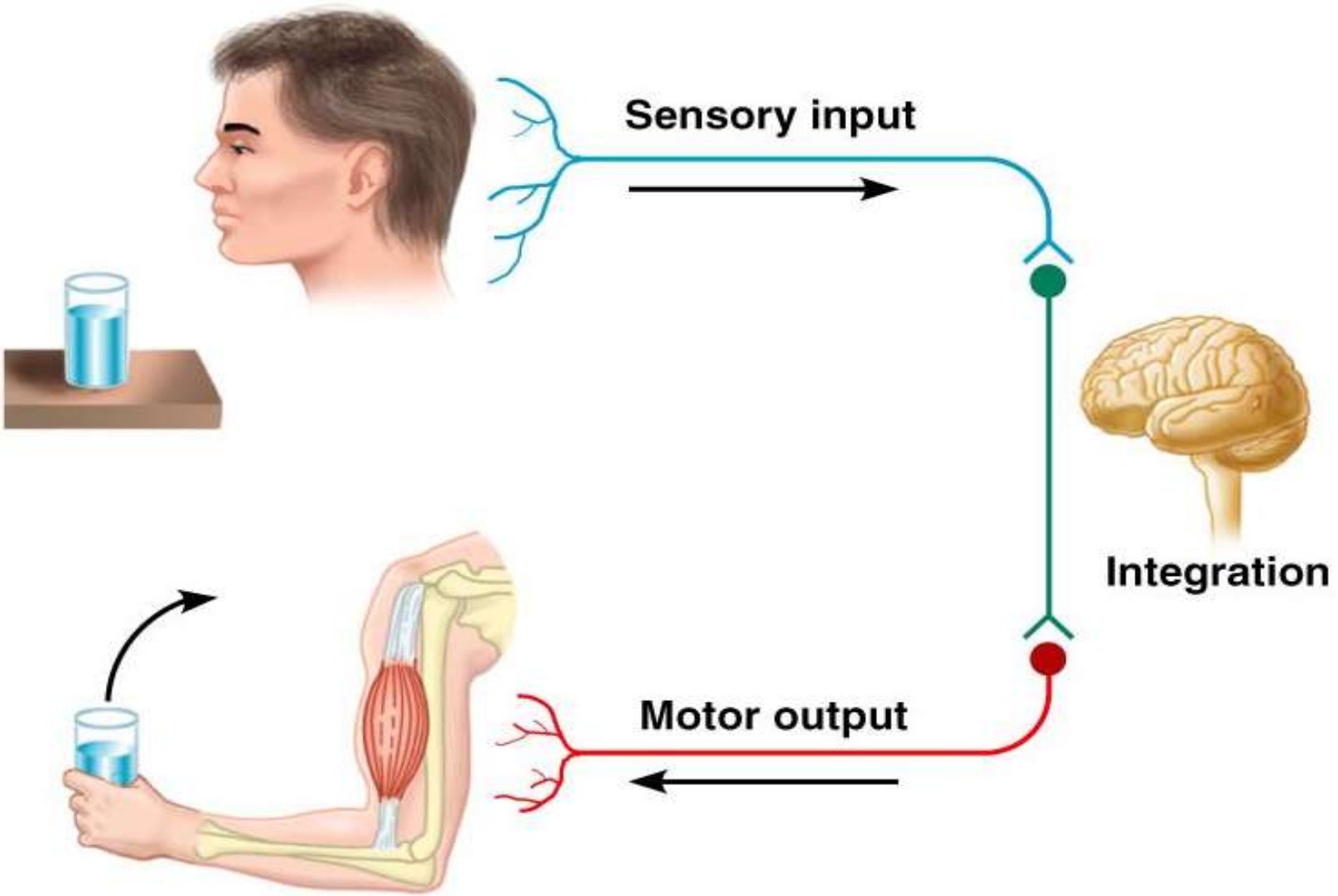
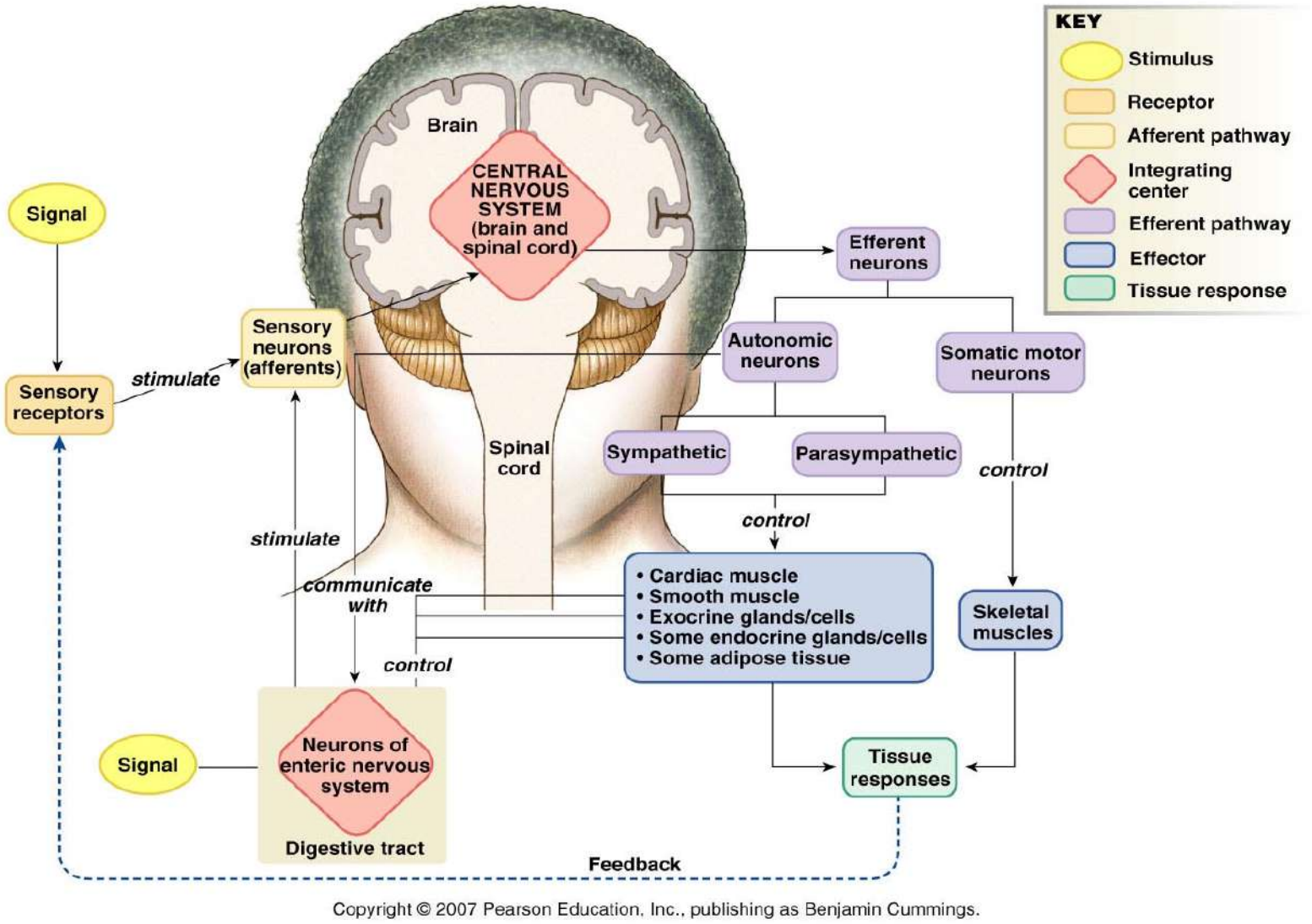
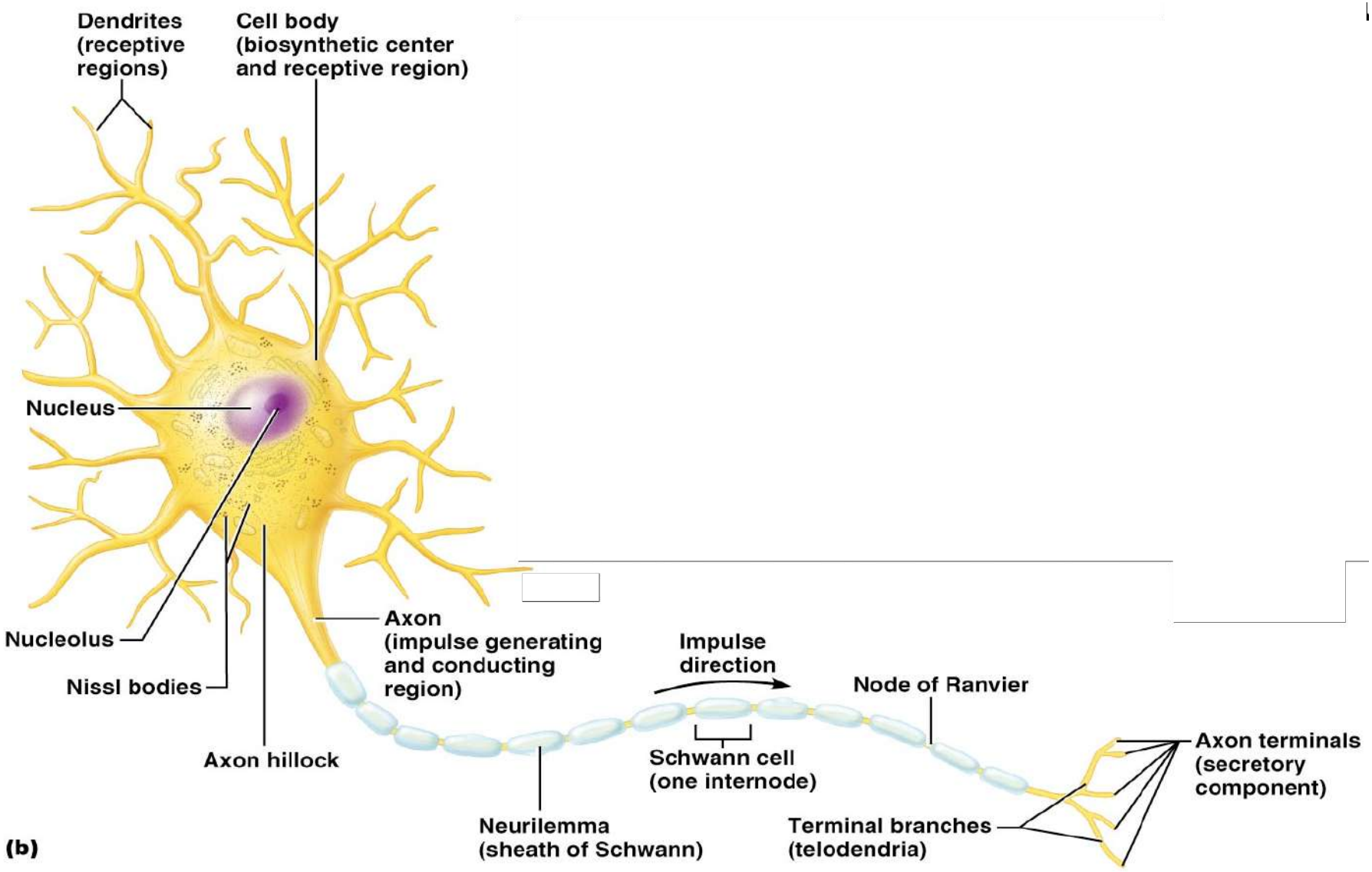
Nervous System

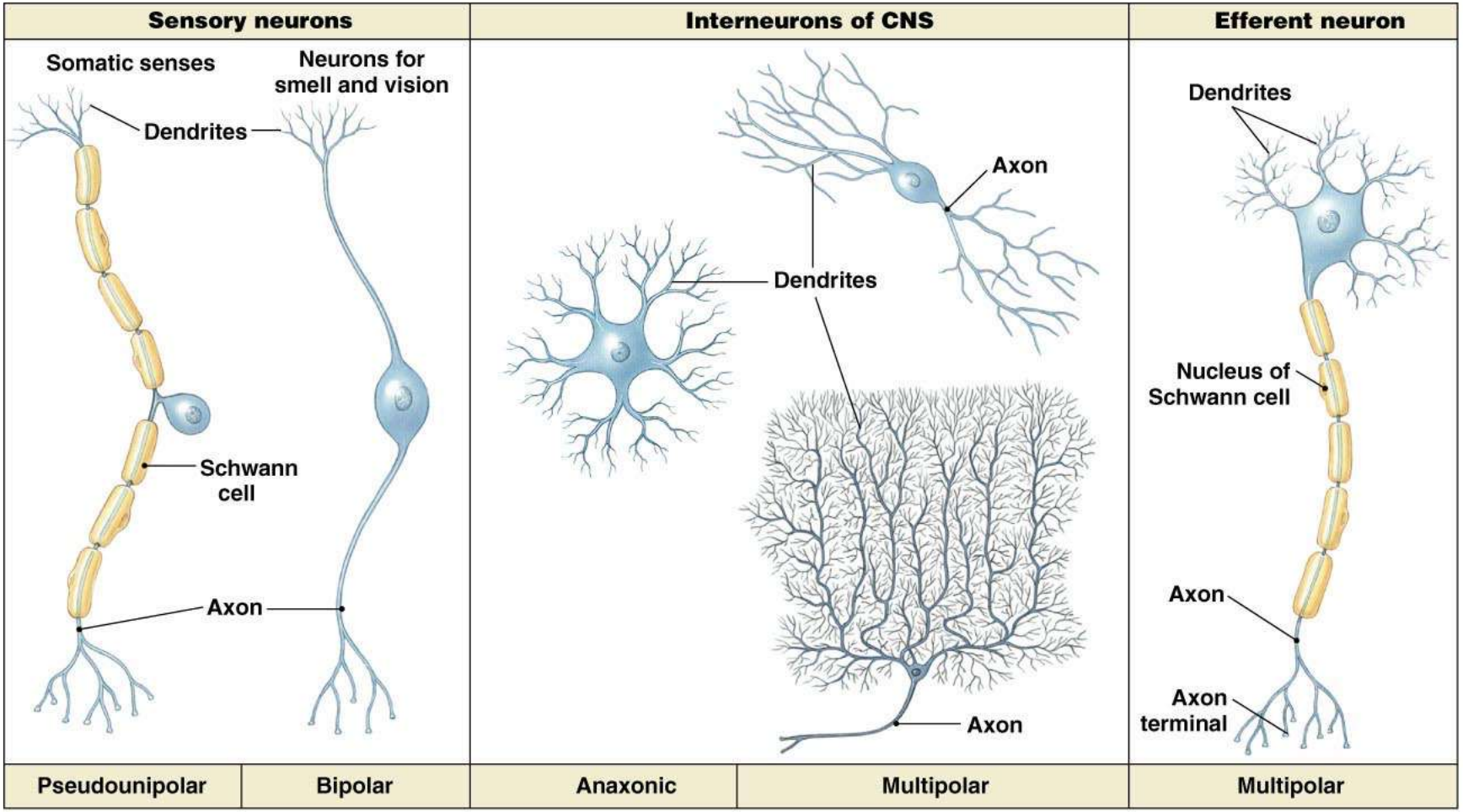


Nervous System



Neurons (Nerve Cells)





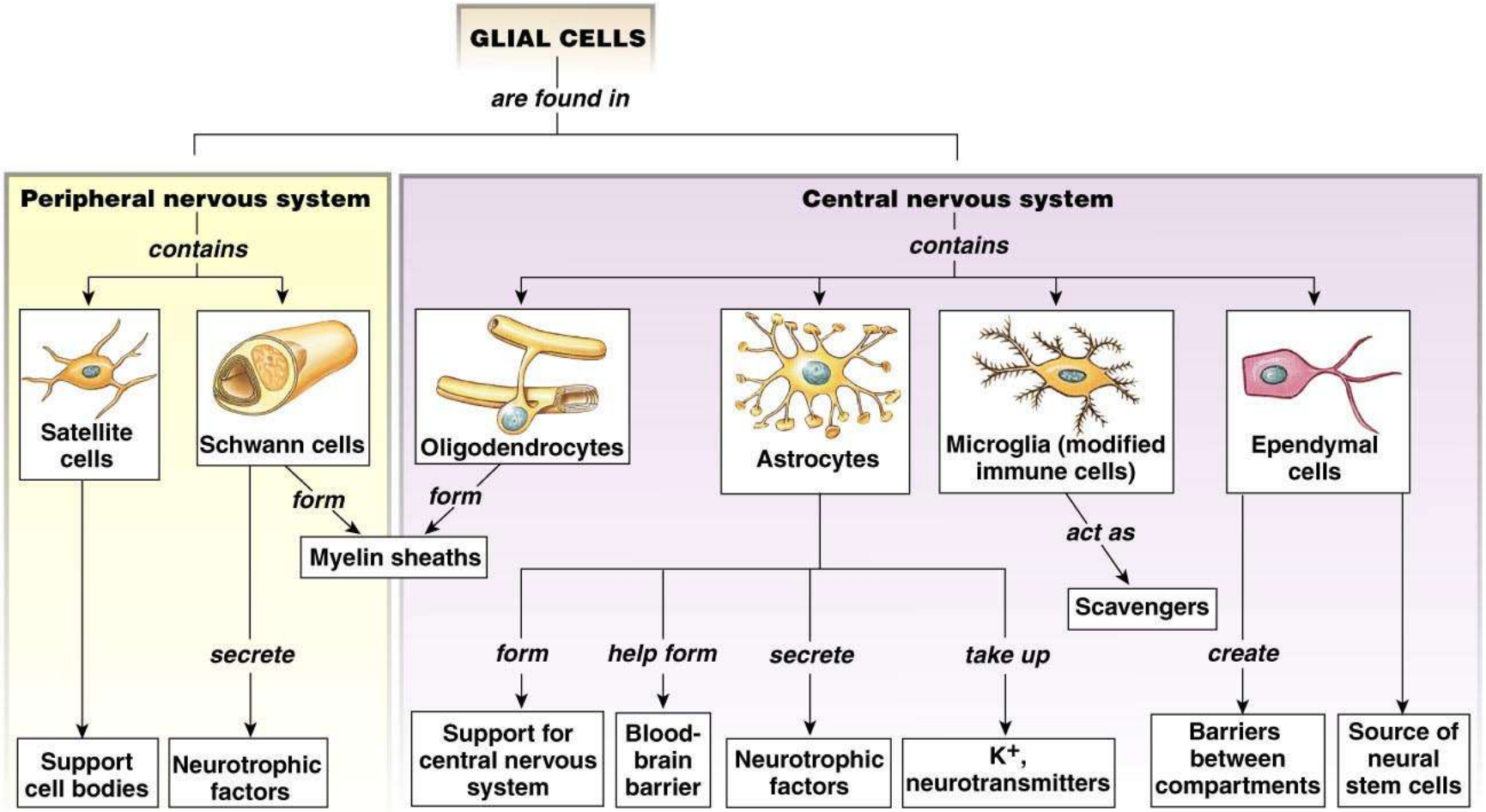
(a) Pseudounipolar neurons have a single process called the axon. During development, the dendrite fused with the axon.

