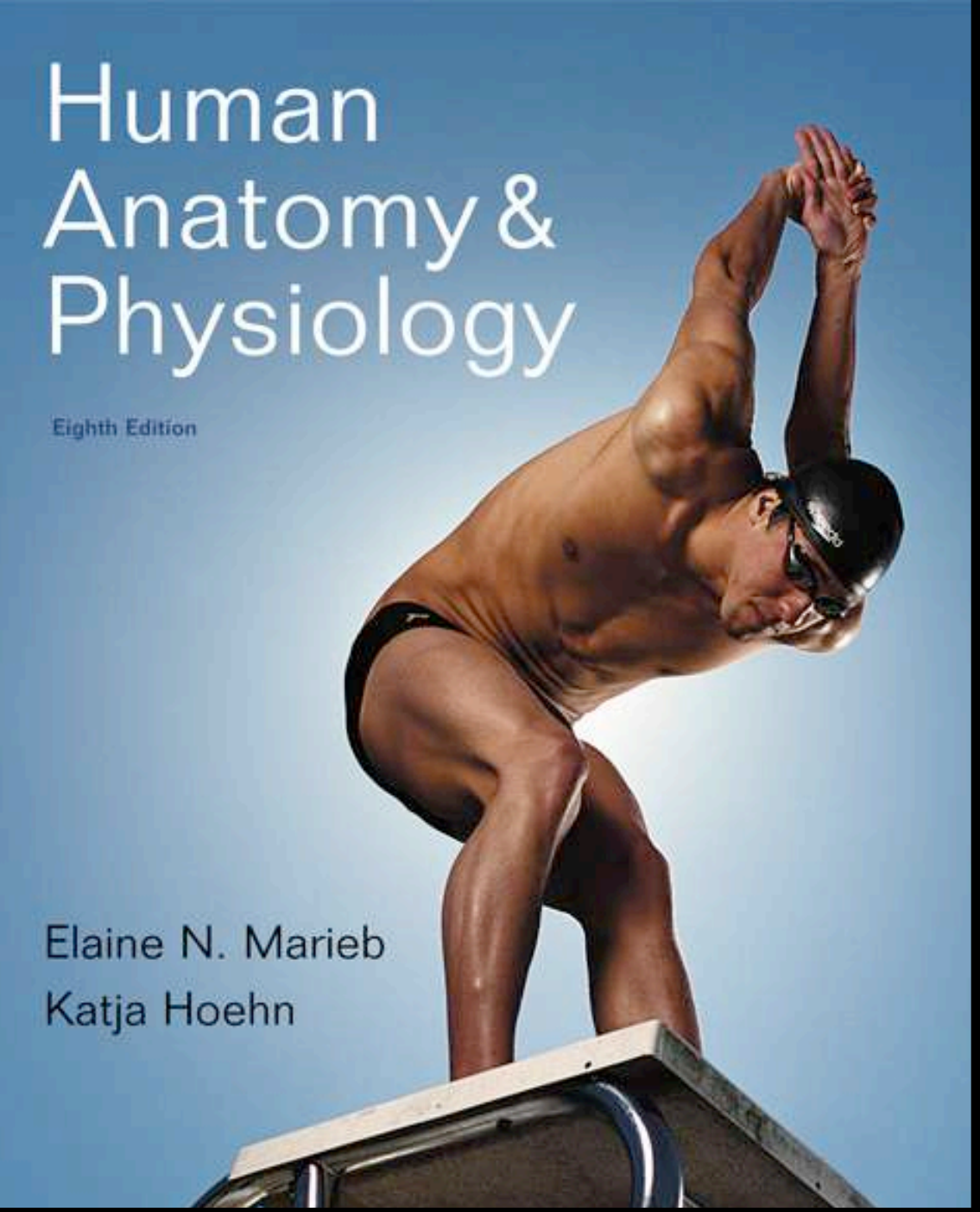


PowerPoint® Lecture Slides
prepared by
Janice Meeking,
Mount Royal College

CHAPTER 12

The Central Nervous System: Part B

Lateralization of Cortical Function

- Lateralization
  - Division of labor between hemispheres
- Cerebral dominance
  - Designates the hemisphere dominant for language (left hemisphere in 90% of people)

Lateralization of Cortical Function

- Left hemisphere
  - Controls language, math, and logic
- Right hemisphere
  - Insight, visual-spatial skills, intuition, and artistic skills
- Left and right hemispheres communicate via fiber tracts in the cerebral white matter

Cerebral White Matter

- Myelinated fibers and their tracts
- Responsible for communication
  - Commissures (in corpus callosum)—connect gray matter of the two hemispheres
  - Association fibers—connect different parts of the same hemisphere
  - Projection fibers—(corona radiata) connect the hemispheres with lower brain or spinal cord

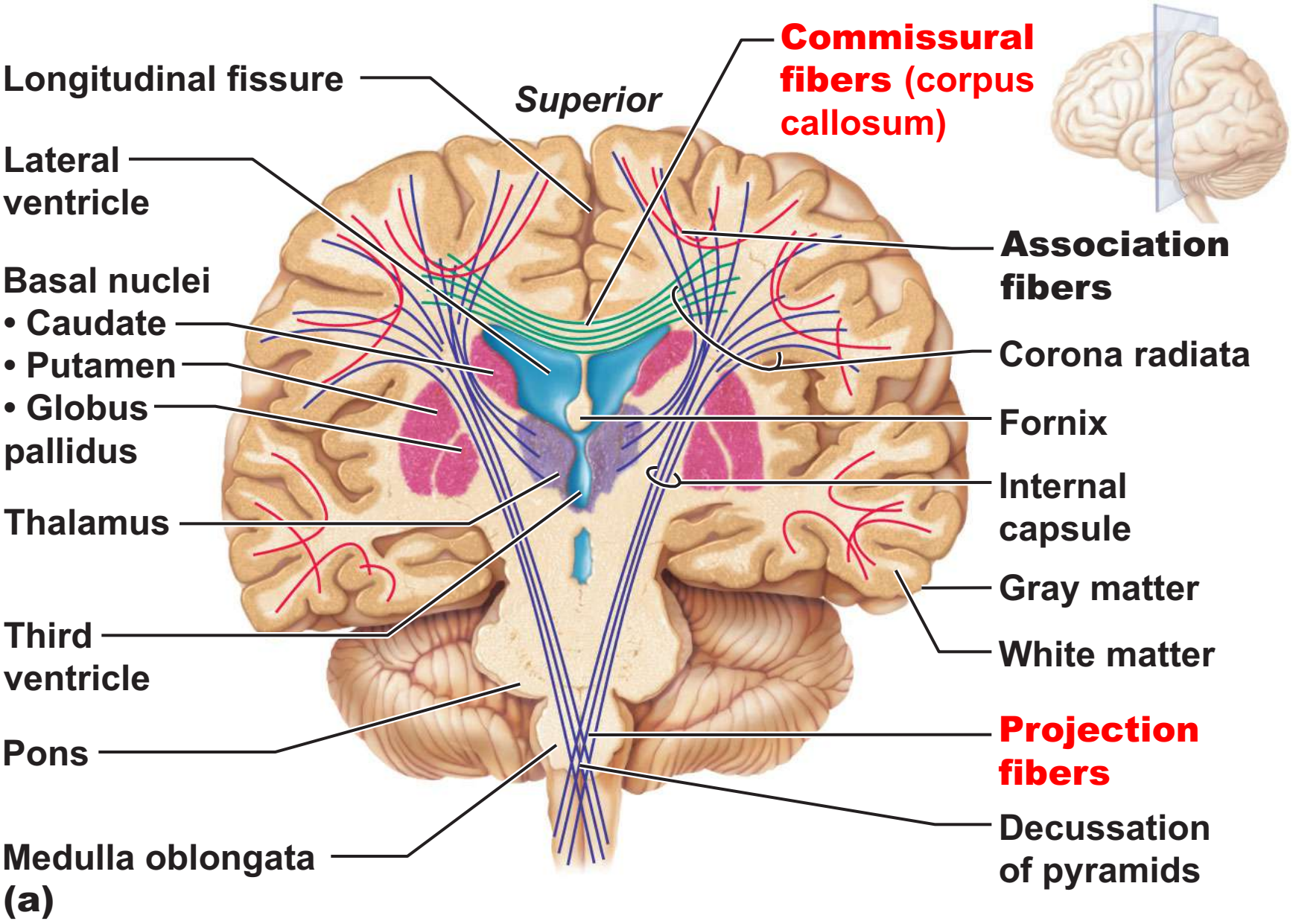


Figure 12.10a

Basal Nuclei (Ganglia)

- Subcortical nuclei
- Consists of the corpus striatum
  - Caudate nucleus
  - Lentiform nucleus (putamen + globus pallidus)
- Functionally associated with the subthalamic nuclei (diencephalon) and the substantia nigra (midbrain)

