Essentials of Anatomy & Physiology, 4th Edition

Martini / Bartholomew

8 The Nervous System

PowerPoint® Lecture Outlines
prepared by Alan Magid, Duke University

Slides 1 to 145

The Nervous System

- What Two Organ Systems Control All the Other Organ Systems?
  - Nervous system characteristics
    - Rapid response
    - Brief duration
  - Endocrine system characteristics
    - Slower response
    - Long duration

The Nervous System

What are the Two Anatomical Divisions?

- Central nervous system (CNS)
  - Brain
  - Spinal cord
- Peripheral nervous system (PNS)
  - All the neural tissue outside CNS
  - *Afferent* division (sensory input)
  - *Efferent* division (motor output)
    - Somatic nervous system
    - Autonomic nervous system

Neural Tissue Organization

What is the Anatomic Organization of CNS Neurons?

White matter—Bundles of axons (*tracts*) that share origins, destinations, and functions

Neural Tissue Organization

What is the Anatomic Organization of PNS Neurons?

- *Ganglia*—Groupings of neuron cell bodies
- *Nerve*—Bundle of axons supported by connective tissue
  - Spinal nerves
    - To/from spinal cord
  - Cranial nerves
    - To/from brain

Neural Tissue Organization

What are the Pathways in the CNS?

- *Ascending pathways*
  - Carry information from *sensory* receptors to processing centers in the brain
- *Descending pathways*
  - Carry commands from specialized CNS centers to skeletal muscles

The Central Nervous System

Meninges—Layers that surround and protect the brain and spinal cord (CNS)

- *Dura mater* (“tough mother”)
- *Arachnoid* (“spidery”)
- *Pia mater* (“delicate mother”)

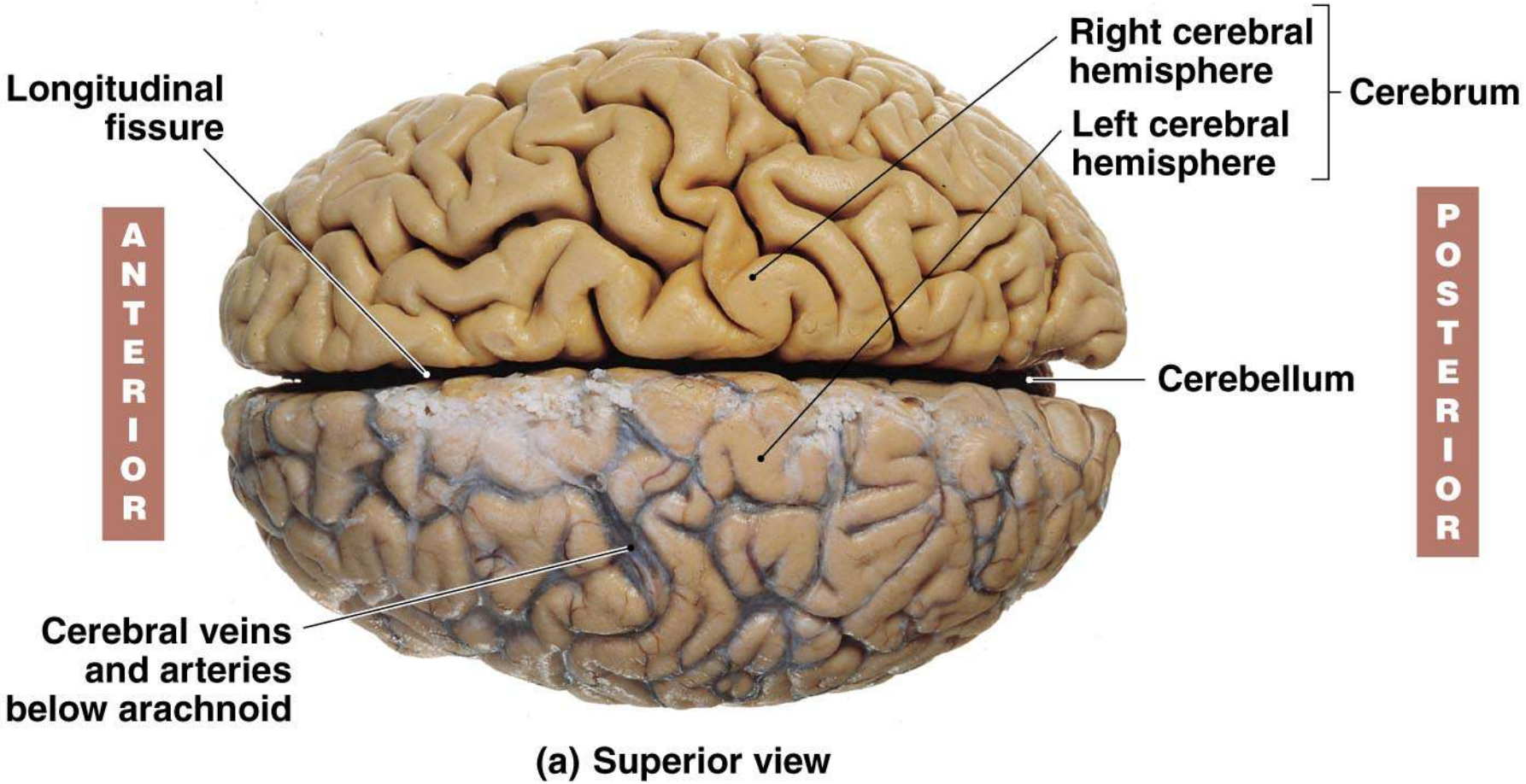
The Central Nervous System

What are the Brain Regions?

- *Cerebrum*
- *Diencephalon*
- *Midbrain*
- *Pons*
- *Medulla oblongata*
- *Cerebellum*

The Central Nervous System

The Brain



(a) Superior view

Figure 8-16(a)

The Central Nervous System

The Brain

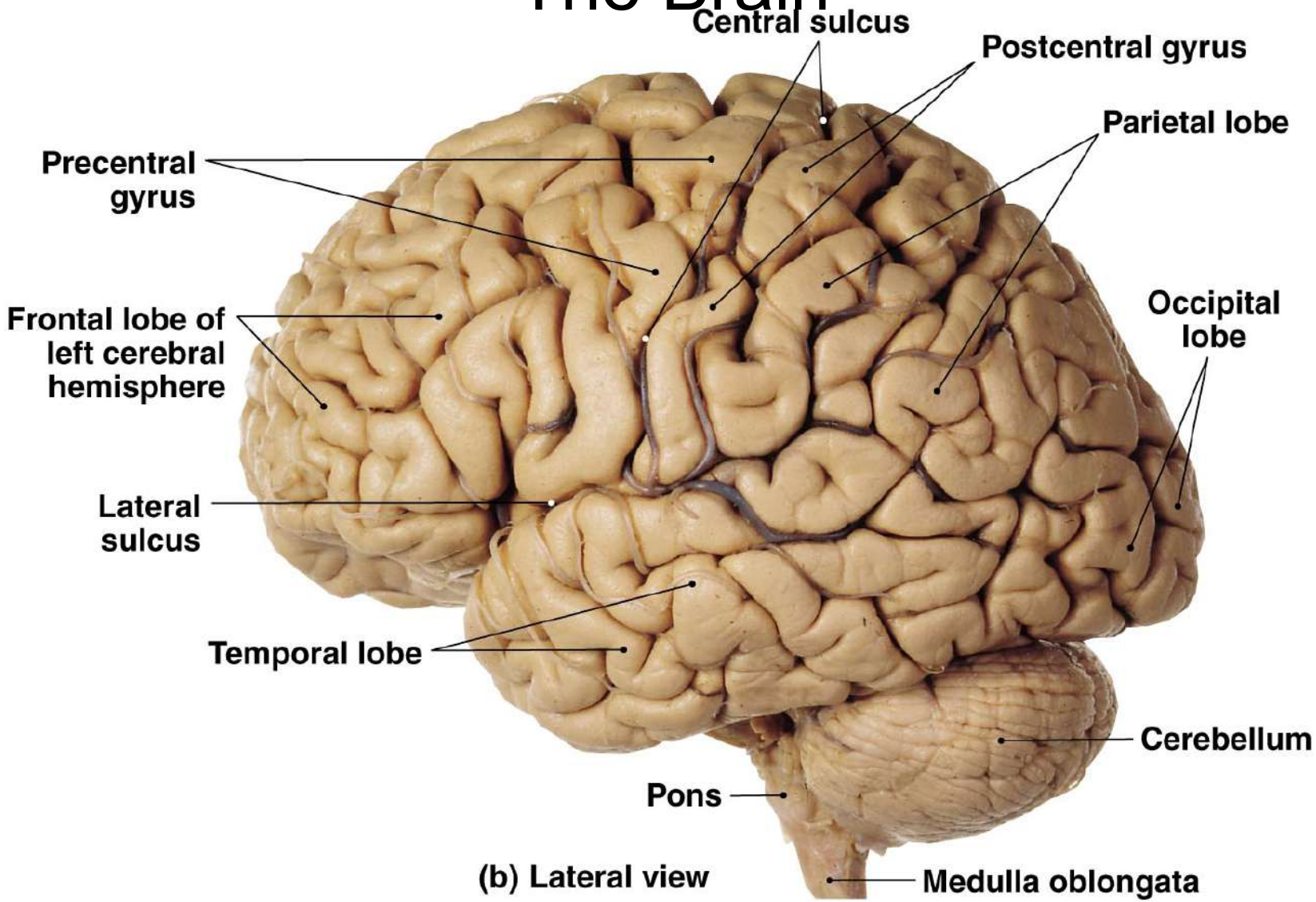


Figure 8-16(b)

The Central Nervous System

The Brain

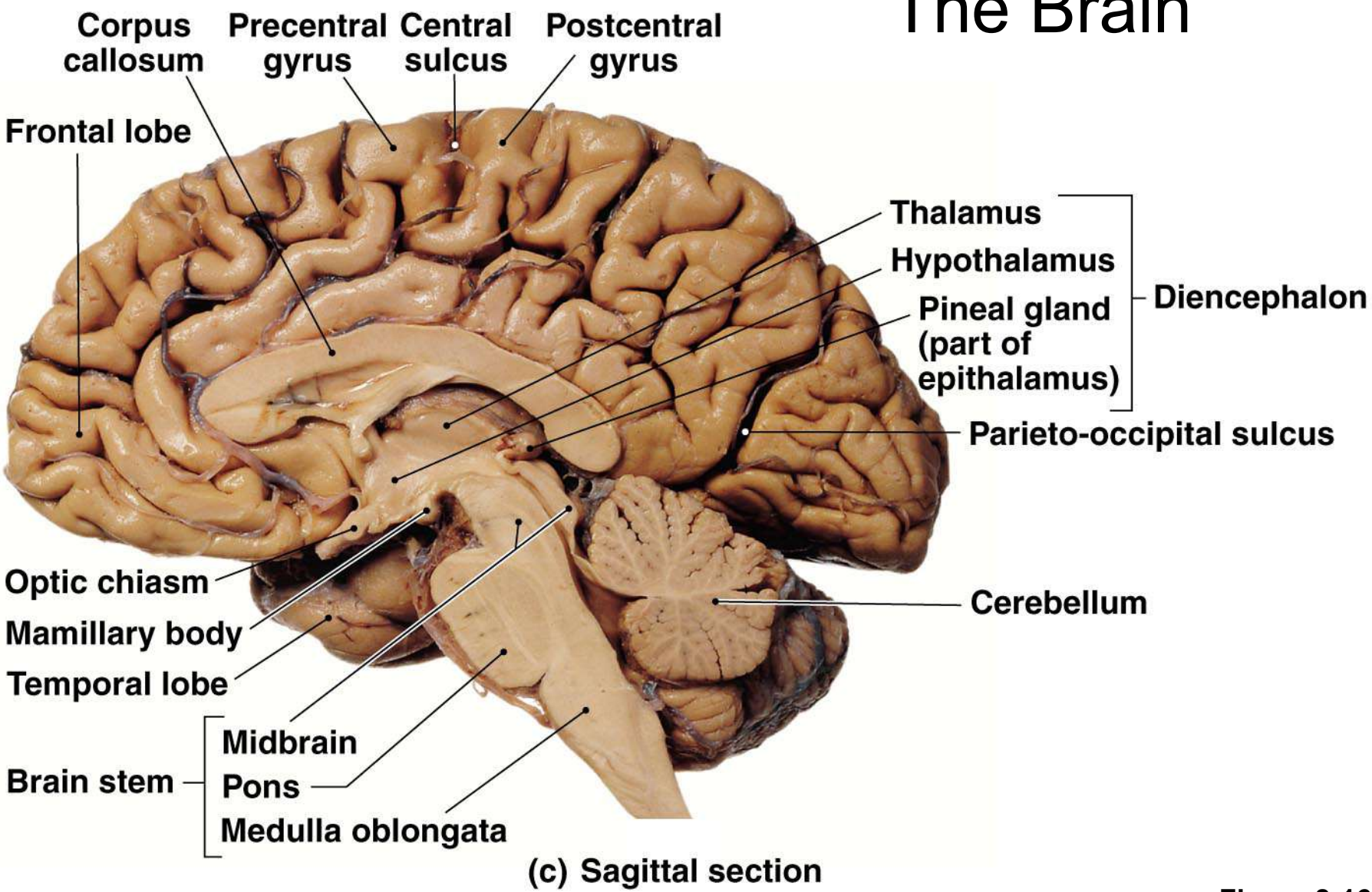


Figure 8-16(c)

The Central Nervous System

Brain—The four hollow chambers in the center of the brain filled with *cerebrospinal fluid* (CSF)

