

PRINCIPLES OF HUMAN PHYSIOLOGY

THIRD EDITION

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9



The Nervous System: Central Nervous System

PowerPoint® Lecture Slides prepared by W.H. Preston, College of the Sequoias

Central Nervous System

- CNS: brain and spinal cord
- Necessary for the maintenance of homeostasis
- Contains 10^{11} neurons
- Contains 10^{14} synapses
- Responsible for everything we perceive, do, feel, and think

Glial Cells

- 90% of CNS composed of glia
- Five types of glial cells
 - Astrocyte—numerous functions
 - Ependymal cells—line cavities
 - Microglia—phagocytes
 - Oligodendrocytes—form myelin
 - Schwann cells (located in PNS)—form myelin

Glial Cells

Central Nervous System

Peripheral Nervous System

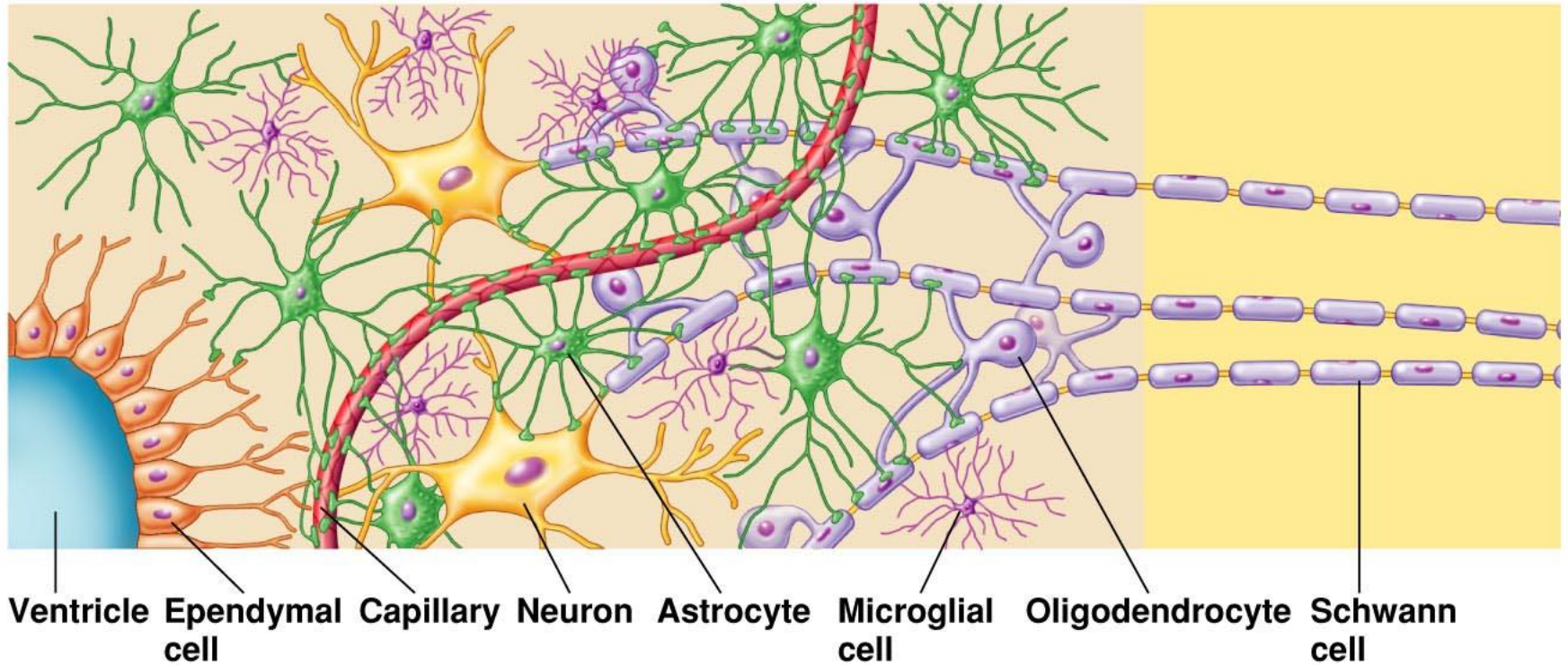


Figure 9.1

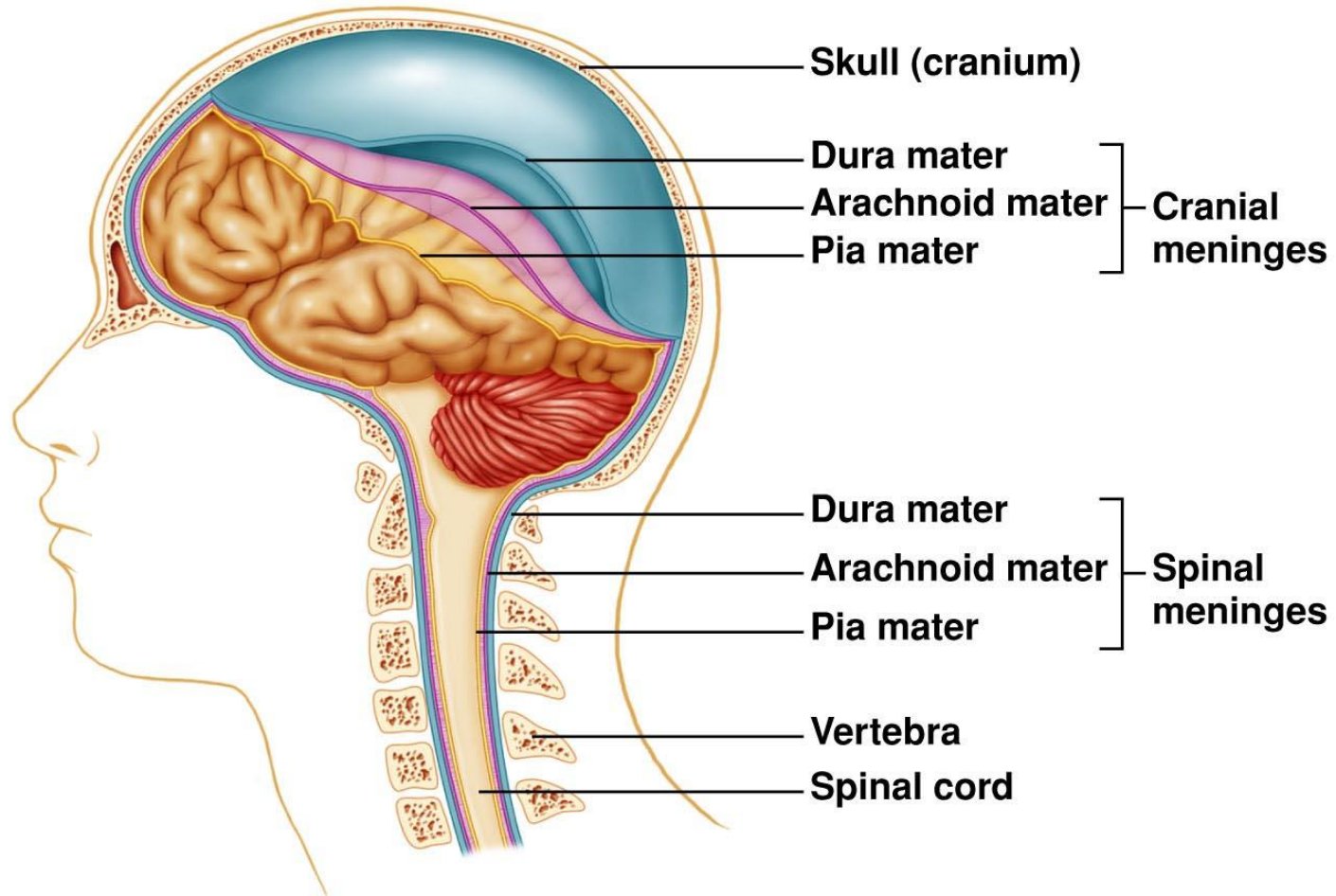
Astrocytes

- Development of neural connections
- Possibly modulate synaptic activity
- Remove neurotransmitter from synaptic cleft
- Communicate to neurons through chemical messengers
- Maintain normal electrolyte composition of ISF in CNS
- Protect neurons against toxic substances and oxidative stress

Microglia

- Protect CNS from foreign matter through phagocytosis
 - Bacteria
 - Dead or injured cells
- Protect CNS from oxidative stress

CNS: Physical Support



(a)