(b) Bipolar neurons have two relatively equal fibers extending off the central cell body.

(c) Anaxonic CNS interneurons have no apparent axon.

(d) Multipolar CNS interneurons are highly branched but lack long extensions.

(e) A typical multipolar efferent neuron has five to seven dendrites, each branching four to six times. A single long axon may branch several times and end at enlarged axon terminals.



(a) Glial cells of the central nervous system

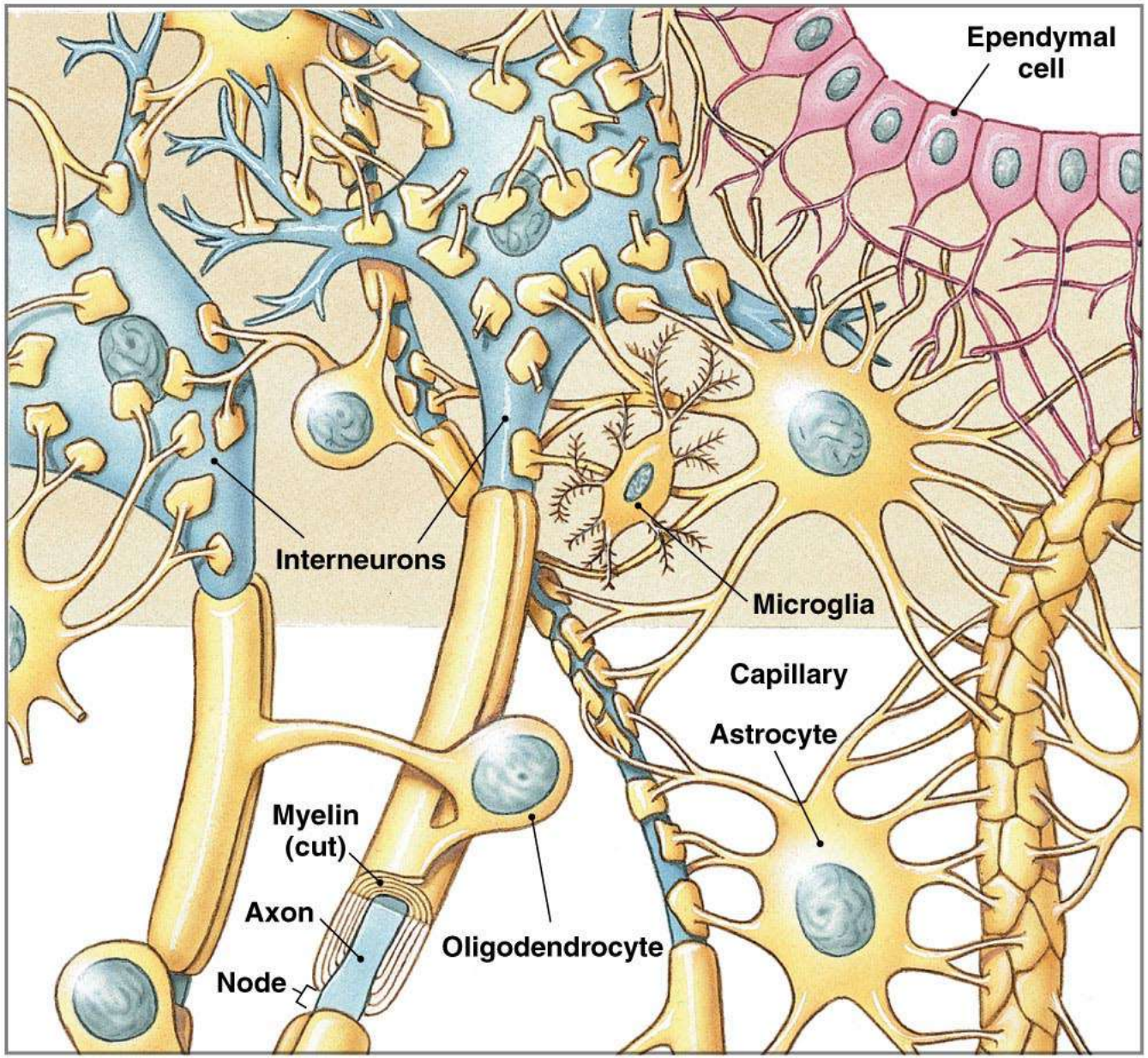
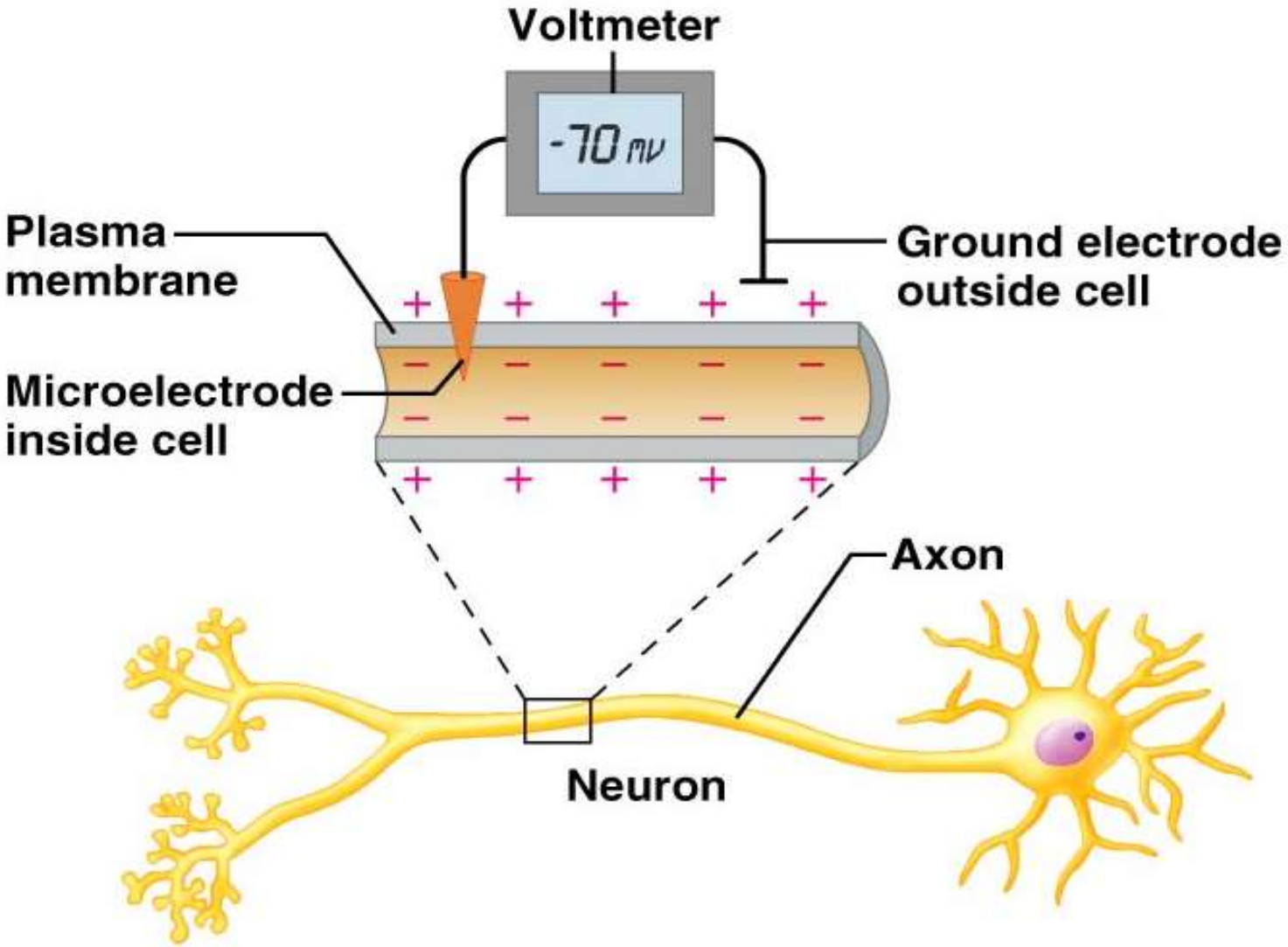


Figure 9.6a

Membrane Potential



Resting Membrane Potential (V_r)