The Central Nervous System

The Ventricles of the Brain

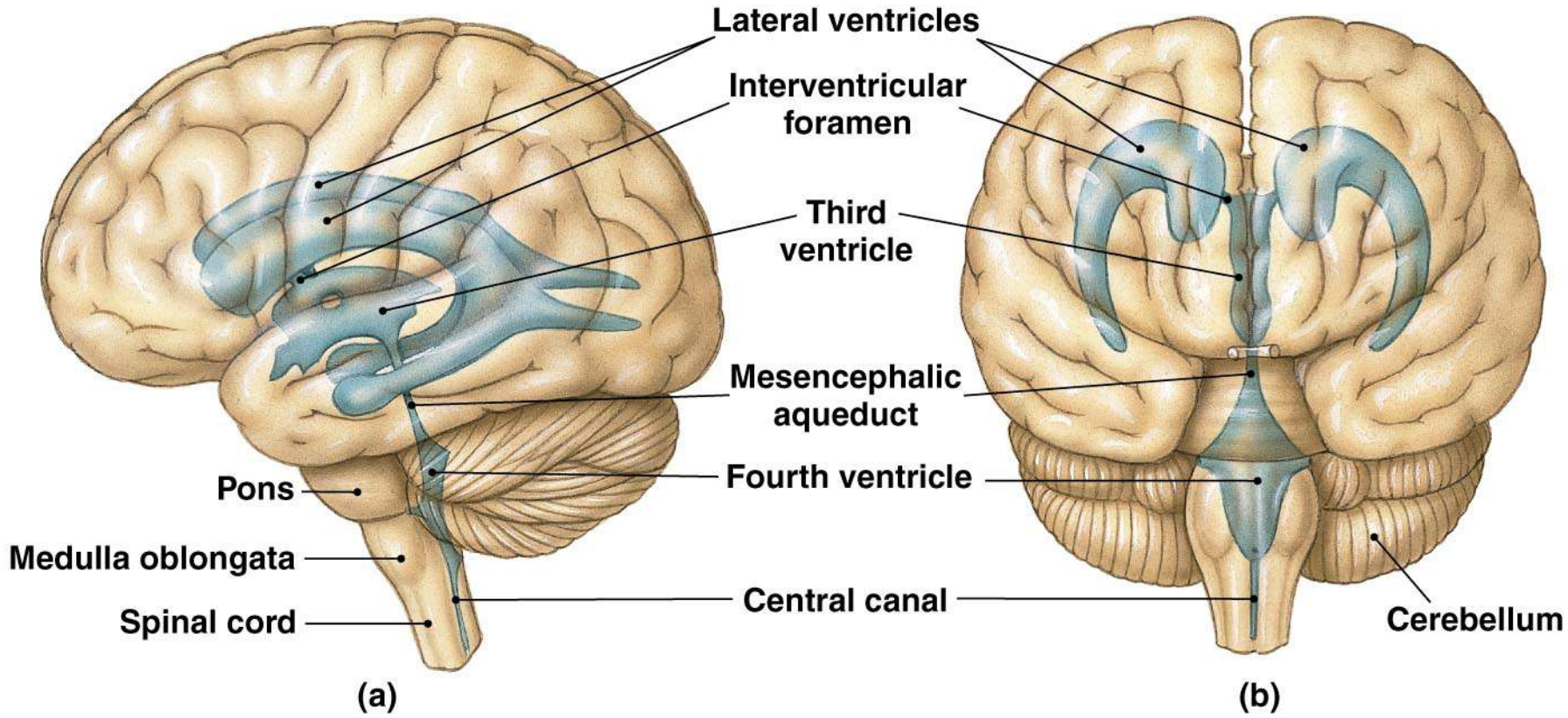


Figure 8-17

The Central Nervous System

The Formation and Circulation of Cerebrospinal Fluid

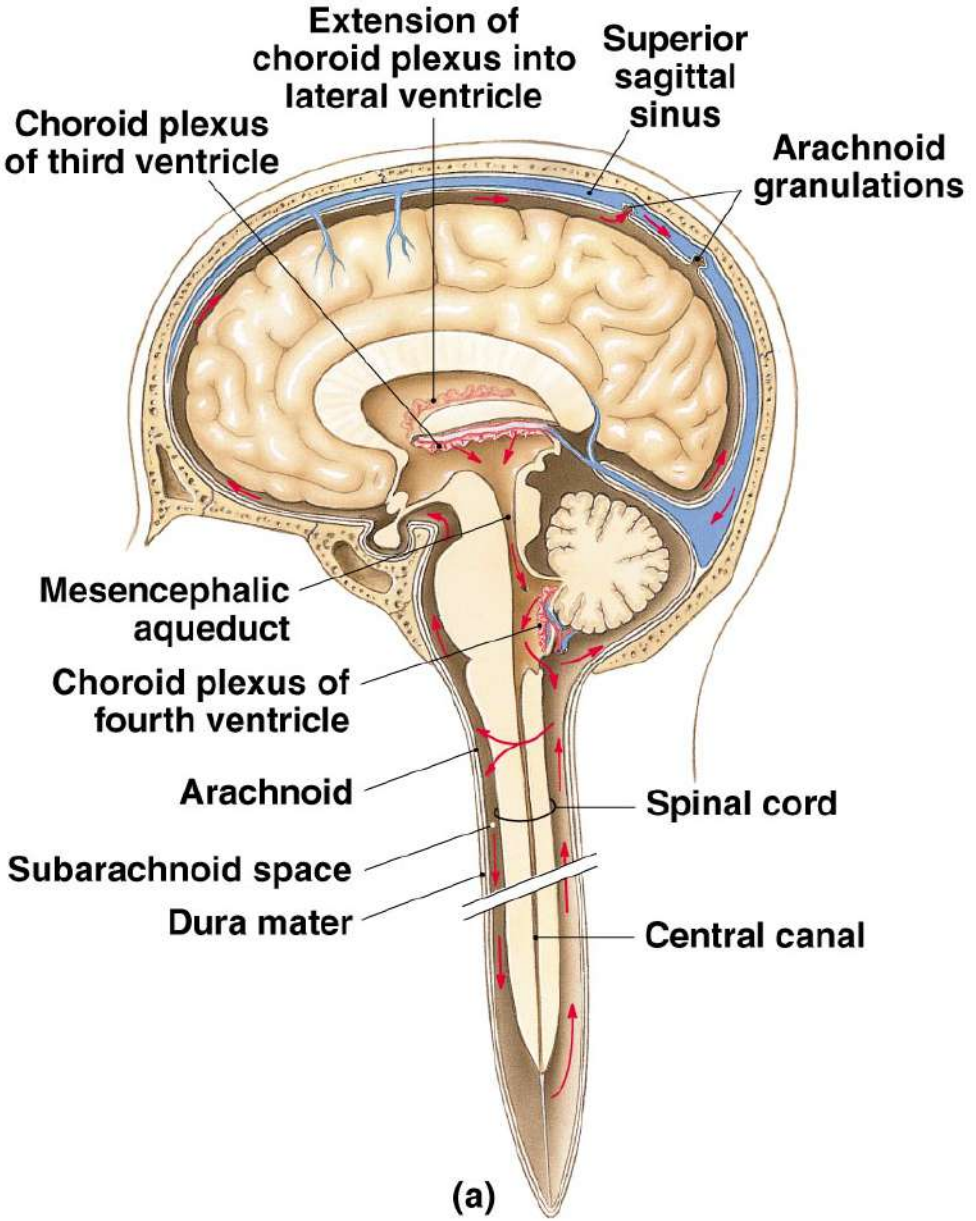


Figure 8-18(a)

The Central Nervous System

The Formation and Circulation of Cerebrospinal Fluid

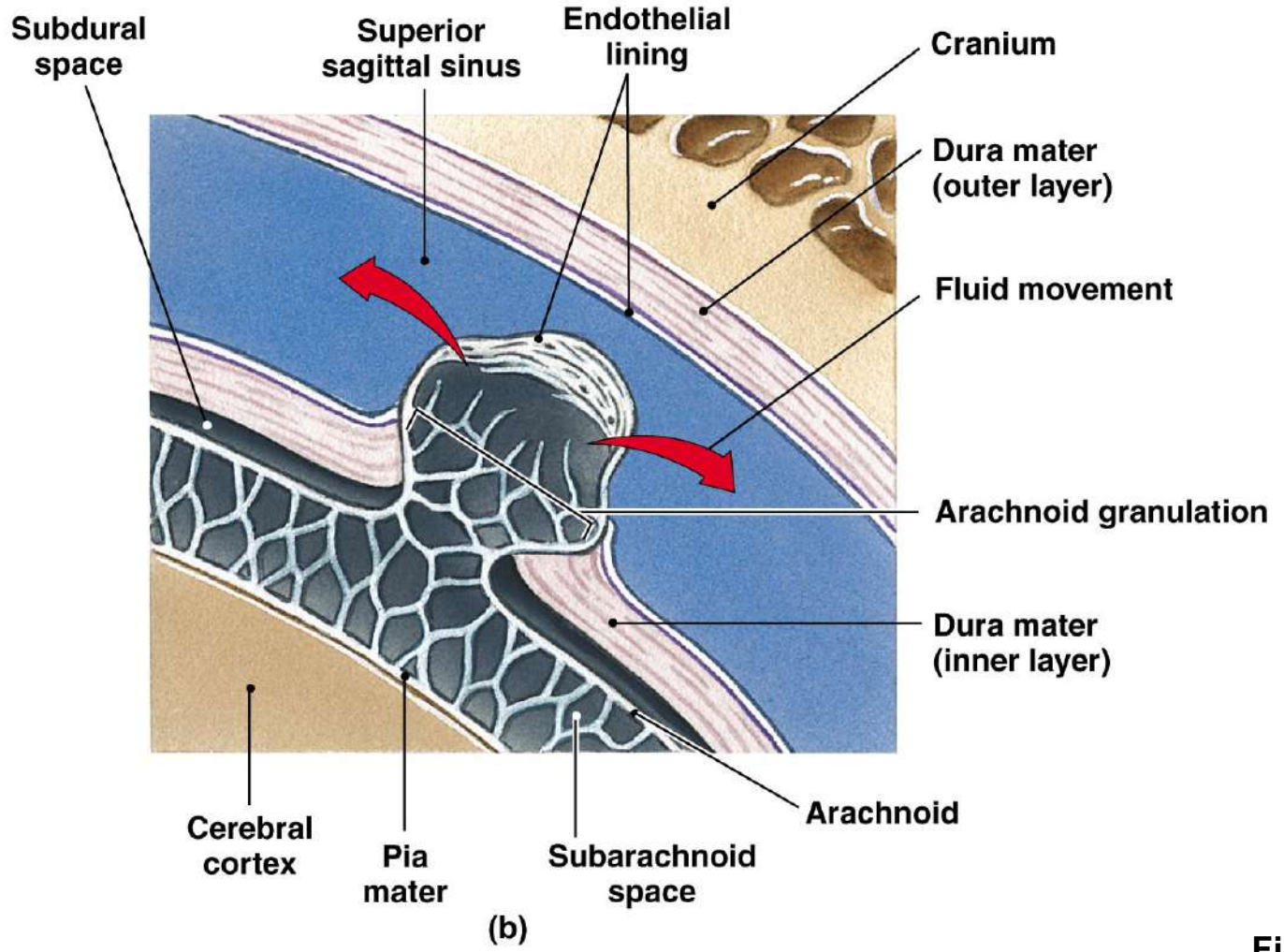


Figure 8-18(b)

The Central Nervous System

What are the Functions of the Cerebrum?

- Conscious thought
- Intellectual activity
- Memory
- Origin of complex patterns of movement

The Central Nervous System

What are the Functions of the Cerebral Cortex?

- *Primary motor cortex* (*precentral* gyrus)
  - Directs voluntary movement
- *Primary sensory cortex* (*postcentral* gyrus)
  - Receives *somatic* sensation (touch, pain, pressure, temperature)
- *Association areas*
  - Interpret sensation
  - Coordinate movement

The Central Nervous System

The Surface of the Cerebral Hemispheres

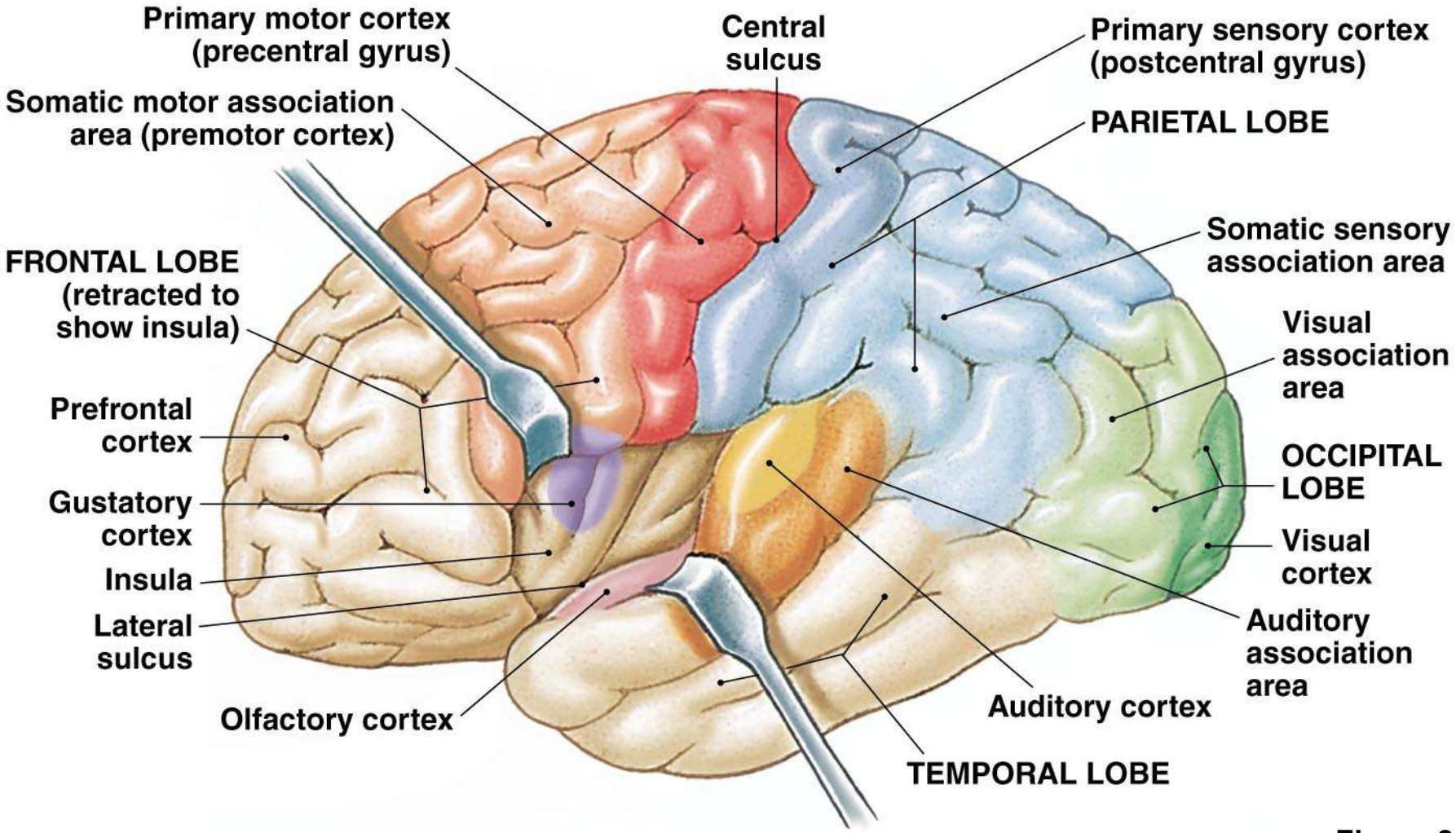


Figure 8-19

The Central Nervous System

Hemispheric Lateralization

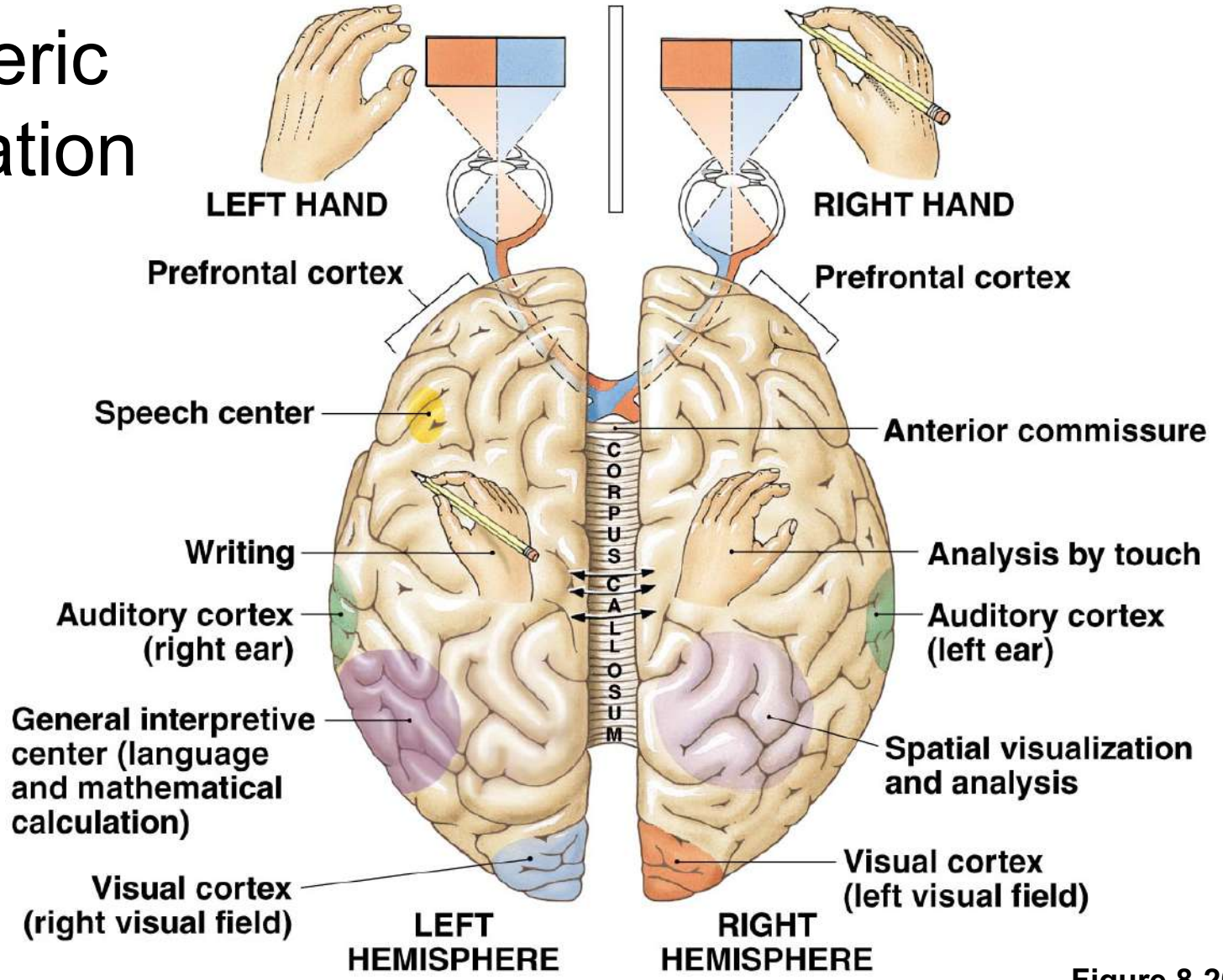
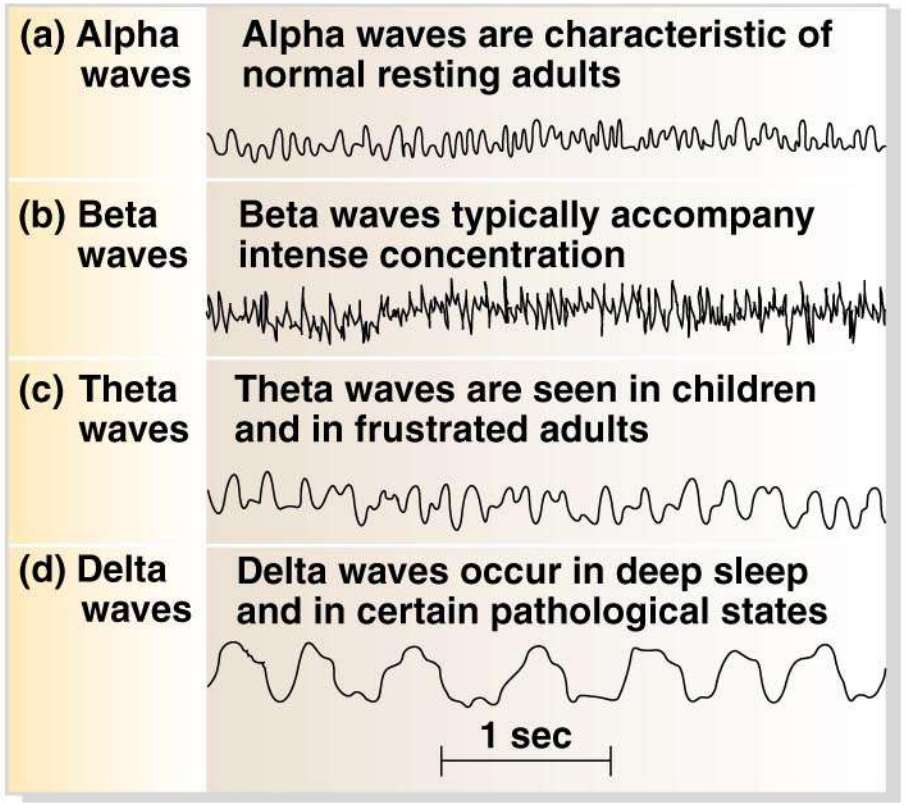