Figure 9.2a

CNS: Physical Support

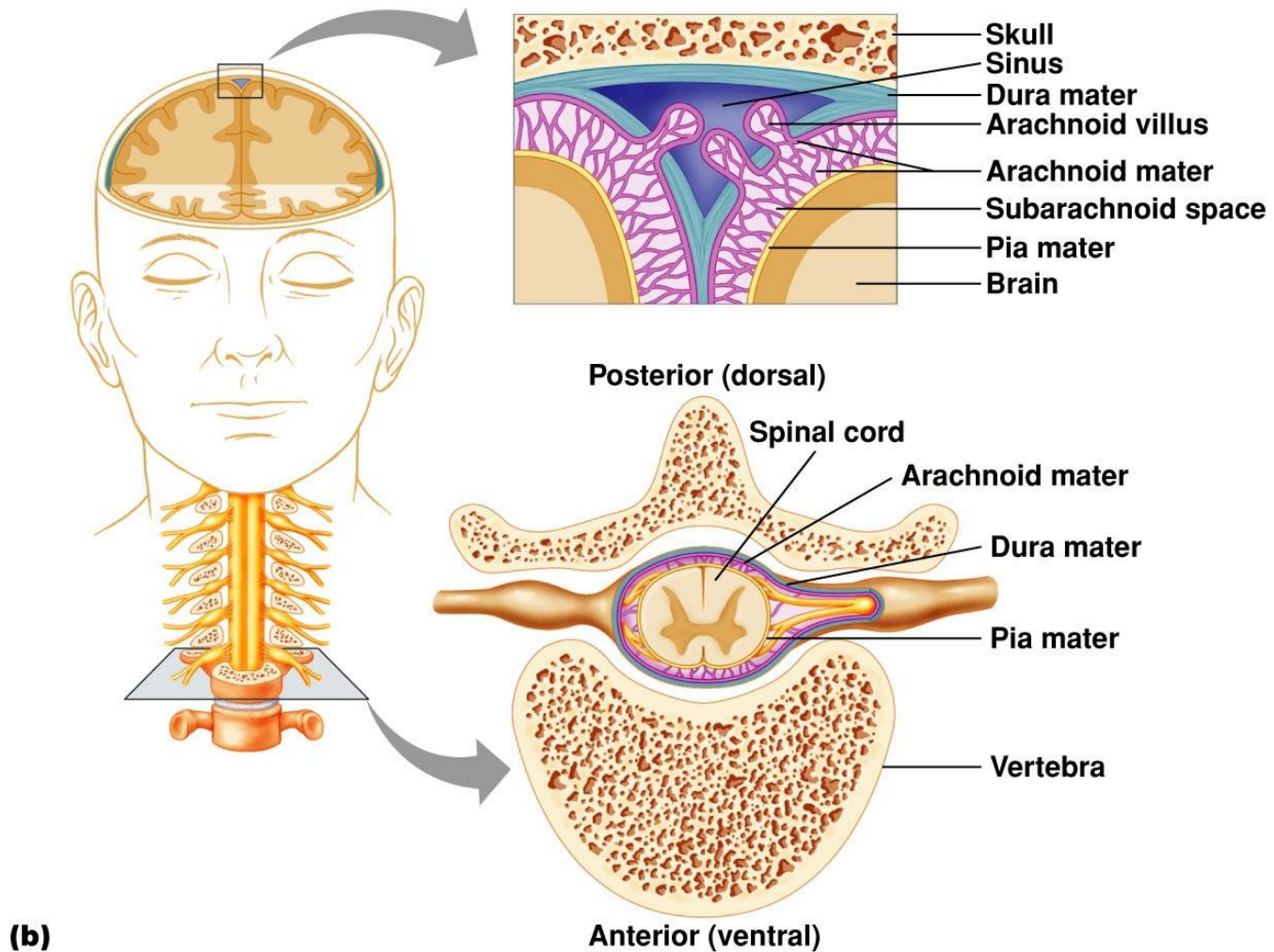


Figure 9.2b

Cerebrospinal Fluid (CSF)

- Extracellular fluid of the CNS
- Secreted by ependymal cells of the choroid plexus
 - Circulates to subarachnoid space and ventricles
 - Reabsorbed by arachnoid villi
- Functions
 - Cushions brain
 - Maintains stable interstitial fluid environment

Cerebral Spinal Fluid

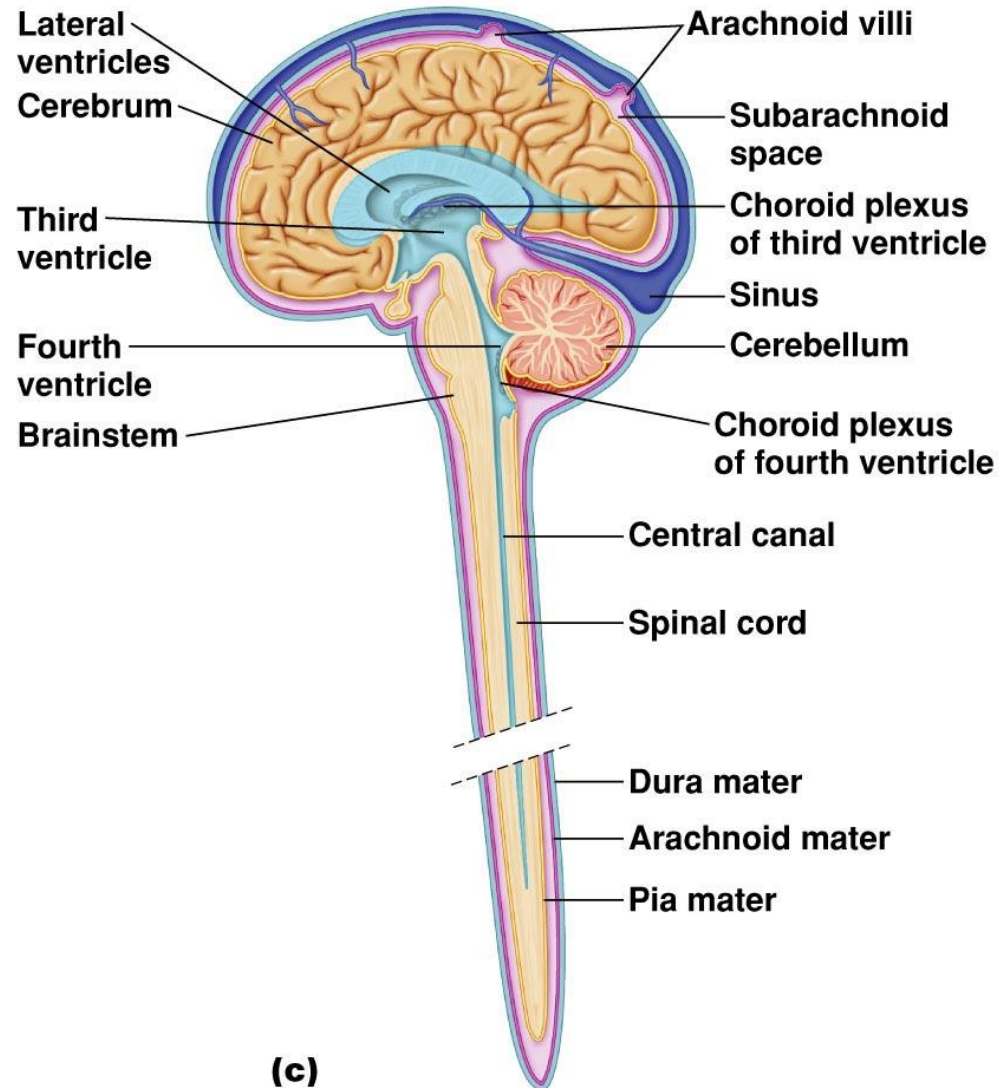


Figure 9.3c

CSF Production

- Total volume of CSF = 125–150 mL
- Choroid plexus produces 400–500 mL/day
- Recycled three times a day

Blood Supply to the CNS

- CNS comprises 2% of body weight (3–4 pounds)
 - Receives 15% of blood supply
- High metabolic rate
 - Brain uses 20% of oxygen consumed by body at rest
 - Brain uses 50% of glucose consumed by body at rest
- Depends on blood flow for energy

High Demand for Blood

- Depends on aerobic glycolysis
- Requires glucose and oxygen
- No glycogen stores
- Fatty acids not used for energy
- Ketones used during extreme conditions

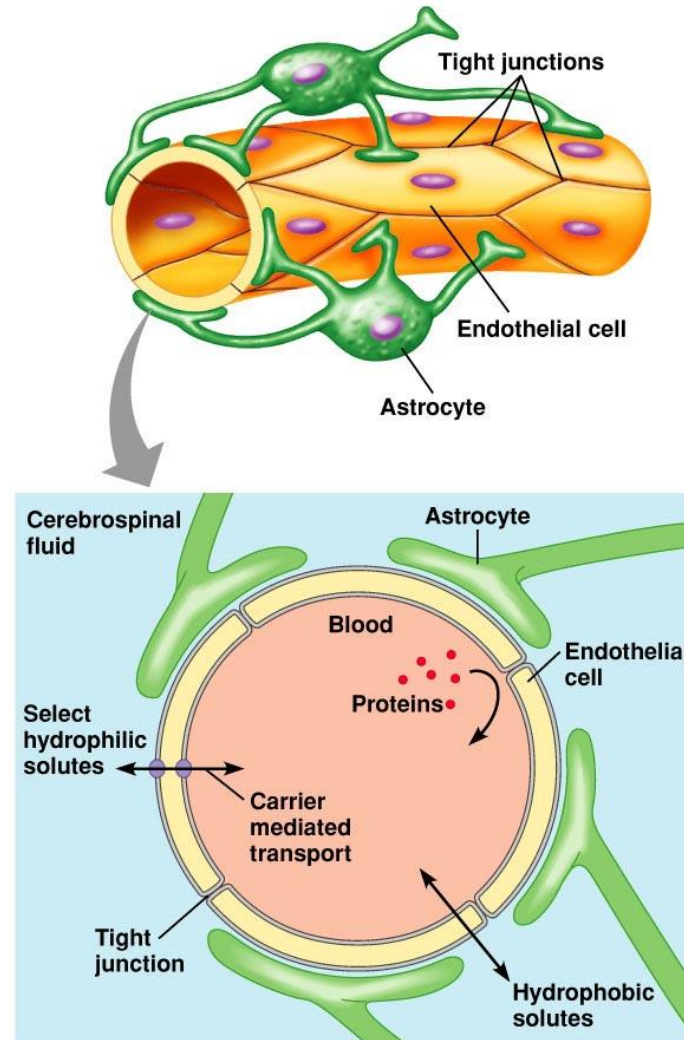
Stroke

- Caused by decreased blood supply
 - Occlusion of cerebral blood vessel
 - Hemorrhage from cerebral blood vessel

Blood-Brain Barrier

- Capillaries
 - Sites of exchange between blood and interstitial fluid
- Blood-brain barrier
 - Special anatomy of CNS capillaries which limit exchange