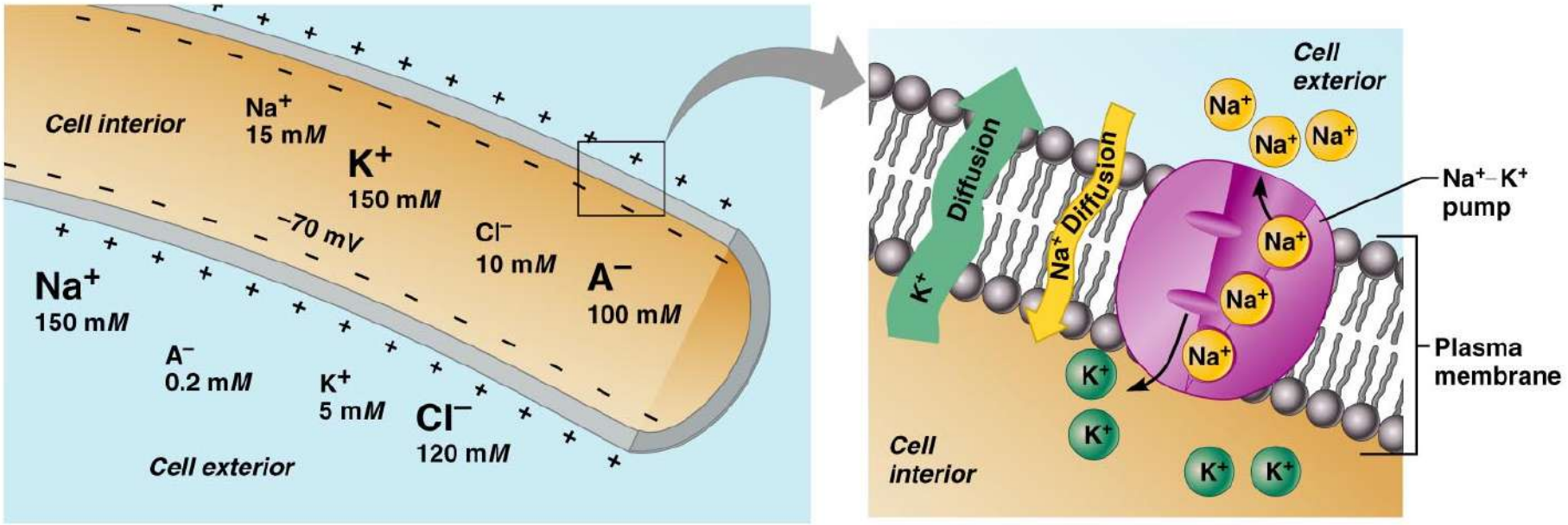


Figure 11.8

Changes in Membrane Potential

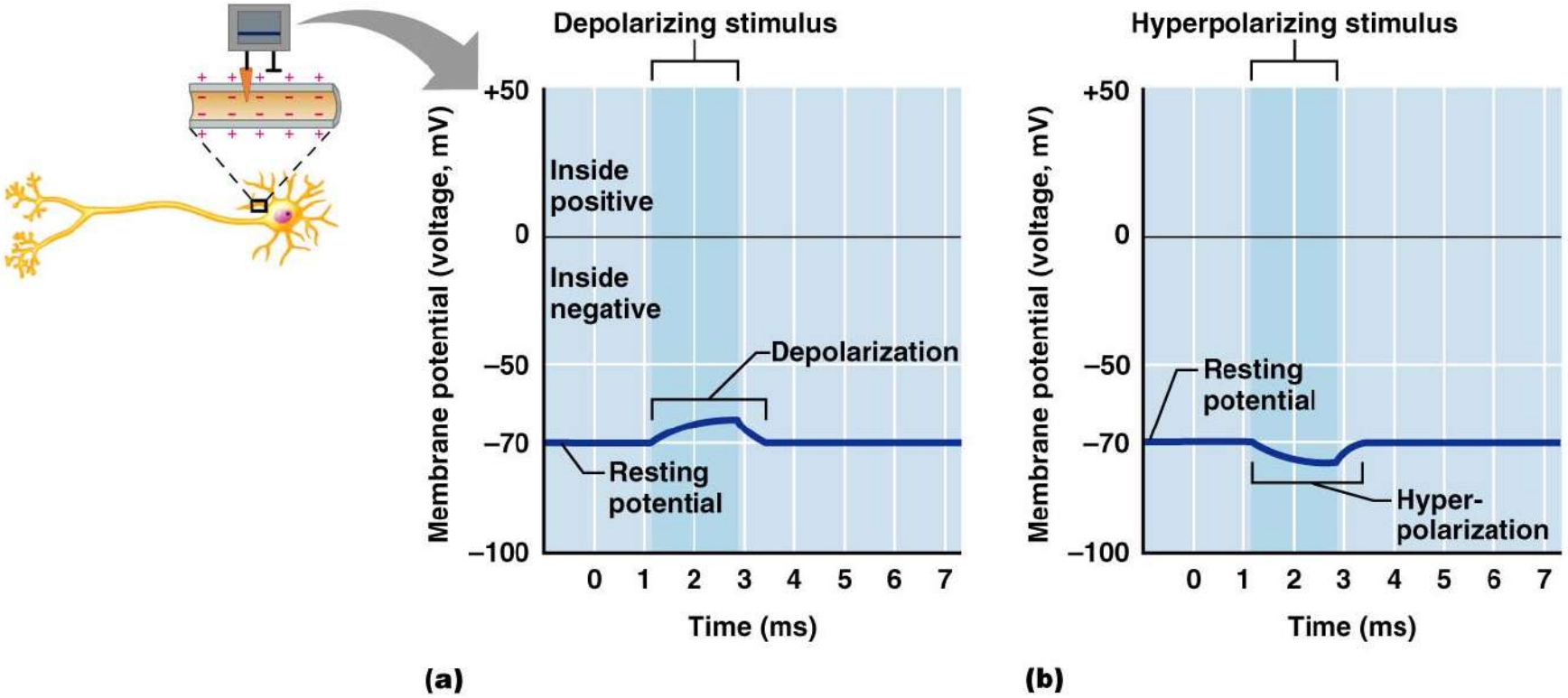


Figure 11.9

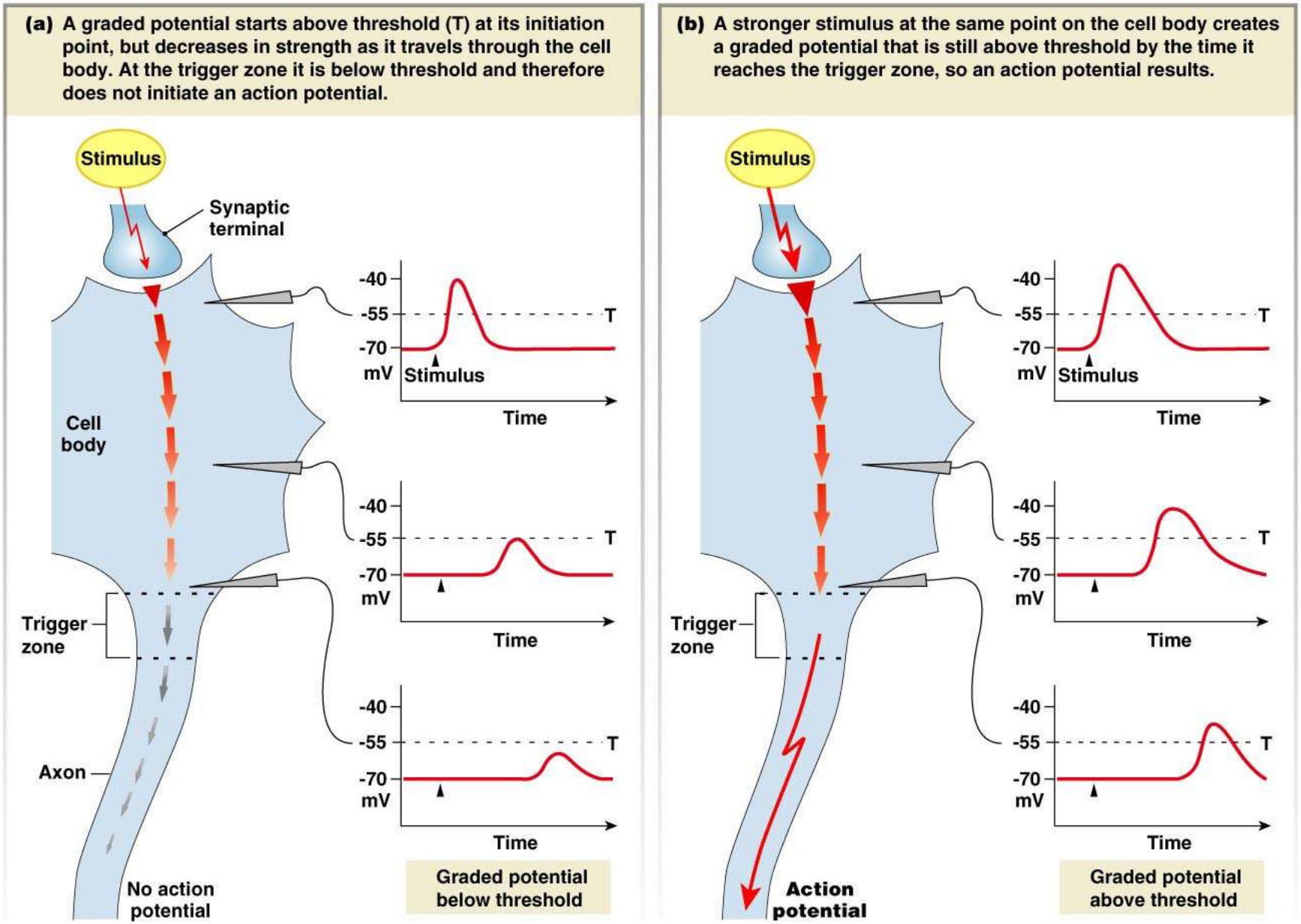
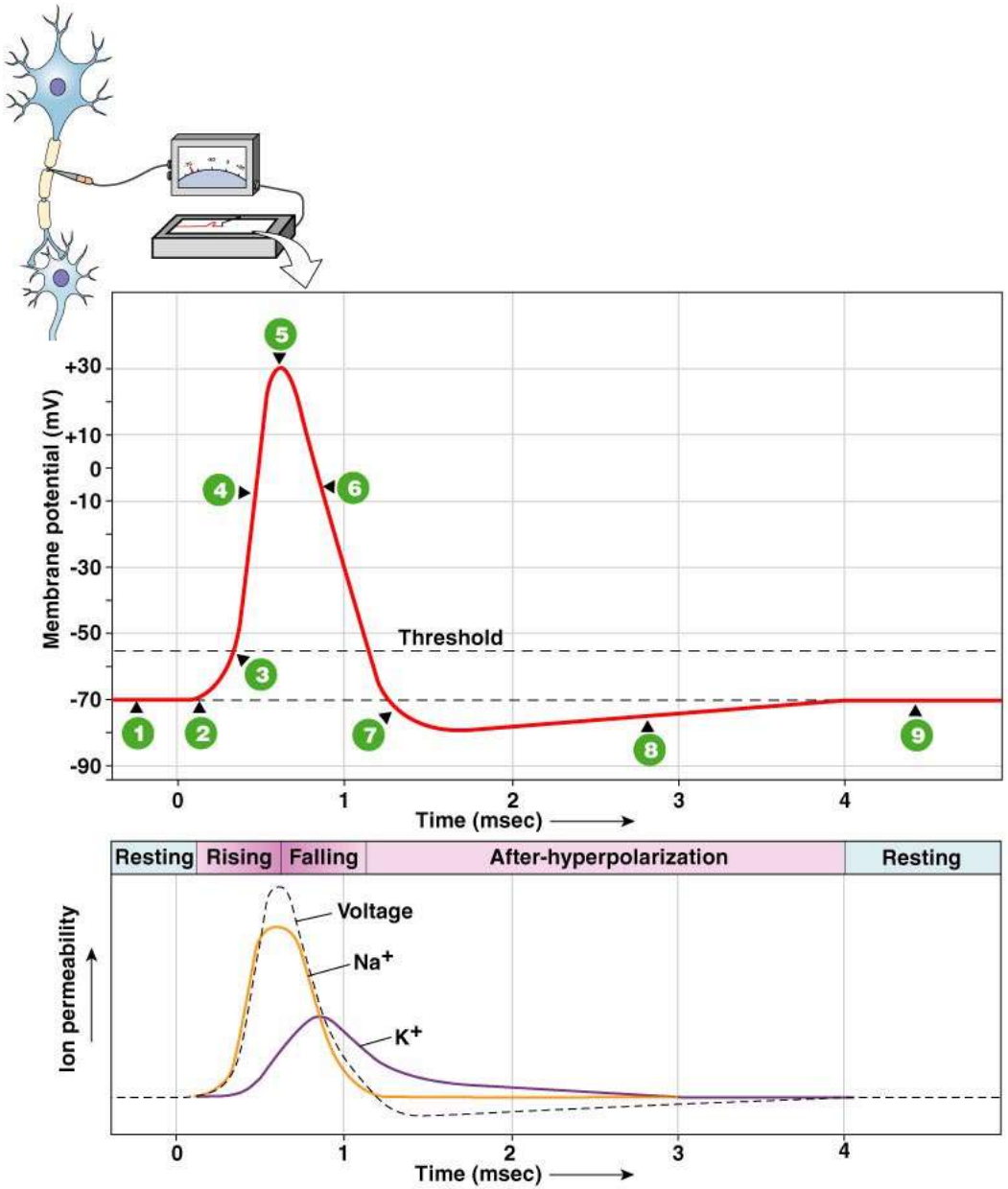


Figure 9-8 Overview



1. Resting membrane potential
2. Depolarizing stimulus
3. Membrane depolarizes to threshold. Voltage-gated Na^+ channels open and Na^+ enters cell. Voltage-gated K^+ channels begin to open slowly.
4. Rapid Na^+ entry depolarizes cell.
5. Na^+ channels close and slower K^+ channels open.
6. K^+ moves from cell to extracellular fluid.
7. K^+ channels remain open and additional K^+ leaves cell, hyperpolarizing it.
8. Voltage-gated K^+ channels close, less K^+ leaks out of the cell.
9. Cell returns to resting ion permeability and resting membrane potential.

Figure 9-9 Overview

Phases of the Action Potential

- 1 – resting state
- 2 – depolarization phase
- 3 – repolarization phase
- 4 – hyperpolarization

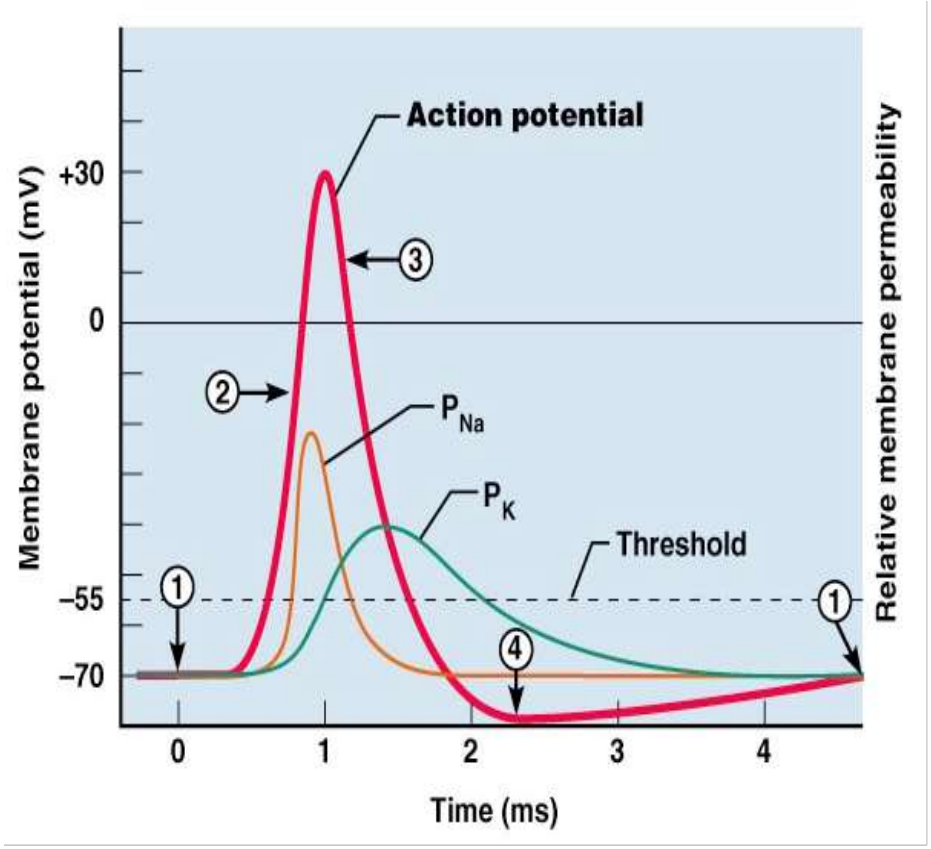
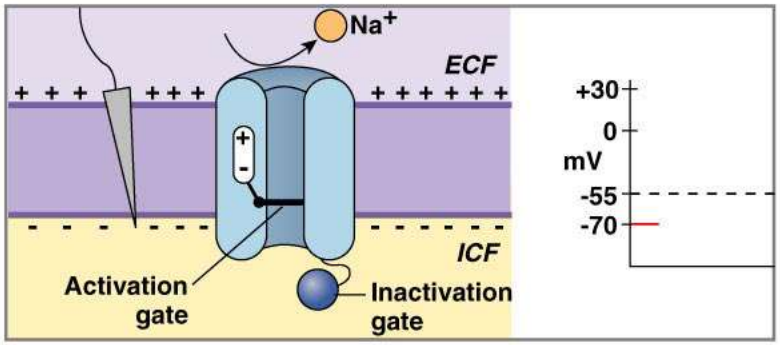
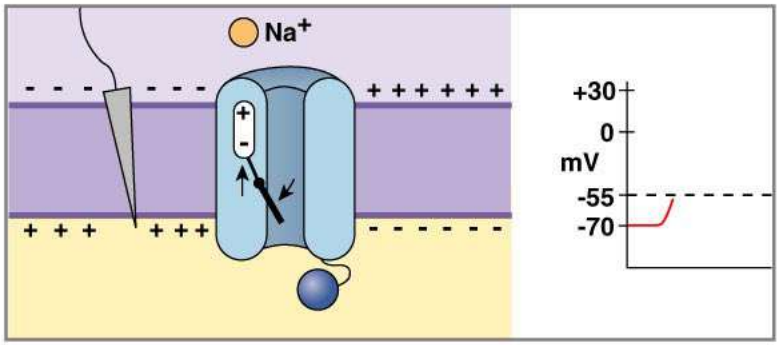


Figure 11.12

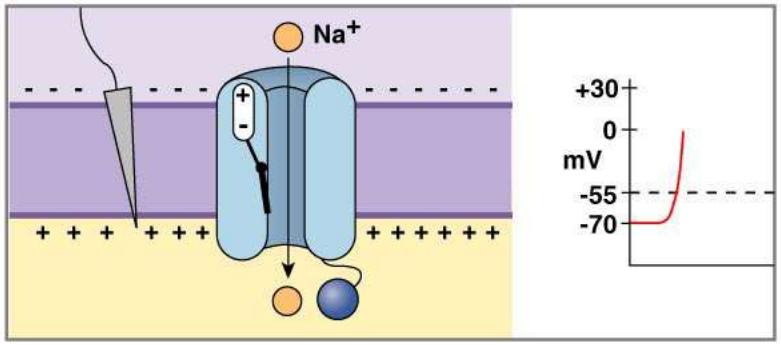
(a) At the resting membrane potential, the activation gate closes the channel.



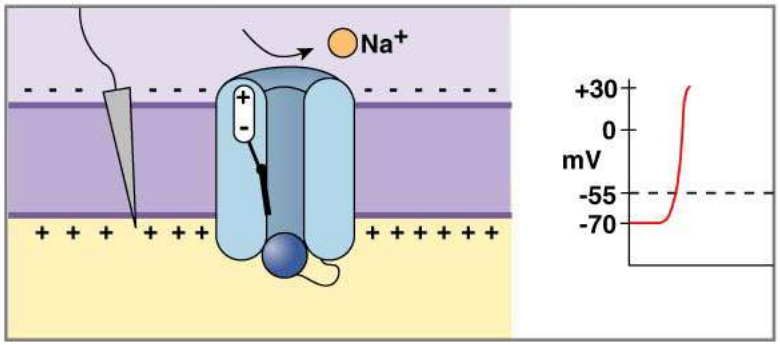
(b) Depolarizing stimulus arrives at the channel.



(c) With activation gate open, Na^+ enters the cell.



(d) Inactivation gate closes and Na^+ entry stops.



(e) During repolarization caused by K^+ leaving the cell, the two gates reset to their original positions.

