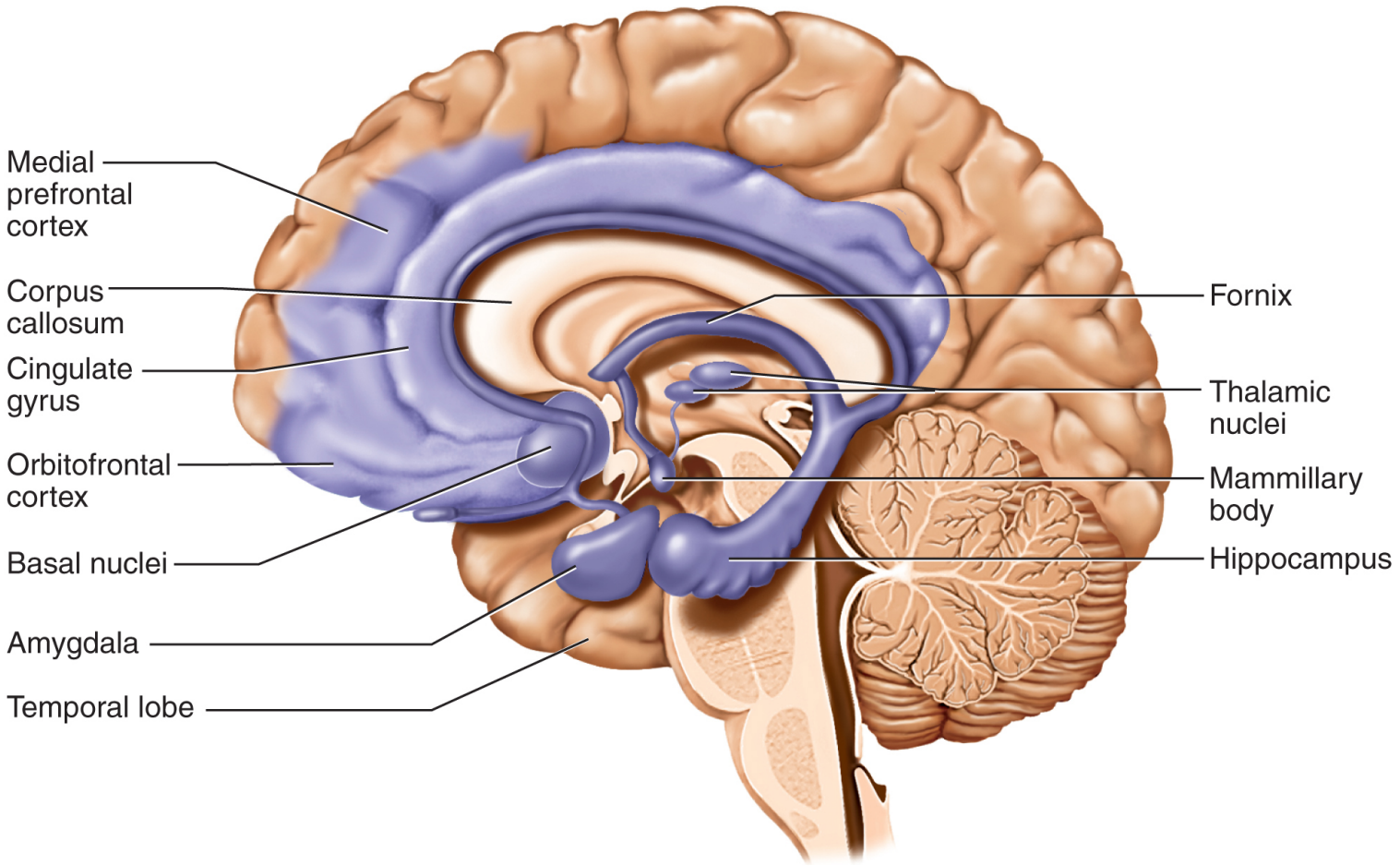
Functions of Cerebrum - Lobes

- **frontal lobe**
  - voluntary motor functions
  - motivation, foresight, planning, memory, mood, emotion, social judgment, and aggression
- **parietal lobe**
  - receives and integrates general sensory information, taste and some visual processing
- **occipital lobe**
  - primary visual center of brain
- **temporal lobe**
  - areas for hearing, smell, learning, memory, and some aspects of vision and emotion
- **insula** (hidden by other regions)
  - understanding spoken language, taste and sensory information from visceral receptors