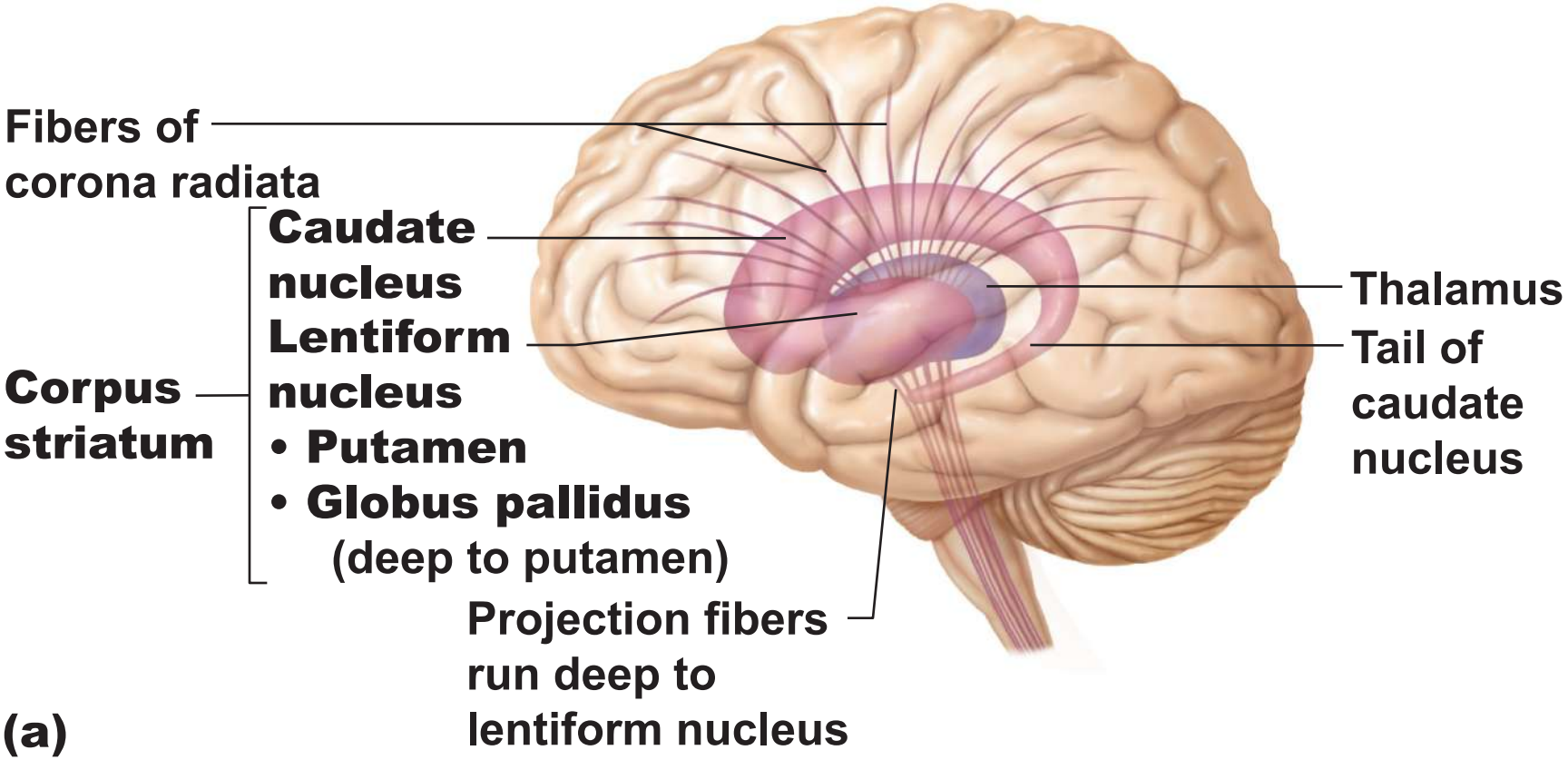


Figure 12.11a

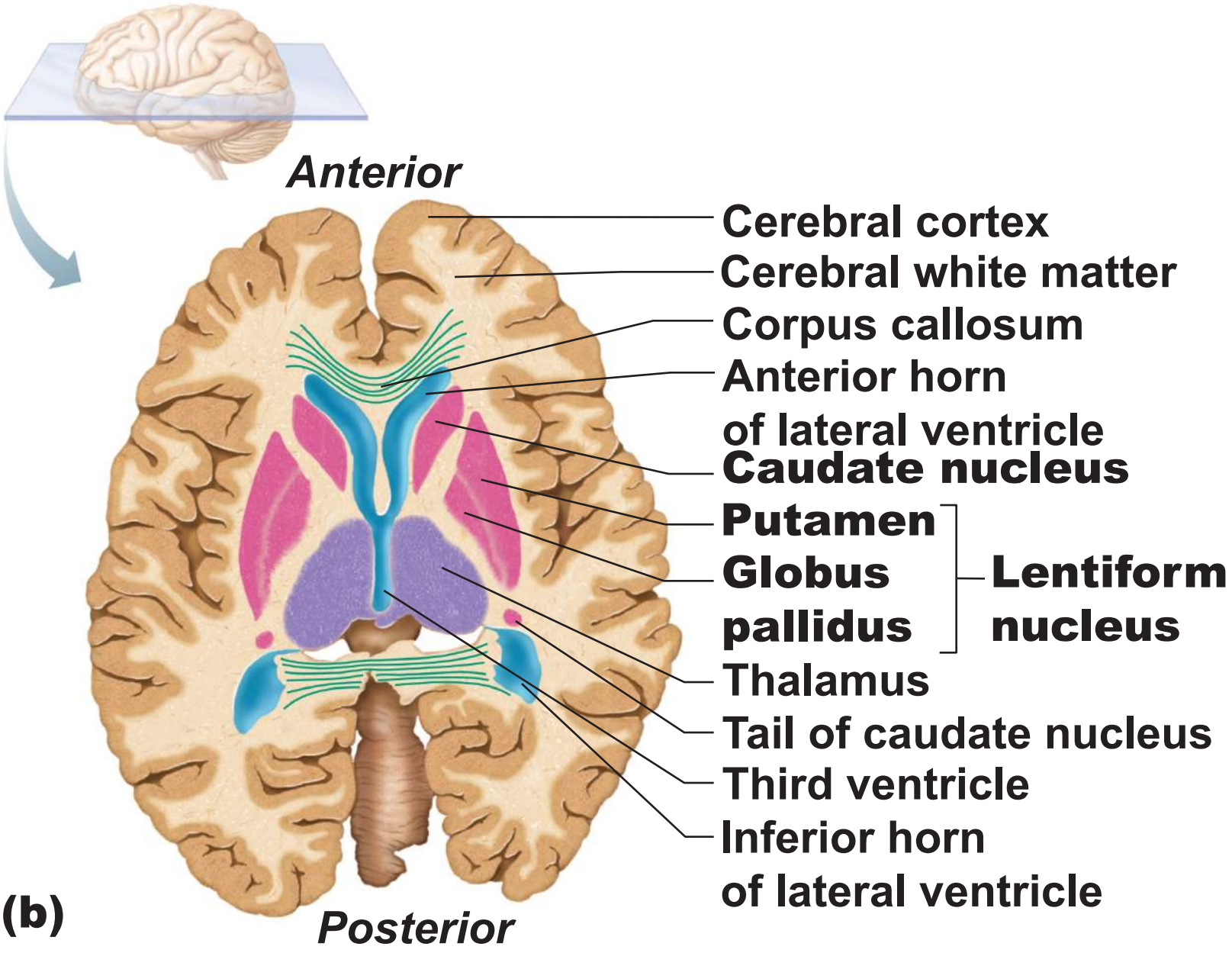


Figure 12.11b (1 of 2)

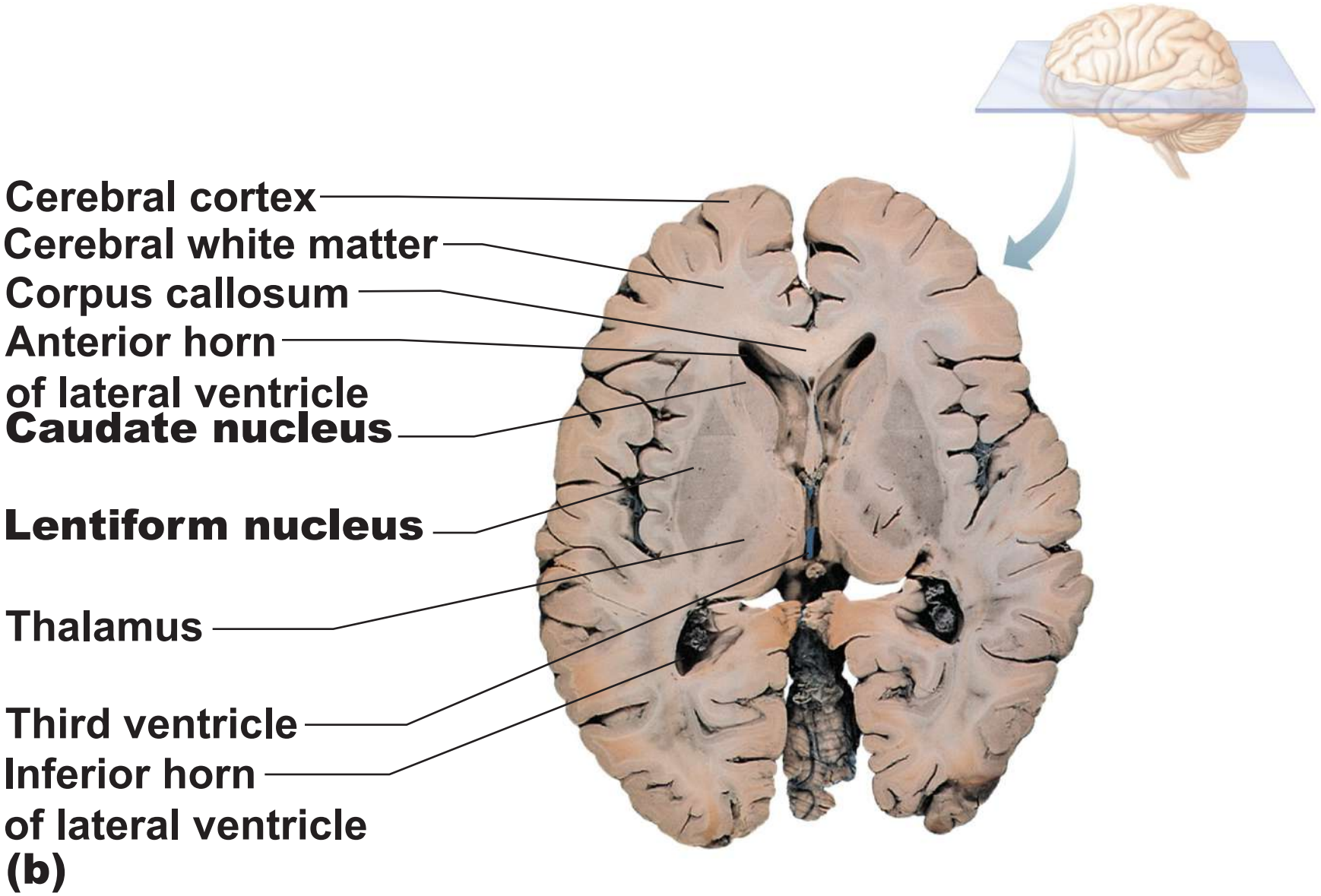


Figure 12.11b (2 of 2)