Blood-Brain Barrier



(b) Brain capillary

Figure 9.4b

CNS: Gray and White Matter

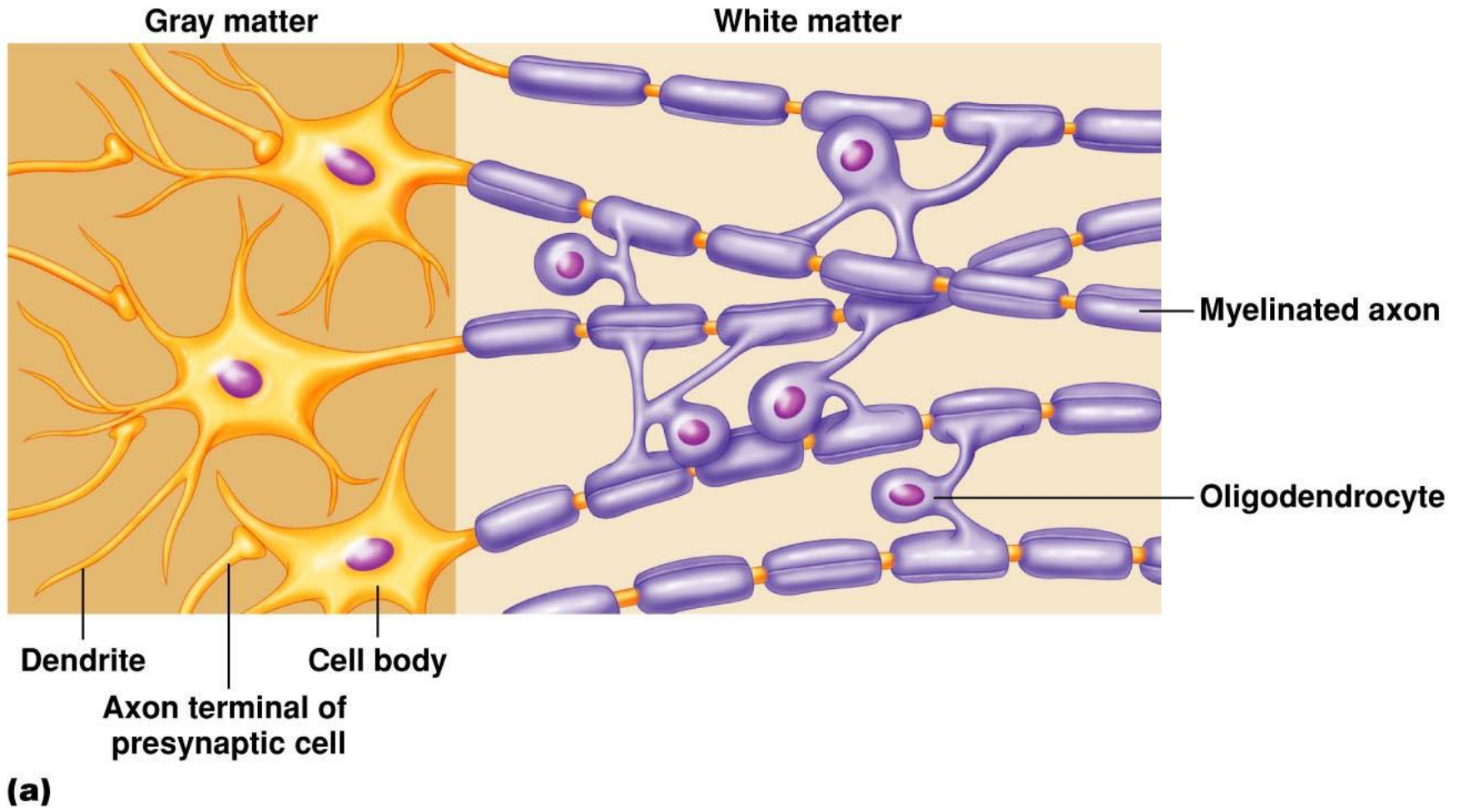


Figure 9.5a

White Matter in Brain

- Projection fibers
 - Cerebral cortex with lower levels of brain or spinal cord
- Association fibers
 - Connect two areas of cerebral cortex on same side of brain
- Commissural fibers
 - Connect same cortical regions on two sides of brain
- Corpus callosum
 - Primary location of commissural fibers

CNS: Gray and White Matter

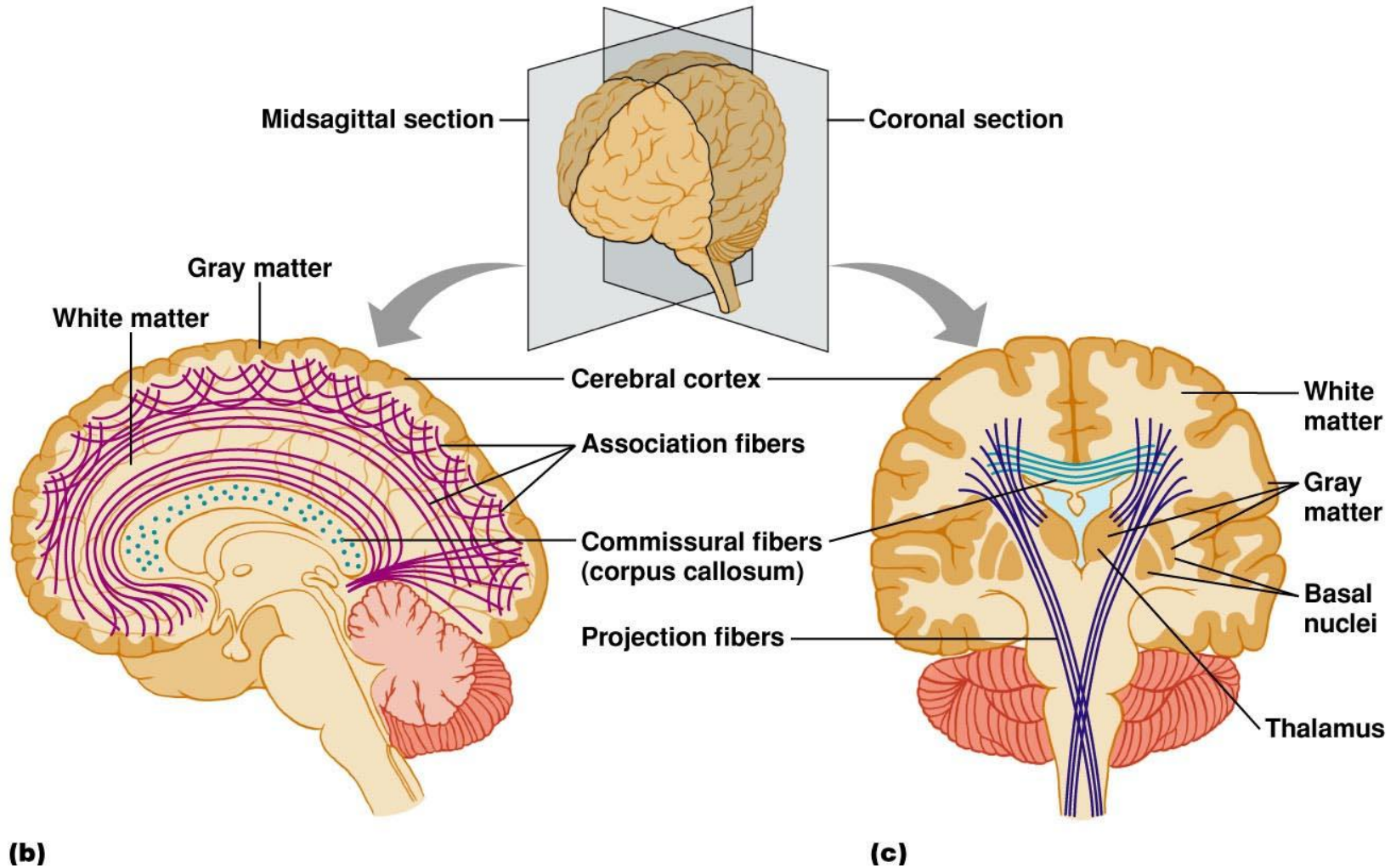


Figure 9.5b–c

II. Spinal Cord

- Cylinder of nerve tissue
- Continuous with brain
- Surrounded by vertebral column
- Origin of spinal nerves (31 pairs)