Limbic System

- **limbic system** – center of emotion and learning
  - **hippocampus** – in the medial temporal lobe - memory
  - **amygdala** – immediately rostral to the hippocampus - emotion
- circular patterns of feedback



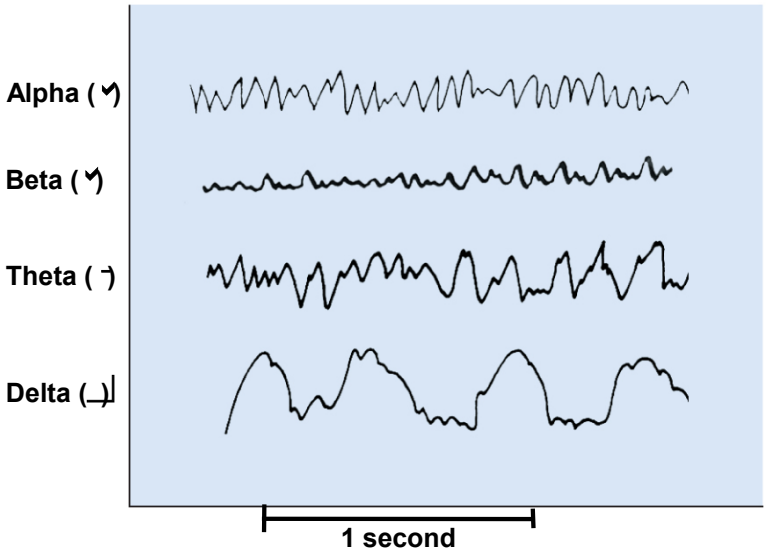
Higher Brain Functions

- higher brain functions - sleep, memory, cognition, emotion, sensation, motor control, and language
- involve interactions between cerebral cortex and basal nuclei, brainstem and cerebellum
- functions of the brain do not have easily defined anatomical boundaries
- integrative functions of the brain focuses mainly on the cerebrum, but involves combined action of multiple brain levels

The Electroencephalogram

(a)

Figure 14.18a



(b)