Functions of Basal Nuclei

- Though somewhat elusive, the following are thought to be functions of basal nuclei
  - Influence muscular control
  - Help regulate attention and cognition
  - Regulate intensity of slow or stereotyped movements
  - Inhibit antagonistic and unnecessary movements

Diencephalon

- Three paired structures
  - Thalamus
  - Hypothalamus
  - Epithalamus
- Encloses the third ventricle

PLAY **Animation: Rotating brain (sectioned)**

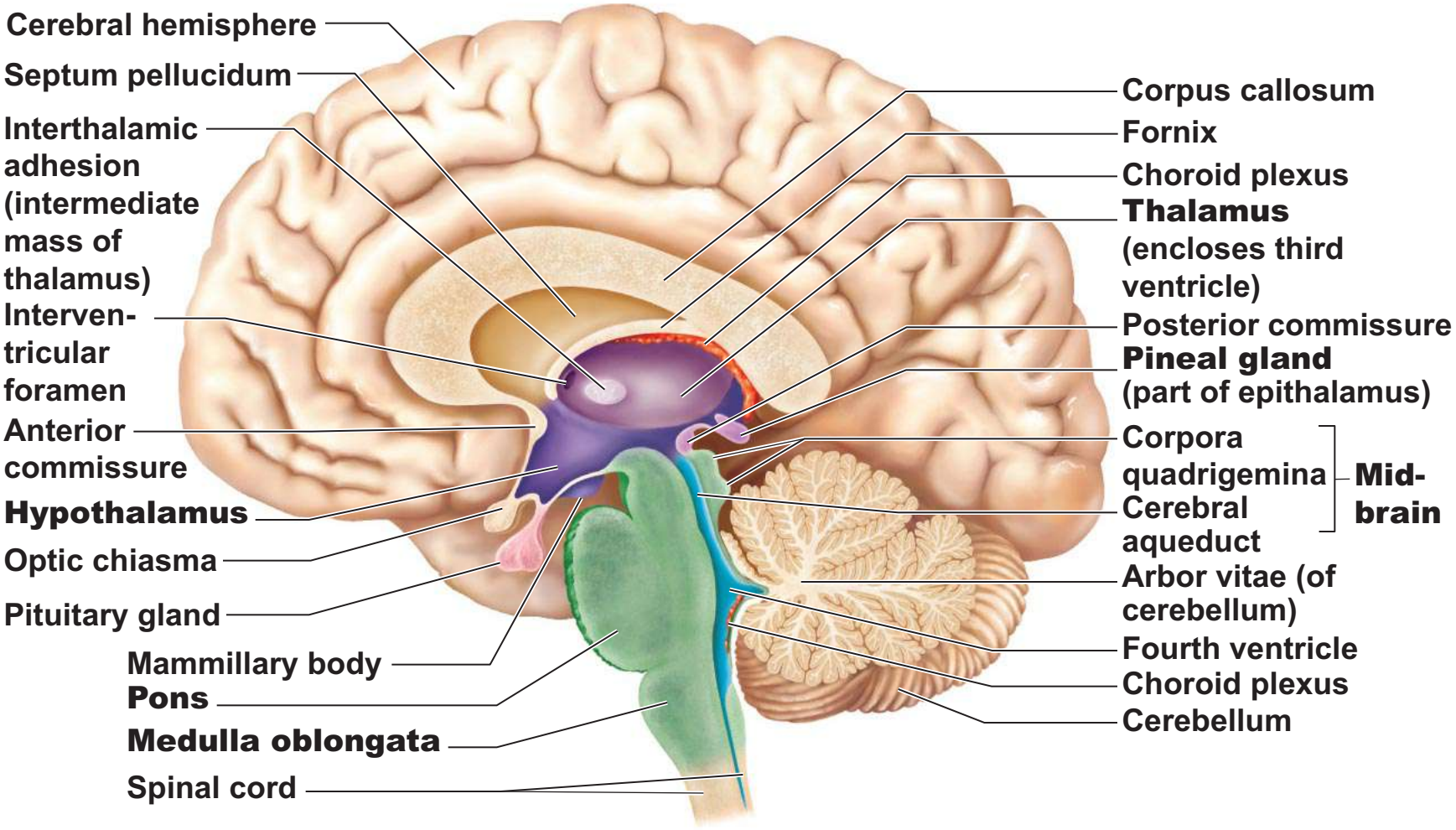
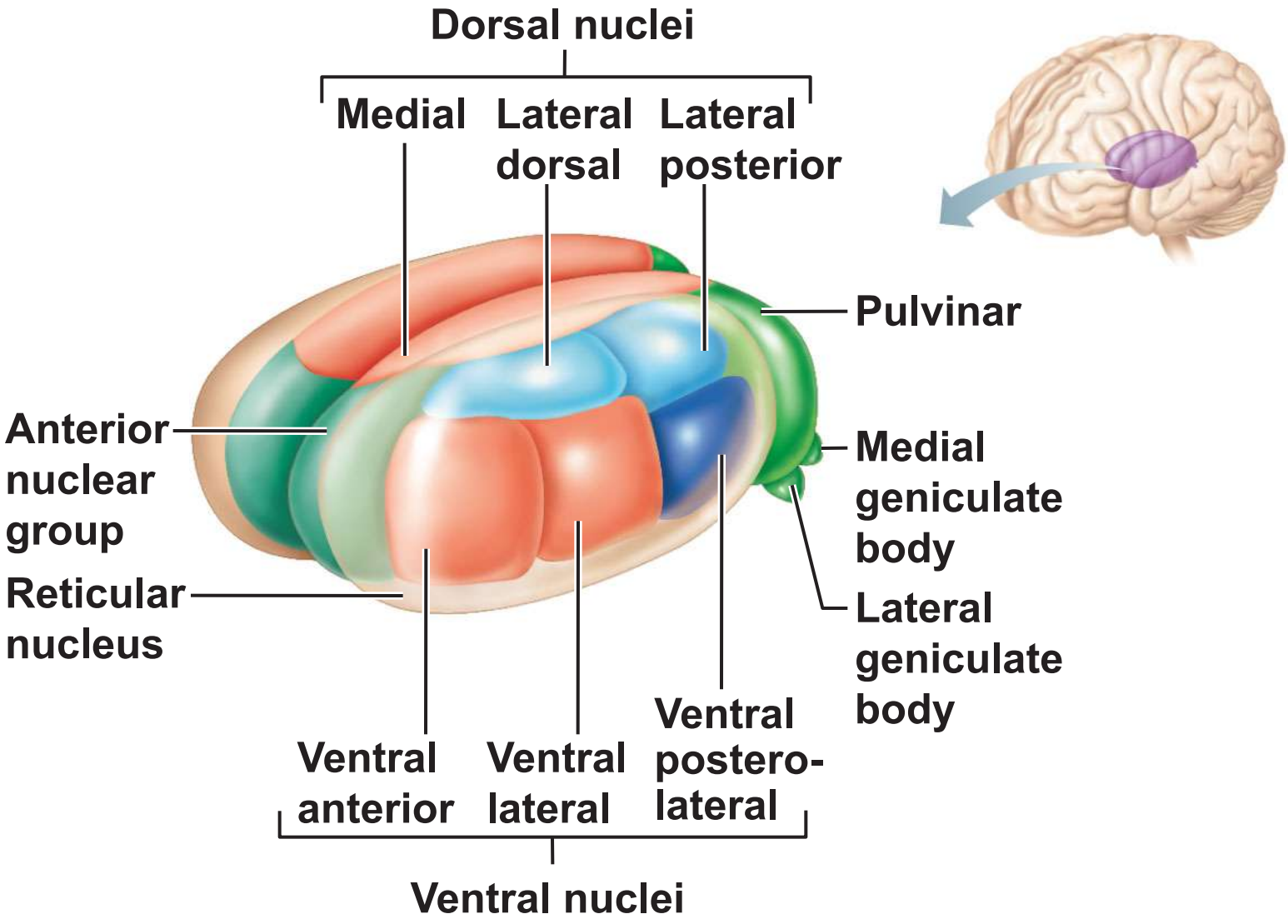


Figure 12.12

Thalamus

- 80% of diencephalon
- Superolateral walls of the third ventricle
- Connected by the interthalamic adhesion (intermediate mass)
- Contains several nuclei, named for their location
- Nuclei project and receive fibers from the cerebral cortex



(a) The main thalamic nuclei. (The reticular nuclei that "cap" the thalamus laterally are depicted as curving translucent structures.)