Spinal Cord

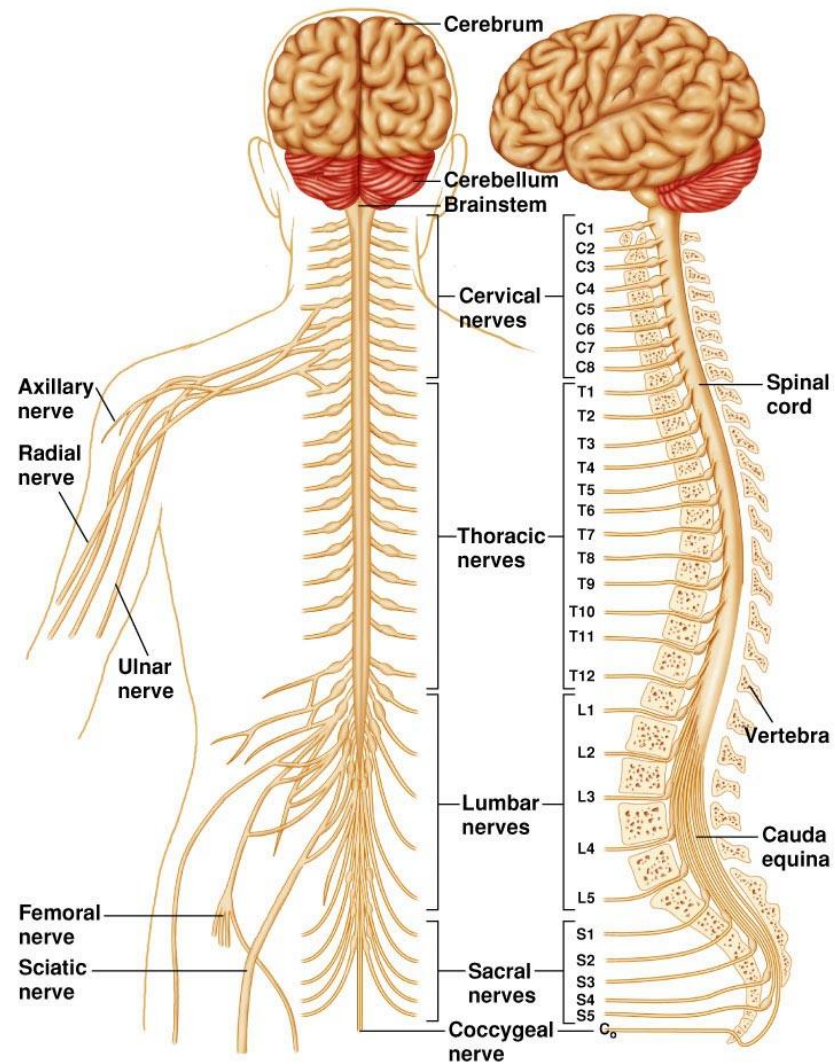


Figure 9.6

Dermatome

- Sensory region of skin
- Each served by spinal nerve

Dermatome

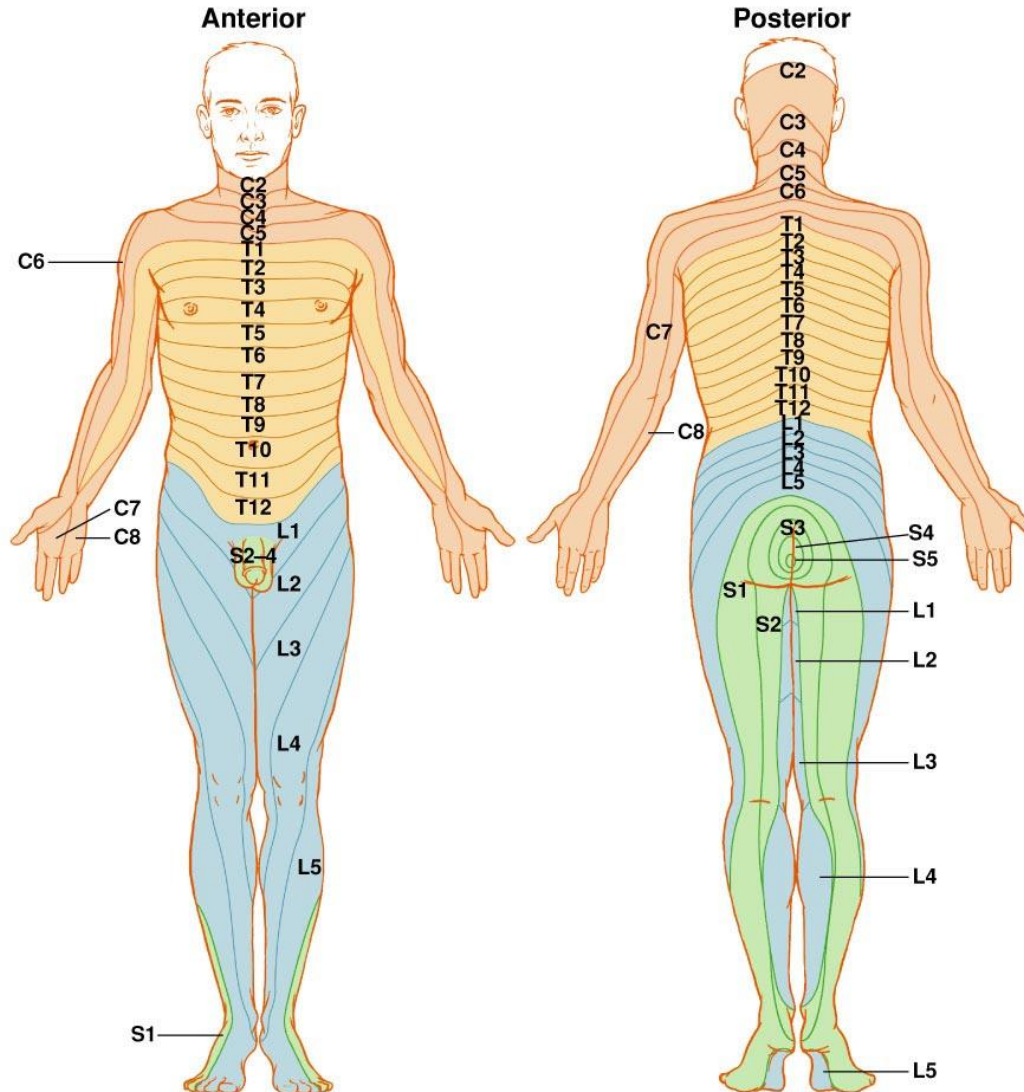


Figure 9.7

Spinal Cord and Spinal Nerves

- Gray matter: functional halves
 - Dorsal: sensory functions
 - Ventral: motor functions
- Spinal nerves are mixed
- White matter forms tracts
 - Ascending
 - Descending