Figure 8-20

The Central Nervous System

Brain Waves

(*Electroencephalogram*)



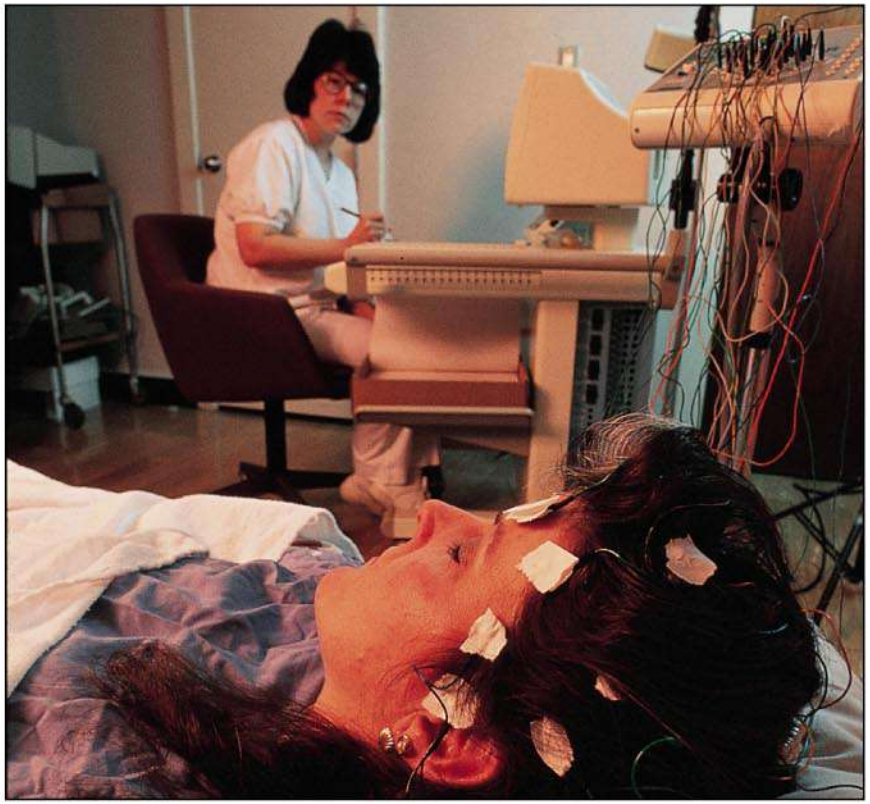


Figure 8-21

The Central Nervous System

The Basal Nuclei

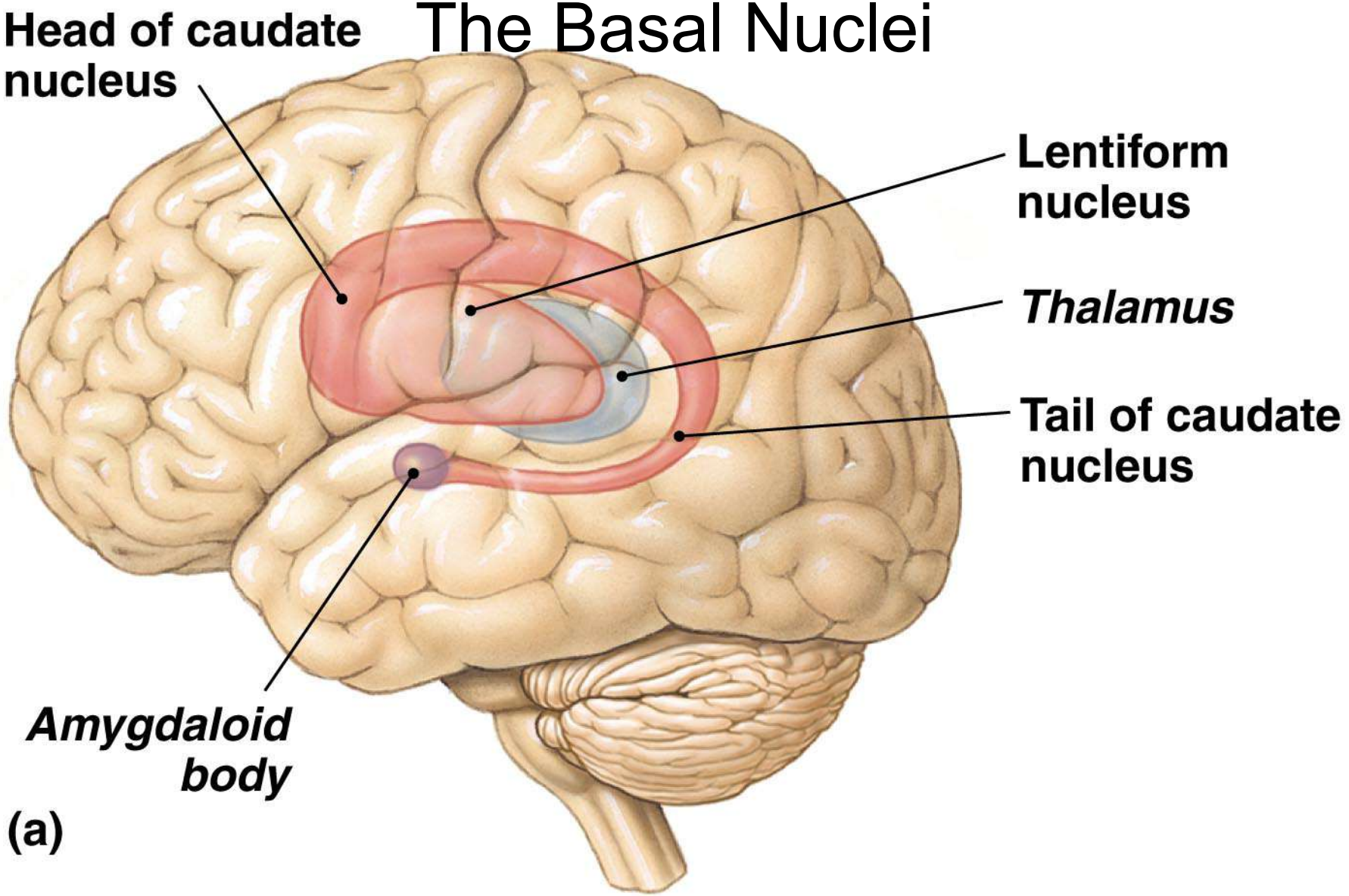


Figure 8-22(a)

The Central Nervous System

The Basal Nuclei

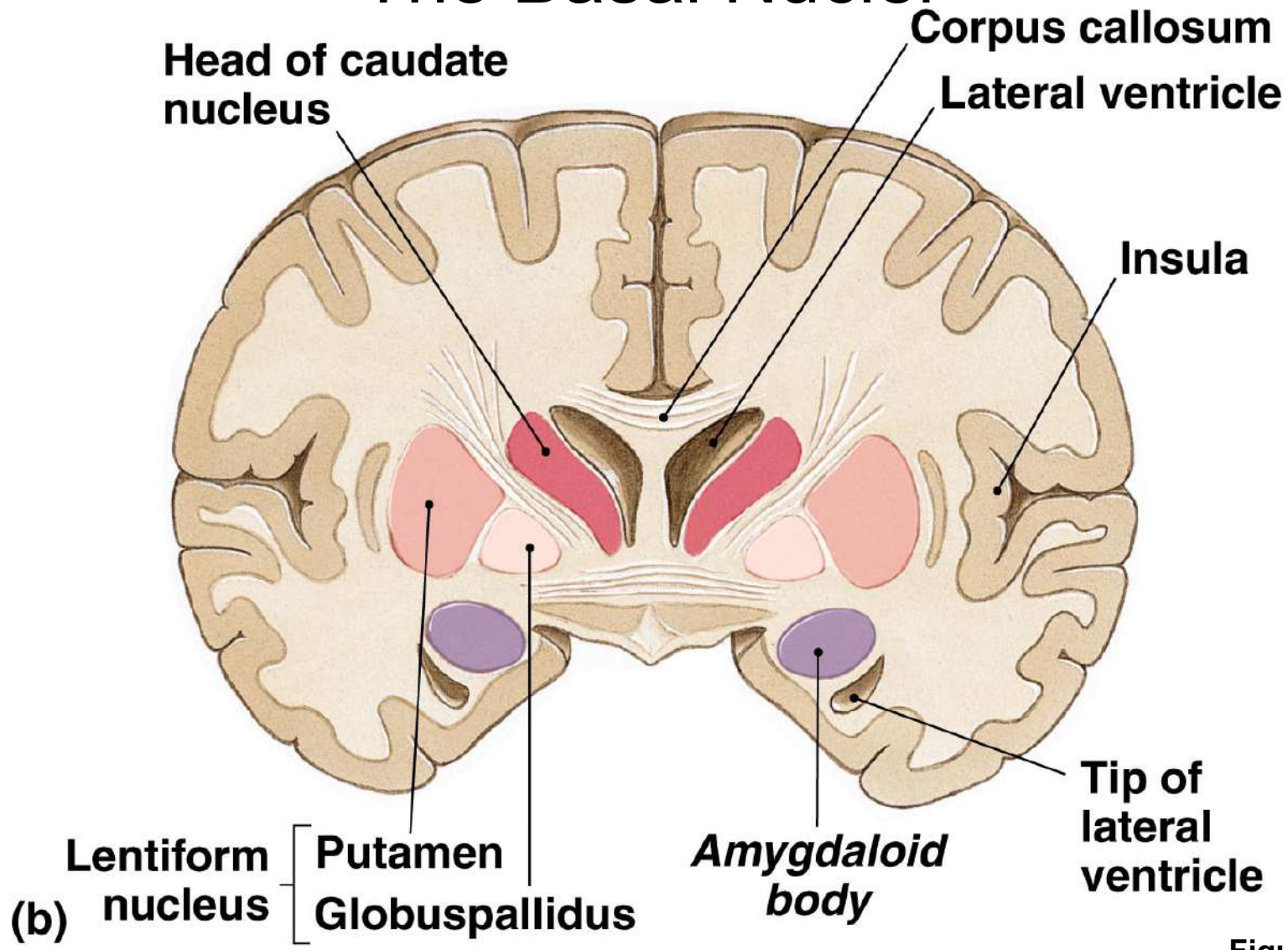


Figure 8-22(b)

The Central Nervous System

What are the Functions of the Limbic System?

- Establish emotions and related drives
- Control reflexes associated with eating
- Store and retrieve long-term memories