Figure 12.13a

Thalamic Function

- Gateway to the cerebral cortex
- Sorts, edits, and relays information
  - Afferent impulses from all senses and all parts of the body
  - Impulses from the hypothalamus for regulation of emotion and visceral function
  - Impulses from the cerebellum and basal nuclei to help direct the motor cortices
- Mediates sensation, motor activities, cortical arousal, learning, and memory

Hypothalamus

- Forms the inferolateral walls of the third ventricle
- Contains many nuclei
  - Example: mammillary bodies
    - Paired anterior nuclei
    - Olfactory relay stations
- Infundibulum—stalk that connects to the pituitary gland

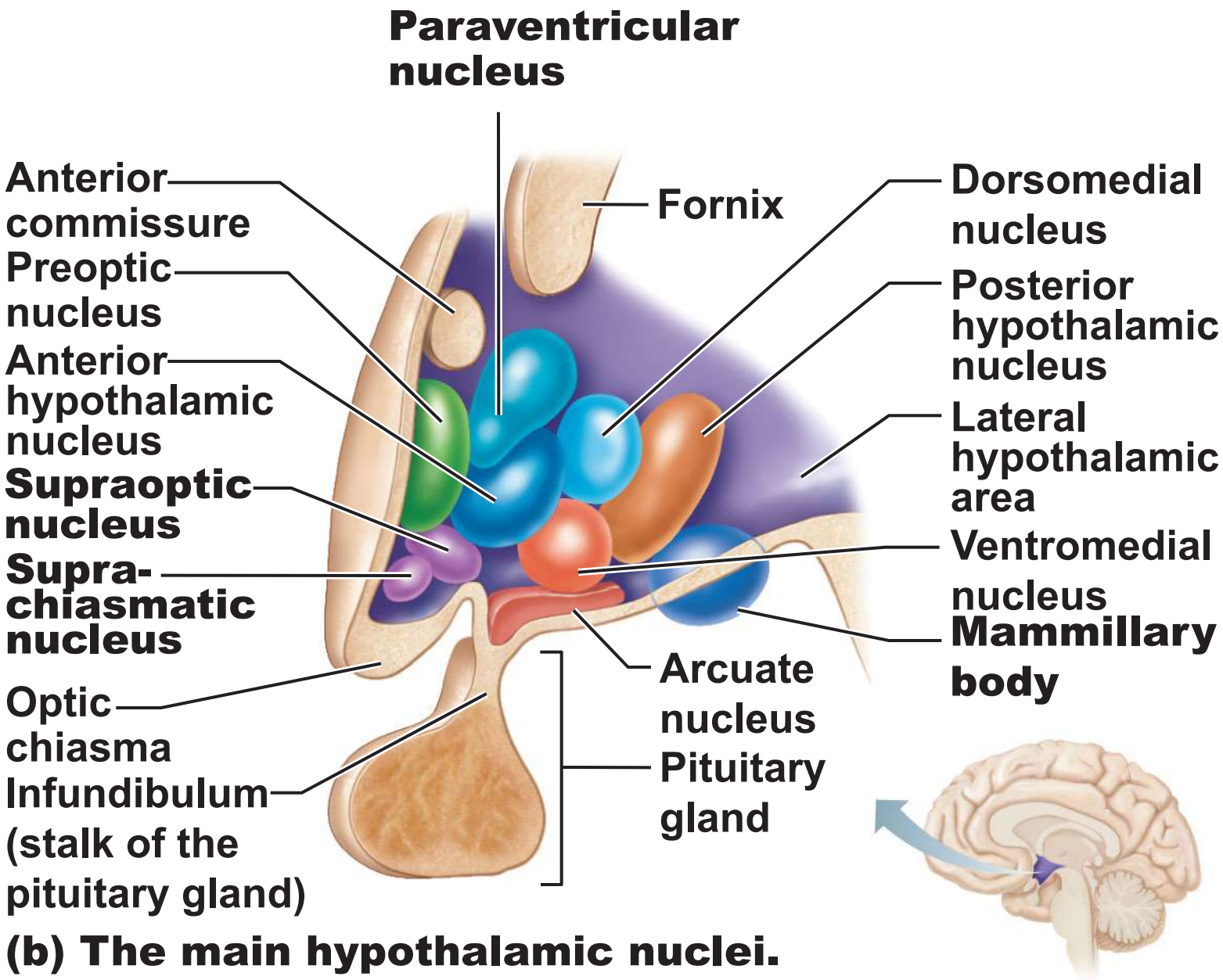


Figure 12.13b

Hypothalamic Function

- Autonomic control center for many visceral functions (e.g., blood pressure, rate and force of heartbeat, digestive tract motility)
- Center for emotional response: Involved in perception of pleasure, fear, and rage and in biological rhythms and drives

Hypothalamic Function

- Regulates body temperature, food intake, water balance, and thirst
- Regulates sleep and the sleep cycle
- Controls release of hormones by the anterior pituitary
- Produces posterior pituitary hormones

Epithalamus

- Most dorsal portion of the diencephalon; forms roof of the third ventricle
- Pineal gland—extends from the posterior border and secretes melatonin
  - Melatonin—helps regulate sleep-wake cycles

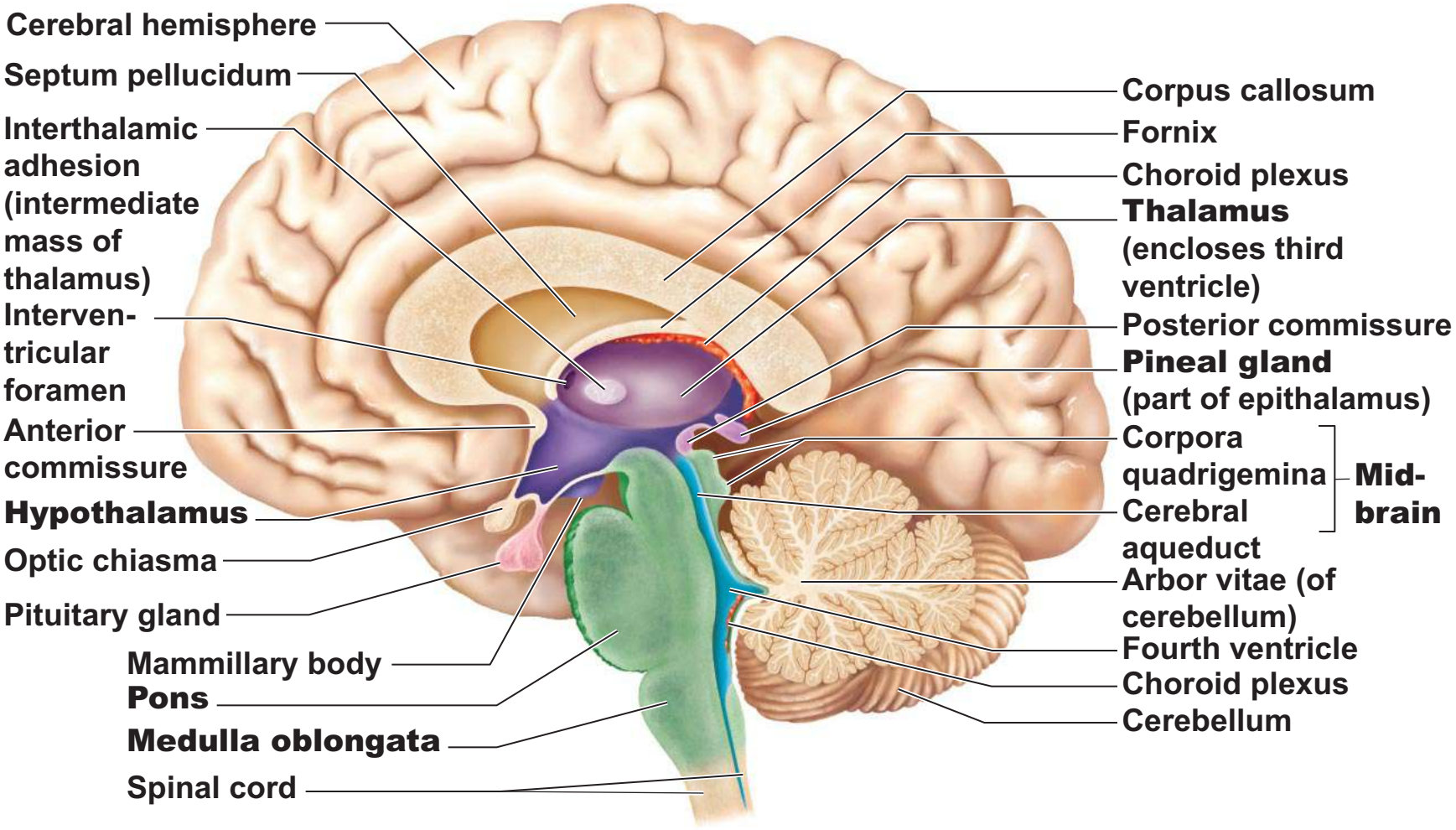


Figure 12.12

Brain Stem

- Three regions
  - Midbrain
  - Pons
  - Medulla oblongata

Brain Stem

- Similar structure to spinal cord but contains embedded nuclei
- Controls automatic behaviors necessary for survival
- Contains fiber tracts connecting higher and lower neural centers
- Associated with 10 of the 12 pairs of cranial nerves