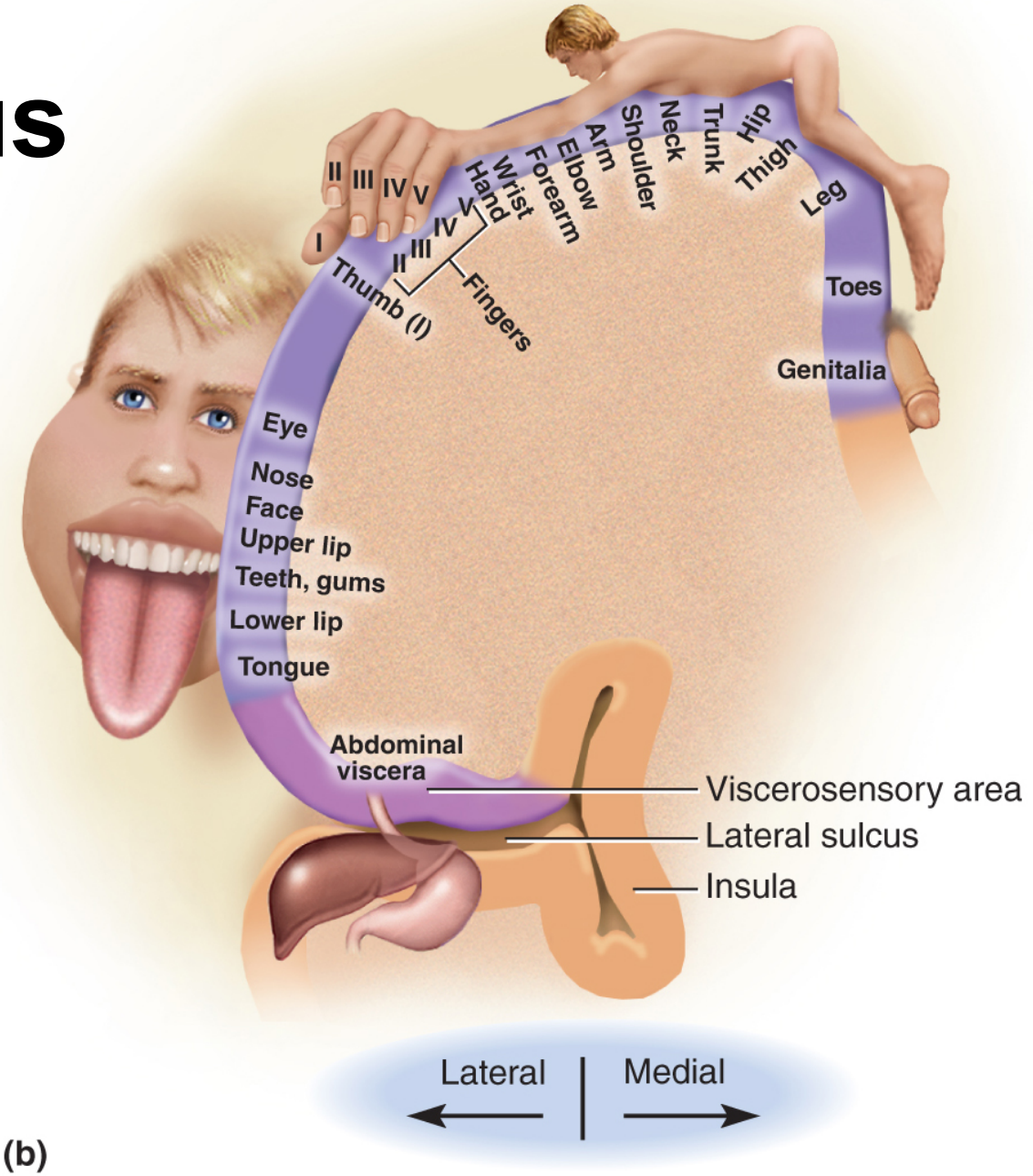
Figure 14.18b

- **electroencephalogram (EEG)** – monitors surface electrical activity of the brain waves
  - useful for studying normal brain functions as sleep and consciousness
  - in diagnosis of degenerative brain diseases, metabolic abnormalities, brain tumors, etc.
- **brain waves** – rhythmic voltage changes resulting from synchronized postsynaptic potentials at the superficial layer of the cerebral cortex
  - 4 types distinguished by amplitude (mV) and frequency (Hz)
- persistent absence of brain waves is common clinical and legal criterion of brain death

Brain Waves

- **alpha waves**
  - awake and resting with eyes closed and mind wandering
  - suppressed when eyes open or performing a mental task
- **beta waves**
  - eyes open and performing mental tasks
  - accentuated during mental activity and sensory stimulation
- **theta waves**
  - drowsy or sleeping
  - if awake and under emotional stress
- **delta waves**
  - deep sleep

Sensory Homunculus



(b)