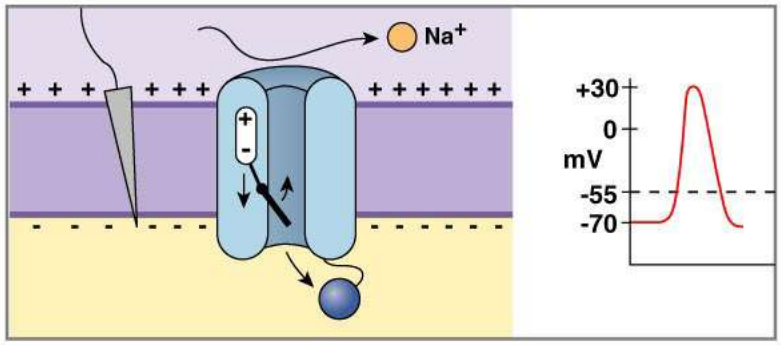


Figure 8-10 Overview

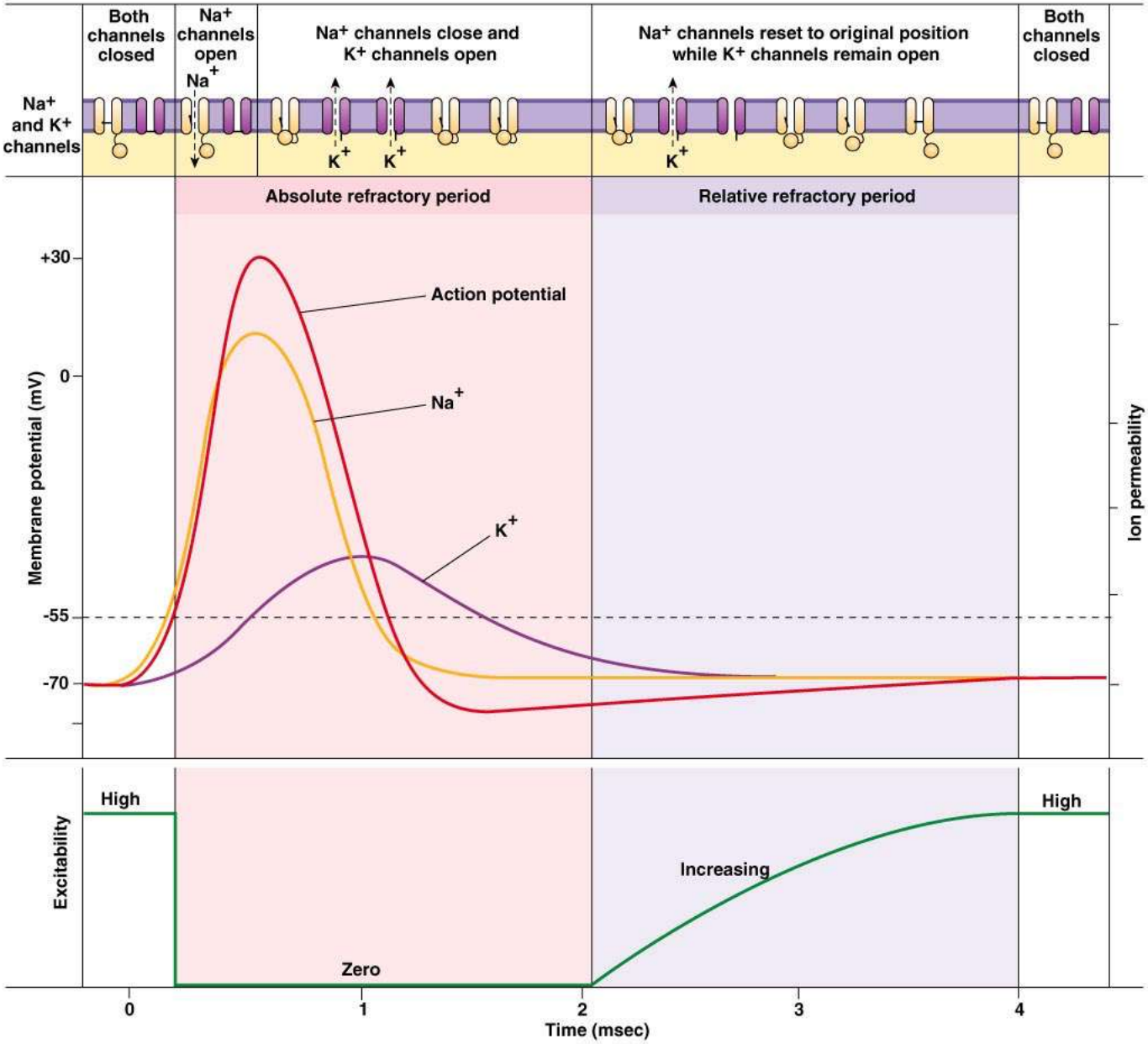


Figure 9.12

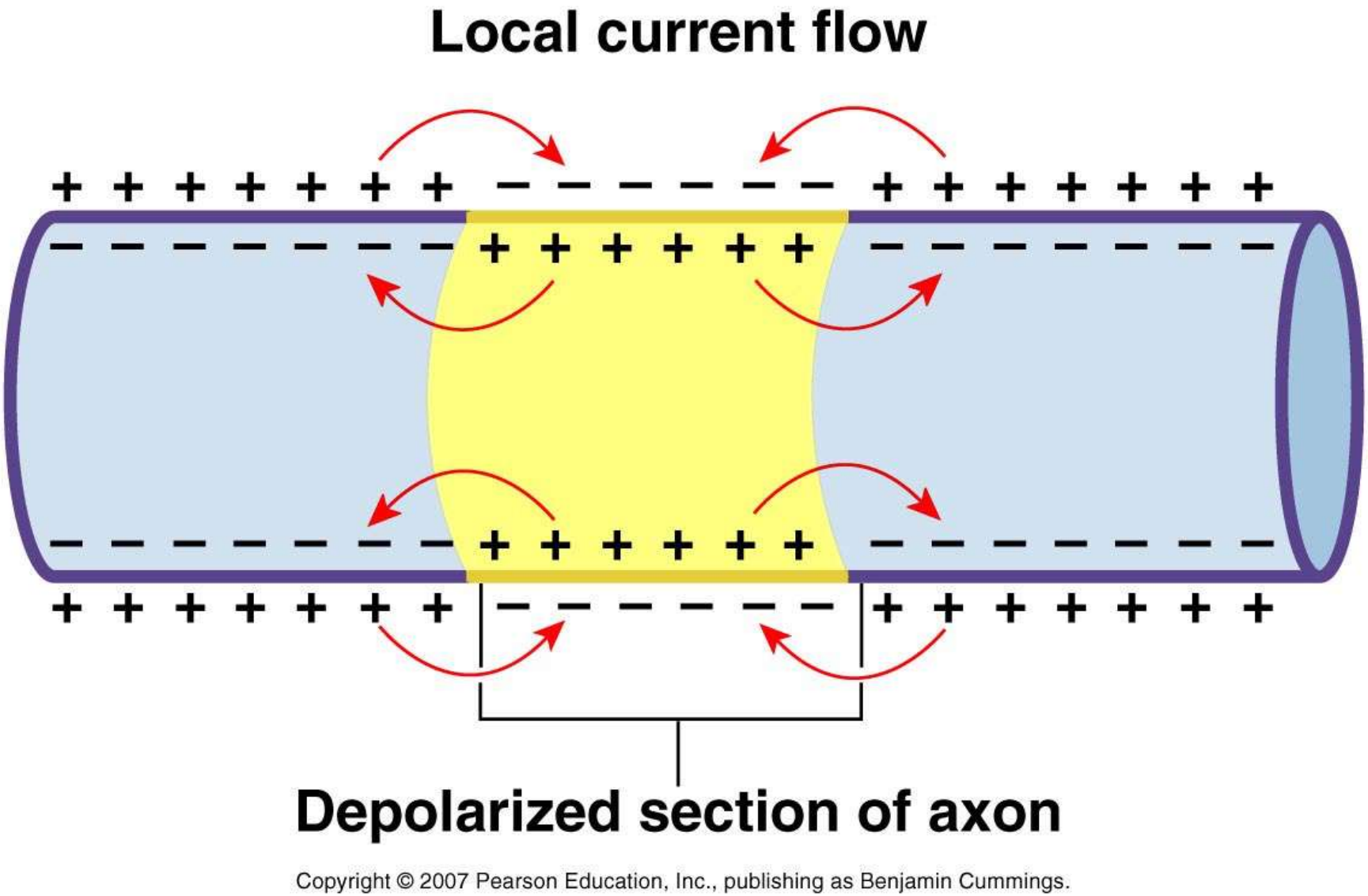


Figure 9.14

Saltatory Conduction

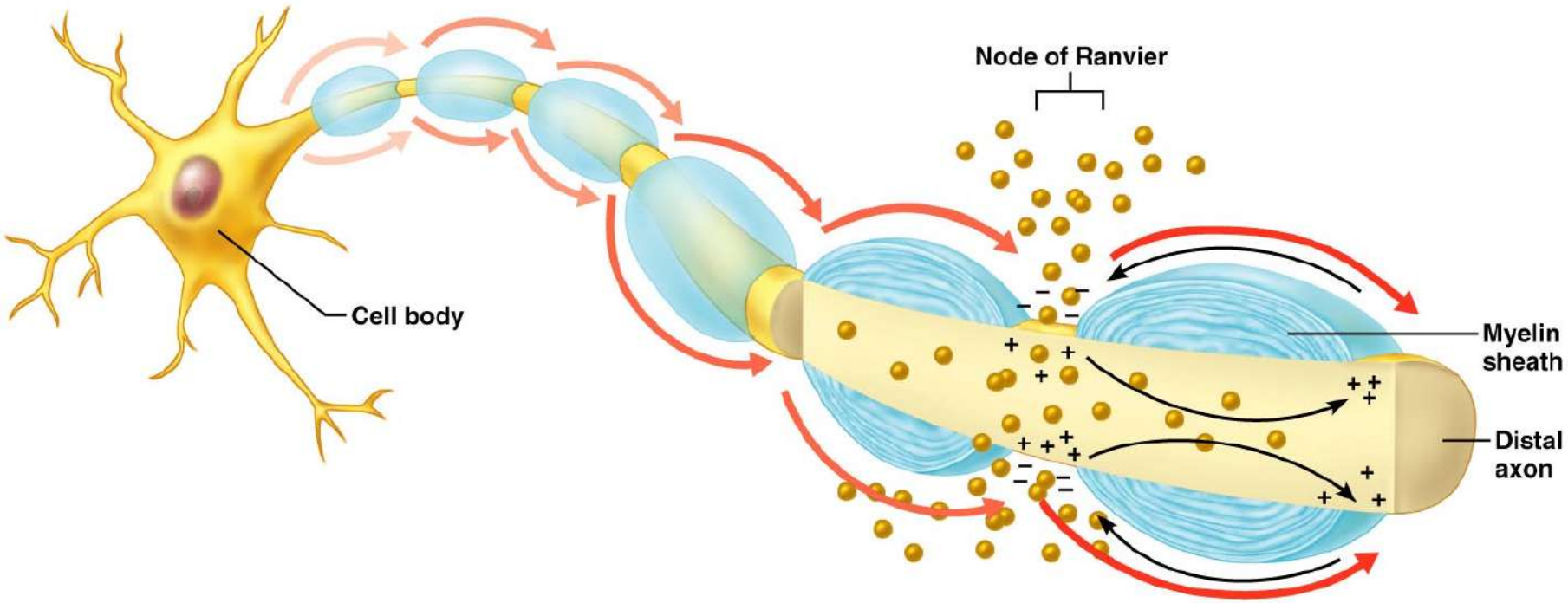
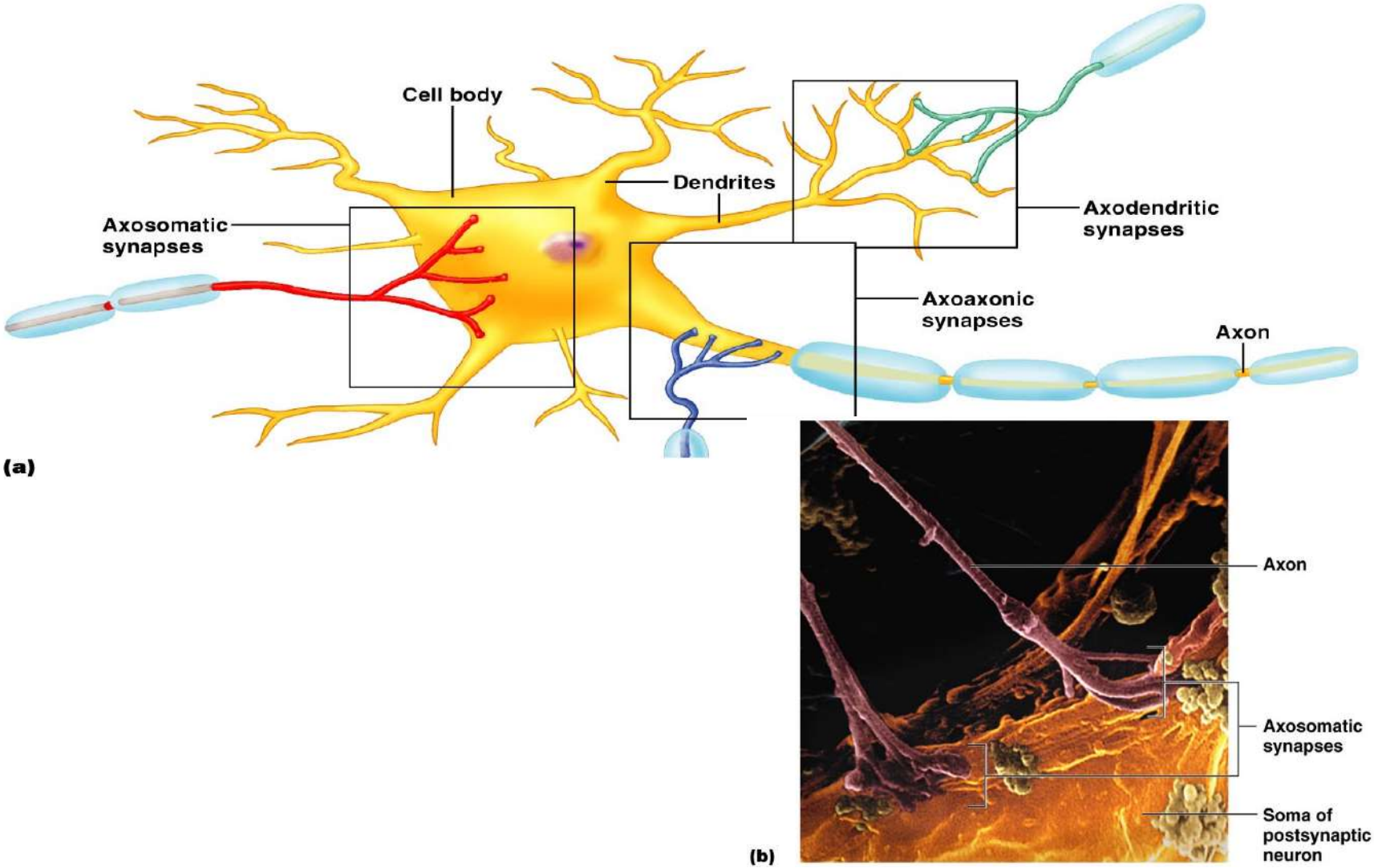