The Central Nervous System

The Limbic System

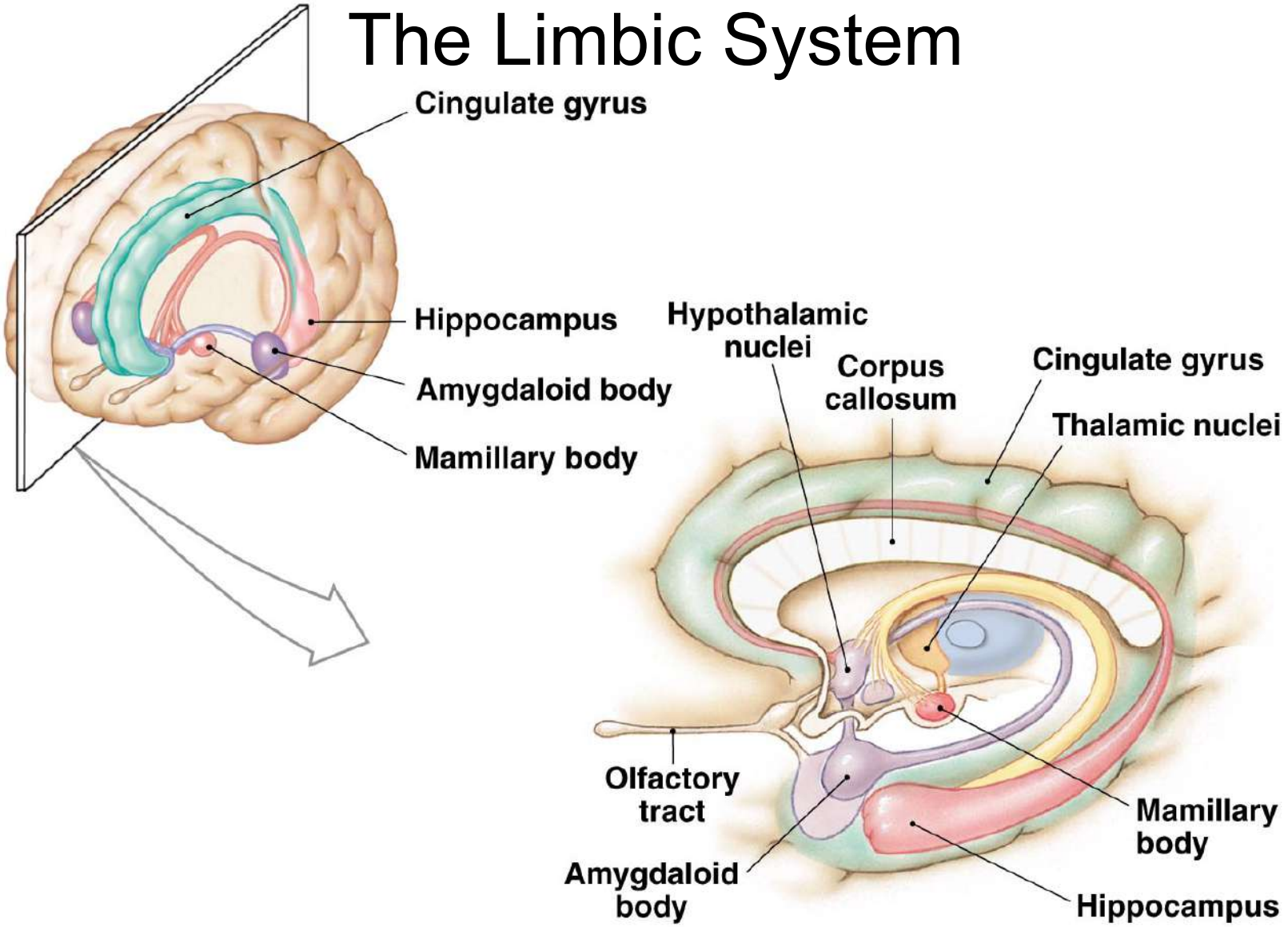


Figure 8-23

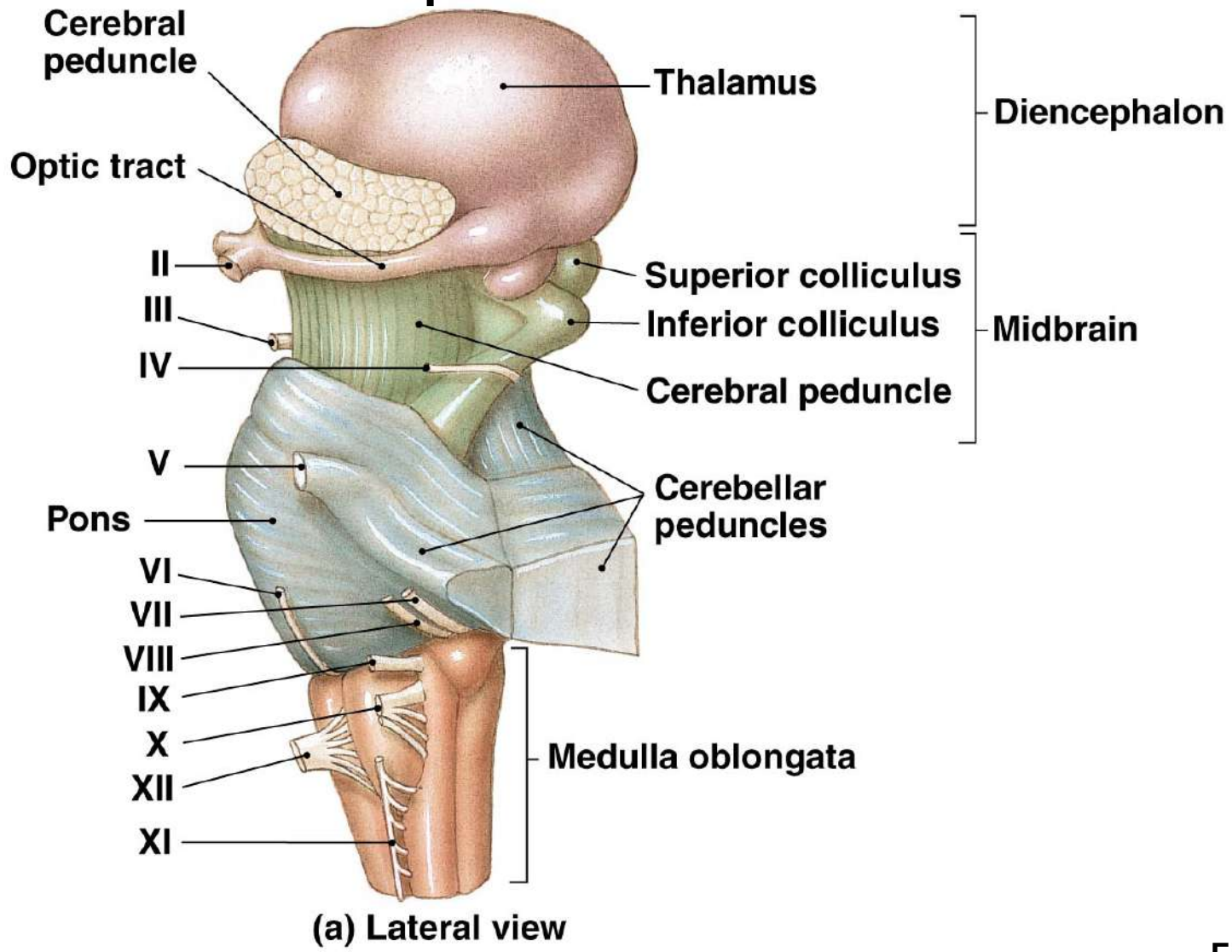
The Central Nervous System

What is the Diencephalon?

- Switching and relay center
- Components include:
  - *Epithalamus*
  - *Thalamus*
  - *Hypothalamus*

The Central Nervous System

The Diencephalon and Brain Stem



(a) Lateral view

Figure 8-24(a)

The Central Nervous System

The Diencephalon and Brain Stem

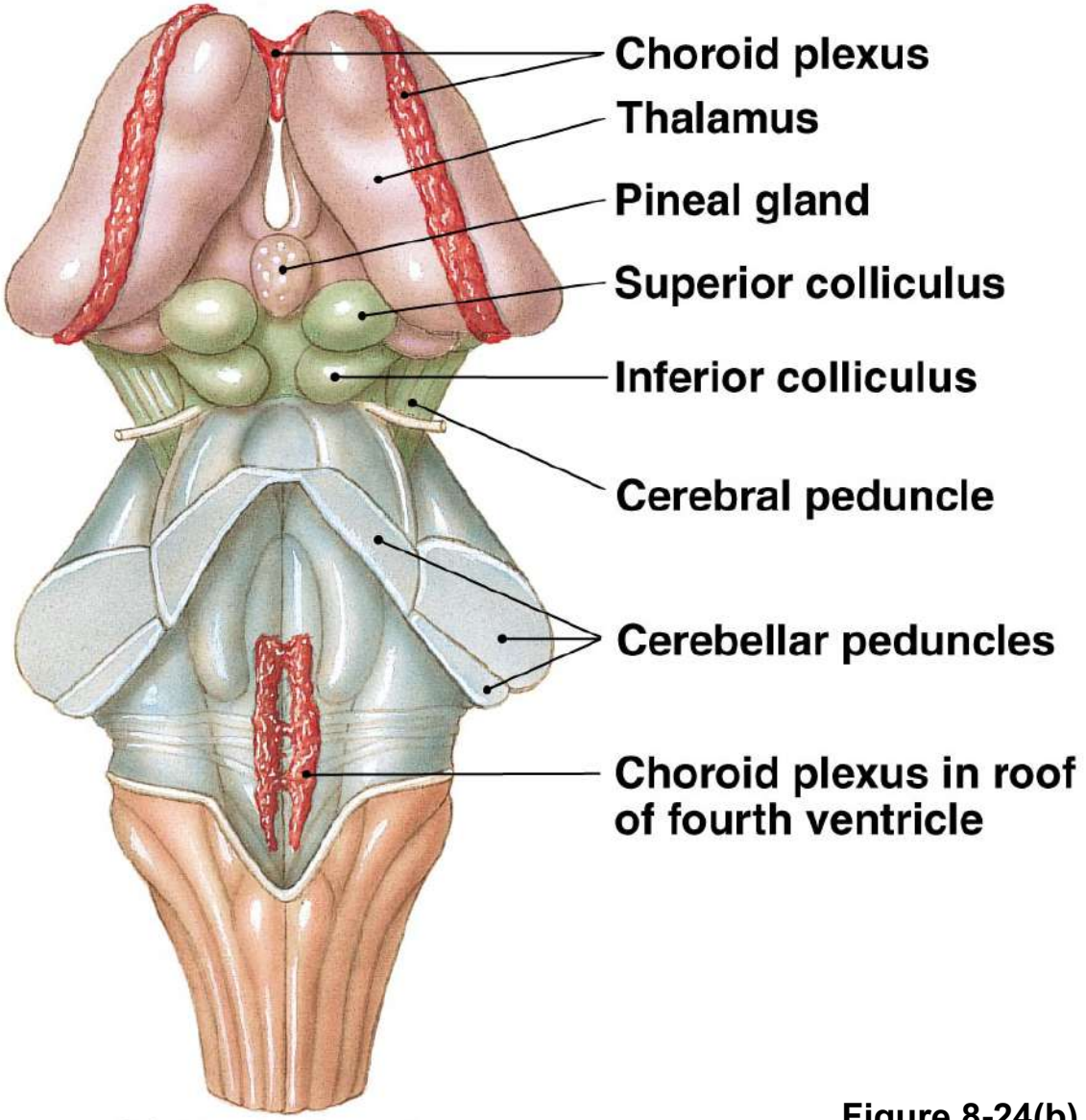


Figure 8-24(b)

The Central Nervous System

What are the Functions of the Thalamus?

- Relay and filter all *ascending* (sensory) information
- Coordinate voluntary and involuntary motor behavior

The Central Nervous System

What are the Functions of the Hypothalamus?

- Produce emotions and behavioral drives
- Coordinate nervous and endocrine systems
- Secrete hormones
- Coordinate voluntary and autonomic functions
- Regulate body temperature

The Central Nervous System

What is the Anatomy and Function of the Brain Stem?

- *Midbrain*
  - Process visual, auditory information
  - Generate involuntary movements
- *Pons*
  - Links to cerebellum
  - Involved in control of movement
- *Medulla oblongata*
  - Relay sensory information
  - Regulate autonomic function

The Central Nervous System

What is the Anatomy and Function of the Cerebellum?

- Oversees postural muscles
- Stores patterns of movement
- Fine tunes most movements

The Central Nervous System

- What are the Functions of the Medulla Oblongata?
  - Relays ascending information to cerebral cortex
  - Controls crucial organ systems by reflex
    - Cardiovascular centers
    - Respiratory rhythmicity centers

The Central Nervous System

Key Note

The brain, a large mass of neural tissue, contains internal passageways and chambers filled with CSF. The six major regions of the brain have specific functions. As you ascend from the medulla oblongata to the cerebrum, those functions become more complex and variable. Conscious thought and intelligence are provided by the cerebral cortex.

The Peripheral Nervous System

What are the Twelve Pairs Of Cranial Nerves?

Olfactory (CN I)

Sense of smell

Optic (CN II)

Sense of vision

Oculomotor (CN III)

Eye movement

The Peripheral Nervous System

What are the Cranial Nerves? (continued)

- *Trochlear* (CN IV)
  - Eye movement
- *Trigeminal* (CN V)
  - Eye, jaws sensation/movement
- *Abducens* (CN VI)
  - Eye movement
- *Facial* (CN VII)
  - Face, scalp, tongue sensation/movement
- *Vestibulocochlear* (CN VIII)
  - Hearing, balance

The Peripheral Nervous System

What are the Cranial Nerves? (continued)

- Glossopharyngeal (CN IX)
  - Taste, swallowing
- Vagus (CN X)
  - Autonomic control of viscera
- Accessory (CN XI)
  - Swallowing, pectoral girdle movement
- Hypoglossal (CN XII)
  - Tongue movement

The Peripheral Nervous System

The Cranial Nerves

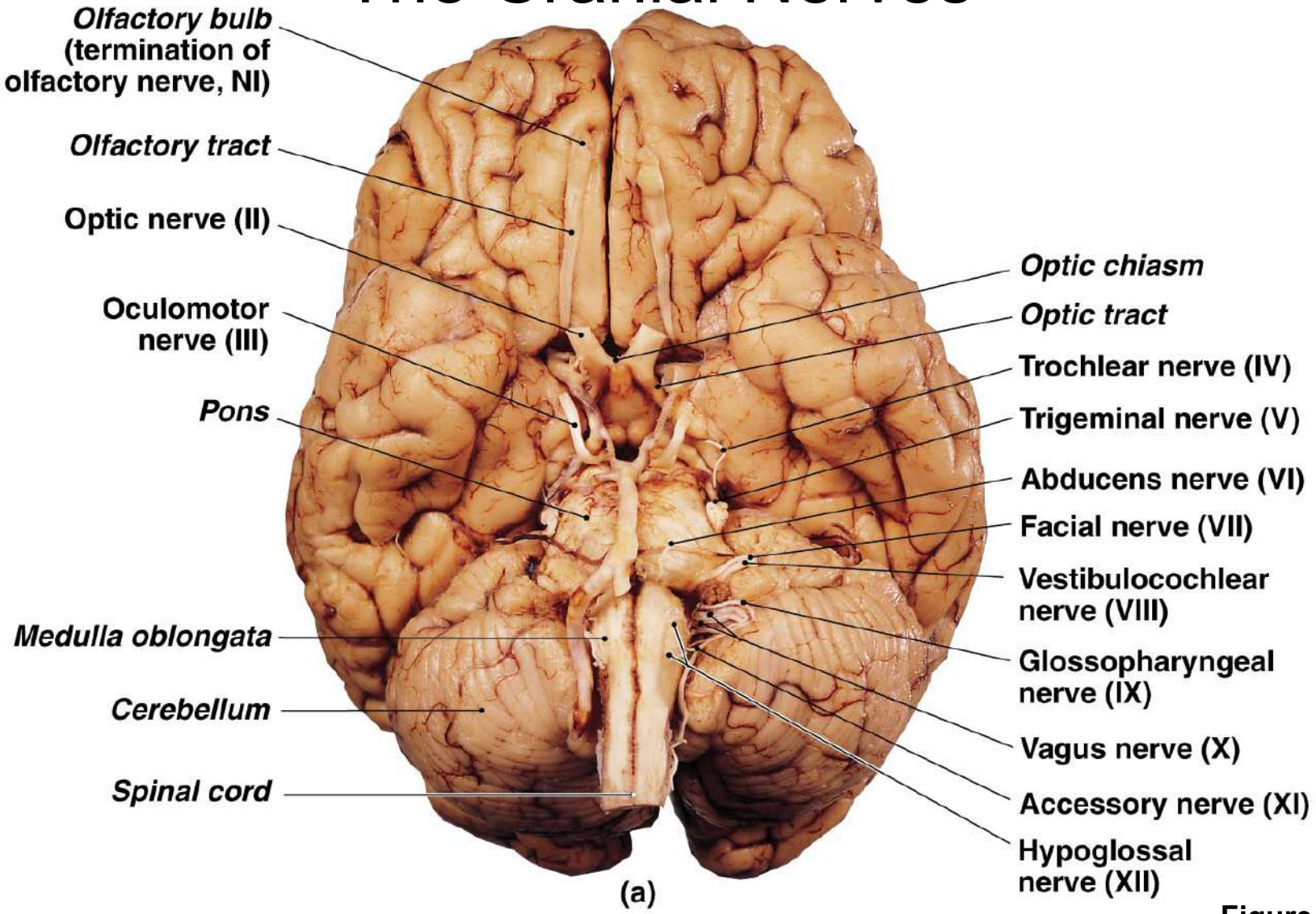


Figure 8-25(a)

The Peripheral Nervous System

The Cranial Nerves

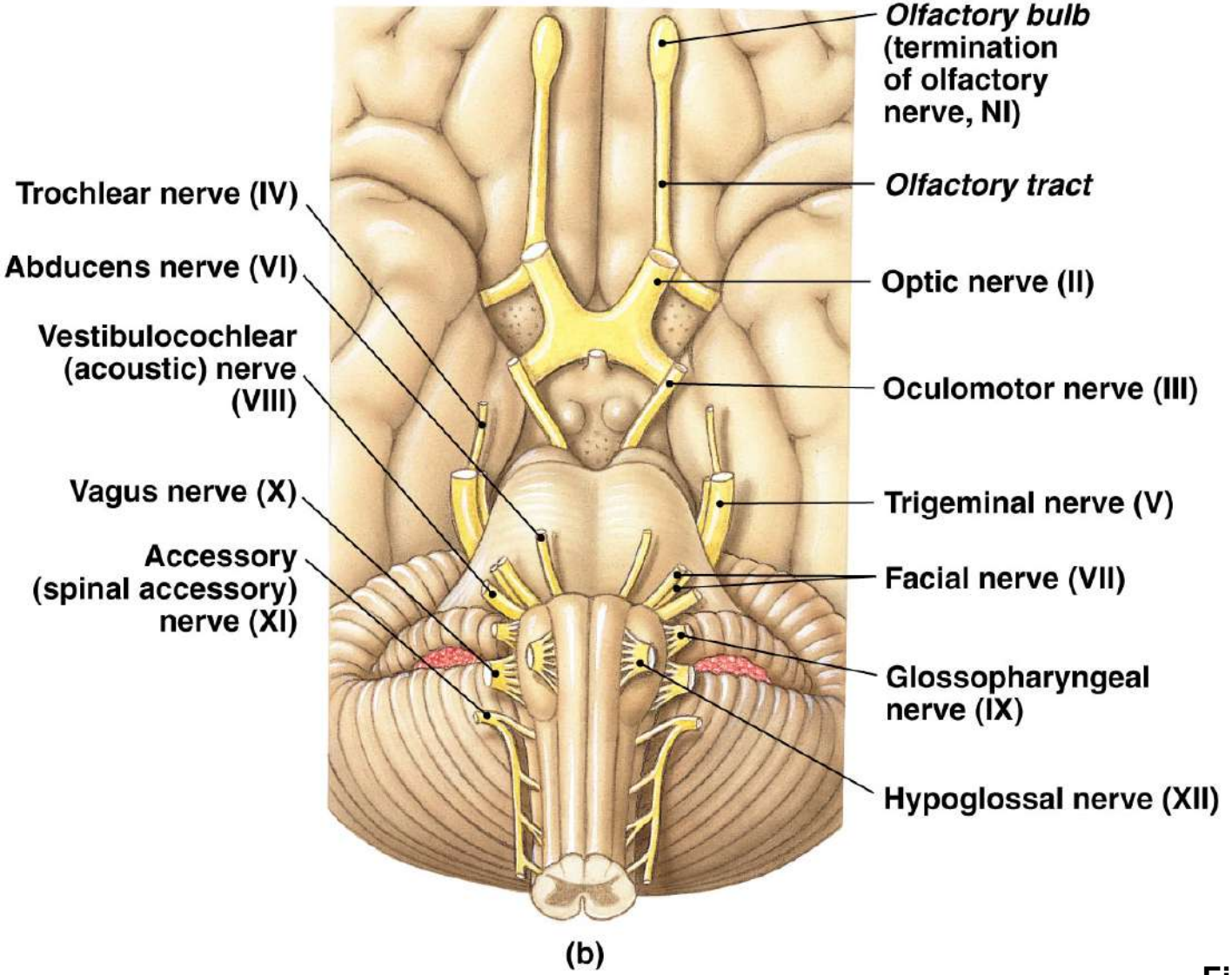


Figure 8-25(b)

The Peripheral Nervous System

Key Note

The 12 pairs of cranial nerves are responsible for the special senses of smell, sight, and hearing/balance, and control movement of the eye, jaw, face, tongue, and muscles of the neck, back, and shoulders. They also provide sensation from the face, neck, and upper chest and autonomic innervation to thoracic and abdominopelvic organs.