Motor Homunculus

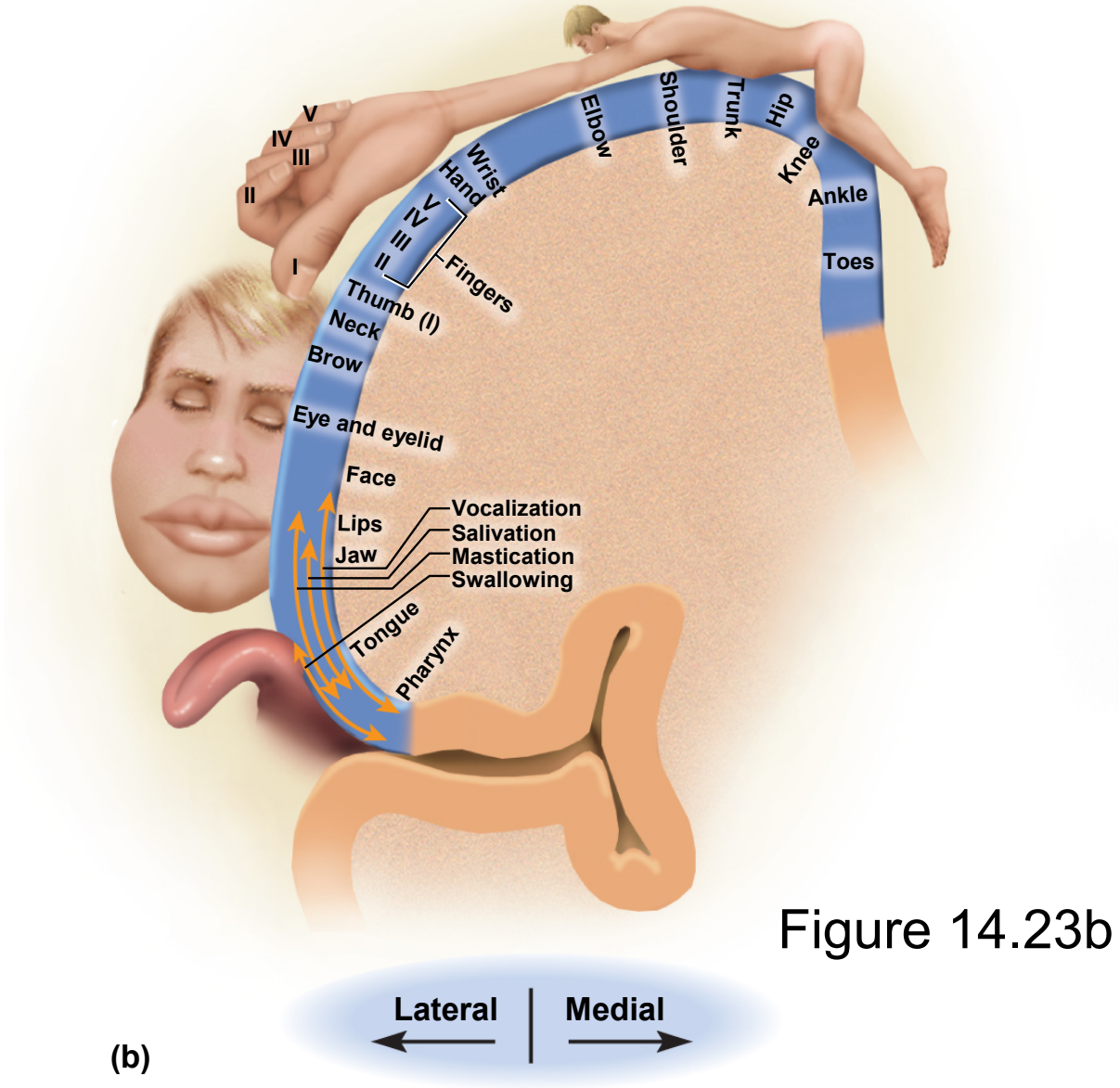