Figure 11.16

Synapses



Synapse

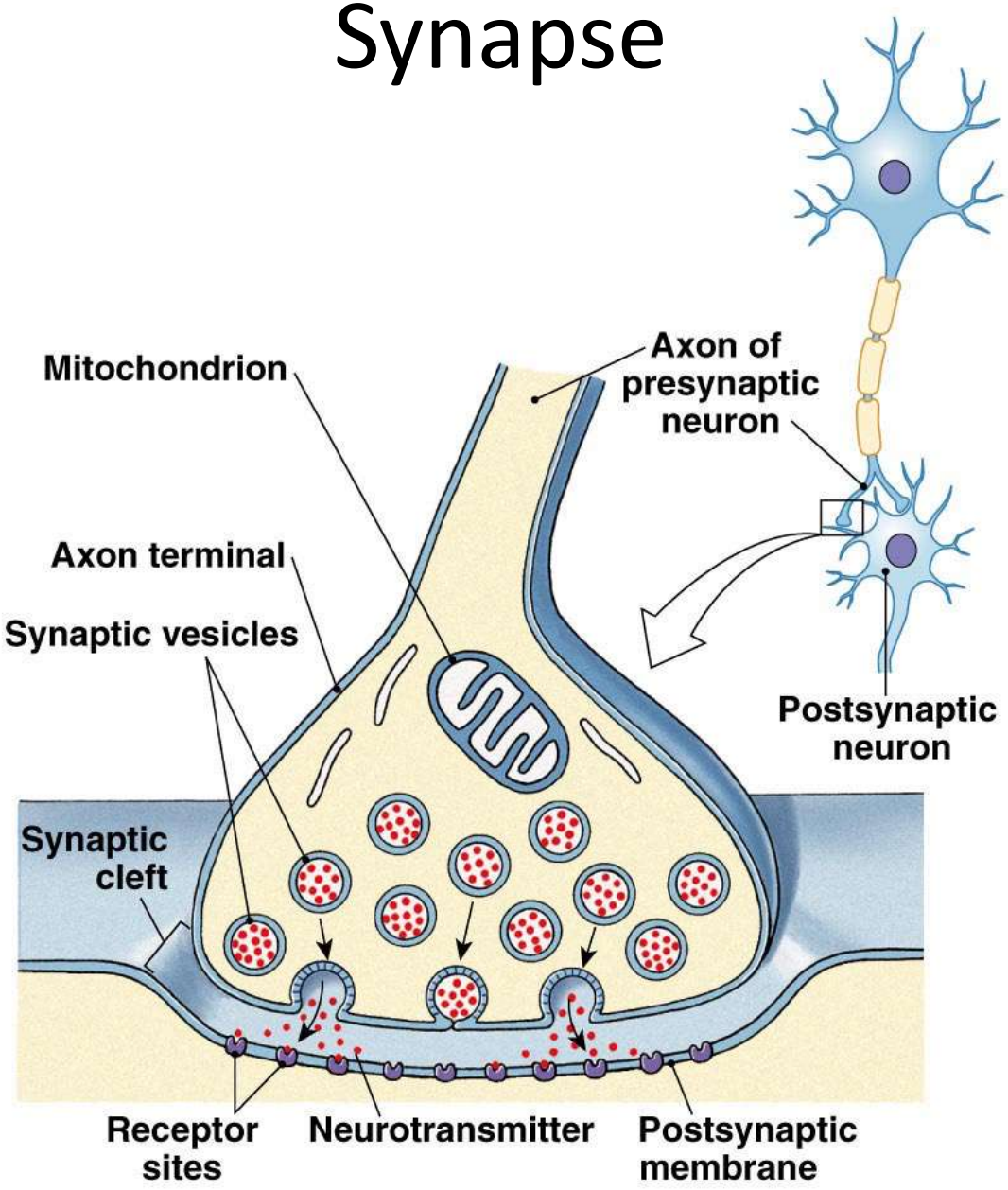


Figure 9.20

Synaptic Transmission

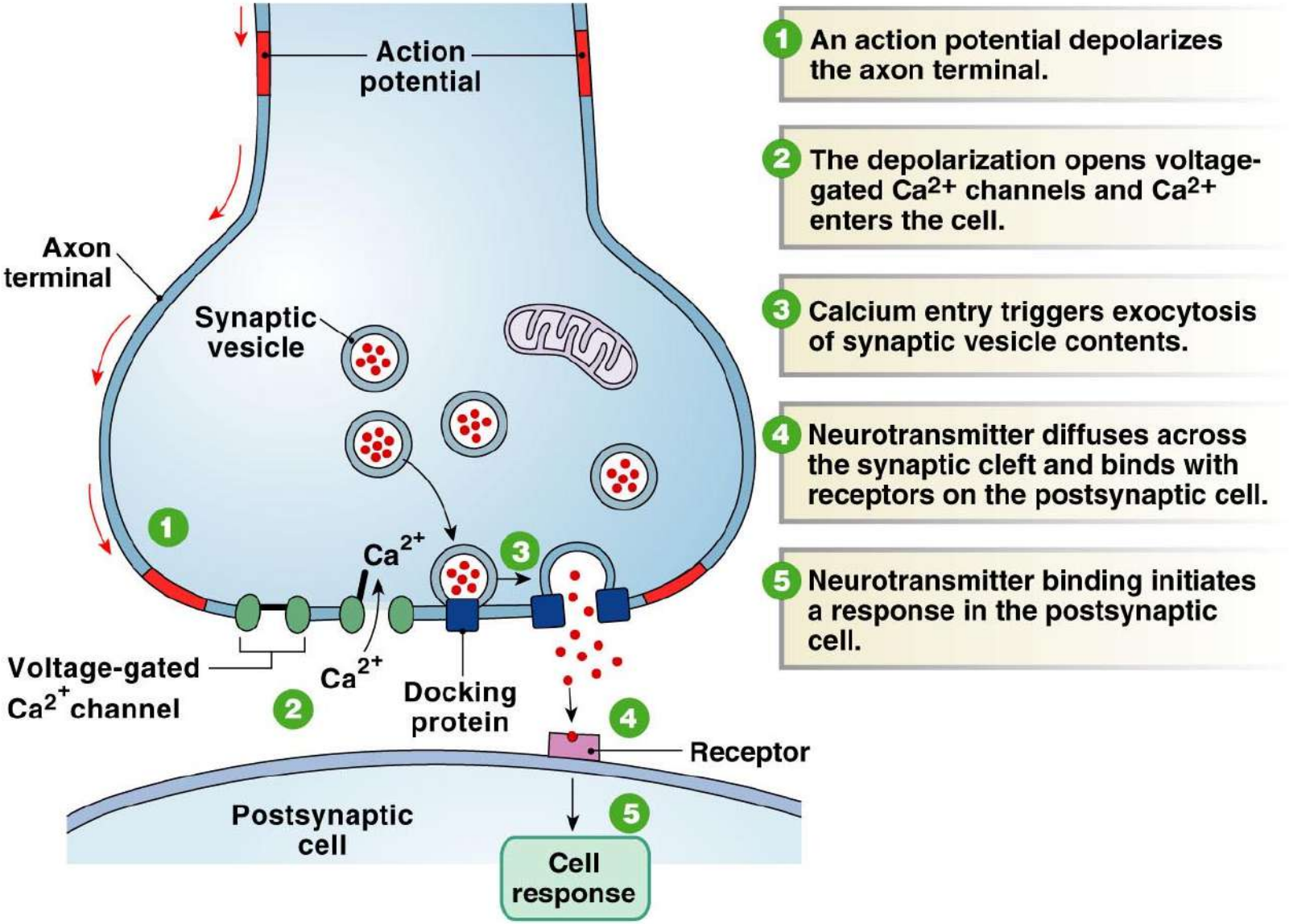


Figure 8.21 Overview

Inactivation of Neurotransmitters

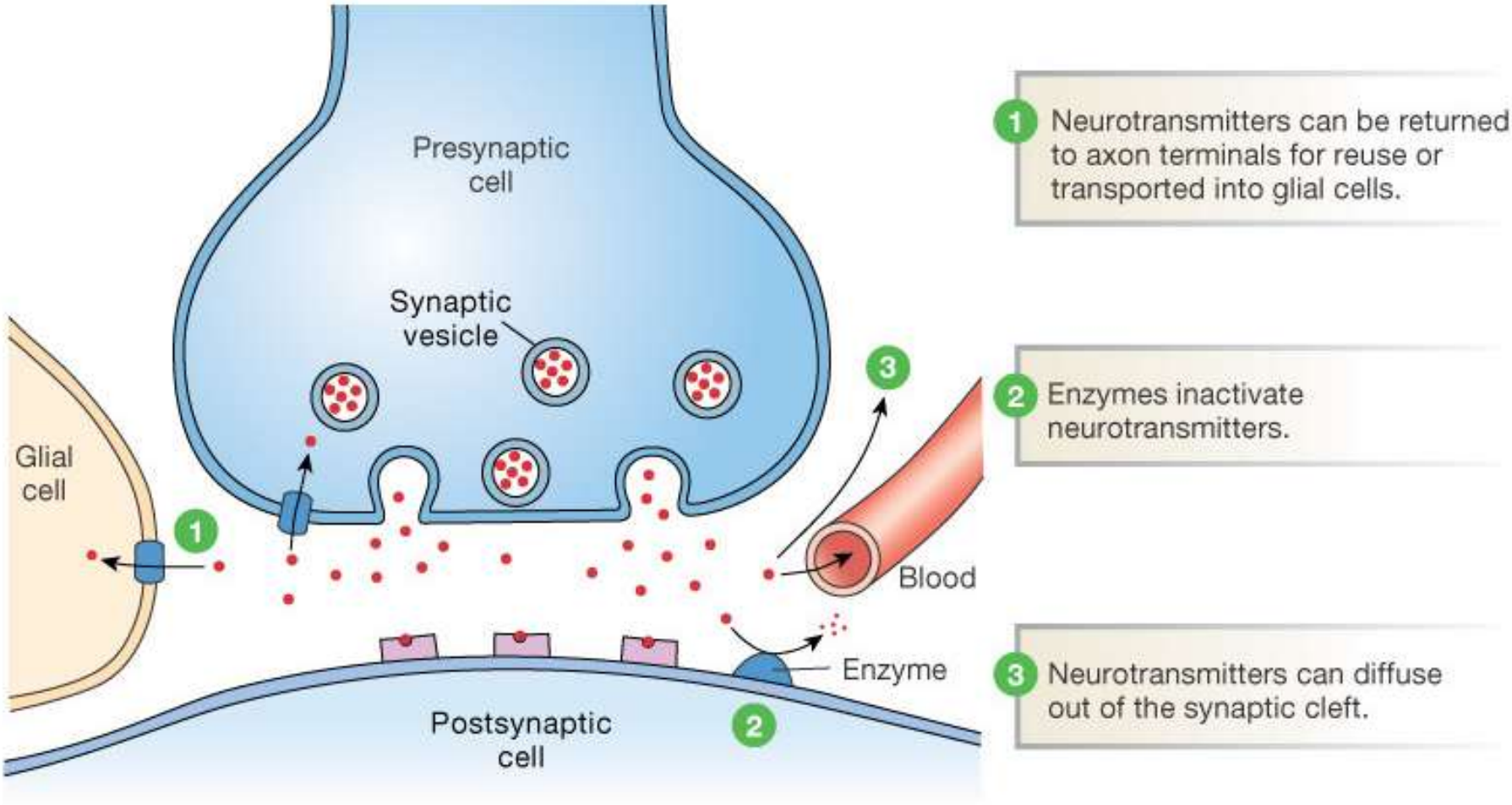


Figure 8-23: Inactivation of neurotransmitters

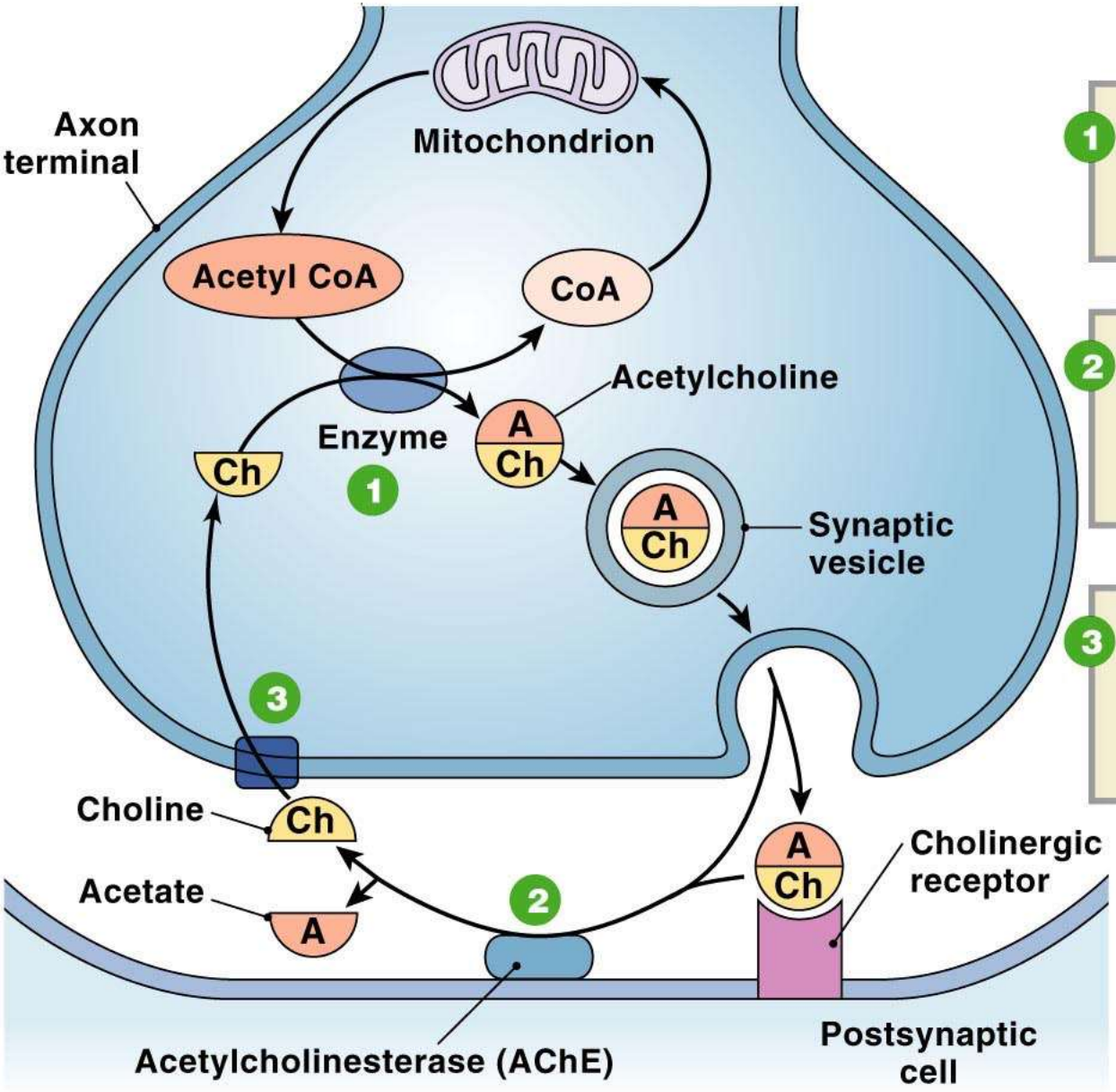
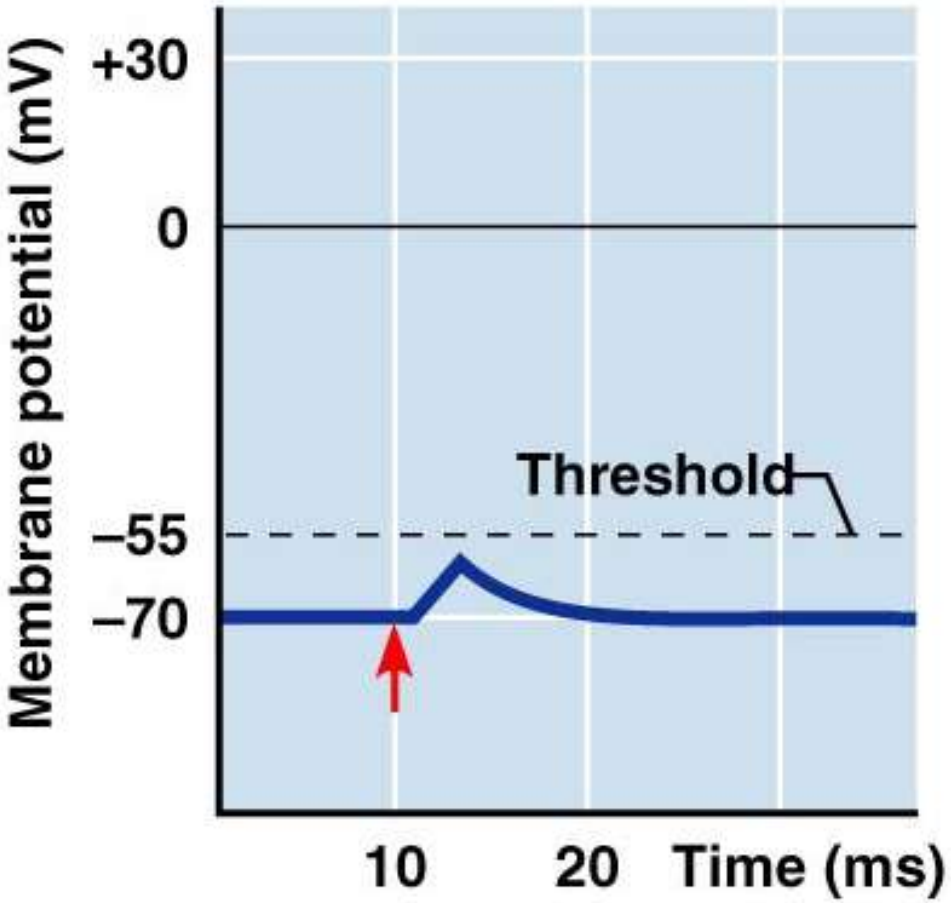


Figure 8.22 Overview

Excitatory Postsynaptic Potentials

- EPSPs are graded potentials that can initiate an action potential in an axon
  - Use only chemically gated channels
  - Na^+ and K^+ flow in opposite directions at the same time
- Postsynaptic membranes do not generate action potentials

Excitatory Postsynaptic Potential



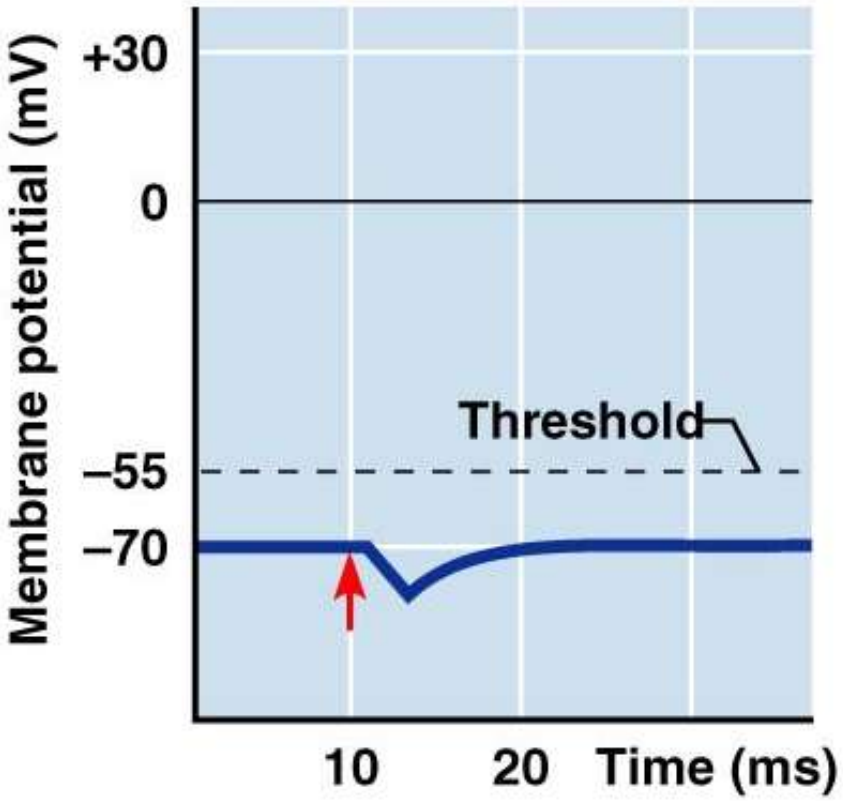
(a) Excitatory postsynaptic potential (EPSP)

Figure 11.19a

Inhibitory Synapses and IPSPs

- Neurotransmitter binding to a receptor at inhibitory synapses:
  - Causes the membrane to become more permeable to potassium and chloride ions
  - Leaves the charge on the inner surface negative
  - Reduces the postsynaptic neuron's ability to produce an action potential

Inhibitory Postsynaptic (IPSP)



(b) Inhibitory postsynaptic potential (IPSP)

Figure 11.19b

Chemical Neurotransmitters

- Acetylcholine (ACh)
- Biogenic amines
- Amino acids
- Peptides
- Novel messengers: ATP and dissolved gases NO and CO

Central Nervous System (CNS)