The Peripheral Nervous System

Nerve Plexus—A complex, interwoven network of nerves

The Peripheral Nervous System

Peripheral Nerves and Nerve Plexuses

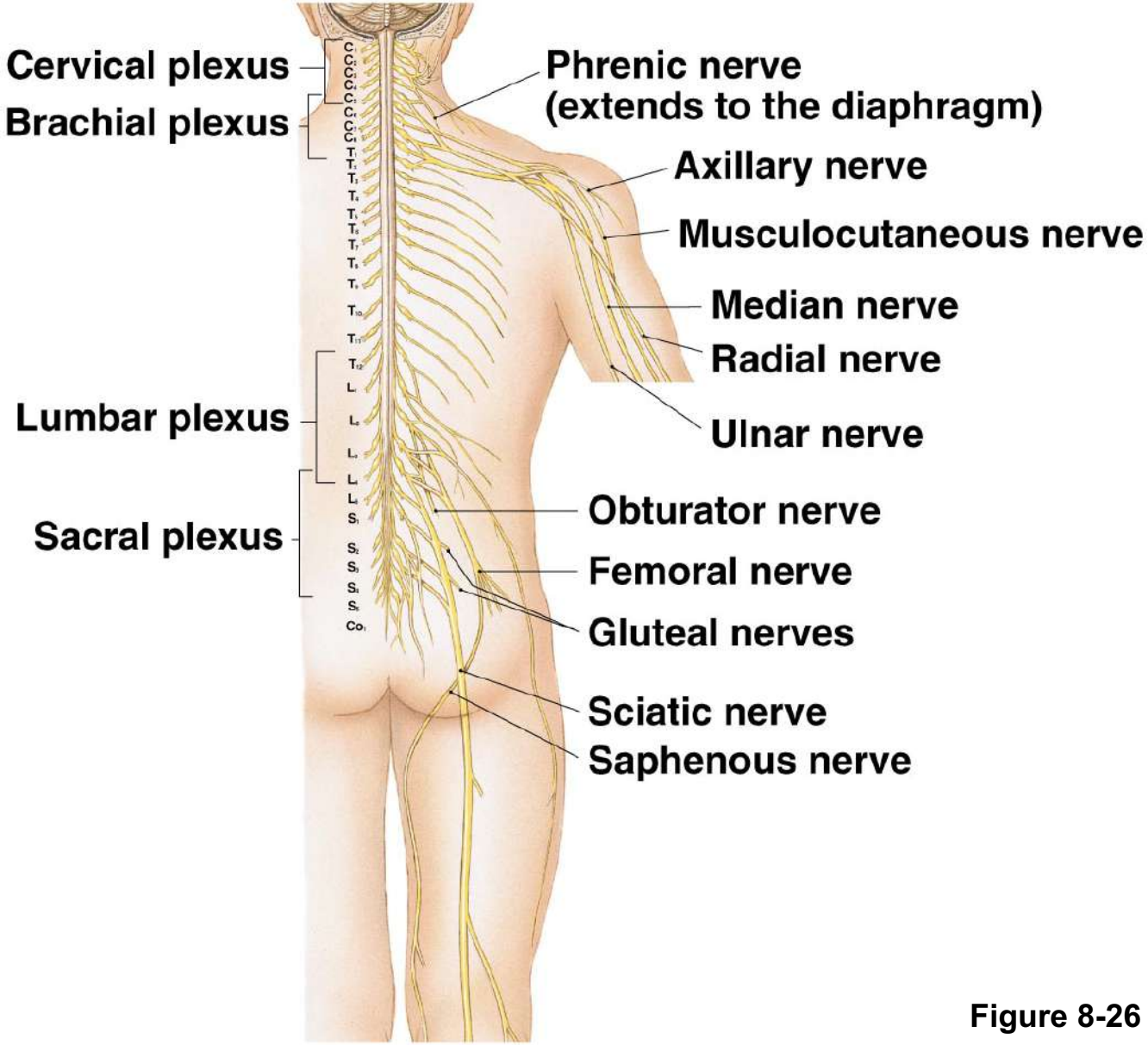


Figure 8-26

The Peripheral Nervous System

Reflex—An automatic involuntary motor response to a specific stimulus

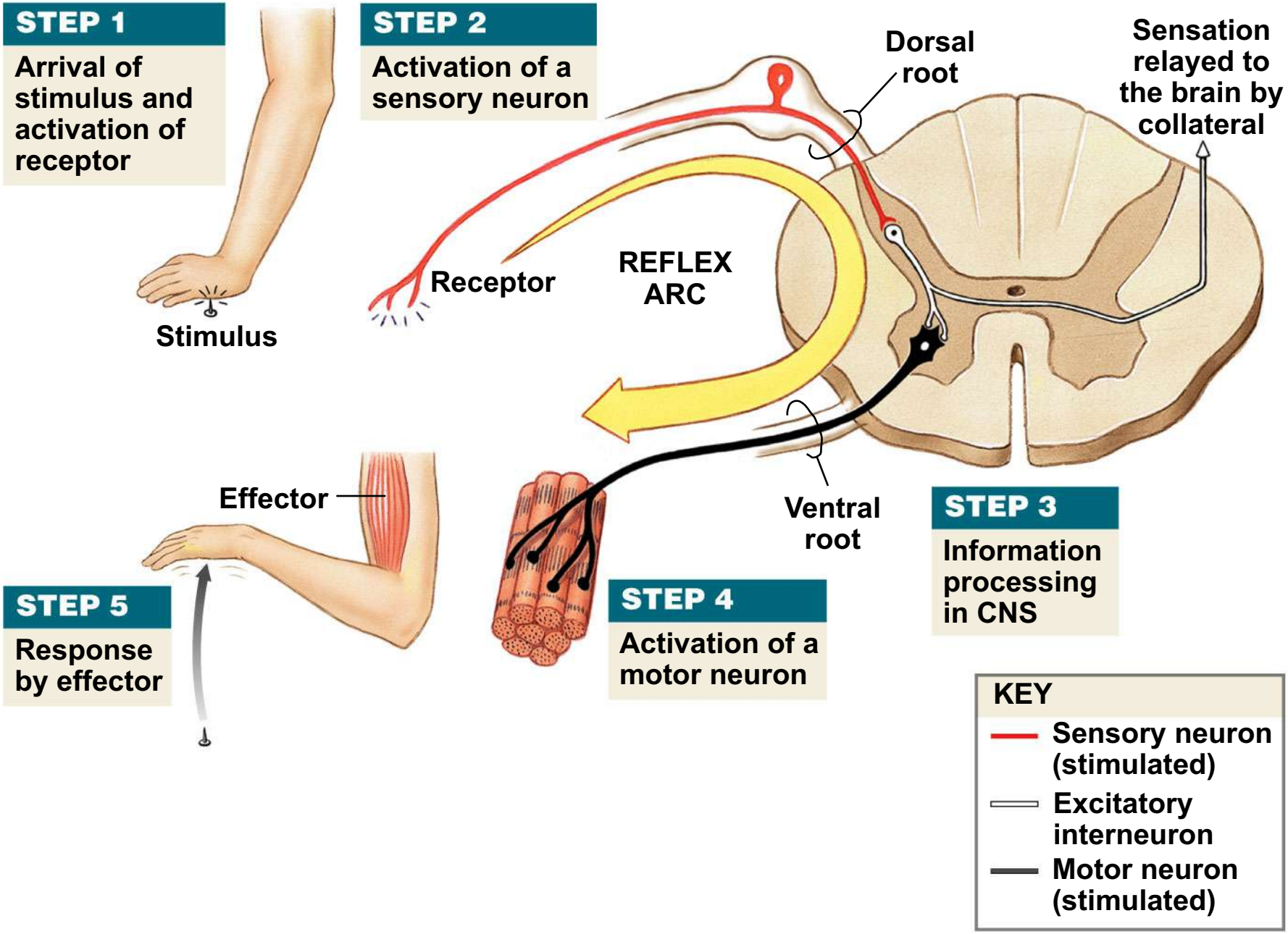


Figure 8-27
1 of 6

STEP 1

Arrival of stimulus and activation of receptor

Stimulus

Figure 8-27
2 of 6

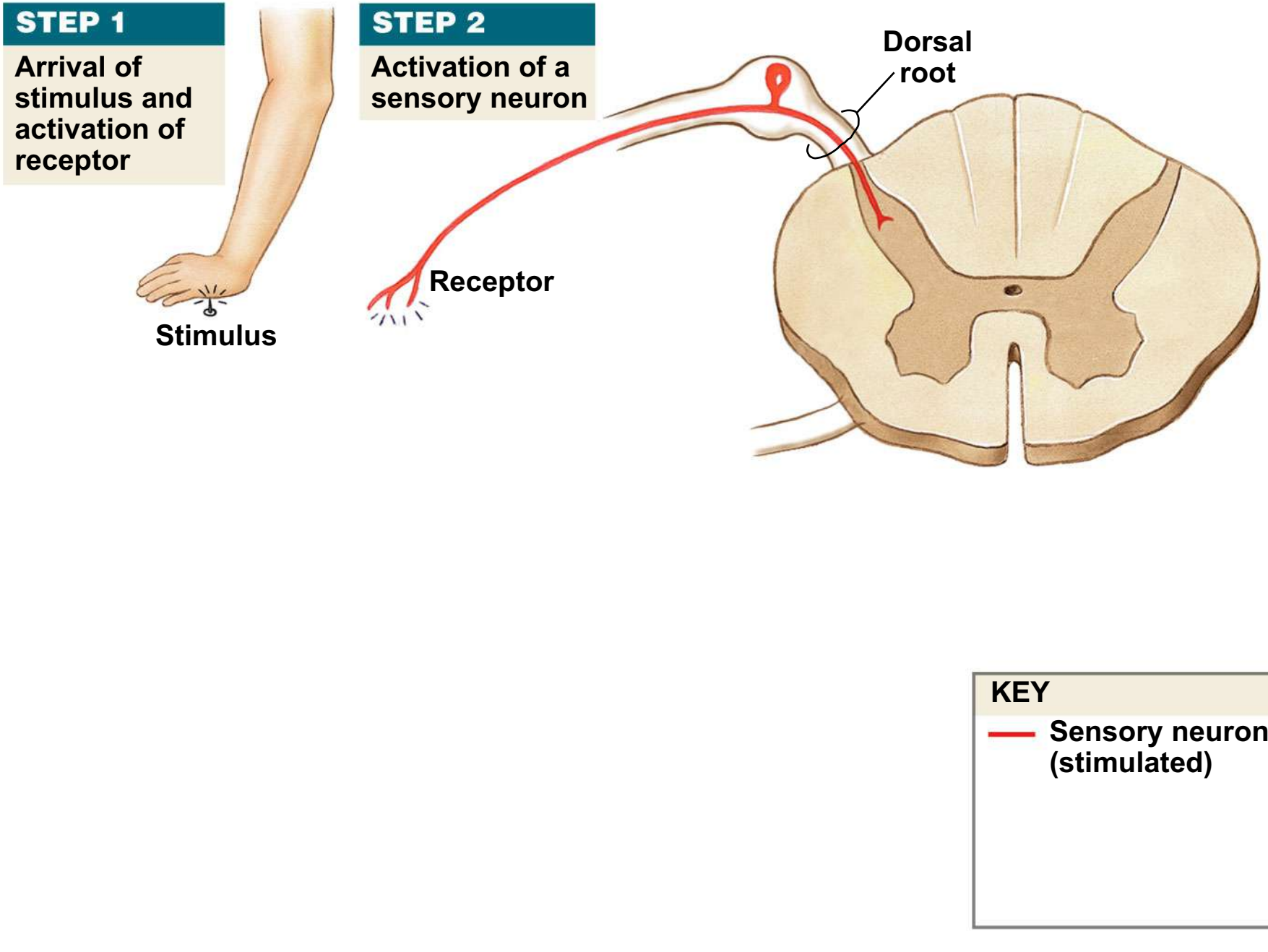
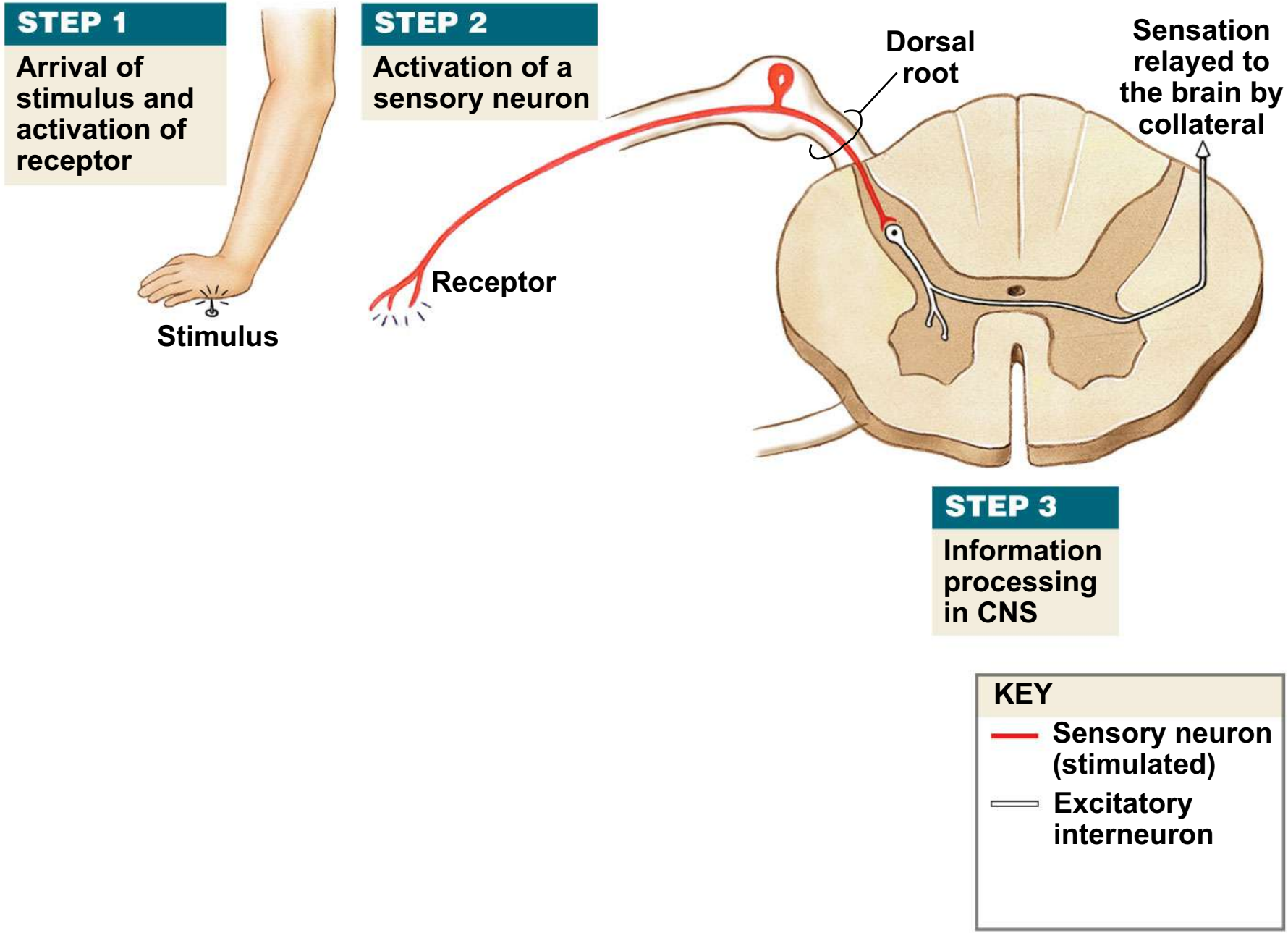