Spinal Cord: Cross Section

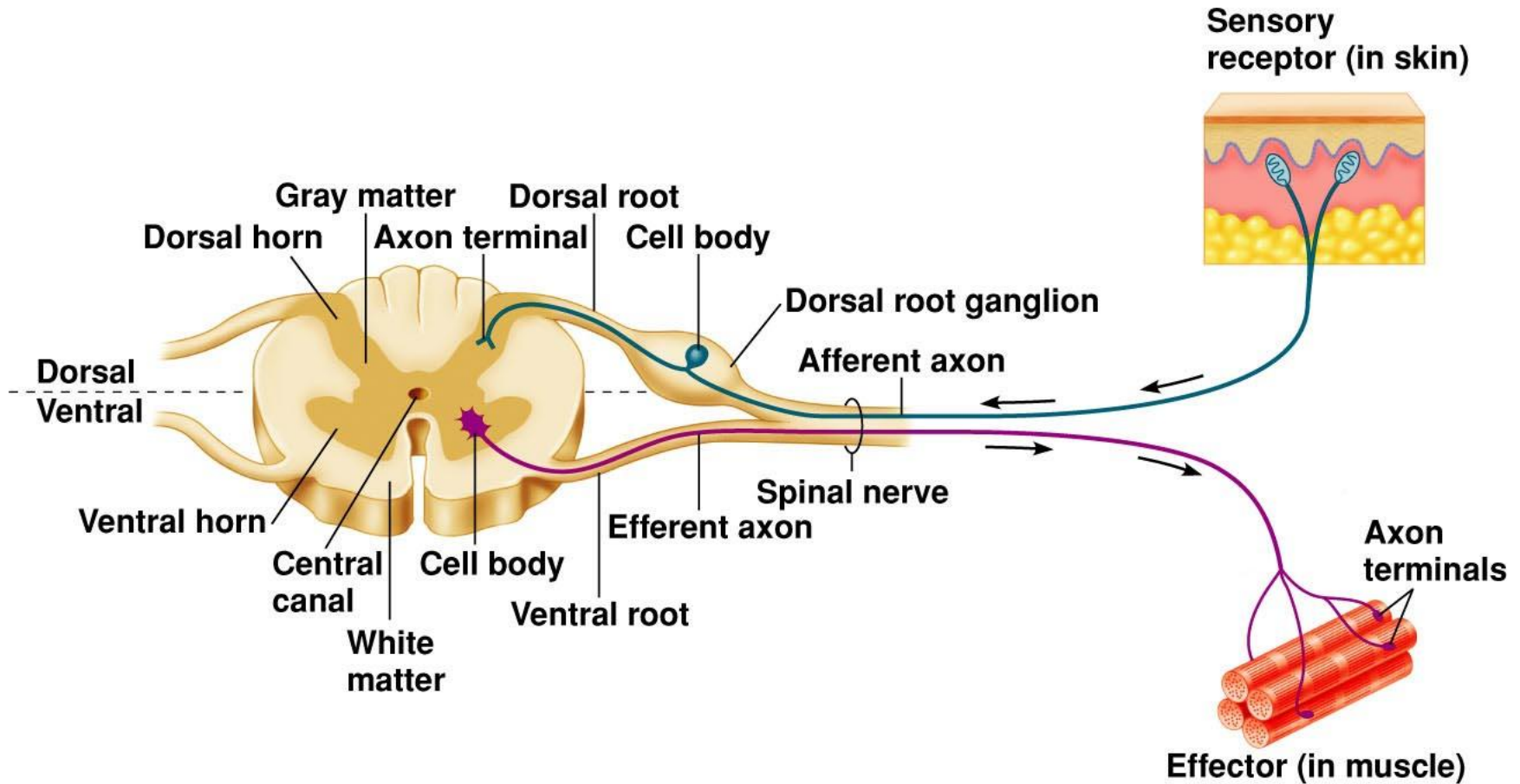


Figure 9.8

Spinal Cord: Tracts

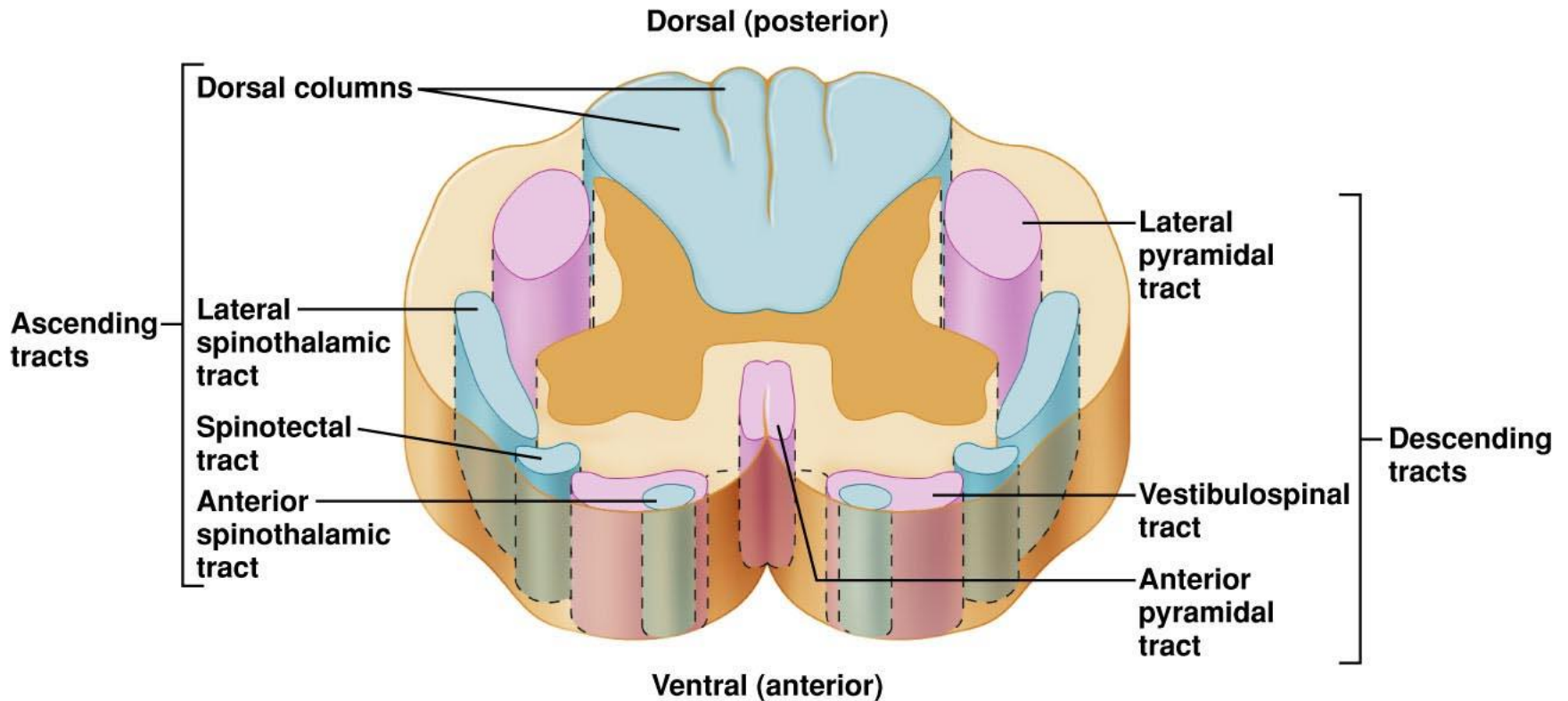
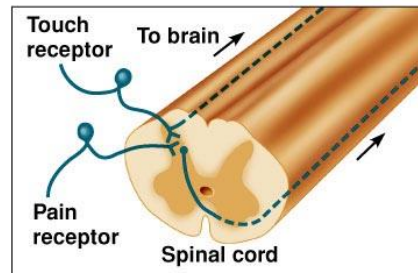
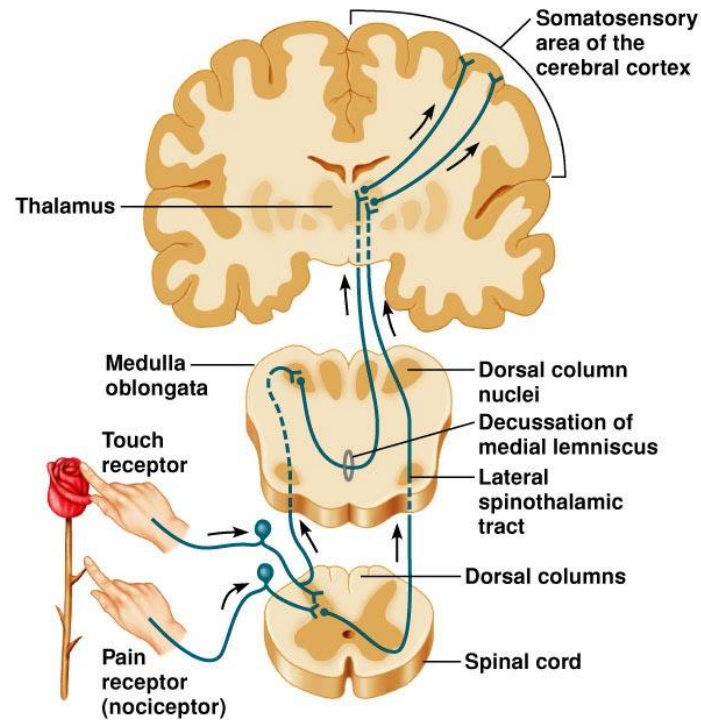