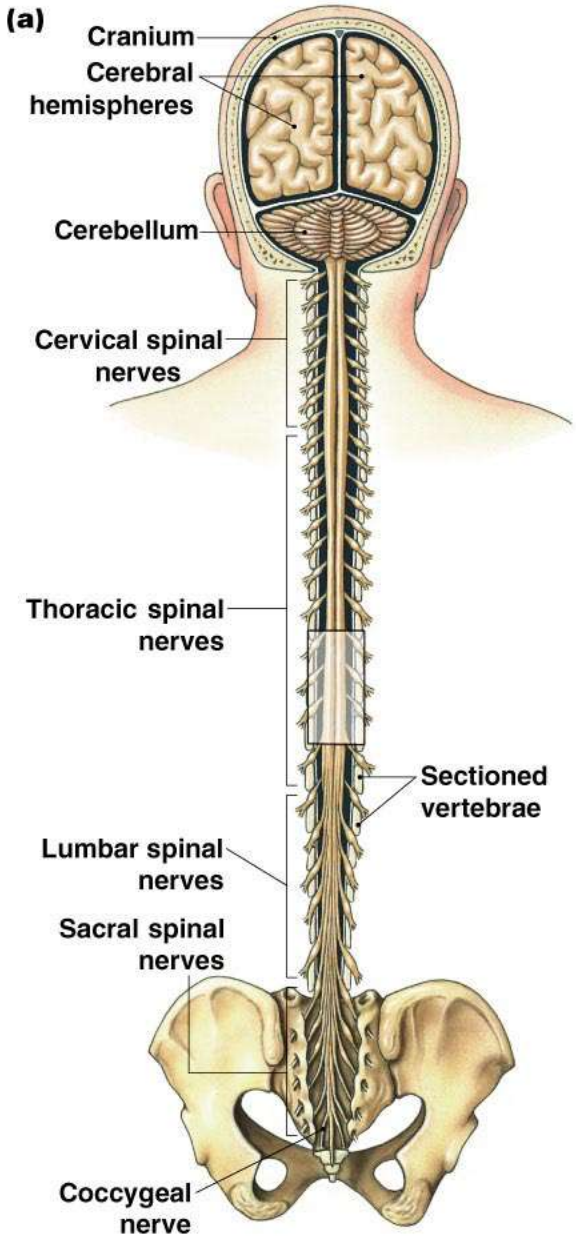


Figure 9.4a

Human Brain: Ventral Aspect

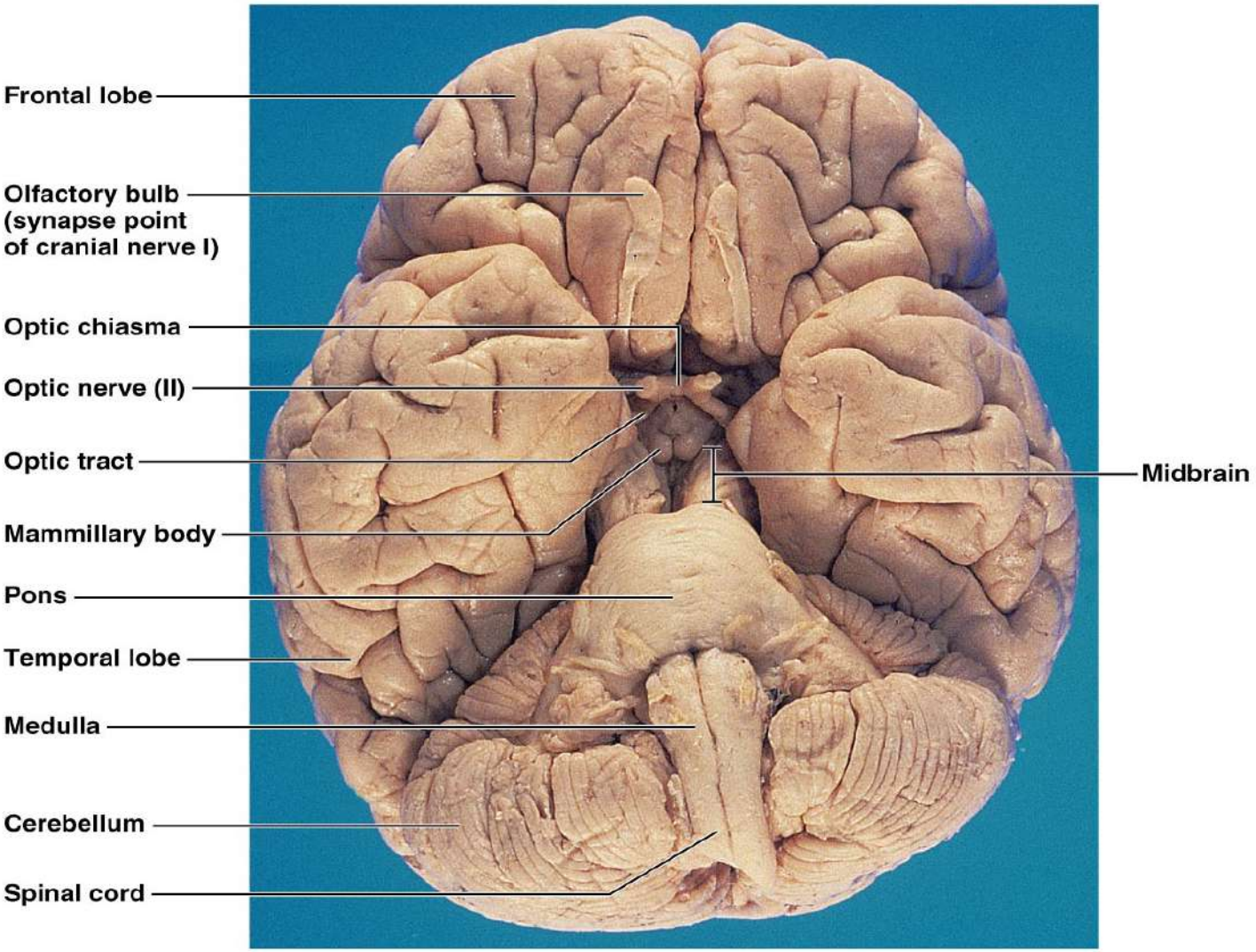


Figure 12.14

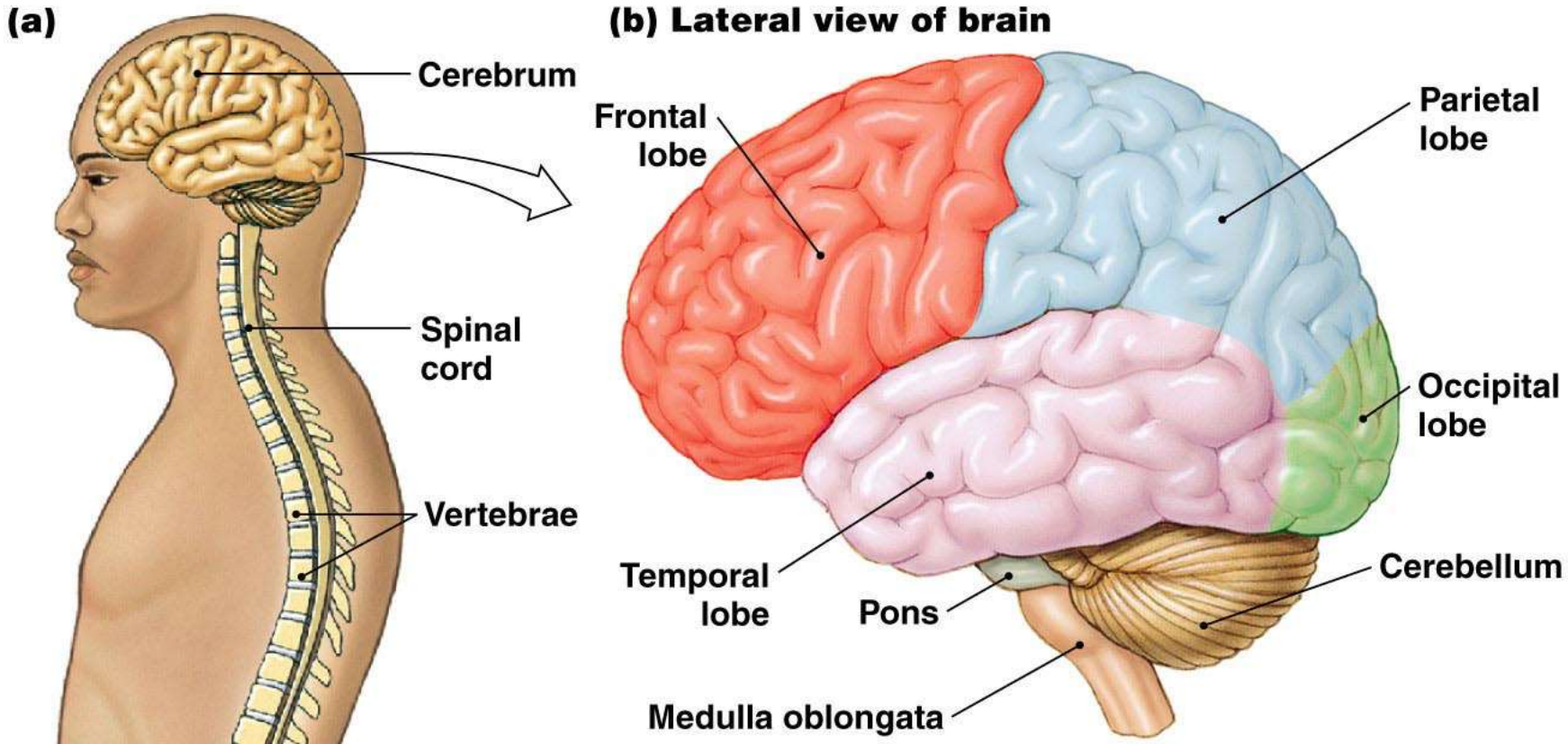
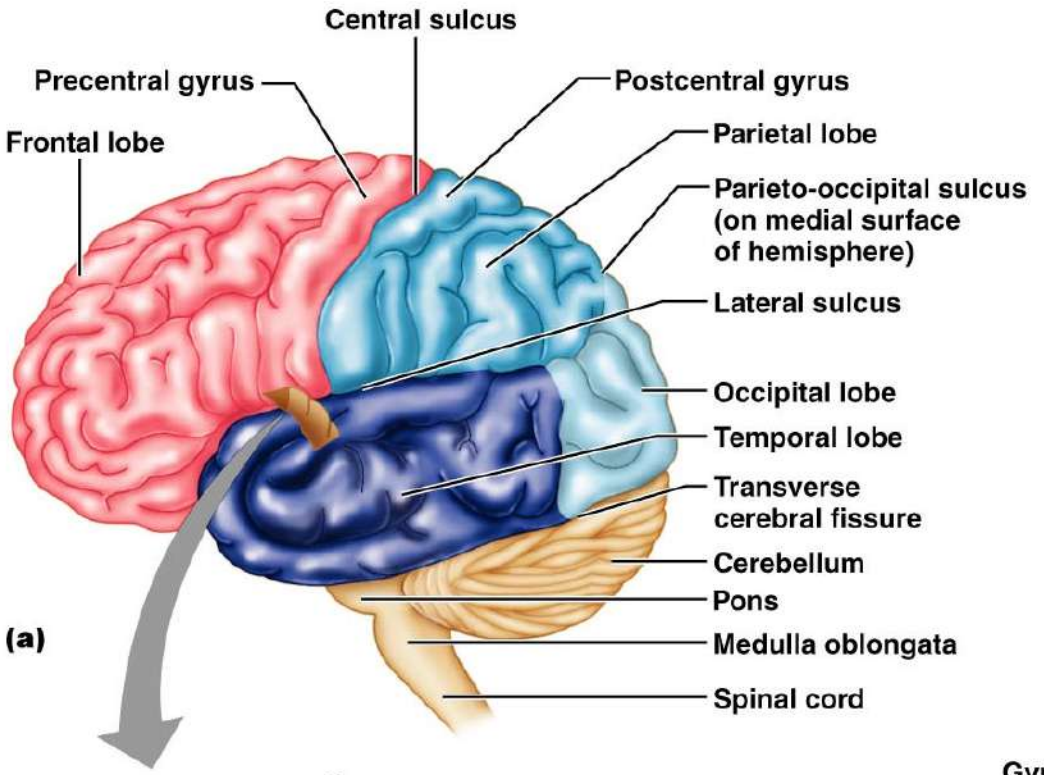
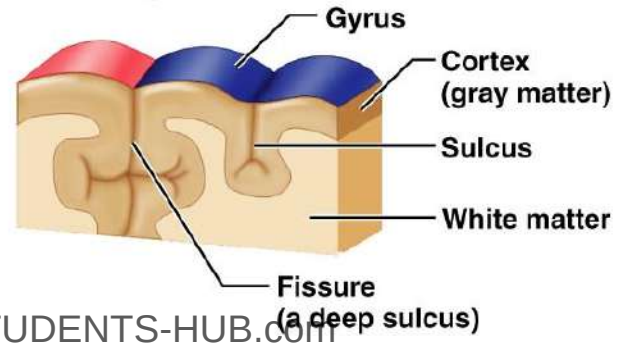
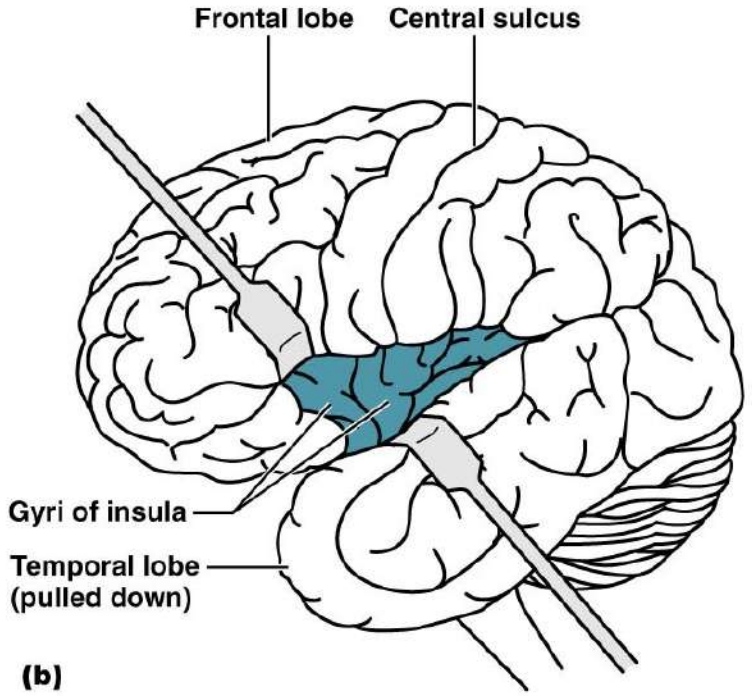


Figure 39-9a-b (1 of 5)