Figure 8-27
3 of 6



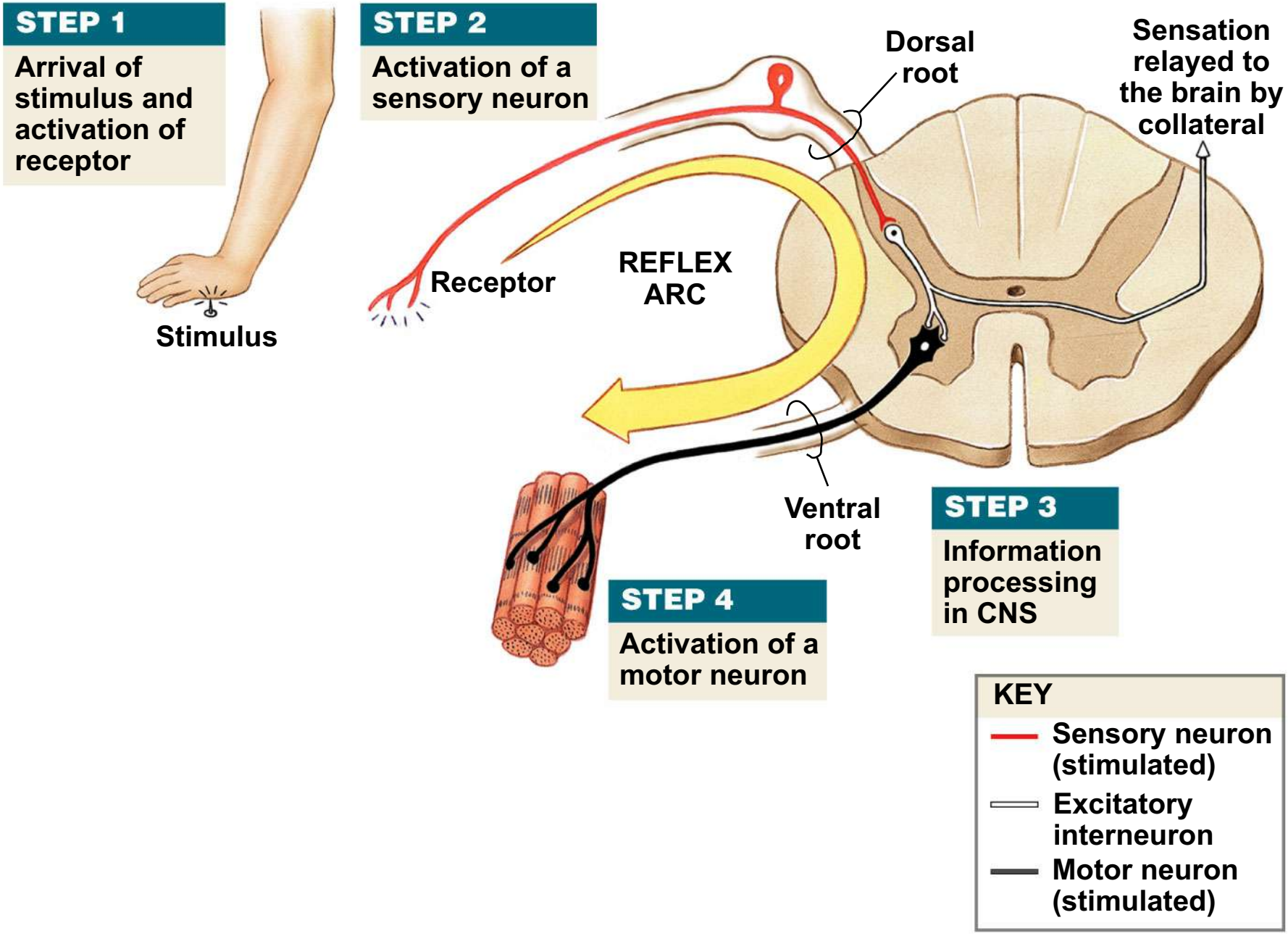


Figure 8-27
5 of 6

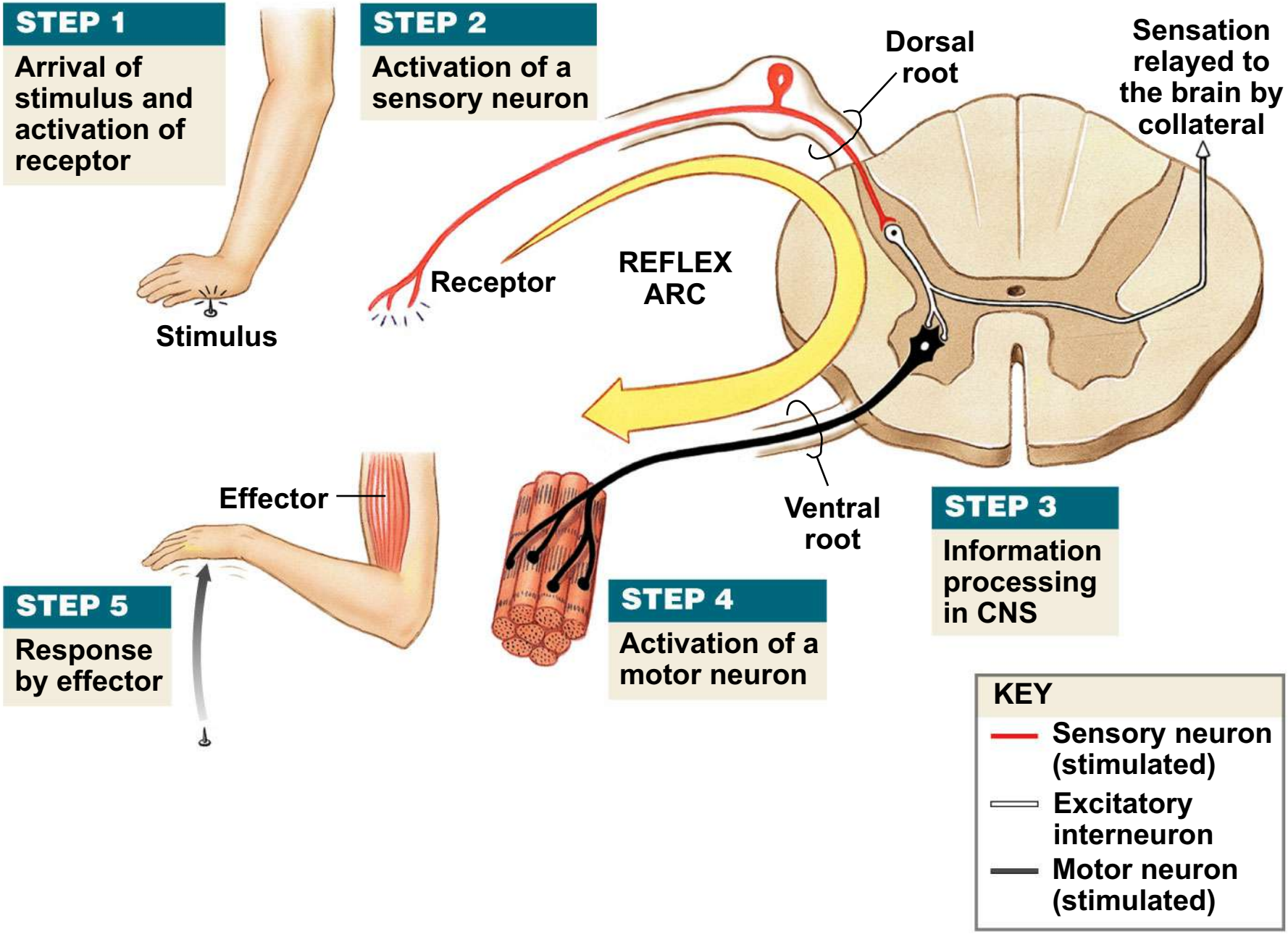


Figure 8-27
6 of 6

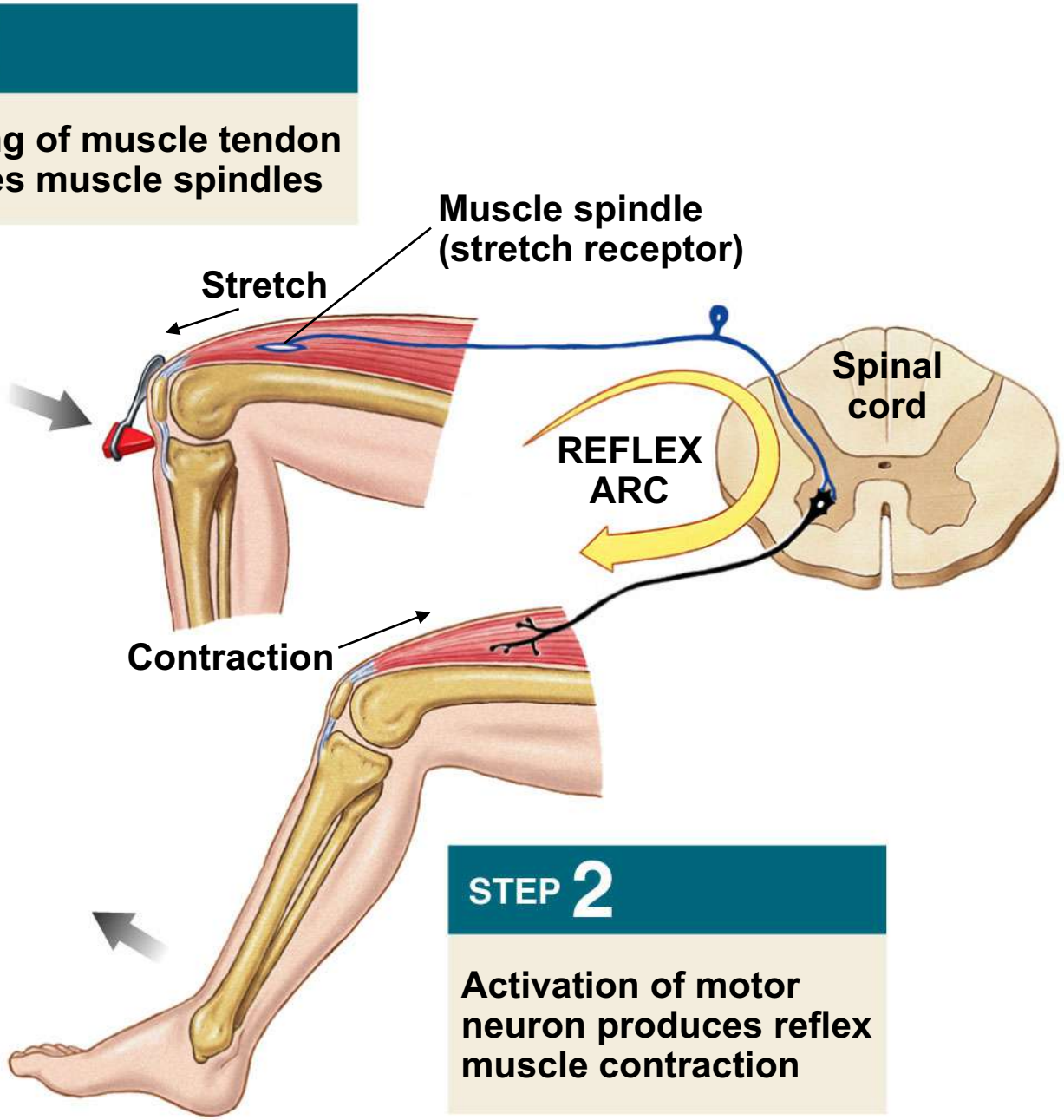


Figure 8-29
1 of 3

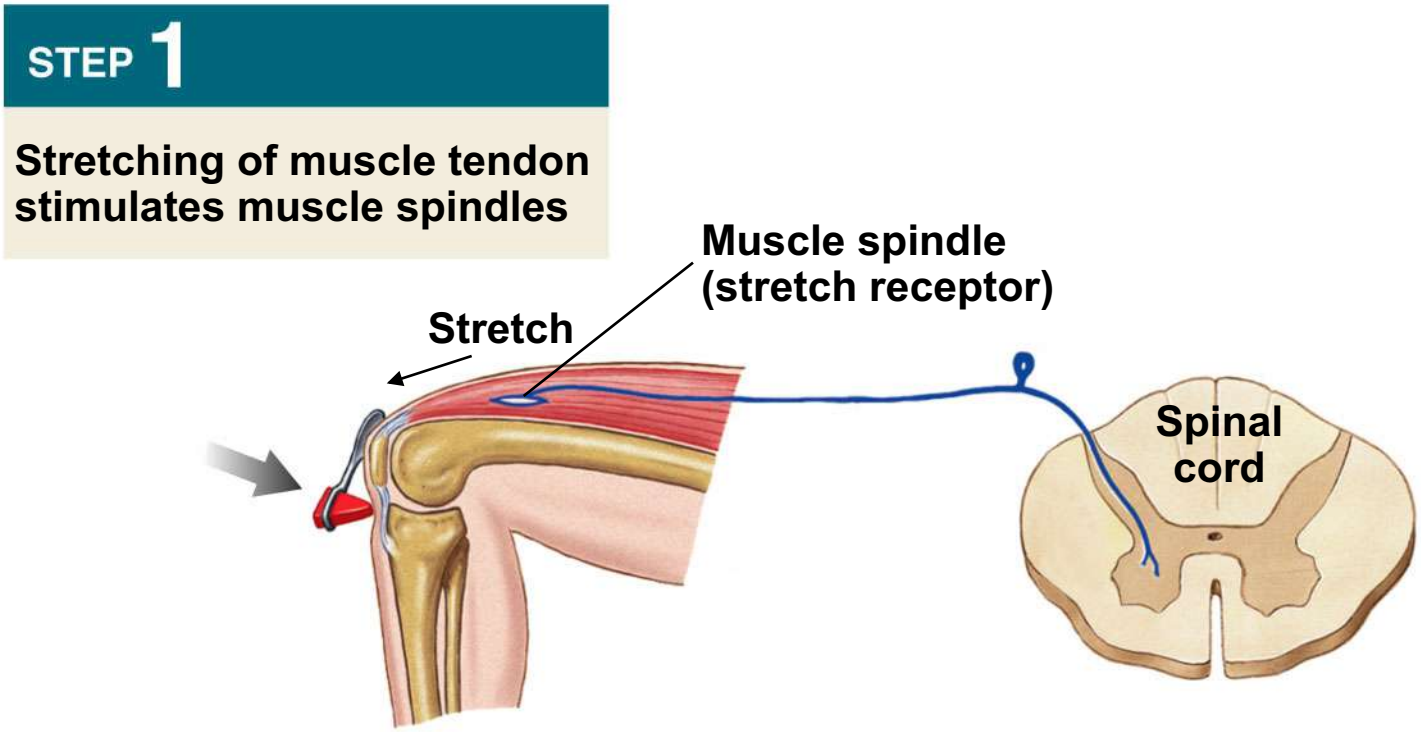


Figure 8-29
2 of 3

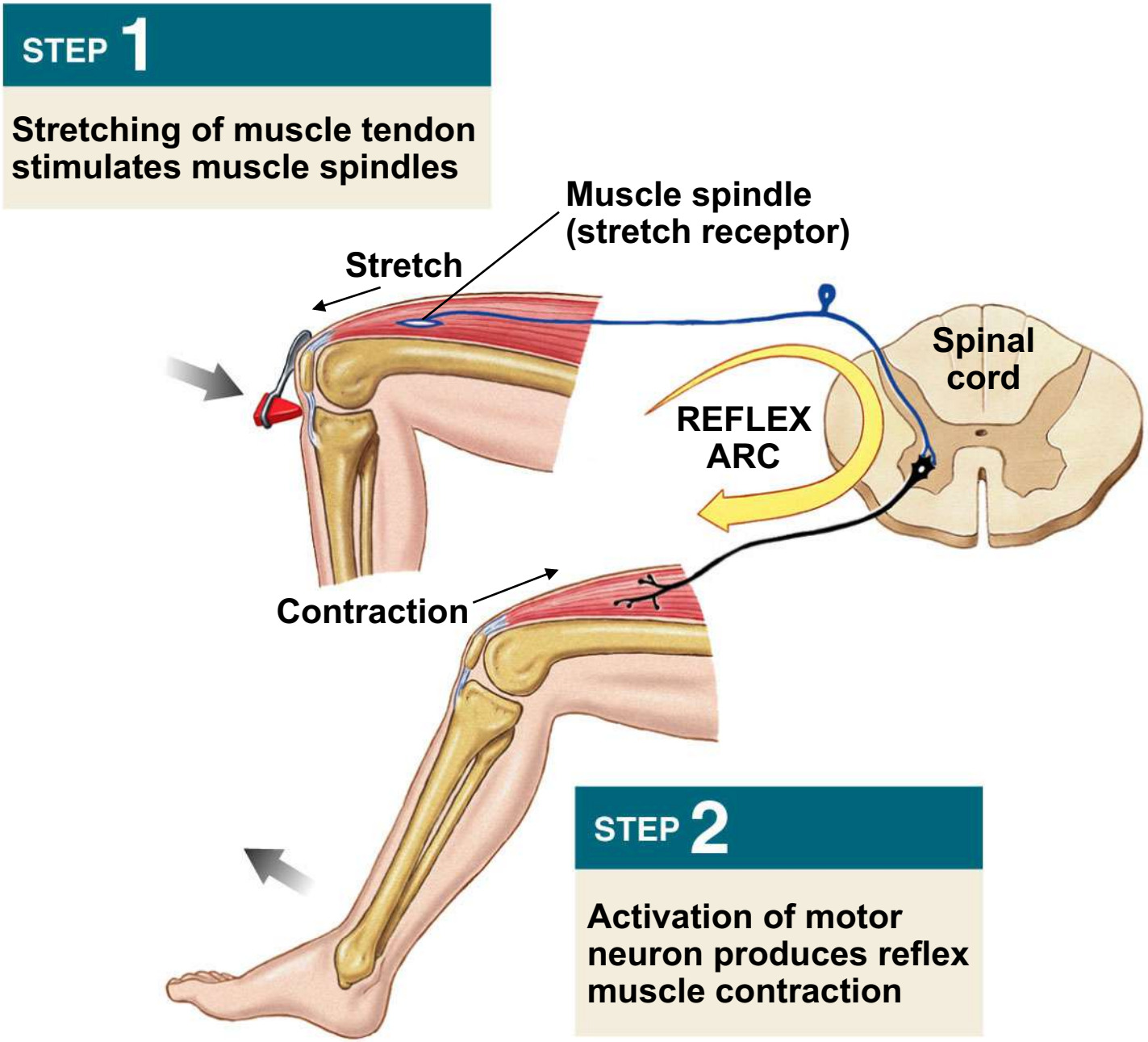


Figure 8-29
3 of 3

The Peripheral Nervous System

The Flexor Reflex, a Type of Withdrawal Reflex

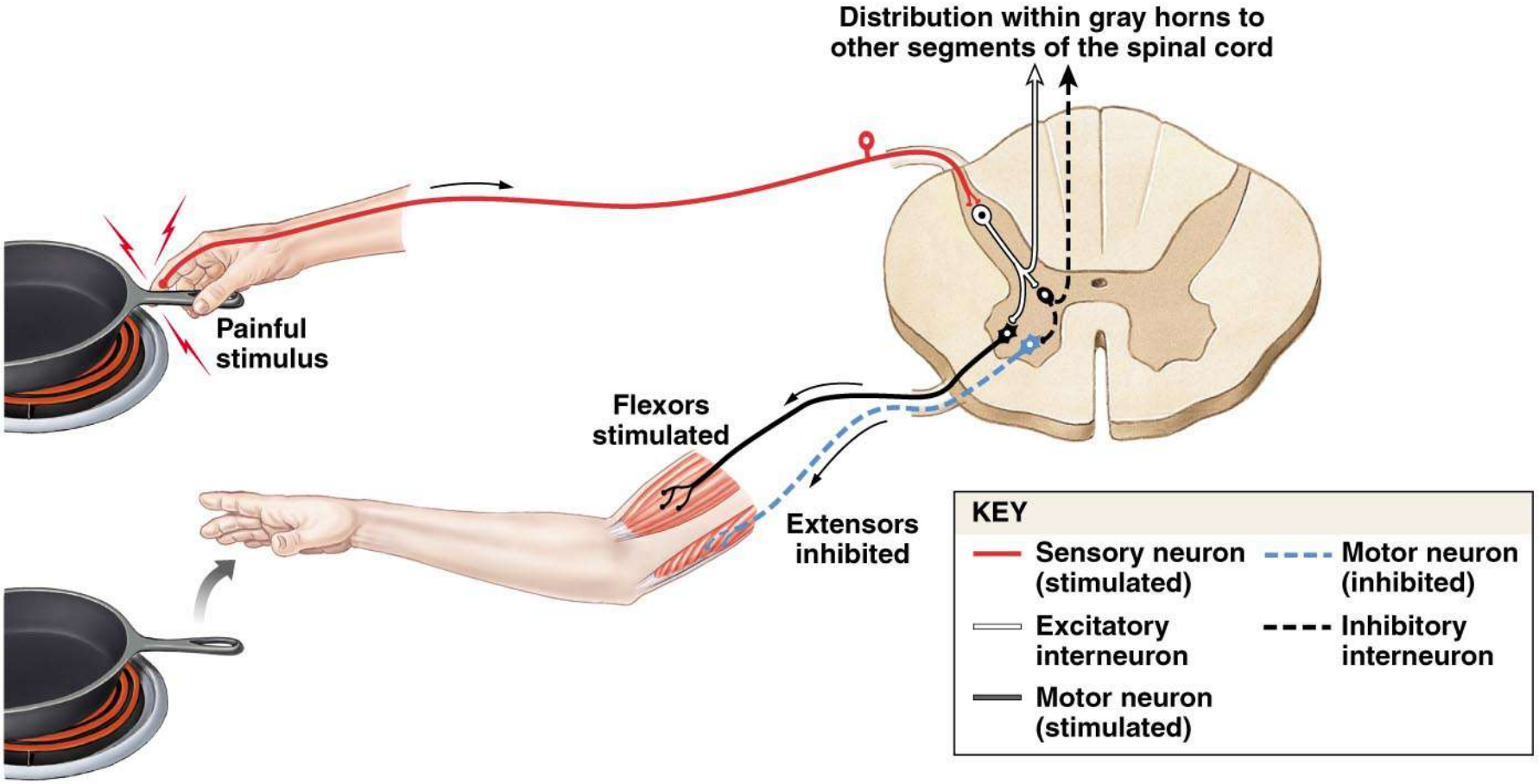


Figure 8-30

The Peripheral Nervous System

Key Note

Reflexes are rapid, automatic responses to stimuli that “buy time” for the planning and execution of more complex responses that are often consciously directed.

The Peripheral Nervous System

The Posterior Column Pathway

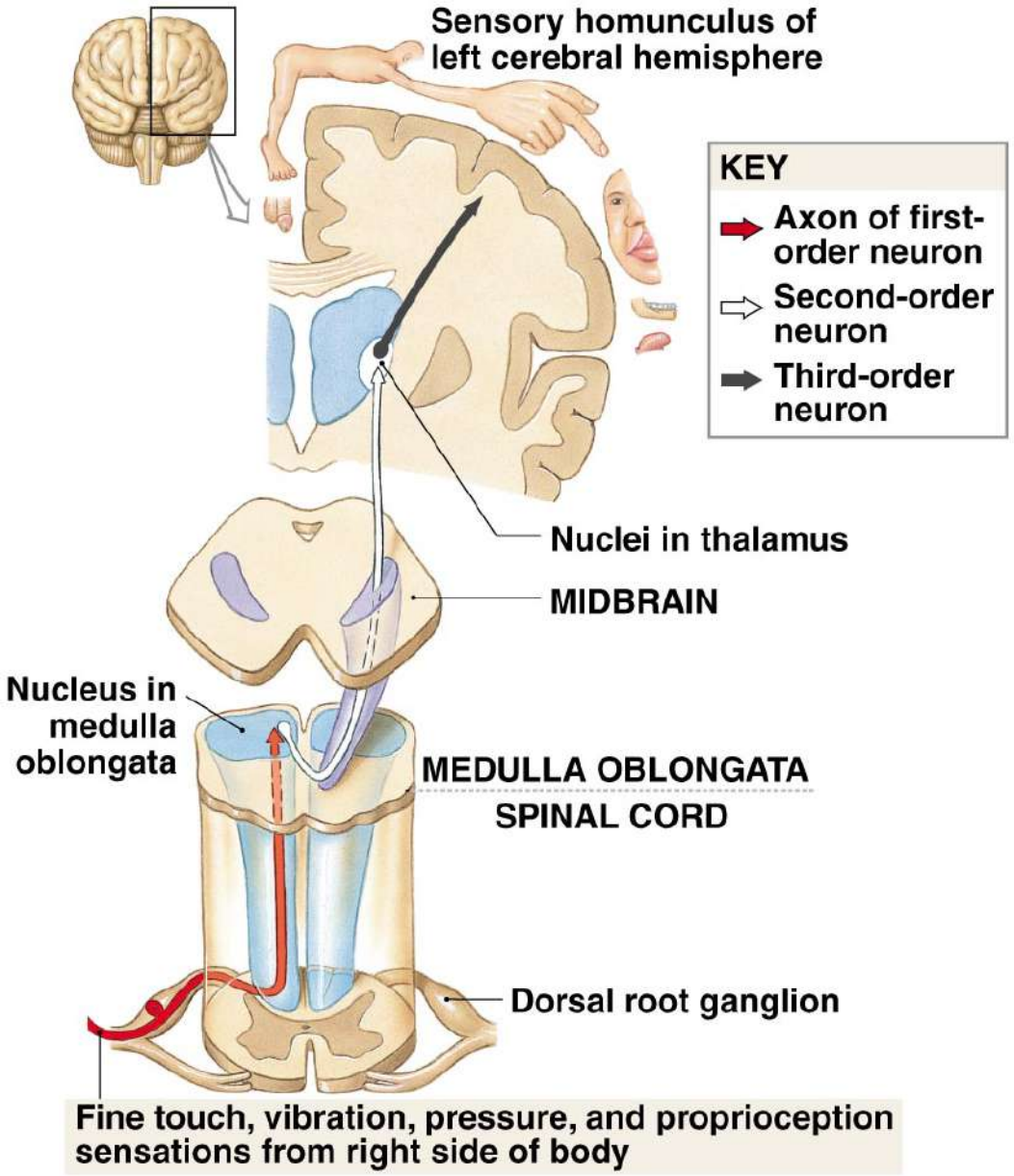


Figure 8-31

The Peripheral Nervous System

The Corticospinal Pathway

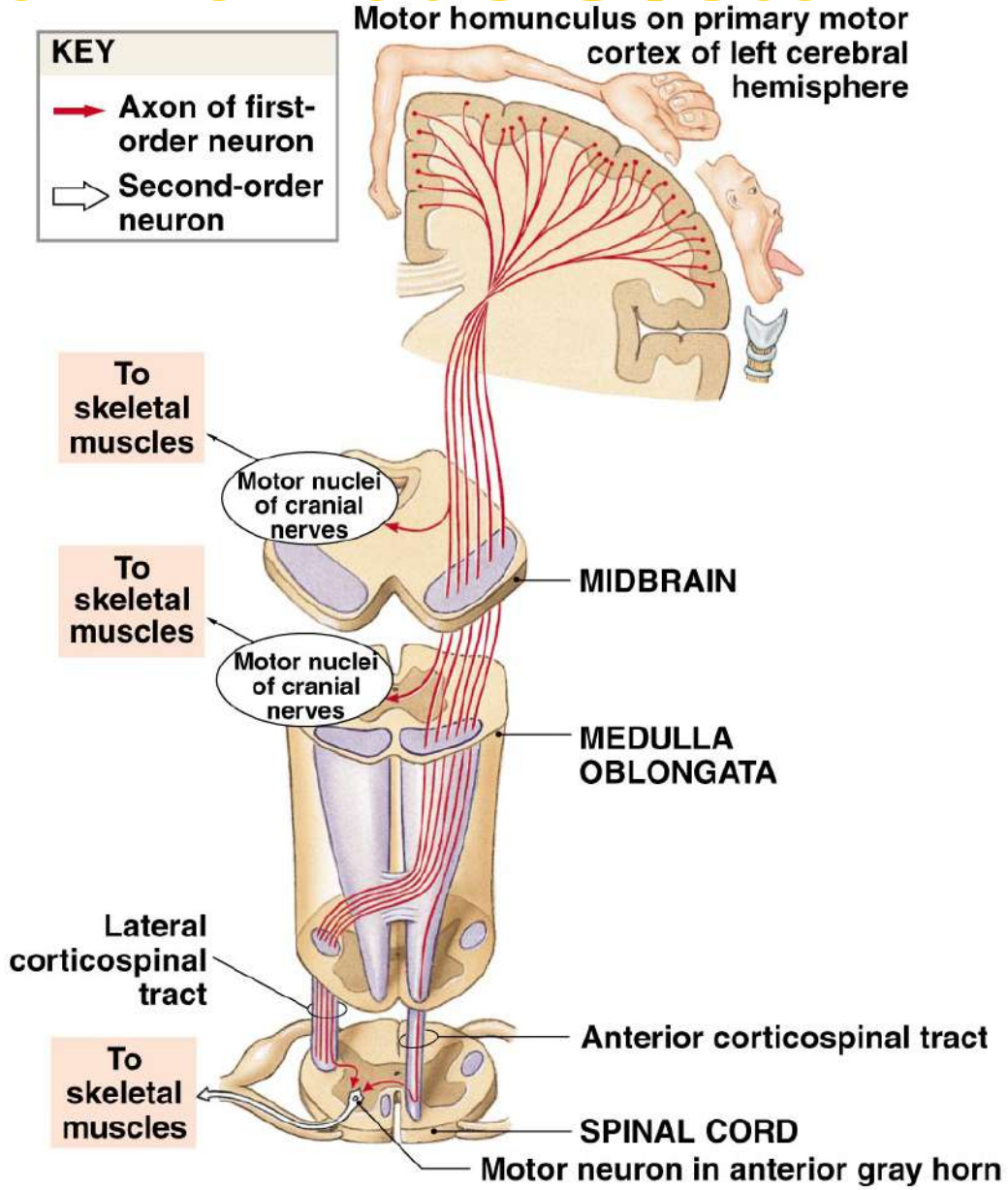


Figure 8-32

The Peripheral Nervous System

TABLE 8-4 *Sensory and Motor Pathways*

PATHWAY	FUNCTION
SENSORY	
Posterior column pathway	Delivers highly localized sensations of fine touch, pressure, vibration, and proprioception to the primary sensory cortex
Spinothalamic pathway	Delivers poorly localized sensations of touch, pressure, pain, and temperature to the primary sensory cortex
Spinocerebellar pathway	Delivers proprioceptive information concerning the positions of muscles, bones, and joints to the cerebellar cortex
MOTOR	
Corticospinal pathway	Provides conscious control of skeletal muscles throughout the body
Medial and lateral pathways	Provides subconscious regulation of skeletal muscle tone, controls reflexive skeletal muscle responses to equilibrium sensations and to sudden or strong visual and auditory stimuli

The Autonomic Nervous System

What Is The Autonomic Nervous System?

Branch of nervous system that coordinates cardiovascular, digestive, excretory, and reproductive functions

The Autonomic Nervous System

What are the Two Divisions of the ANS?