Figure 9.9

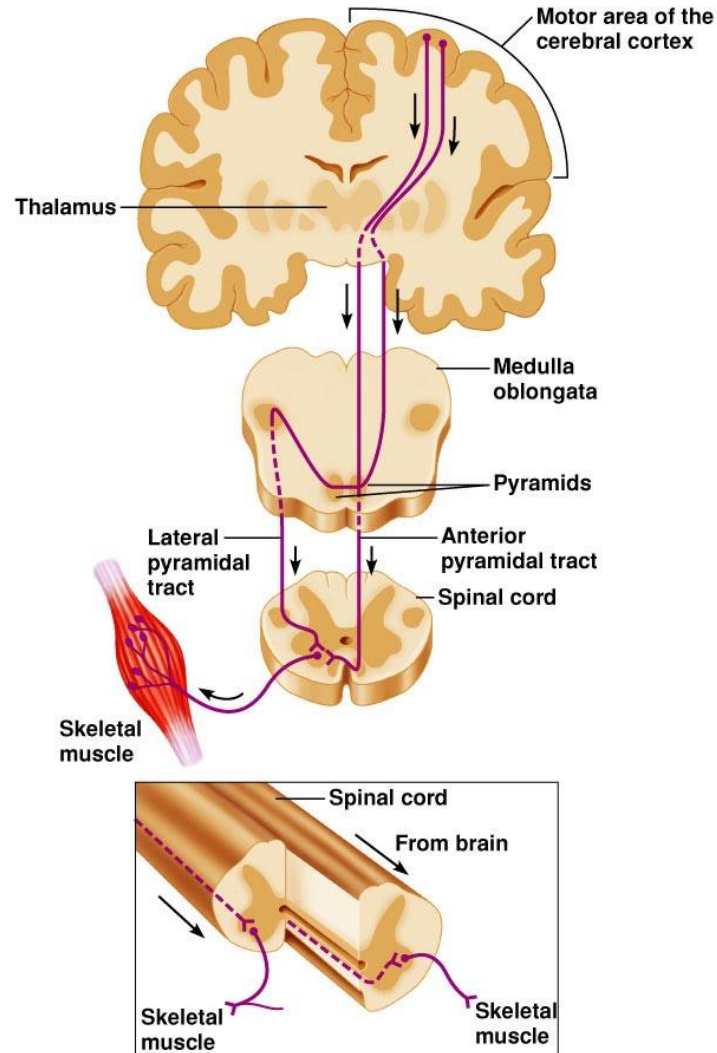
Spinal Cord: Ascending Tracts



(a) Ascending tracts

Figure 9.10a

Spinal Cord: Descending Tracts



(b) Descending tracts

Figure 9.10b

Brain

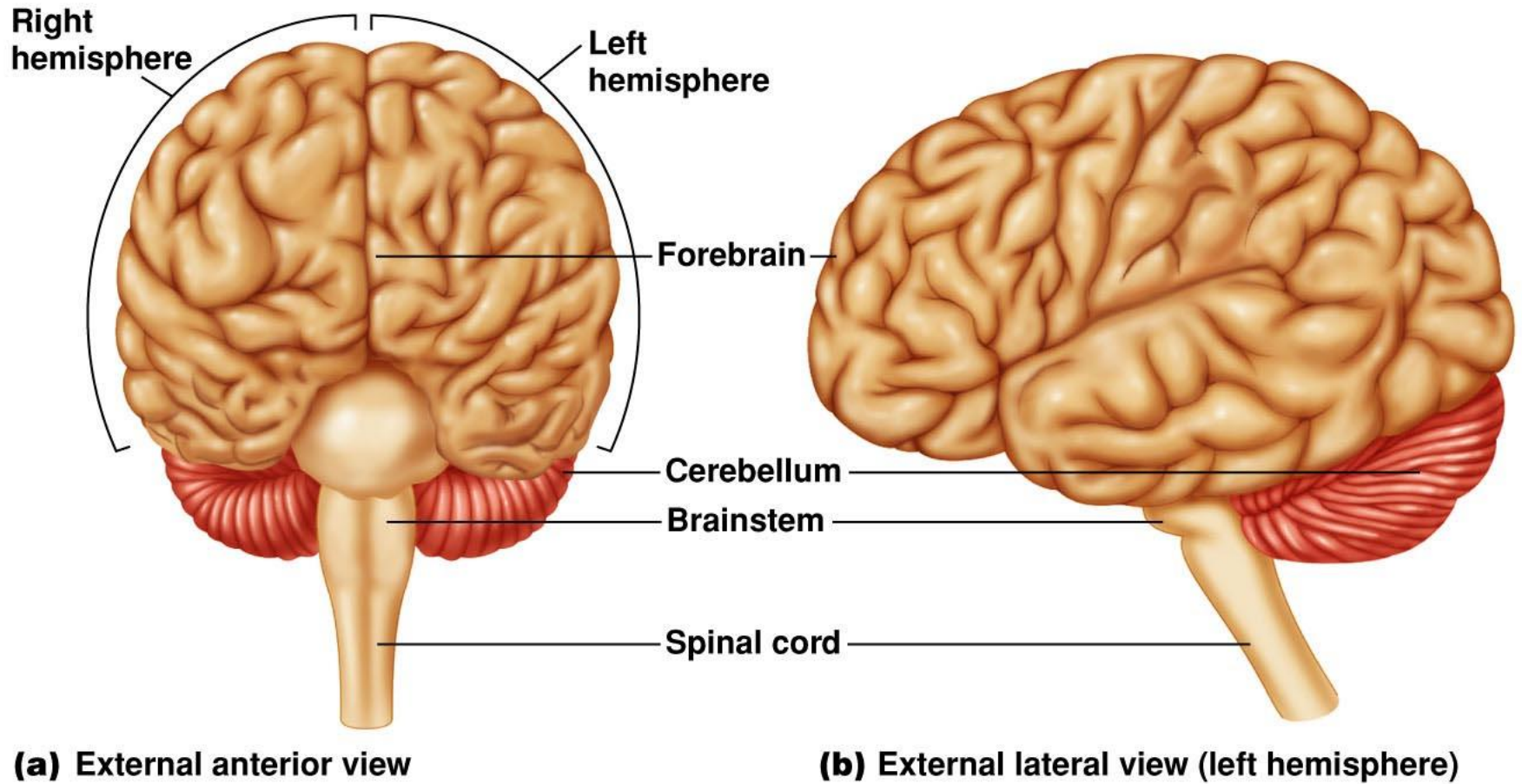


Figure 9.11a–b

Brain: Midsagittal View

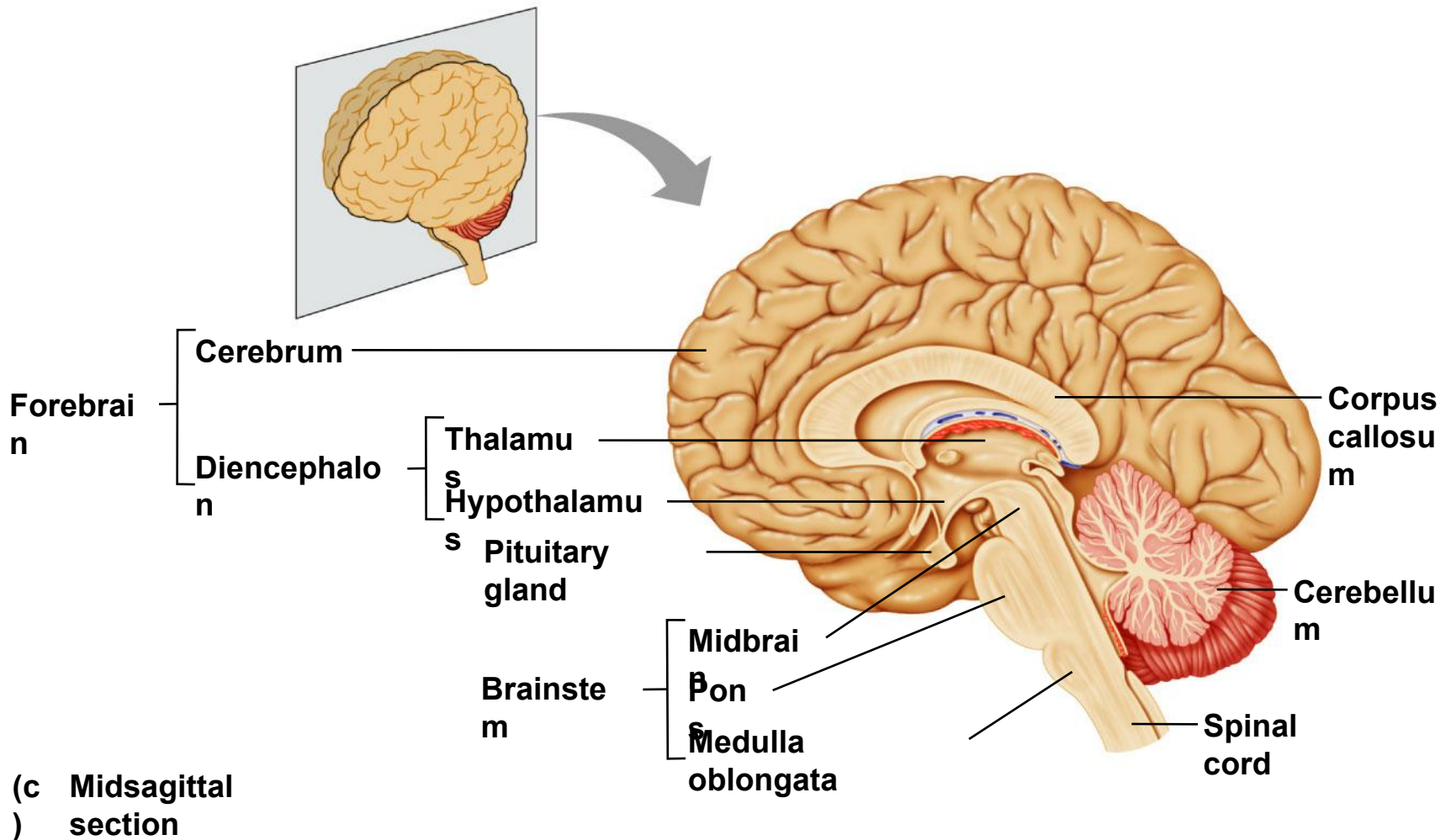


Figure 9.11c

Functional Areas of Cerebrum

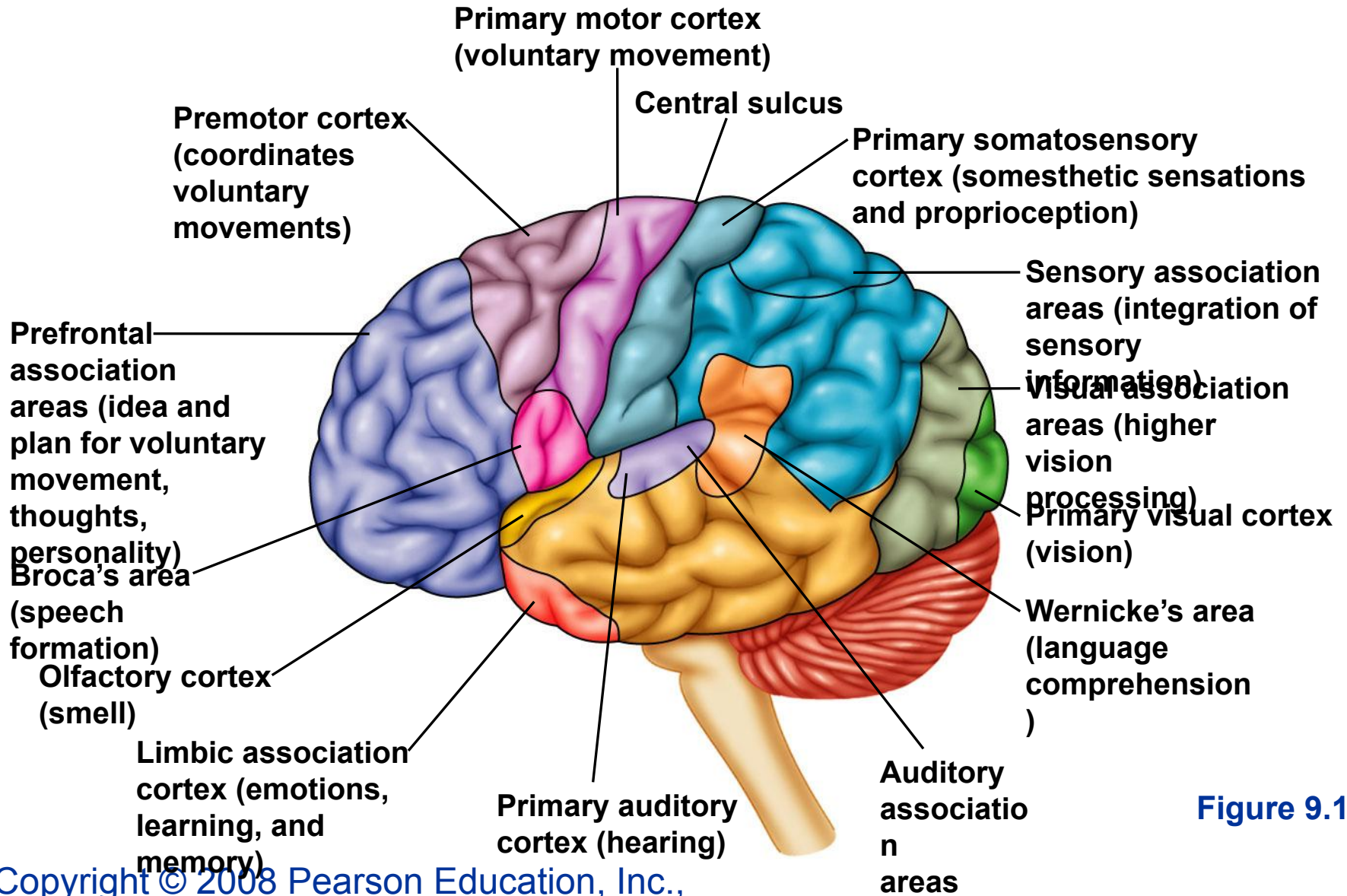


Figure 9.14

Topographical Organization: Motor

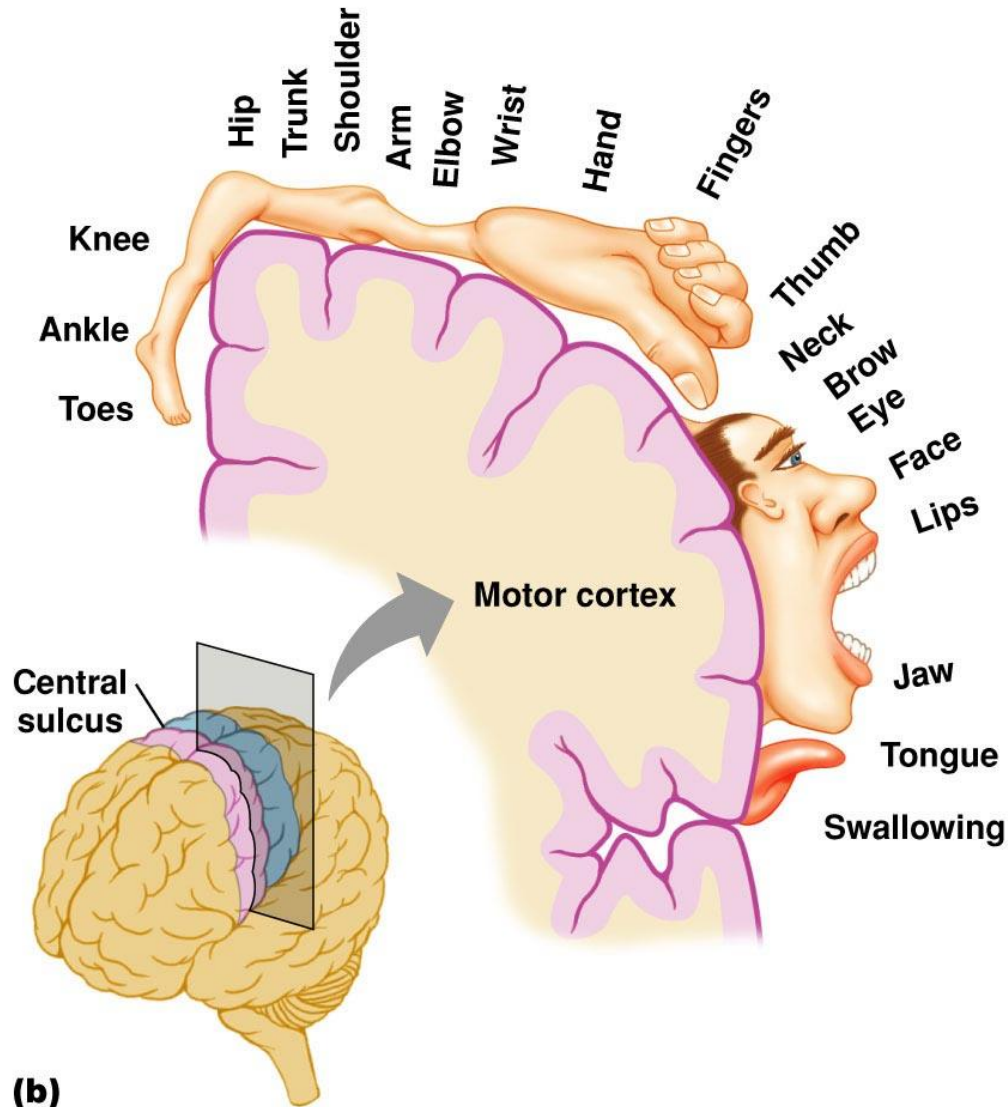


Figure 9.15b

Topographical Organization: Sensory

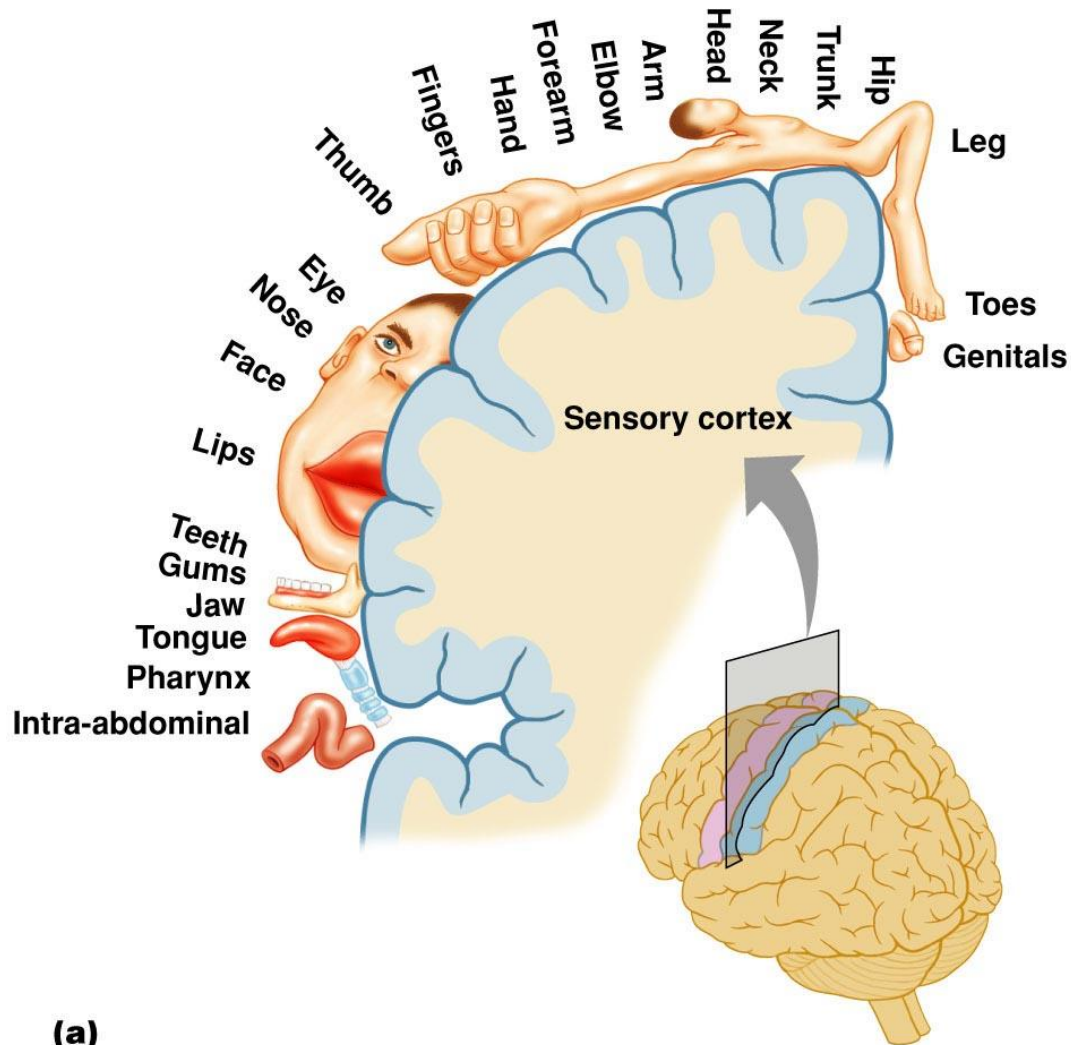


Figure 9.15a

The Limbic System

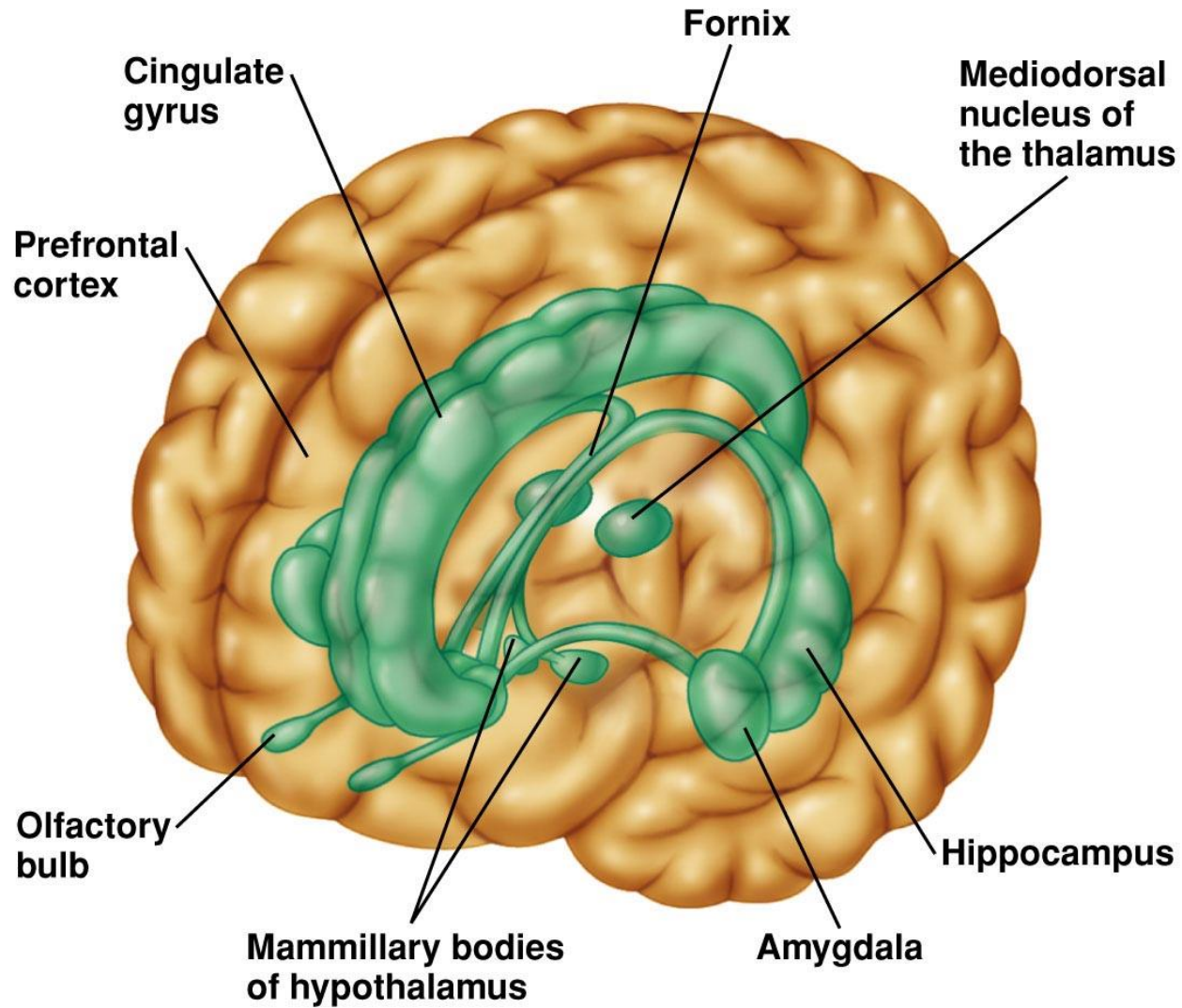


Figure 9.17

Functions of Limbic System

- Learning
- Emotions
- Behavior

Reflexes

Automatic patterned response to a stimulus

Classes of Reflexes

TABLE 9.3 Classes of Reflexes

Basis of classification	Classes	Example
Level of neural processing	Spinal Cranial	Muscle spindle stretch reflex Pupillary reflex
Efferent division controlling effector	Somatic Autonomic	Muscle spindle stretch reflex Baroreceptor reflex to control blood pressure
Developmental pattern	Innate Conditioned	Muscle spindle stretch reflex Salivation reflex of Pavlov's dogs
Number of synapses in the pathway	Monosynaptic Polysynaptic	Muscle spindle stretch reflex All other reflexes