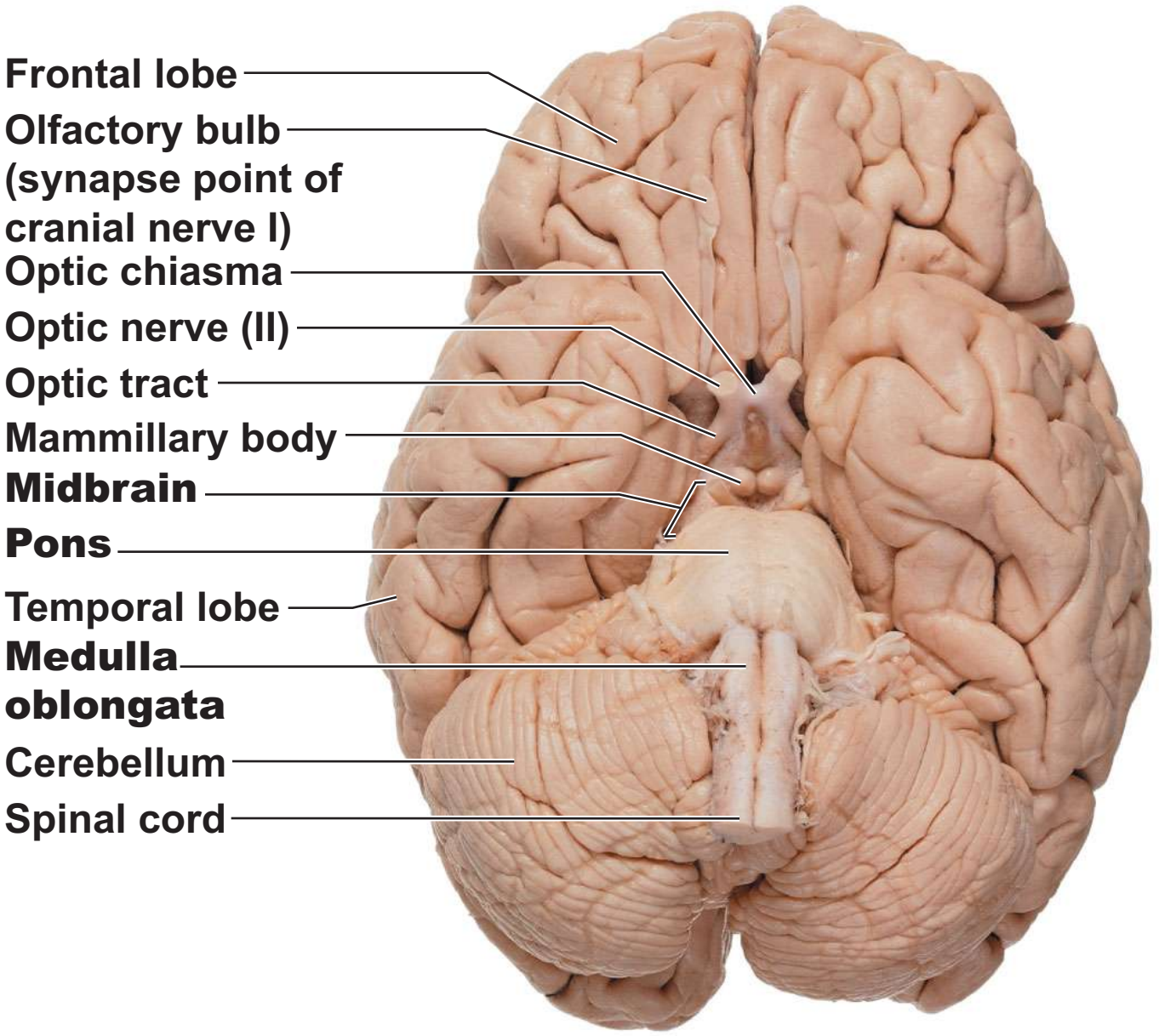


Figure 12.14

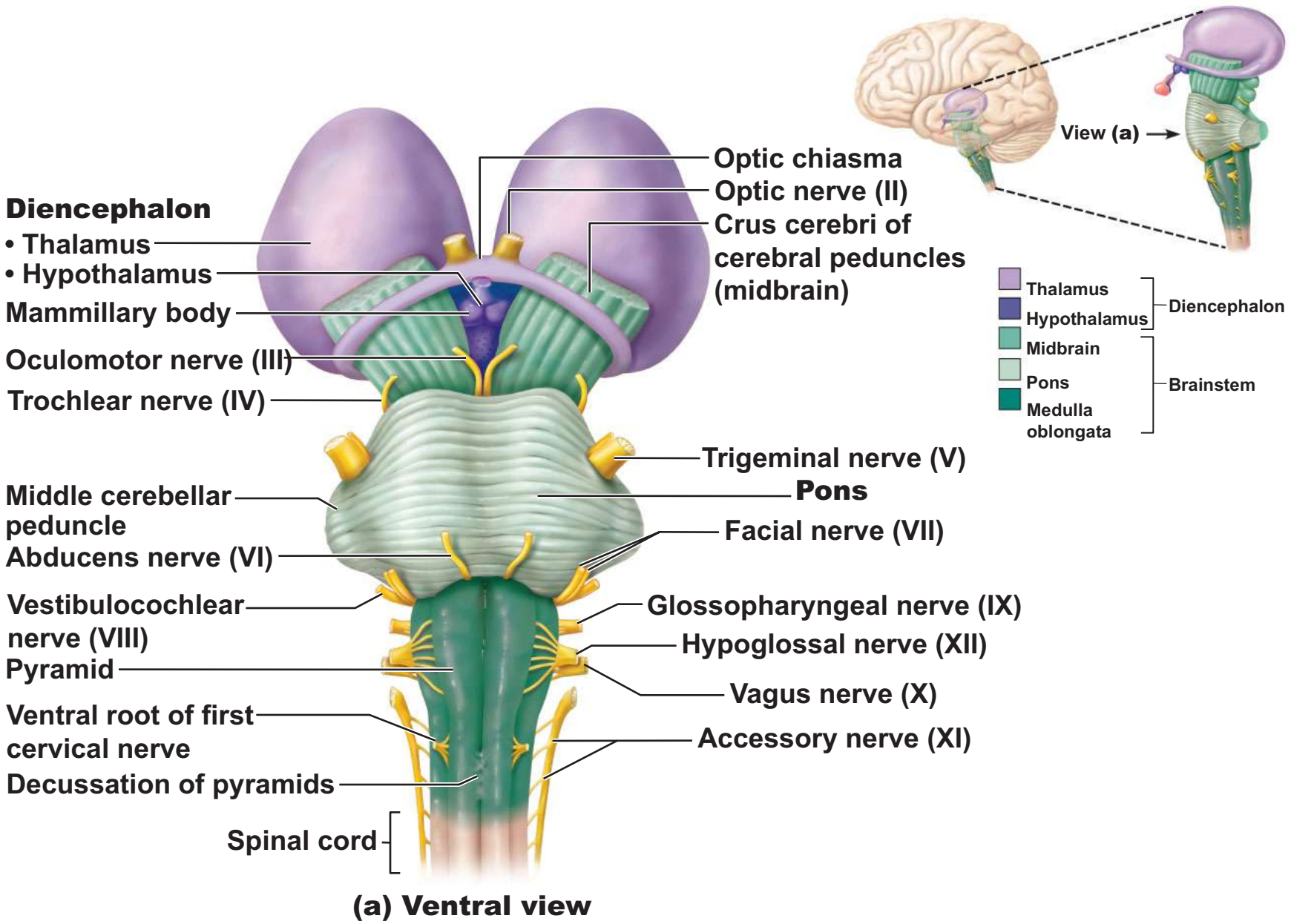
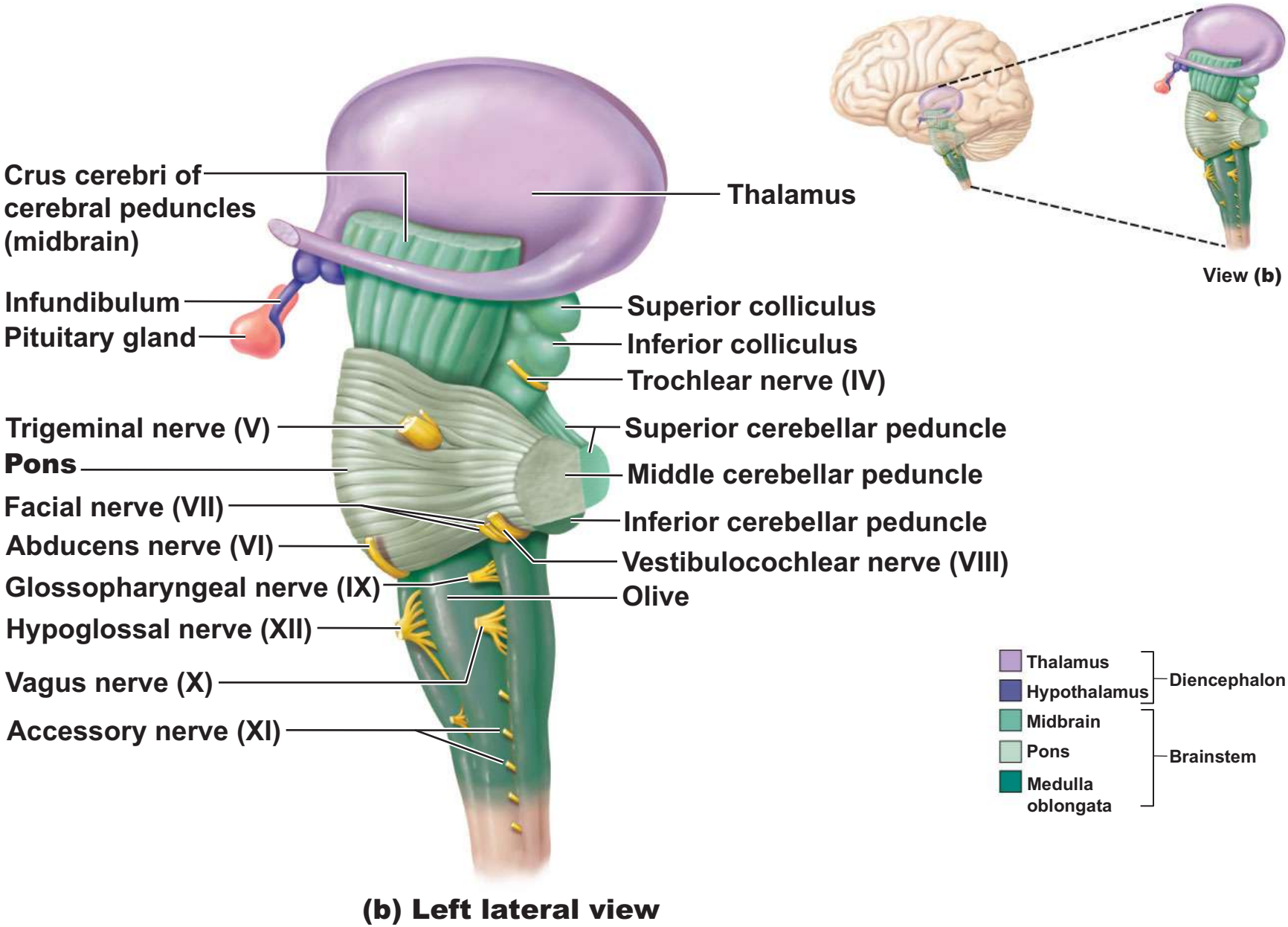