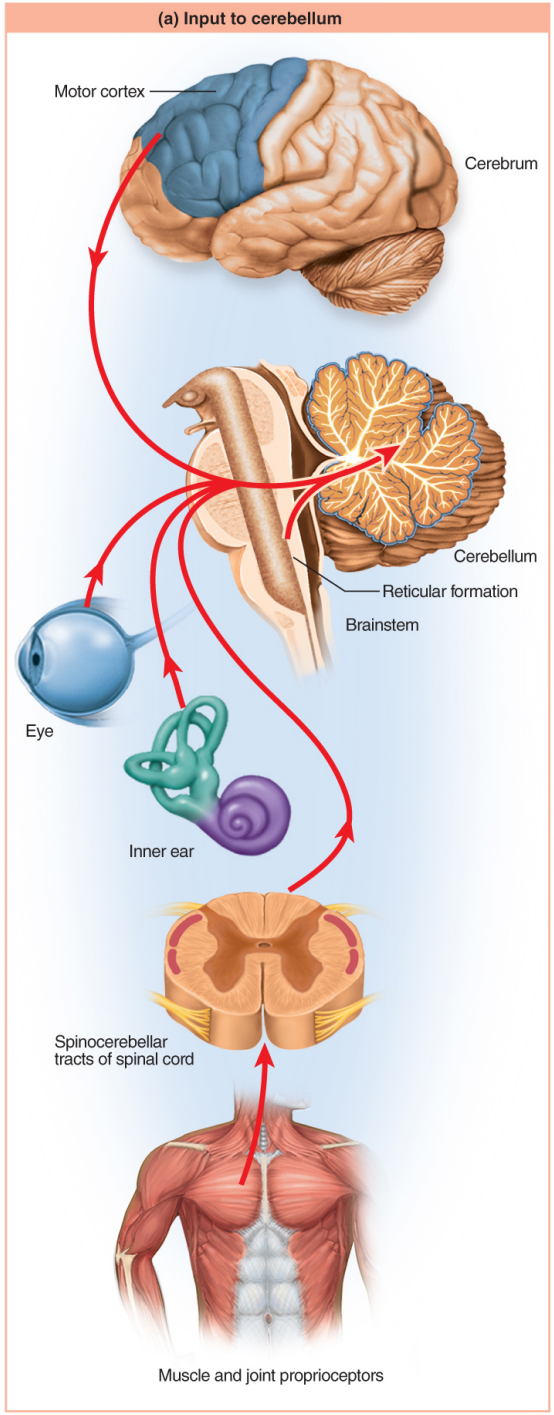
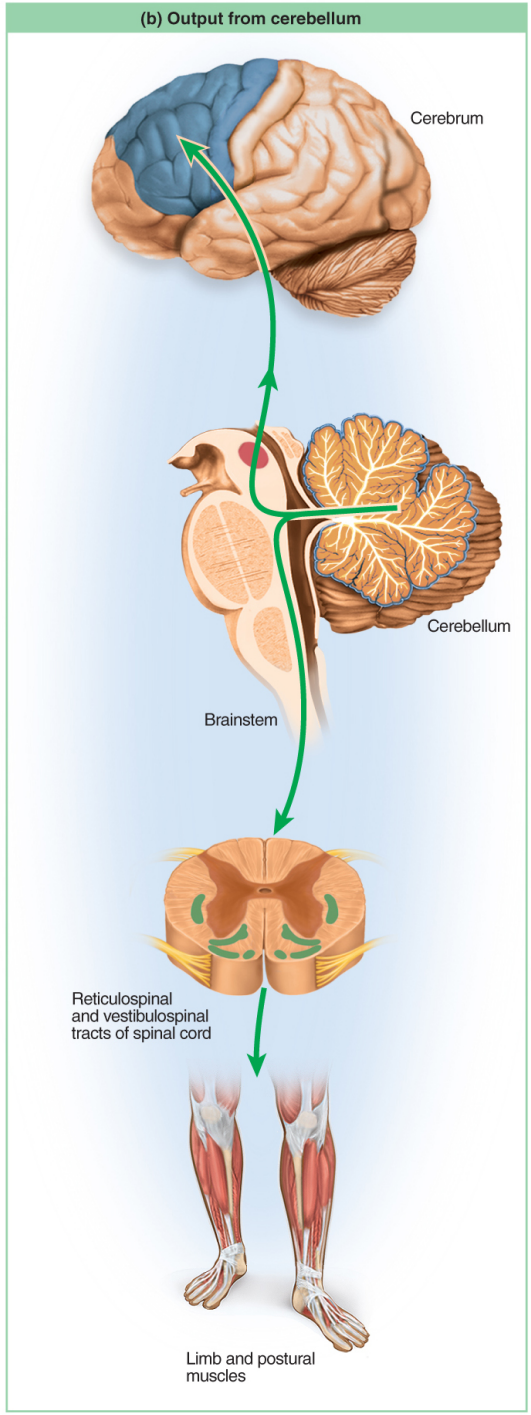