Brain Lobes







Functional Areas of the Cerebral

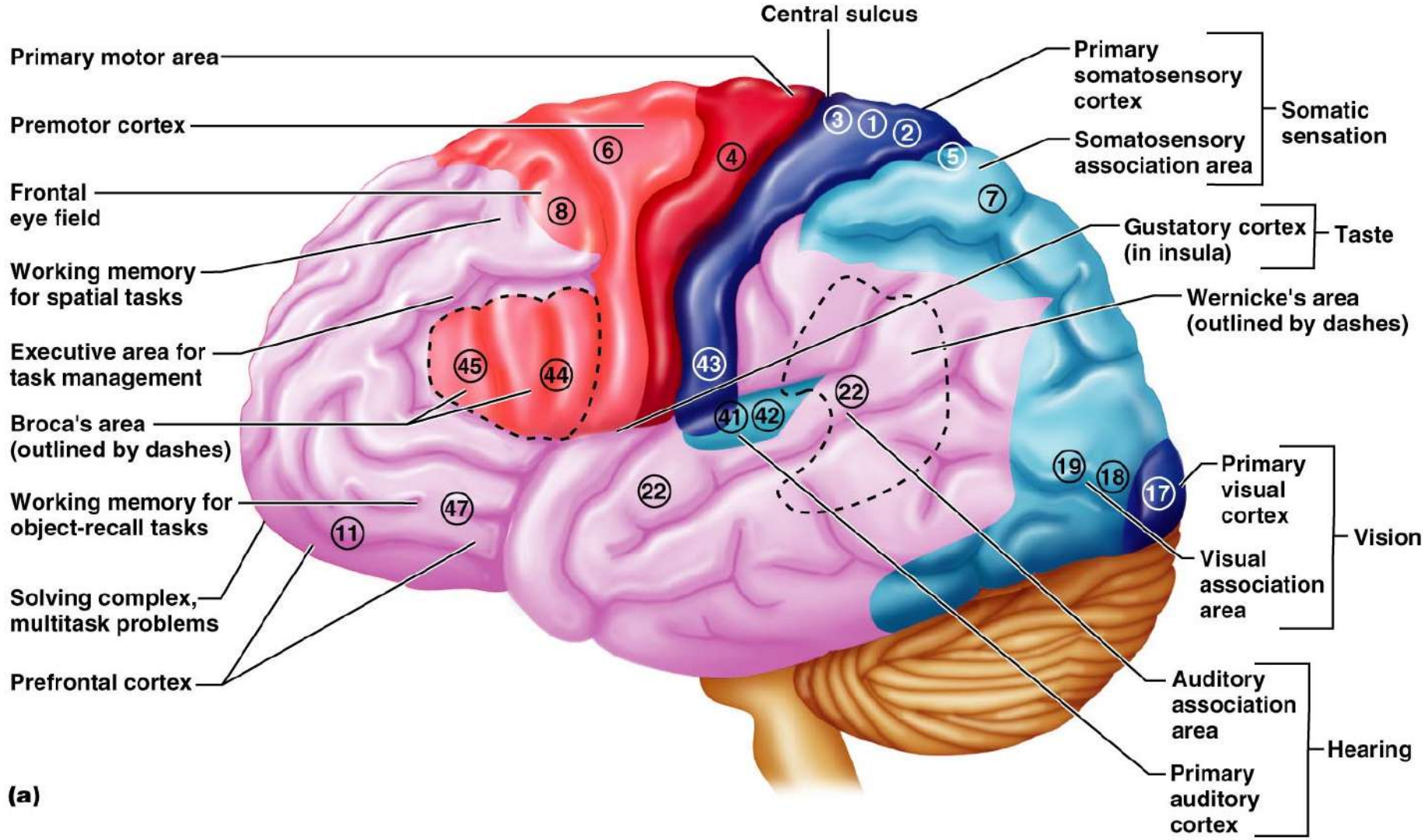


Figure 12.8a

Primary Motor Cortex Homunculus

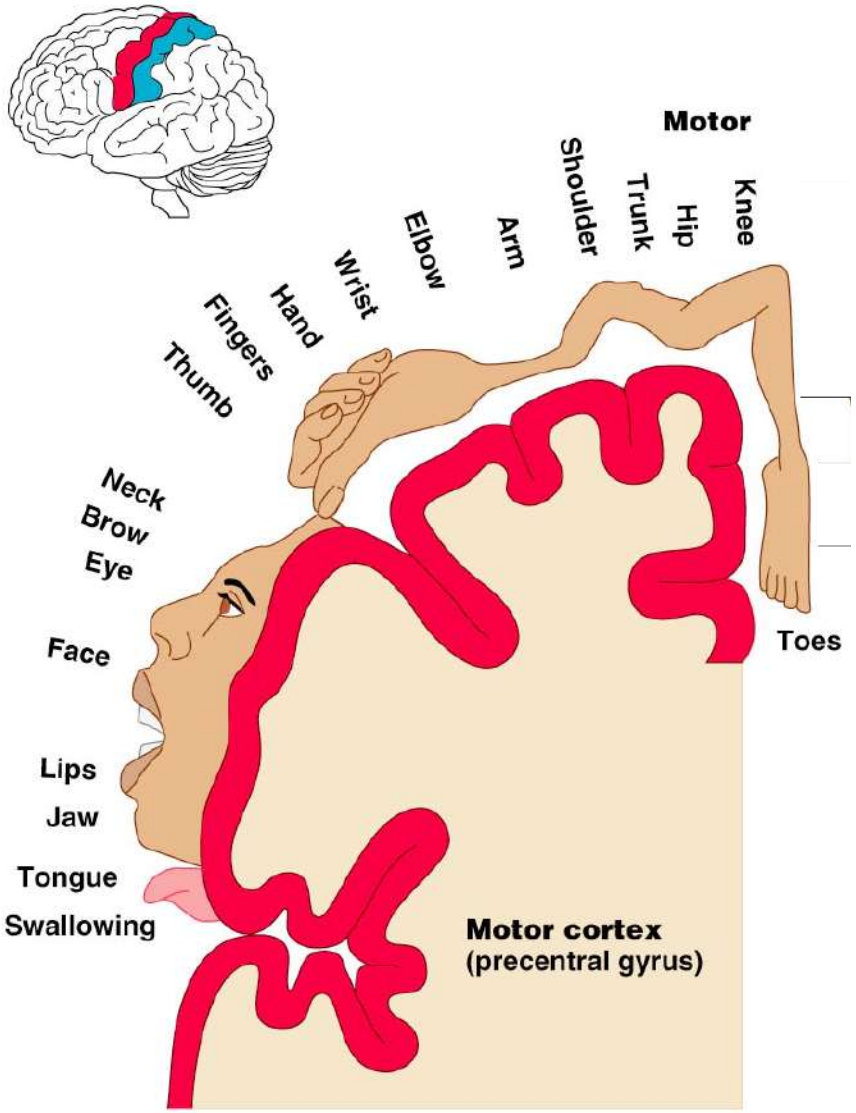


Figure 12.21

Primary Somatosensory Cortex

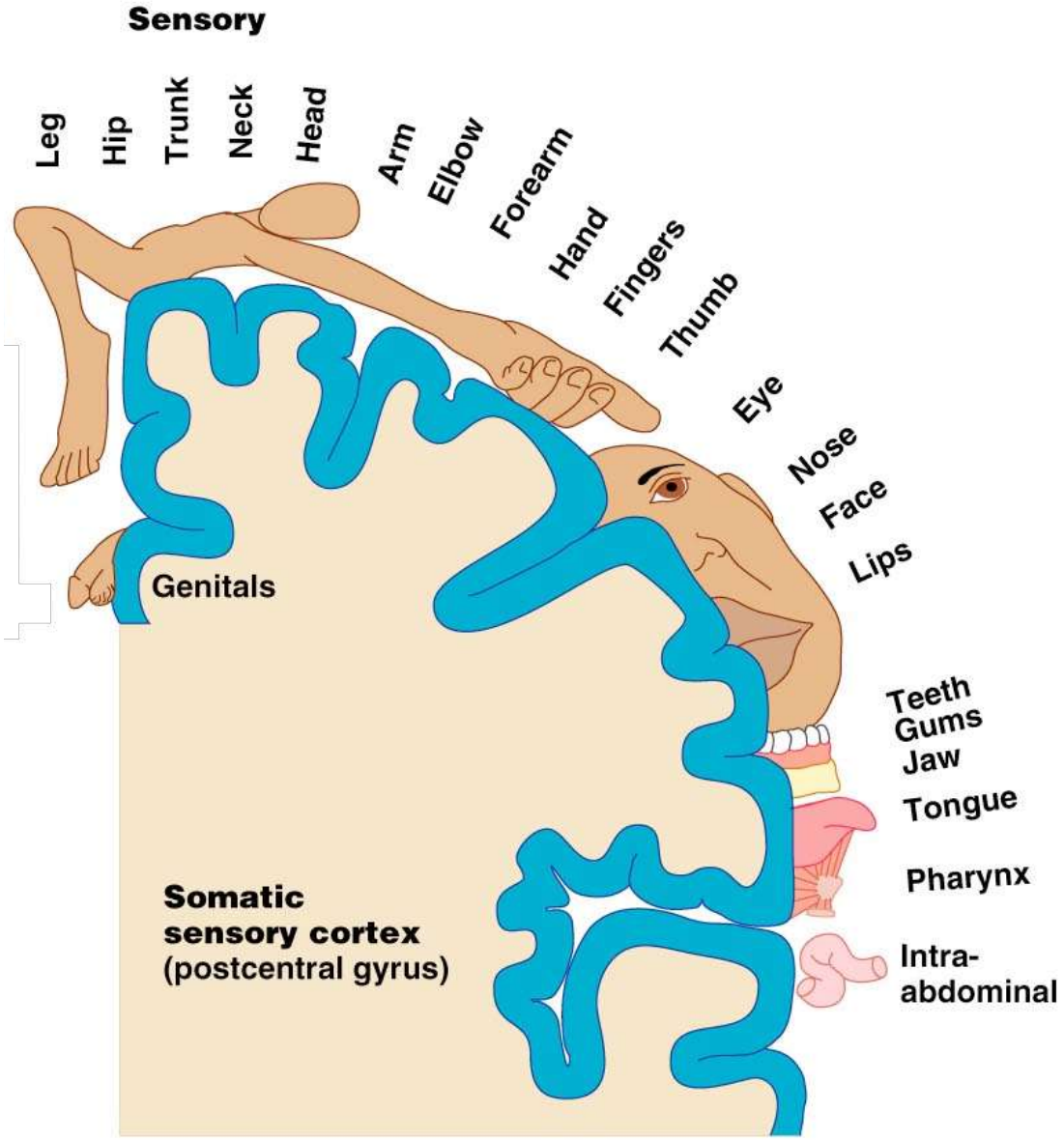


Figure 12.9.2

Fiber Tracts in White Matter

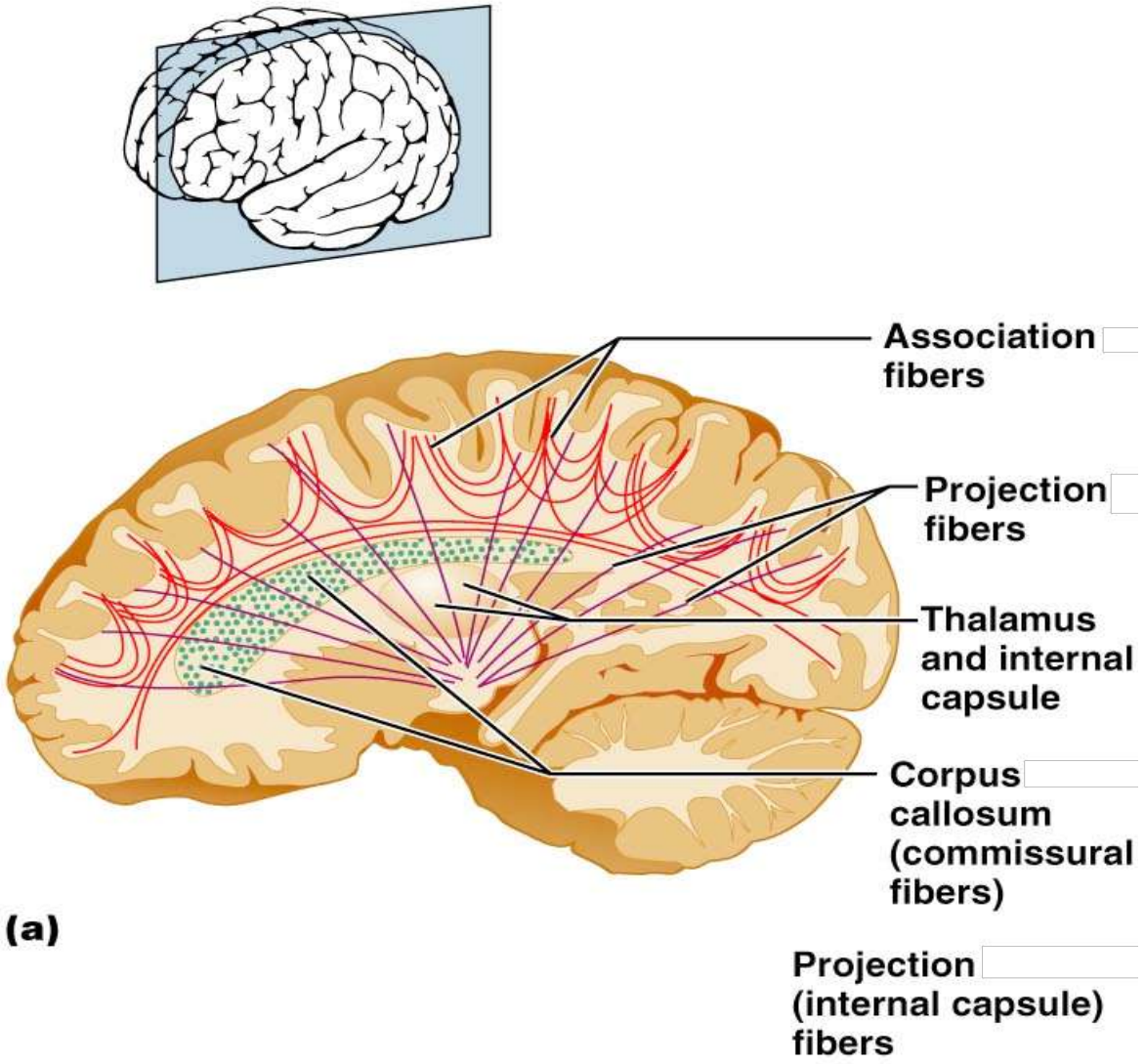


Figure 12.10a

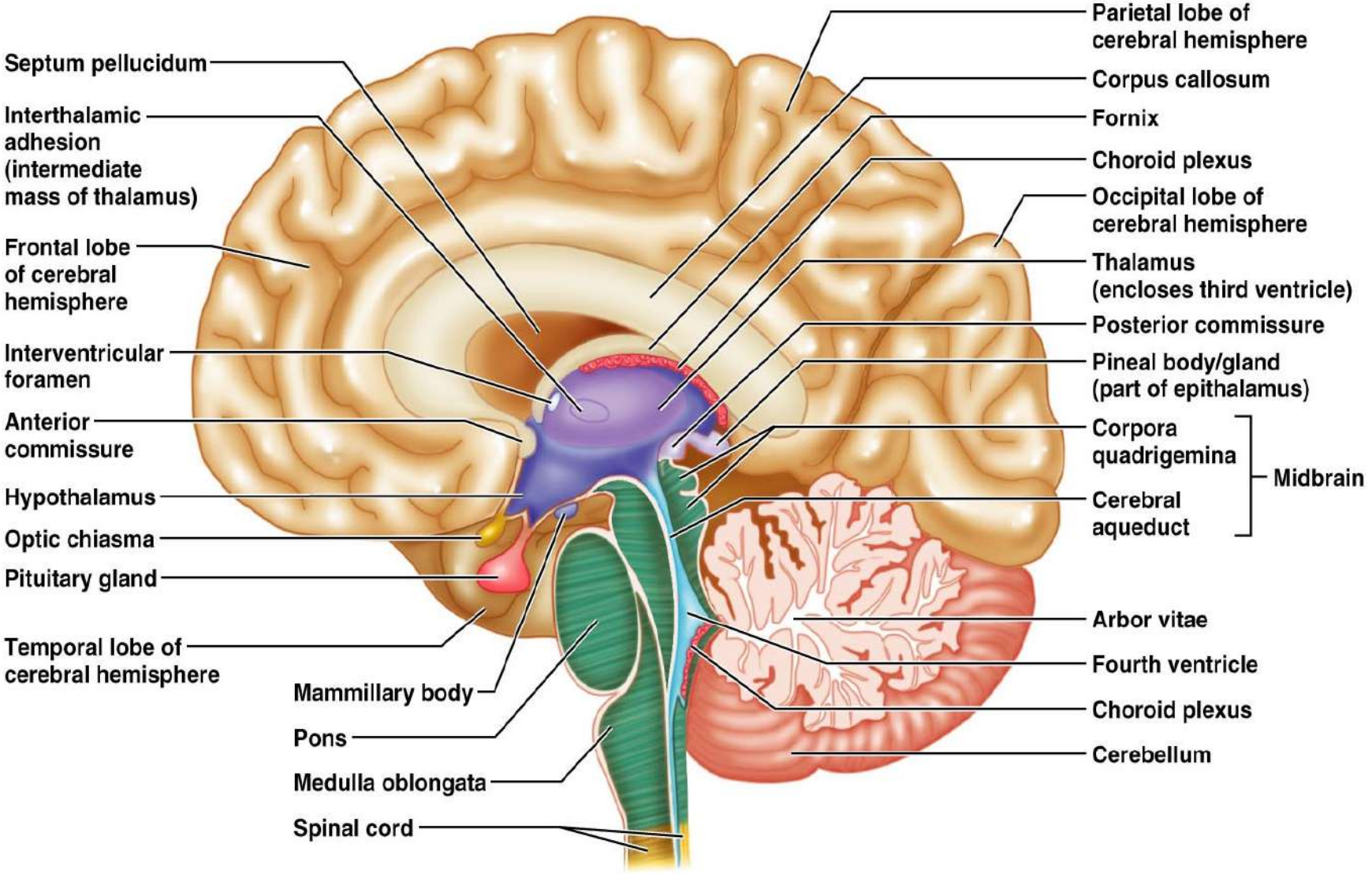


Figure 12.12

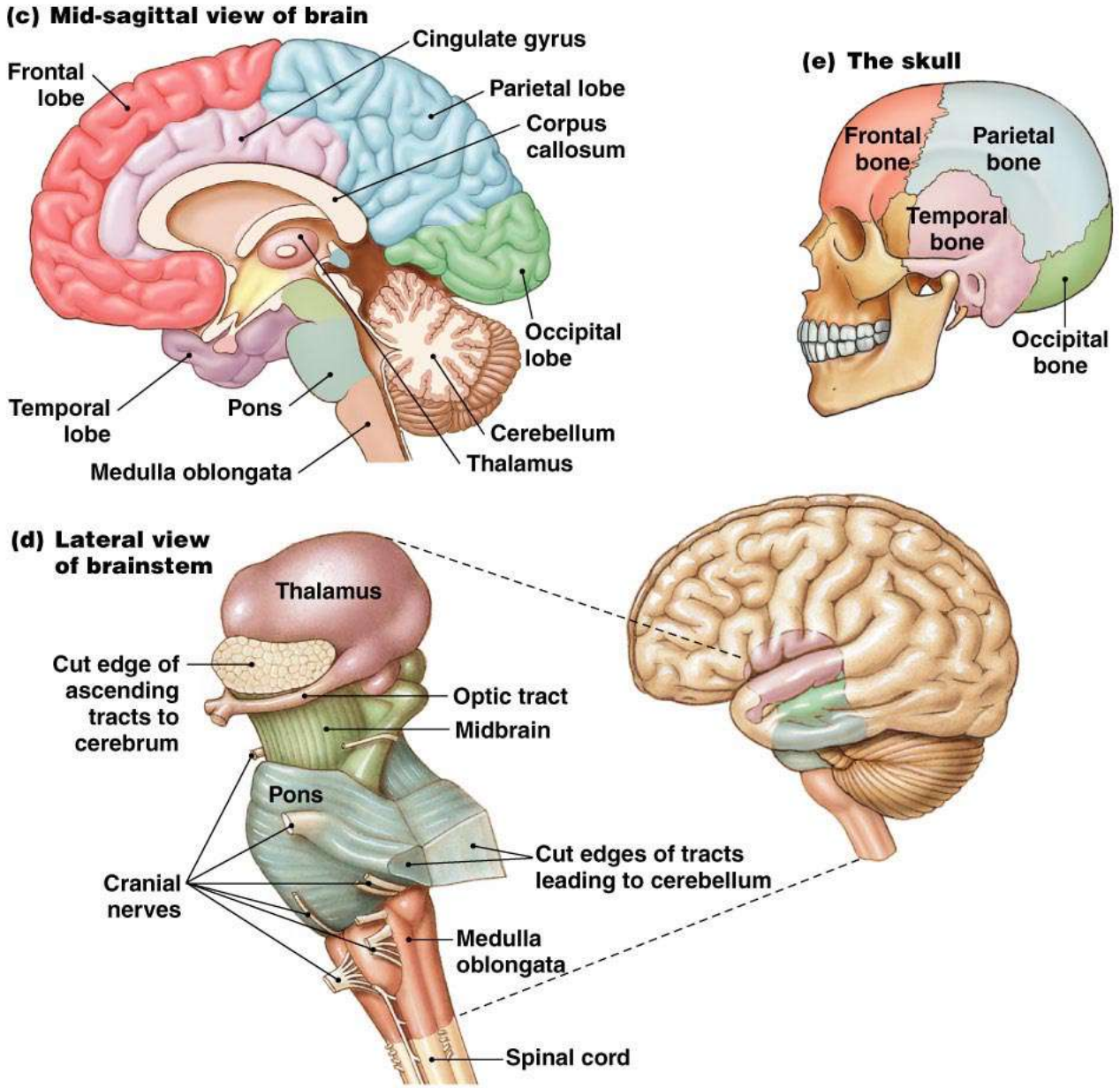


Figure 39-9 ane (2 of 5)