Figure 12.15a



(b) Left lateral view

Figure 12.15b

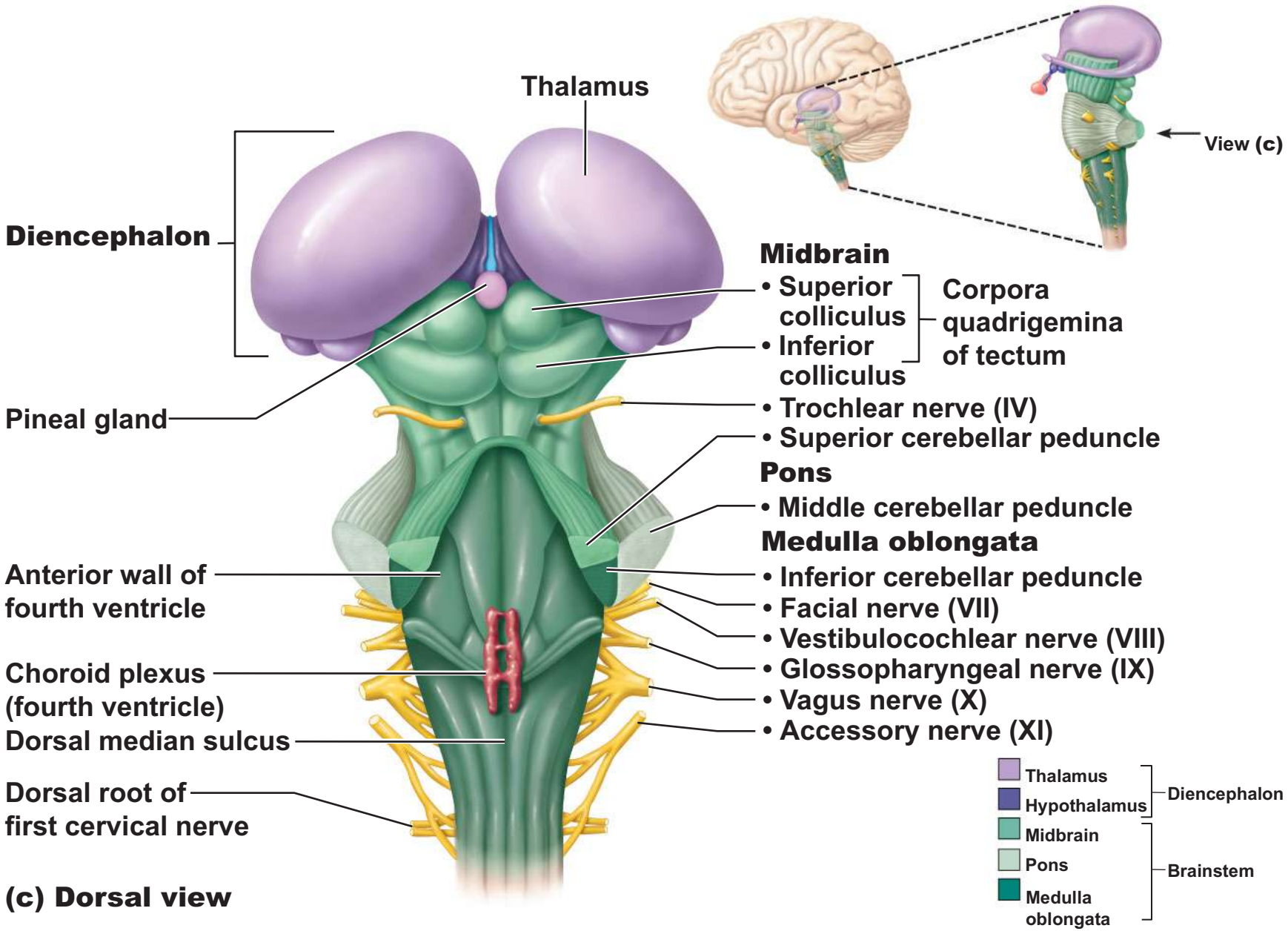


Figure 12.15c

Midbrain

- Located between the diencephalon and the pons
- Cerebral peduncles
  - Contain pyramidal motor tracts
- Cerebral aqueduct
  - Channel between third and fourth ventricles

Midbrain Nuclei

- Nuclei that control cranial nerves III (oculomotor) and IV (trochlear)
- Corpora quadrigemina—domelike dorsal protrusions
  - Superior colliculi—visual reflex centers
  - Inferior colliculi—auditory relay centers
- Substantia nigra—functionally linked to basal nuclei
- Red nucleus—relay nuclei for some descending motor pathways and part of reticular formation