Figure 14.23b

Input and Output to Cerebellum





Functional Regions of Cerebral Cortex

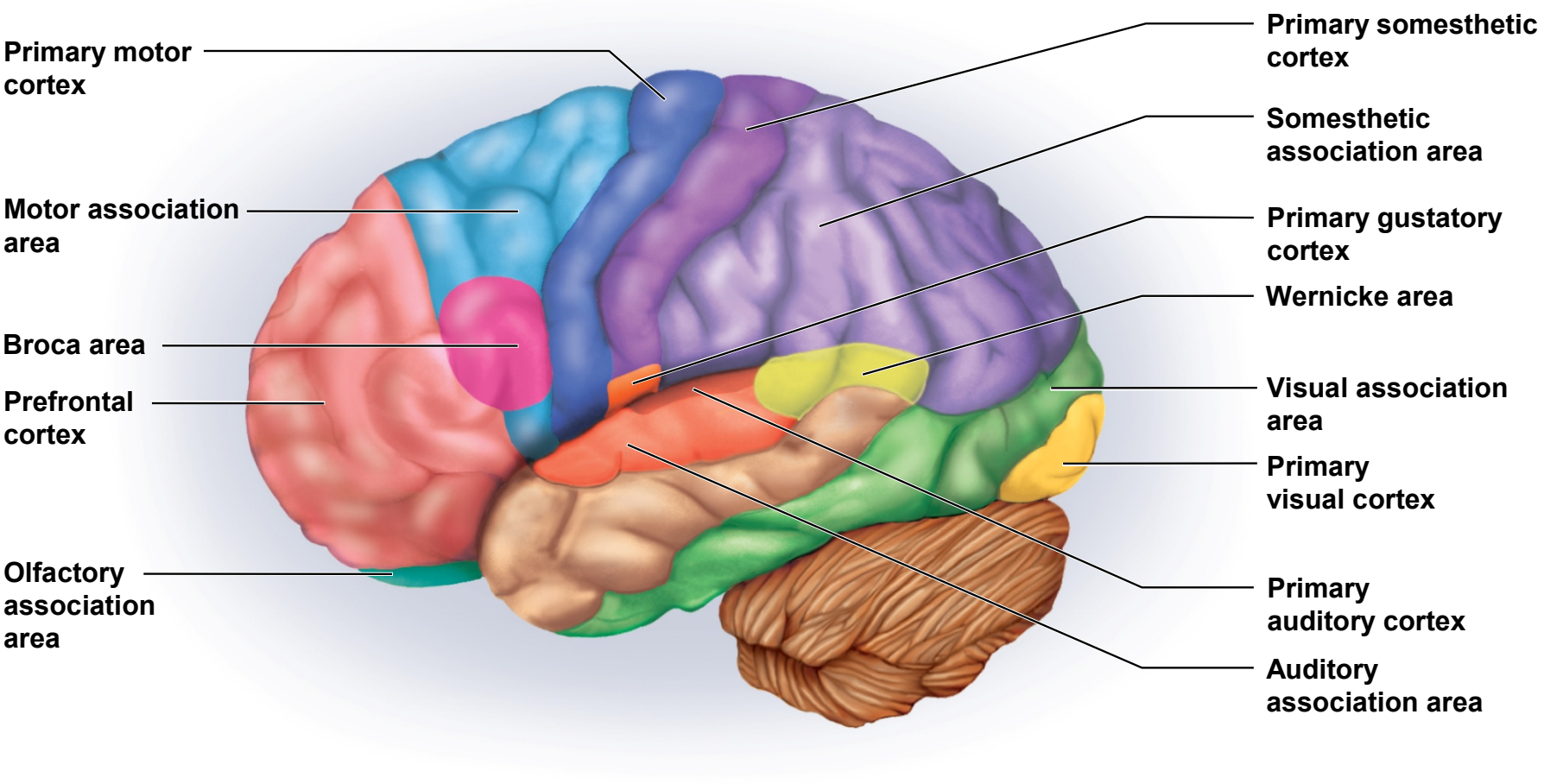


Figure 14.21

Language

- language include several abilities: **reading**, **writing**, **speaking**, and **understanding words** assigned to different regions of the cerebral cortex
- **Wernicke area**
  - permits recognition of spoken and written language and creates plan of speech
  - when we intend to speak, Wernicke area formulates phases according to learned rules of grammar
  - transmits plan of speech to Broca area
- **Broca area**
  - generates motor program for the muscles of the larynx, tongue, cheeks and lips
  - transmits program to primary motor cortex for commands to the lower motor neurons that supply relevant muscles