- *Sympathetic division*
  - "Fight or flight" system
- Parasympathetic division
  - "Rest and digest" system

The Autonomic Nervous System

Key Note

The two divisions of the ANS operate largely without our awareness. The sympathetic division increases alertness, metabolic rate, and muscular abilities; the parasympathetic division reduces metabolic rate and promotes visceral activities such as digestion.

The Autonomic Nervous System

The Somatic and Autonomic Nervous Systems

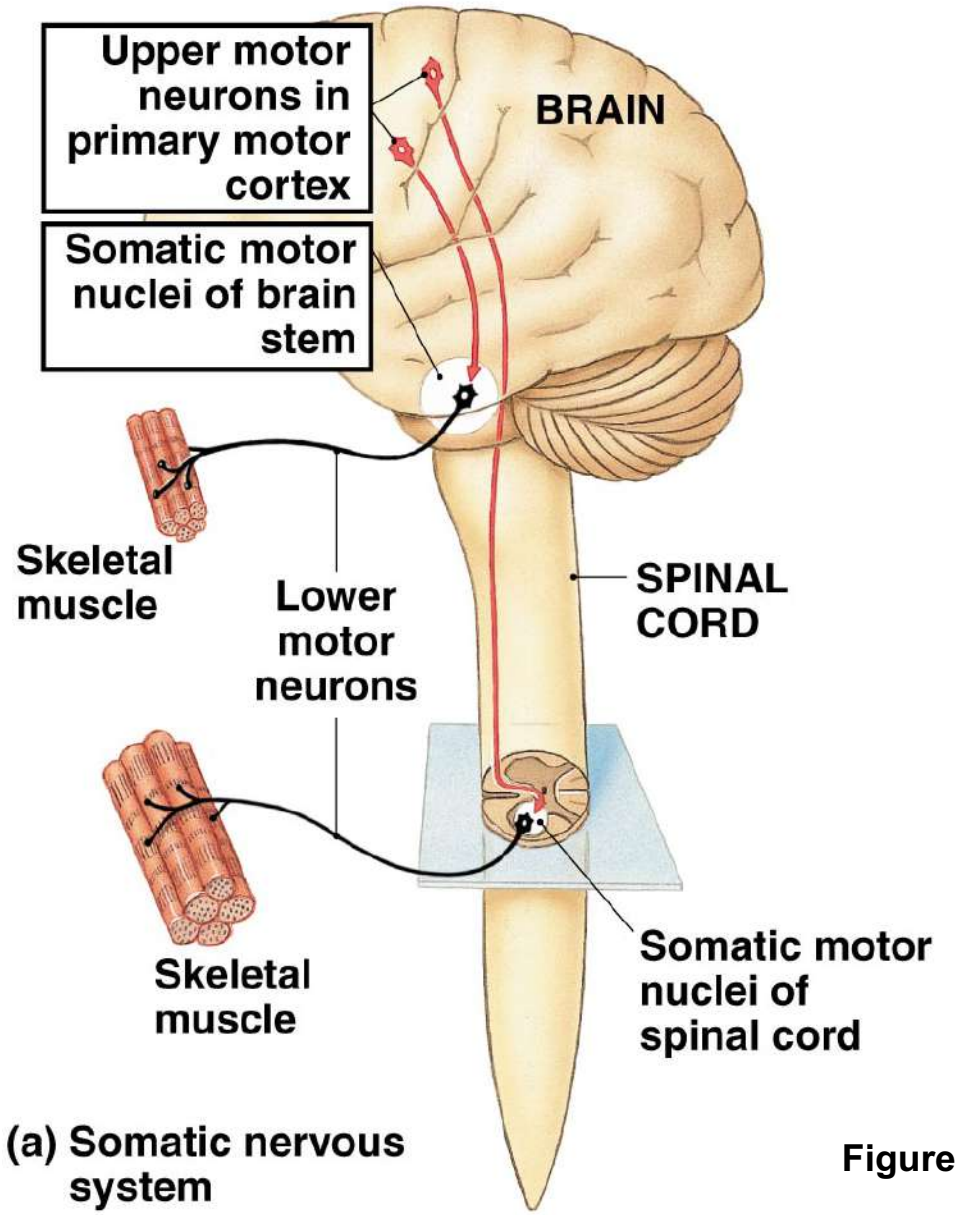
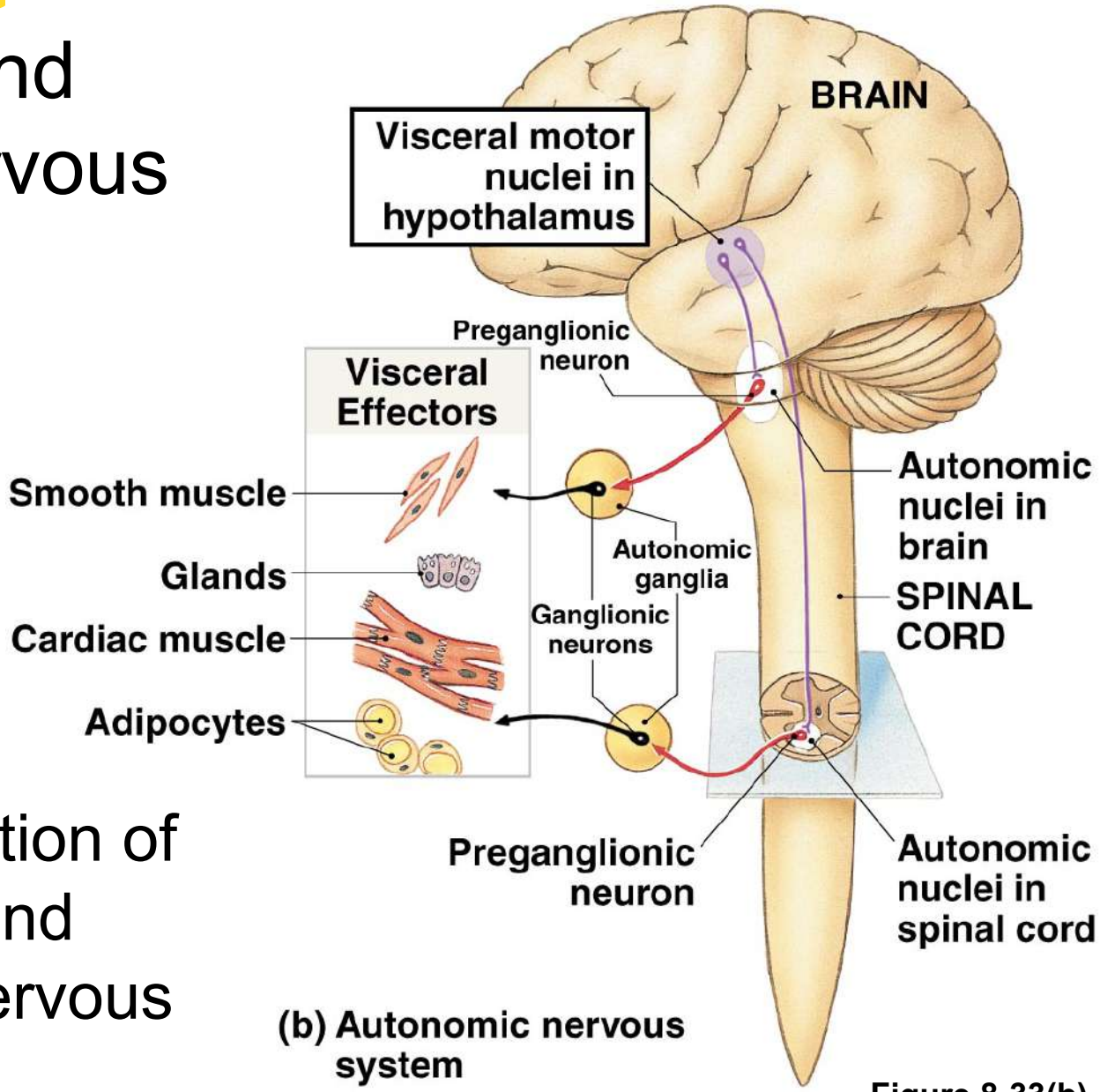


Figure 8-33(a)

The Autonomic Nervous System

The Somatic and Autonomic Nervous Systems



PLAY The Organization of the Somatic and Autonomic Nervous System

Figure 8-33(b)

The Autonomic Nervous System

The Sympathetic Division

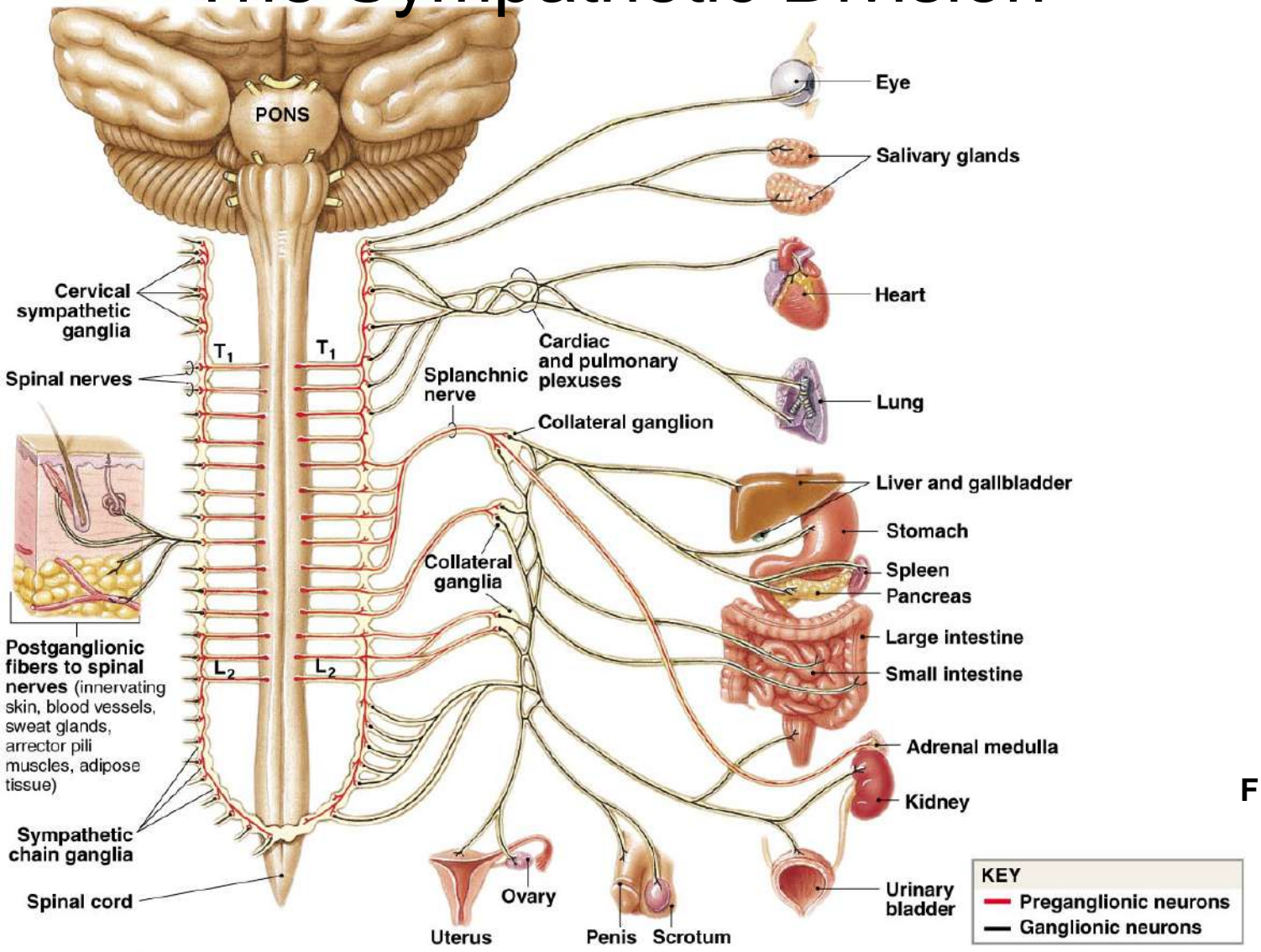


Figure 8-34

The Autonomic Nervous System

What are the Effects of Sympathetic Activation?

- Generalized response in crises
- Increased alertness
- Feeling of euphoria and energy
- Increased cardiovascular activity
- Increased respiratory activity
- Increased muscle tone

The Autonomic Nervous System

The Parasympathetic Division

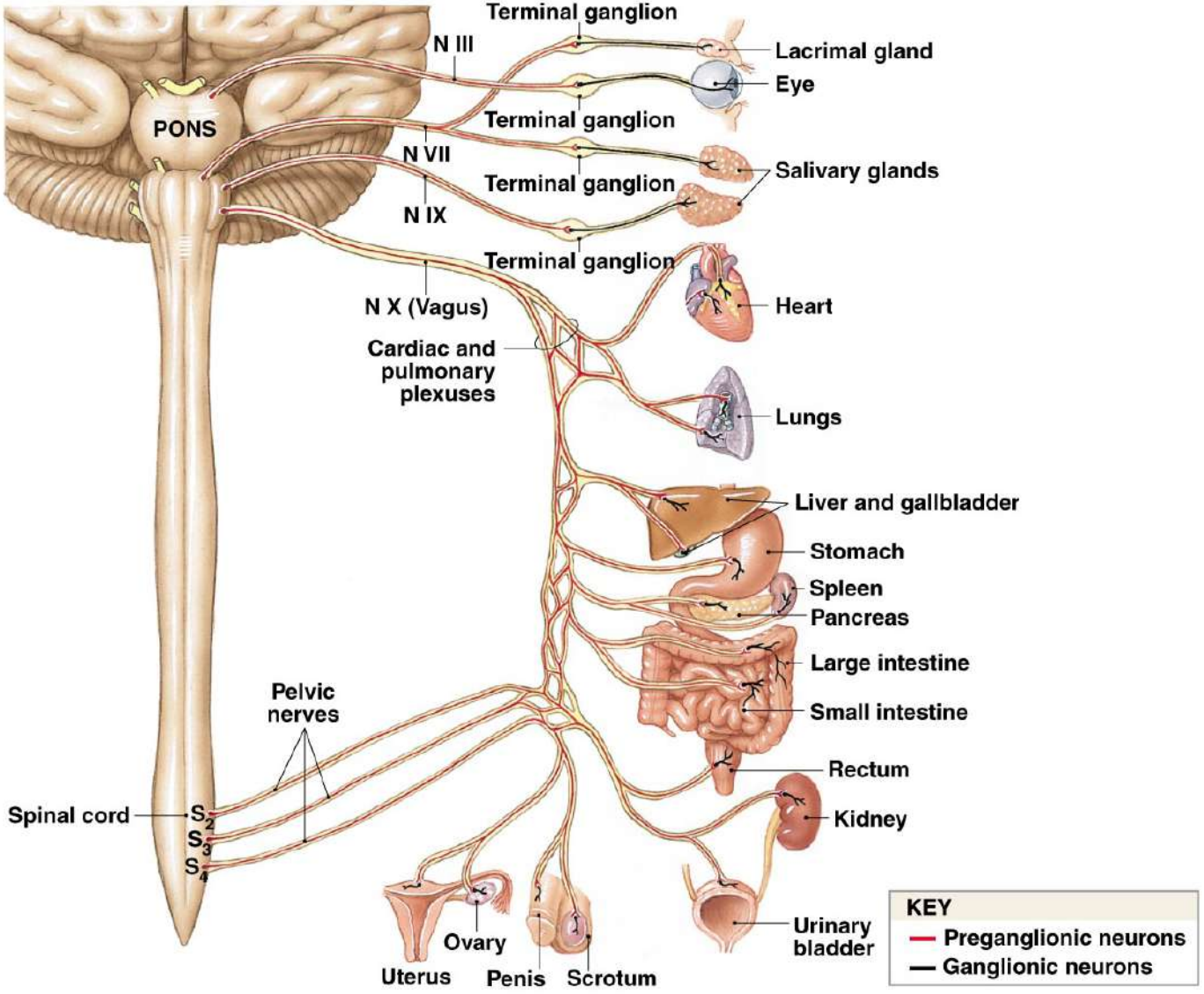


Figure 8-35

The Autonomic Nervous System

What are the Effects of Parasympathetic Activation?

- Relaxation
- Food processing
- Energy absorption
- Brief effects at specific sites

Aging and the Nervous System

What are Age-Related Changes?

- Reduction in brain size and weight
- Loss of neurons
- Decreased brain blood flow
- Changes in synaptic organization of the brain