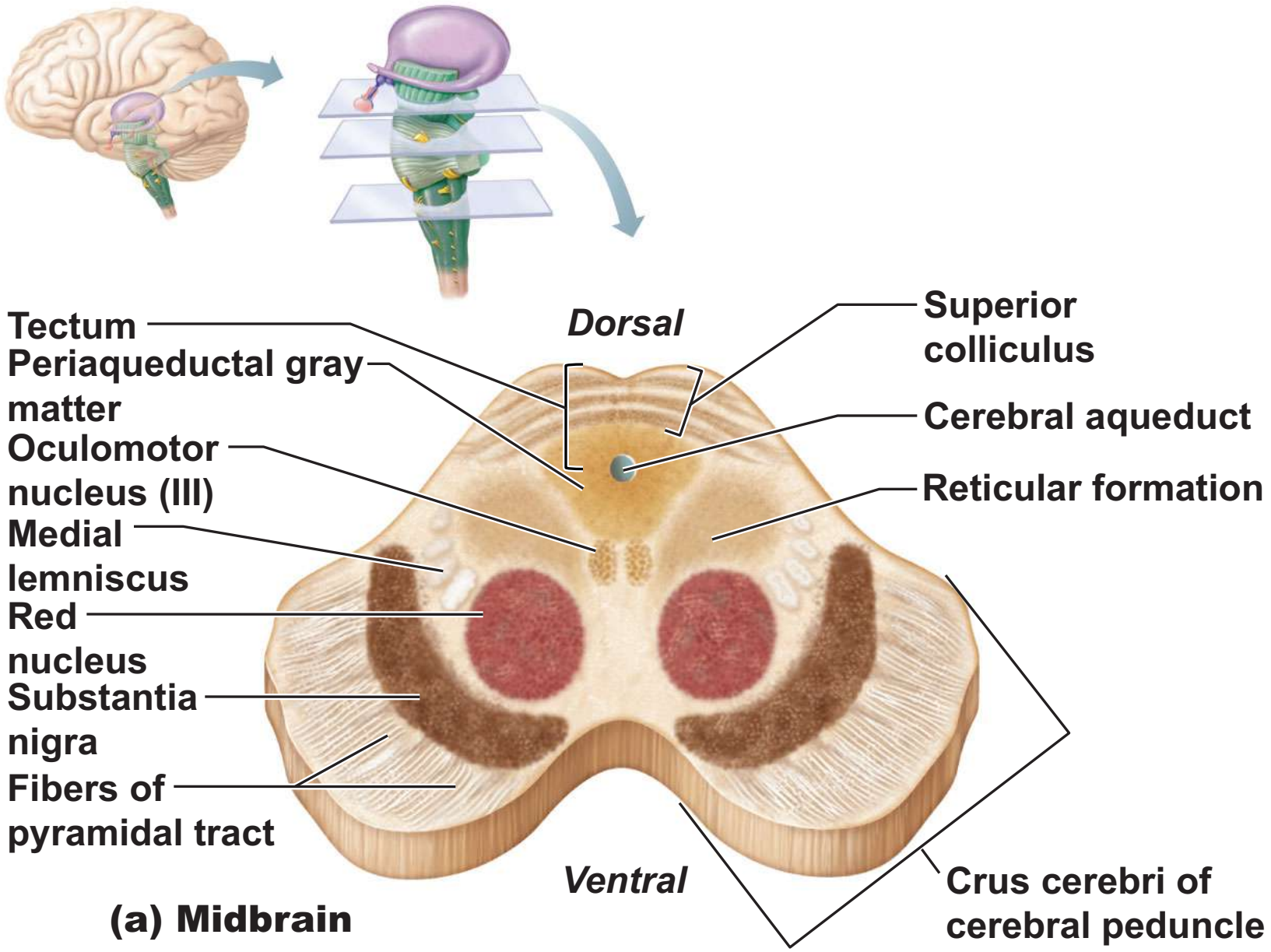
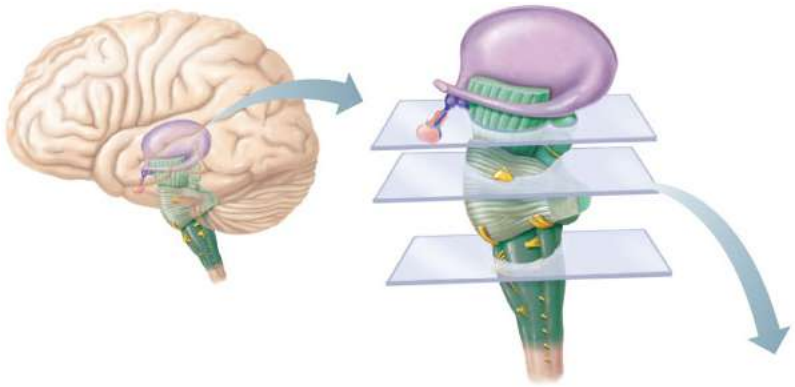
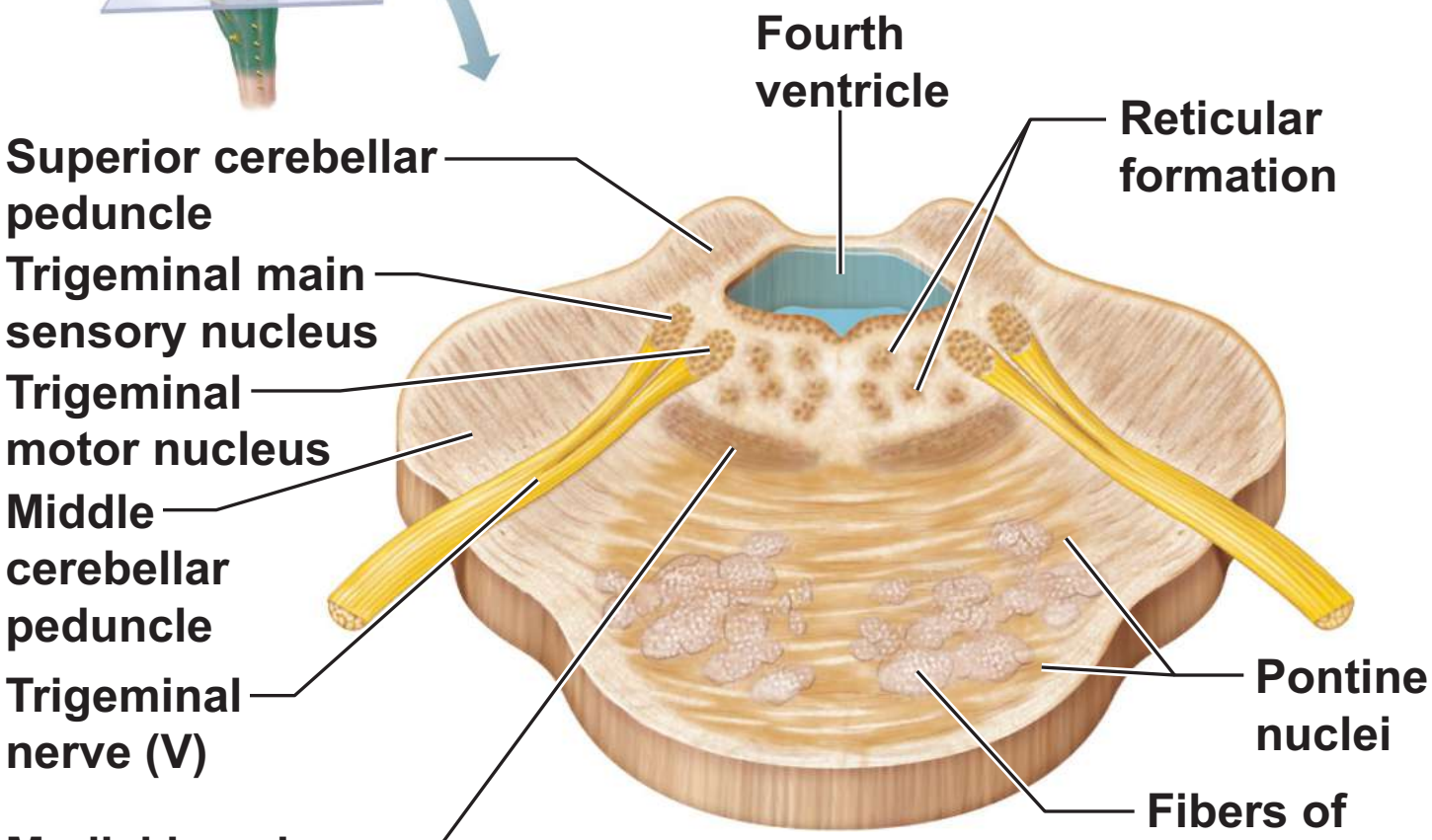


Figure 12.16a

Pons

- Forms part of the anterior wall of the fourth ventricle
- Fibers of the pons
  - Connect higher brain centers and the spinal cord
  - Relay impulses between the motor cortex and the cerebellum
- Origin of cranial nerves V (trigeminal), VI (abducens), and VII (facial)
- Some nuclei of the reticular formation
- Nuclei that help maintain normal rhythm of breathing





(b) Pons

Figure 12.16b

Medulla Oblongata

- Joins spinal cord at foramen magnum
- Forms part of the ventral wall of the fourth ventricle
- Contains a choroid plexus of the fourth ventricle
- Pyramids—two ventral longitudinal ridges formed by pyramidal tracts
- Decussation of the pyramids—crossover of the corticospinal tracts

Medulla Oblongata

- Inferior olivary nuclei—relay sensory information from muscles and joints to cerebellum
- Cranial nerves VIII, X, and XII are associated with the medulla
- Vestibular nuclear complex—mediates responses that maintain equilibrium
- Several nuclei (e.g., nucleus cuneatus and nucleus gracilis) relay sensory information

Medulla Oblongata

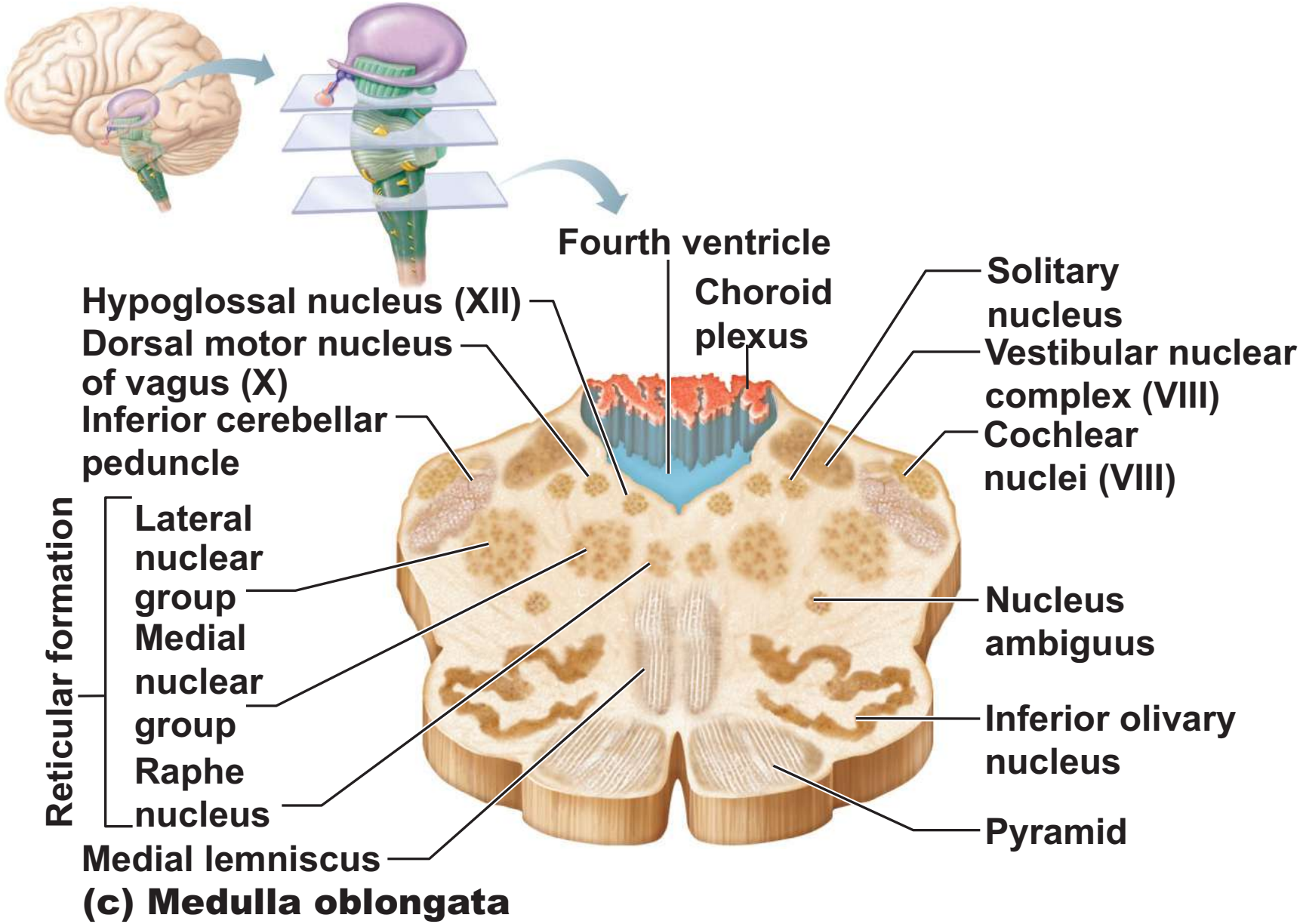
- Autonomic reflex centers
- Cardiovascular center
  - Cardiac center adjusts force and rate of heart contraction
  - Vasomotor center adjusts blood vessel diameter for blood pressure regulation