Table 9.3

Reflex Arc

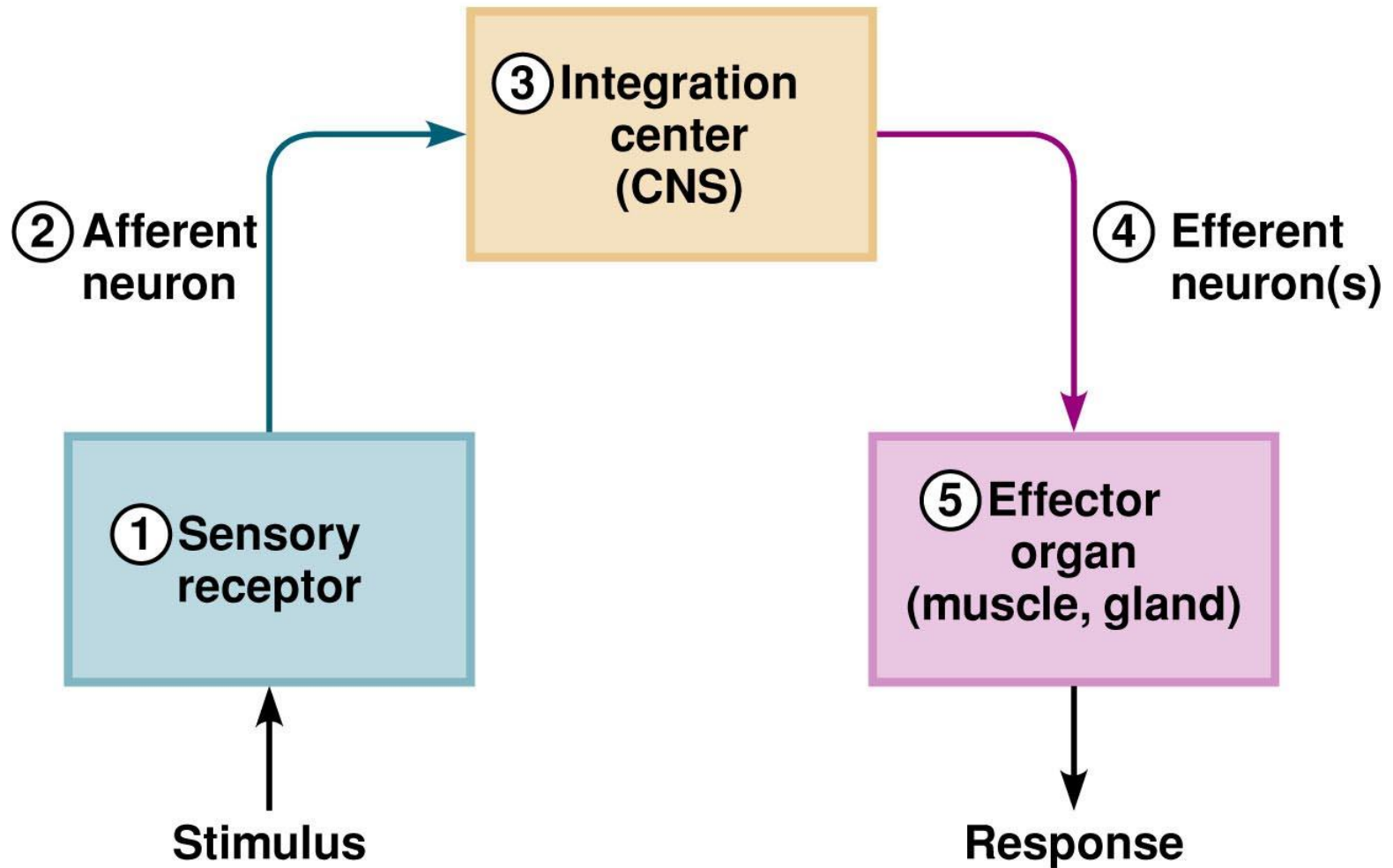


Figure 9.18

Stretch Reflex

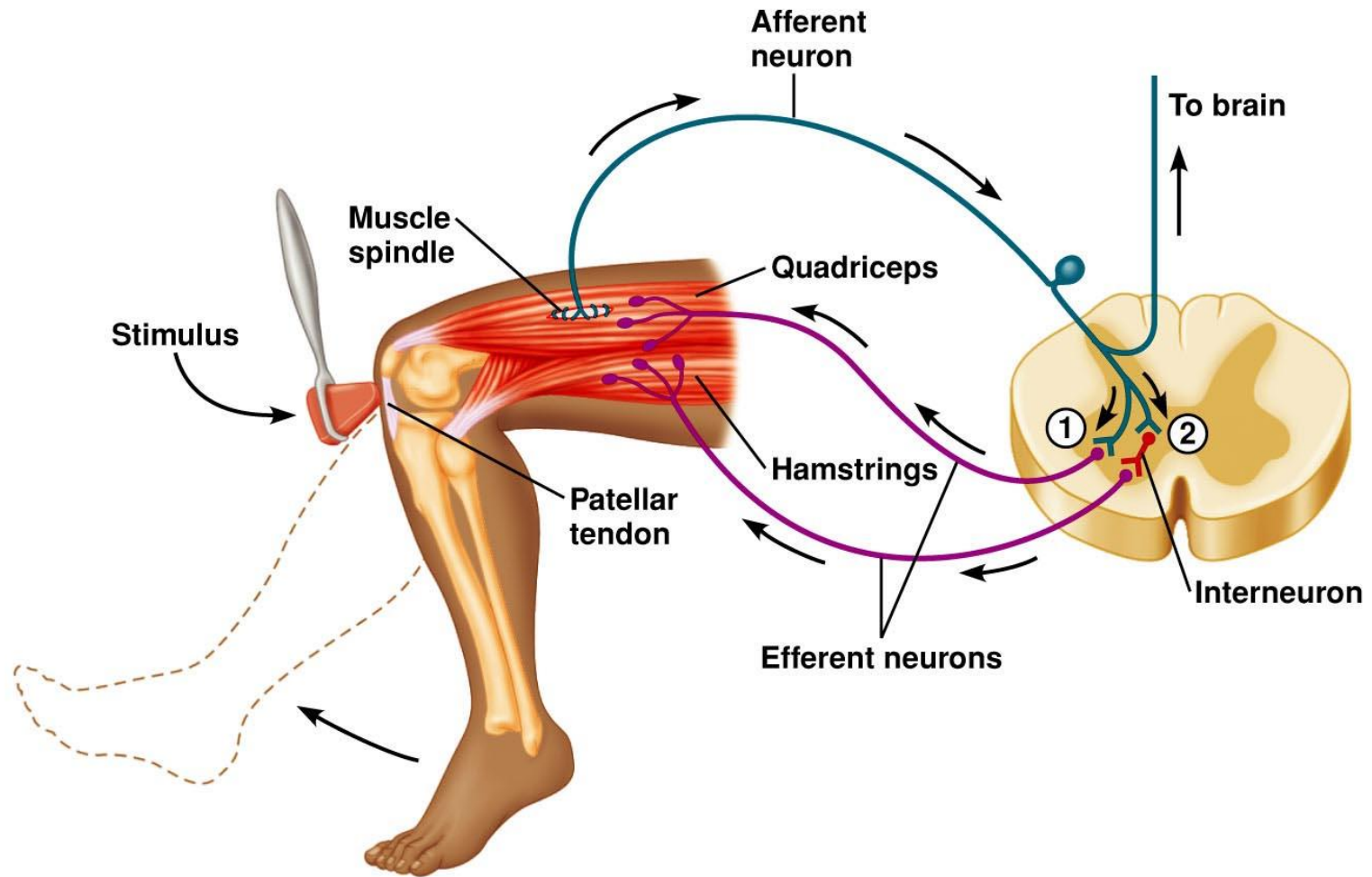


Figure 9.19

Withdrawal and Crossed-Extensor Reflexes

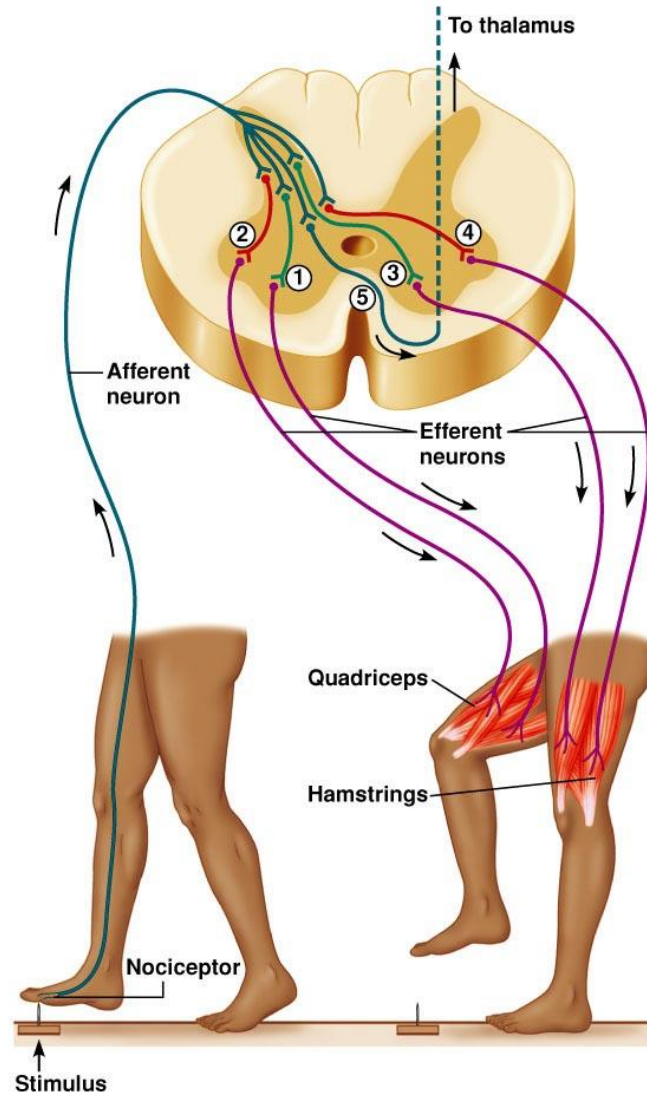


Figure 9.20