Language Centers

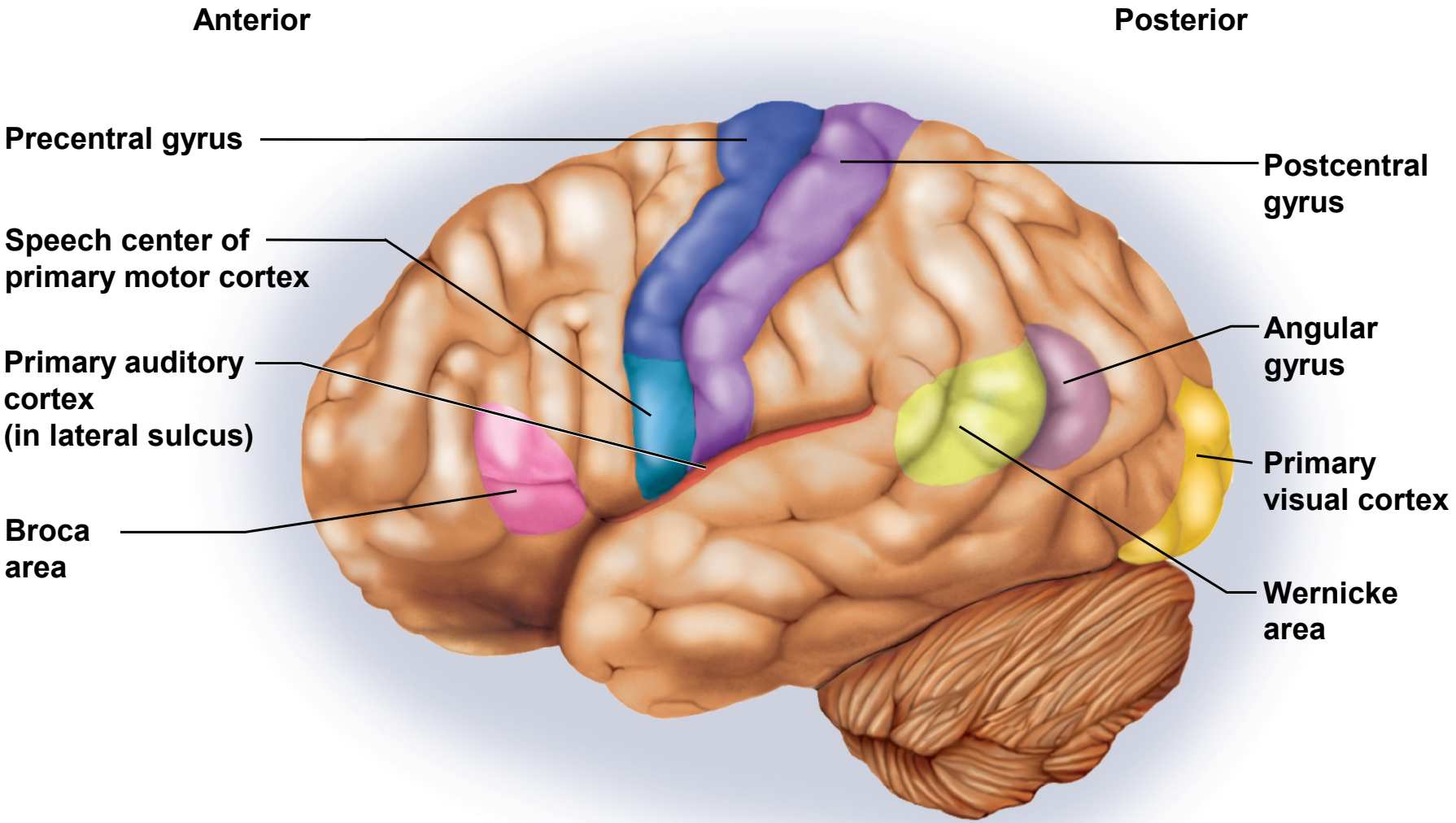


Figure 14.25