Medulla Oblongata

- Respiratory centers
  - Generate respiratory rhythm
  - Control rate and depth of breathing, with pontine centers

Medulla Oblongata

- Additional centers regulate
  - Vomiting
  - Hiccuping
  - Swallowing
  - Coughing
  - Sneezing



(c) Medulla oblongata

Figure 12.16c

The Cerebellum

- 11% of brain mass
- Dorsal to the pons and medulla
- Subconsciously provides precise timing and appropriate patterns of skeletal muscle contraction

Anatomy of the Cerebellum

- Two hemispheres connected by vermis
- Each hemisphere has three lobes
  - Anterior, posterior, and flocculonodular
- Folia—transversely oriented gyri
- Arbor vitae—distinctive treelike pattern of the cerebellar white matter

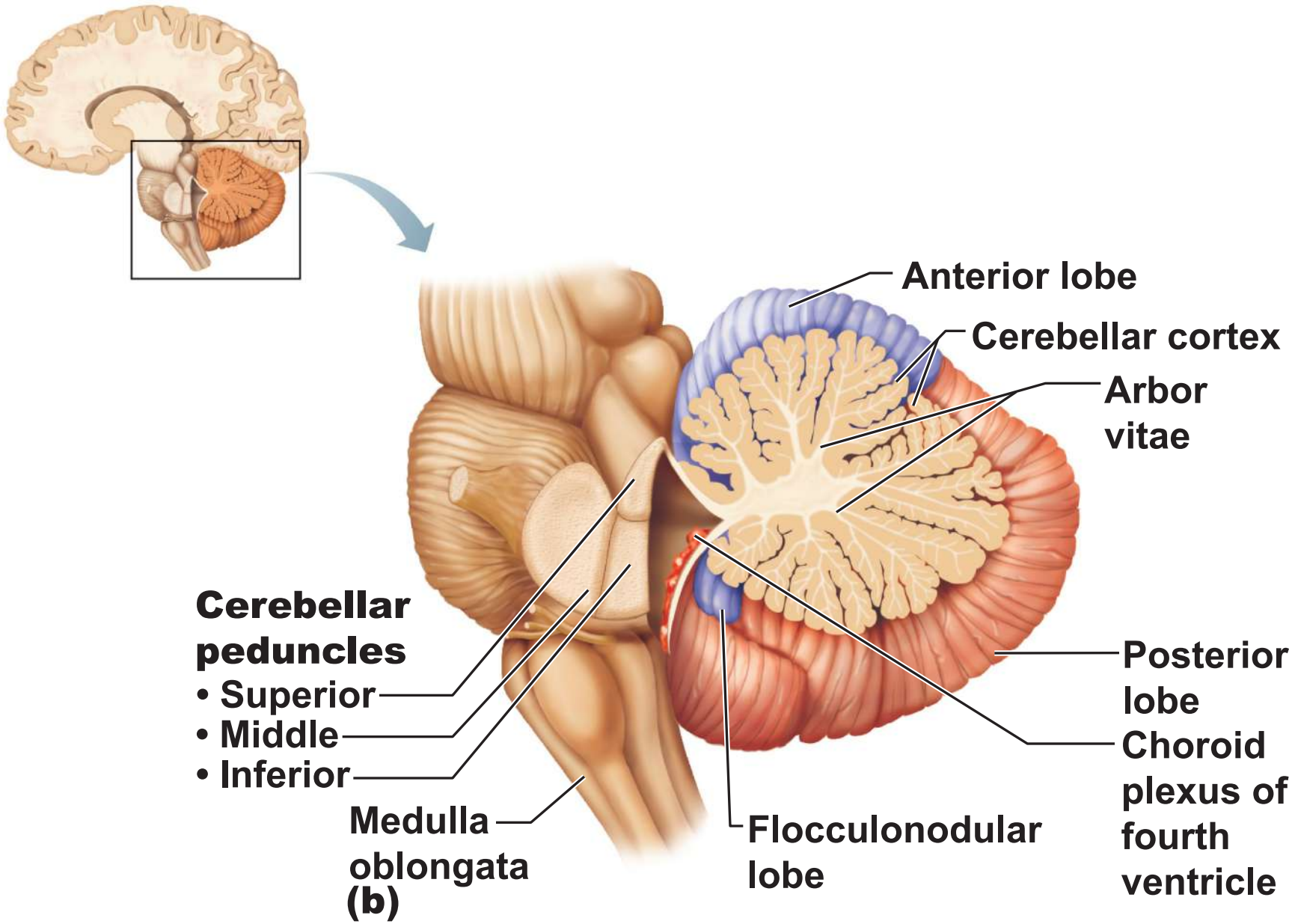


Figure 12.17b

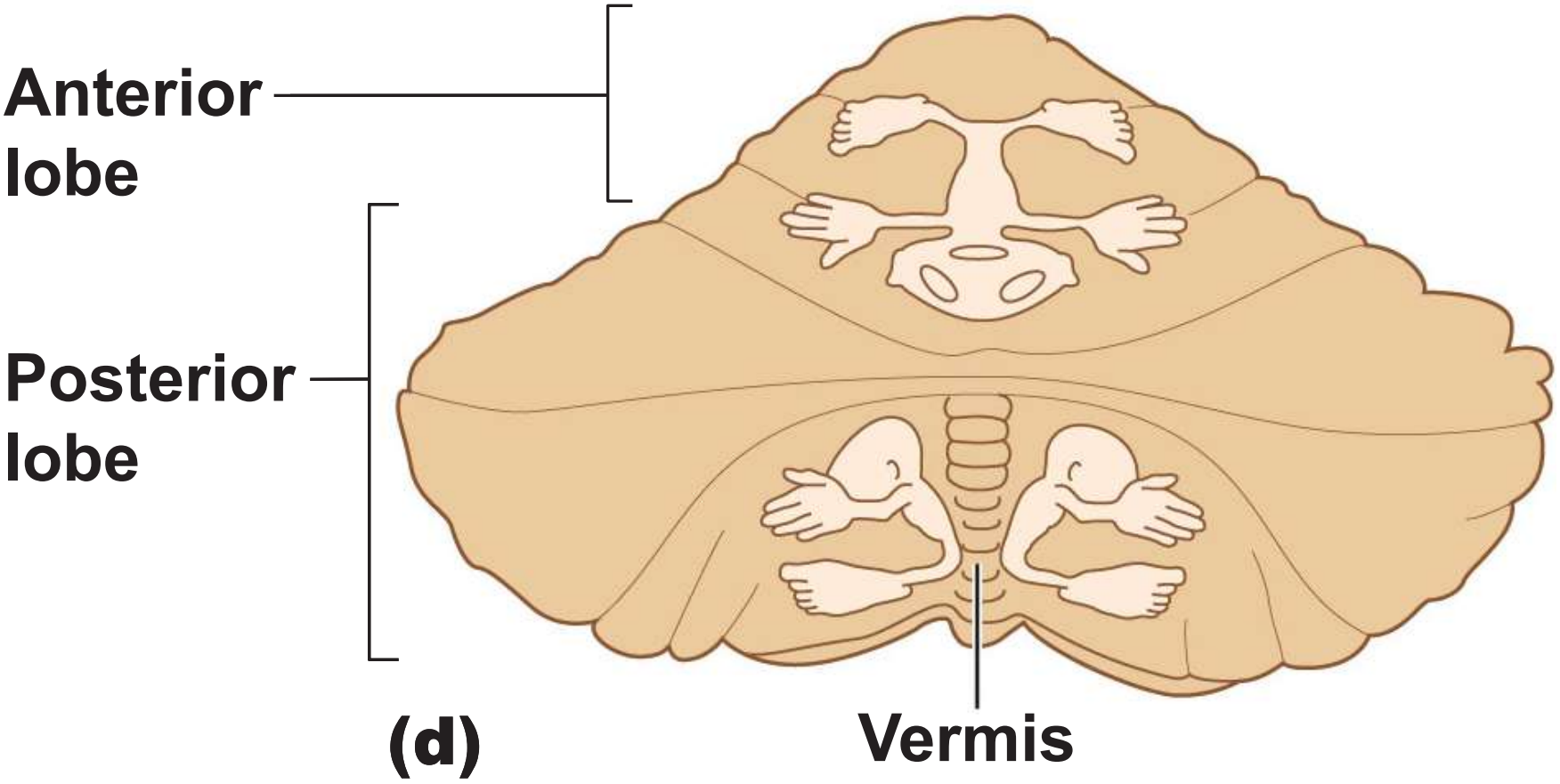


Figure 12.17d

Cerebellar Peduncles

- All fibers in the cerebellum are ipsilateral
- Three paired fiber tracts connect the cerebellum to the brain stem
  - Superior peduncles connect the cerebellum to the midbrain
  - Middle peduncles connect the pons to the cerebellum
  - Inferior peduncles connect the medulla to the cerebellum

Cerebellar Processing for Motor Activity

- Cerebellum receives impulses from the cerebral cortex of the intent to initiate voluntary muscle contraction
- Signals from proprioceptors and visual and equilibrium pathways continuously “inform” the cerebellum of the body’s position and momentum
- Cerebellar cortex calculates the best way to smoothly coordinate a muscle contraction
- A “blueprint” of coordinated movement is sent to the cerebral motor cortex and to brain stem nuclei

Cognitive Function of the Cerebellum

- Recognizes and predicts sequences of events during complex movements
- Plays a role in nonmotor functions such as word association and puzzle solving