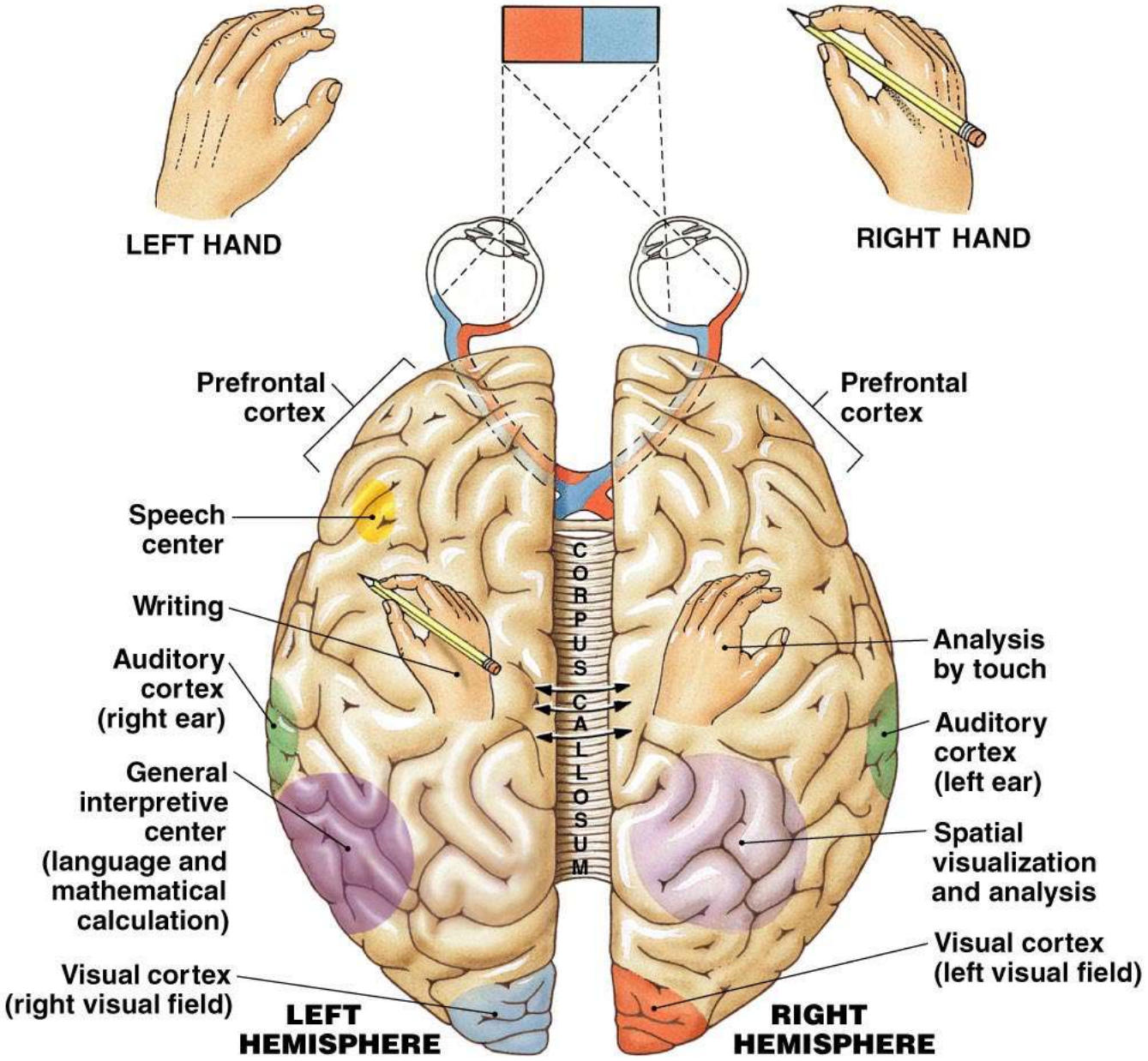


Figure 9.16

Spinal Cord

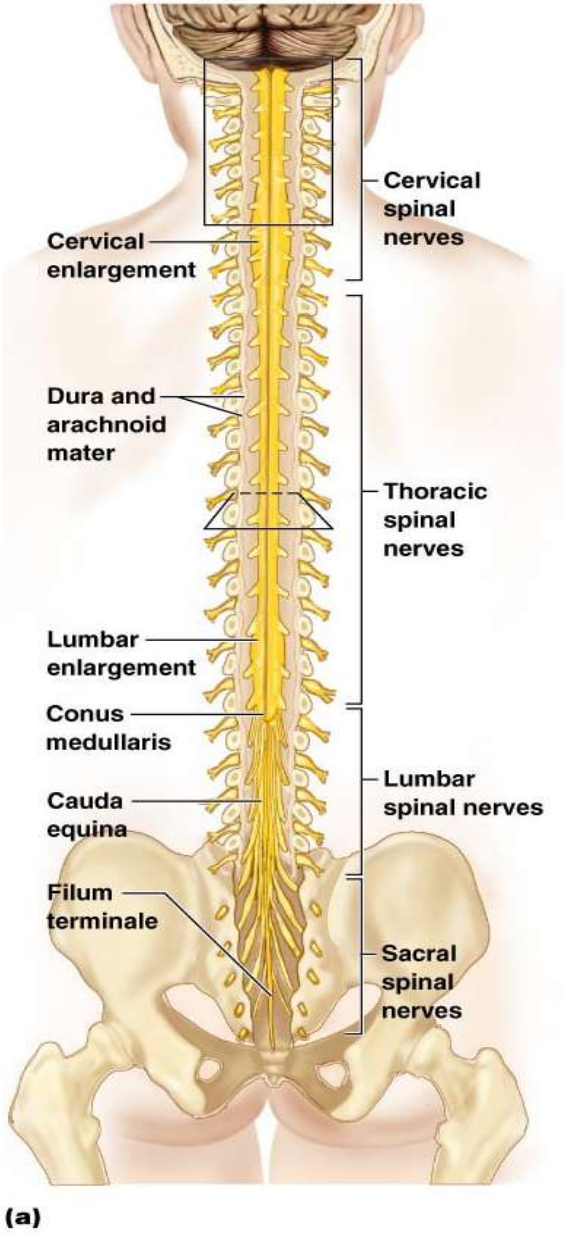


Figure 12.29a

Gray Matter and Spinal Roots

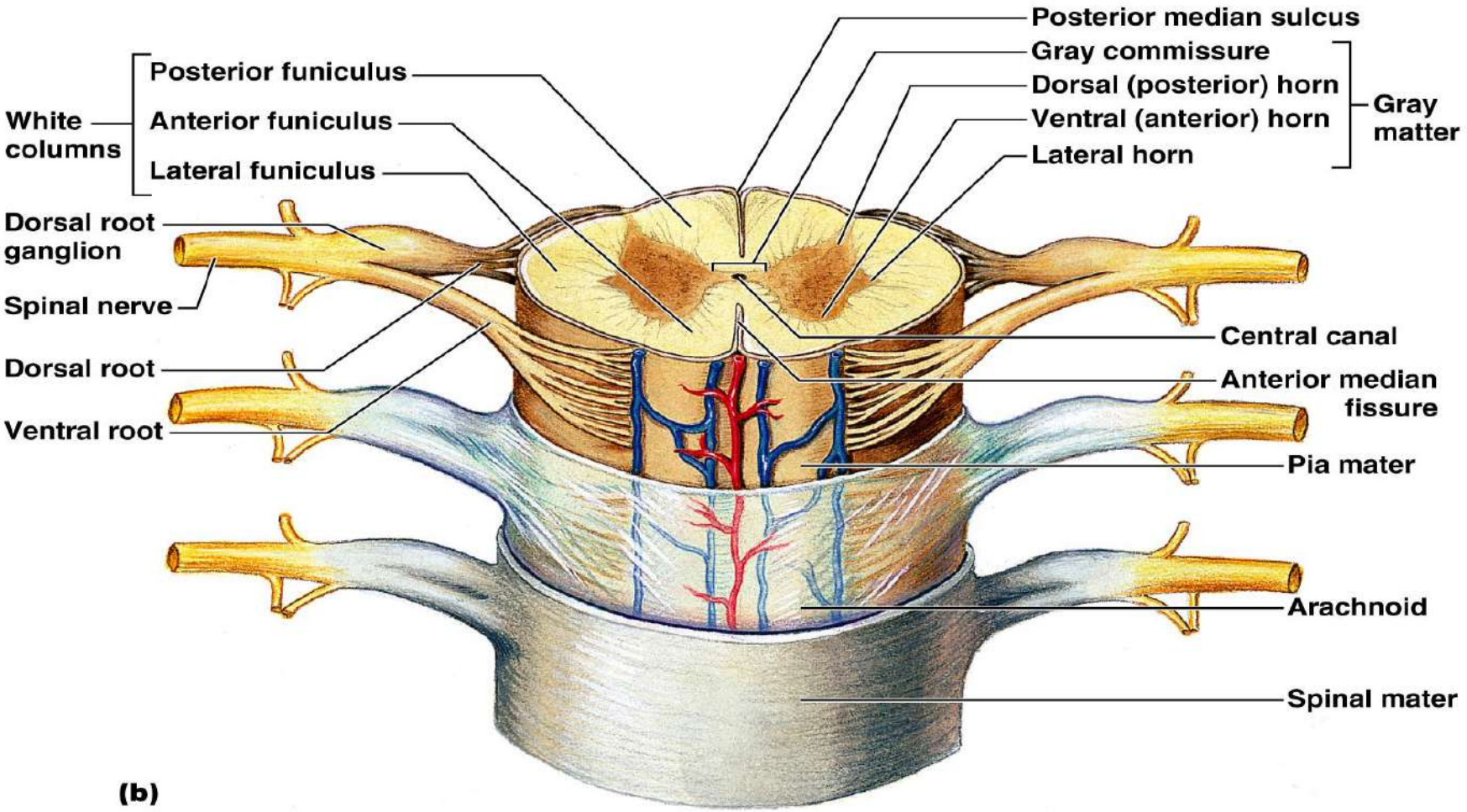
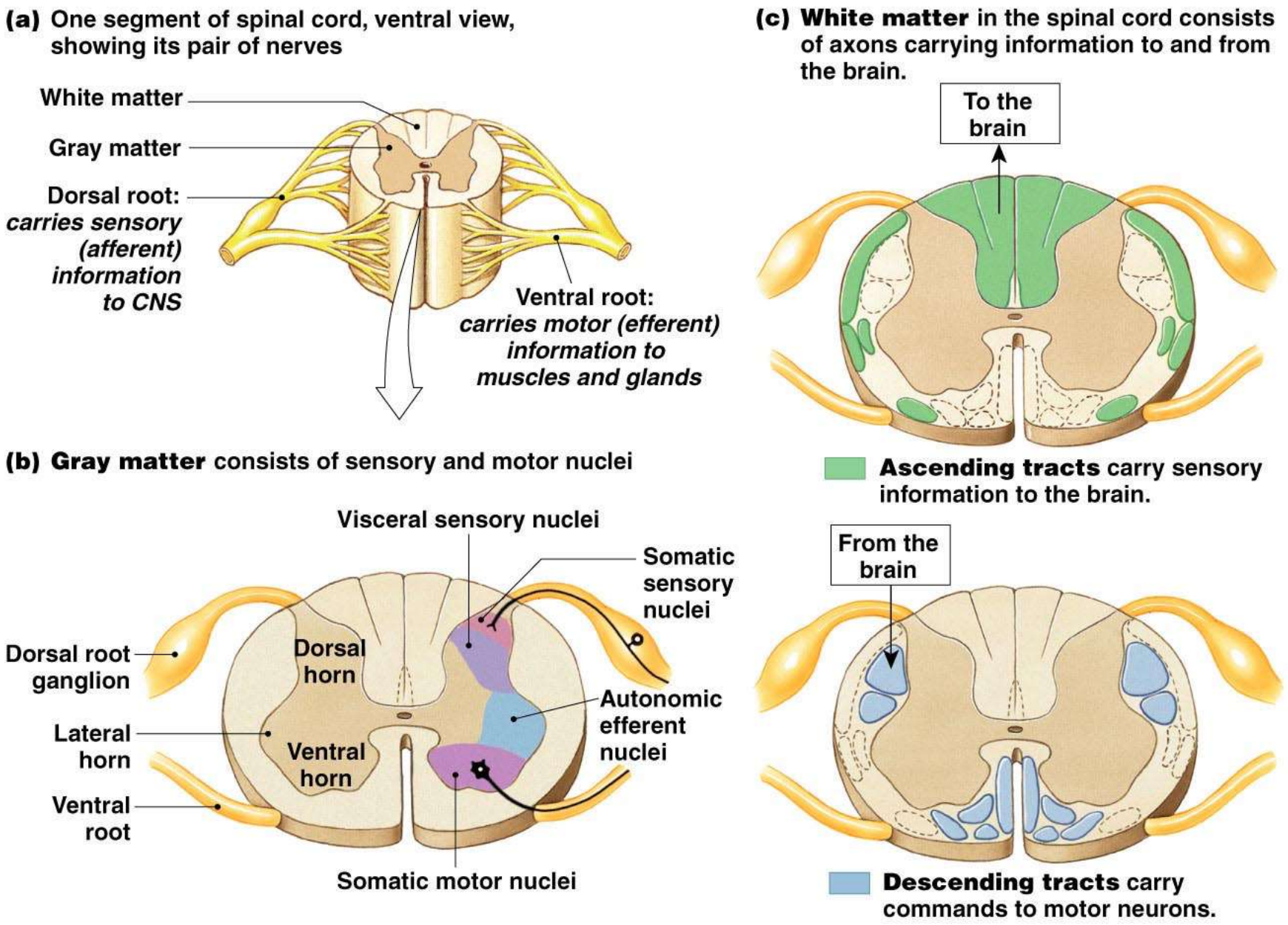


Figure 12.31b



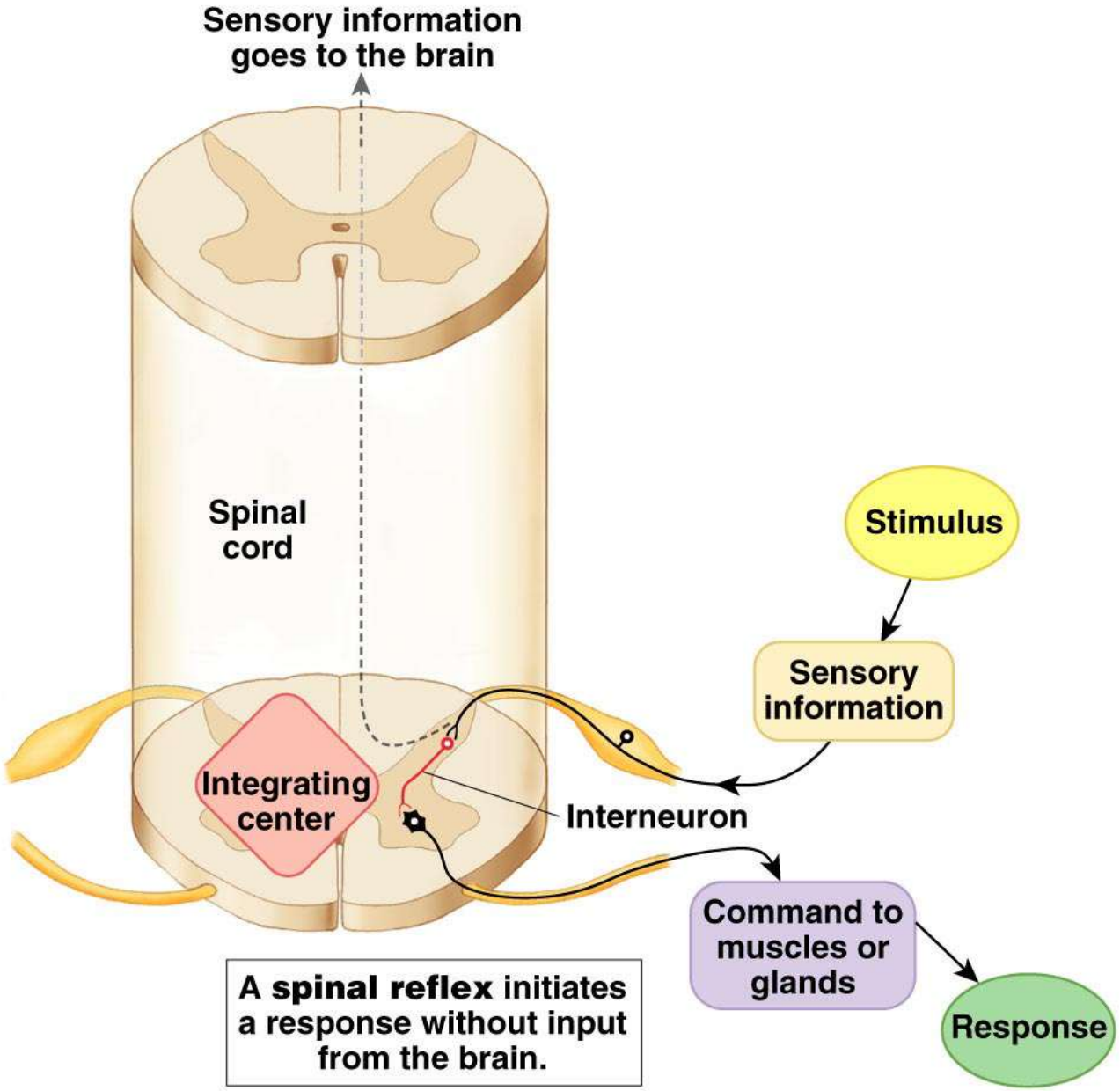


Fig. 9.8

Meninges

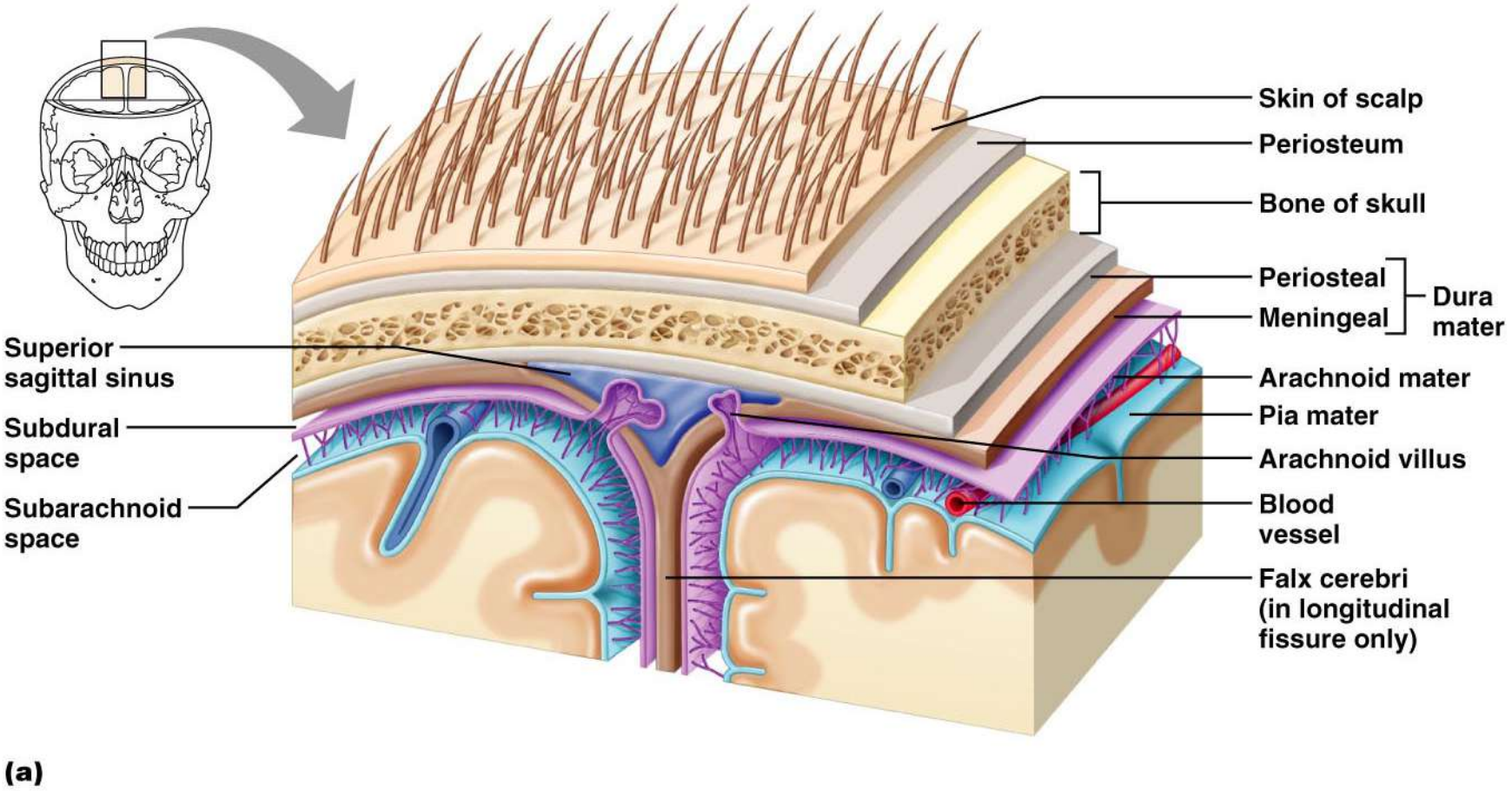


Figure 12.24a

Ventricles of the Brain

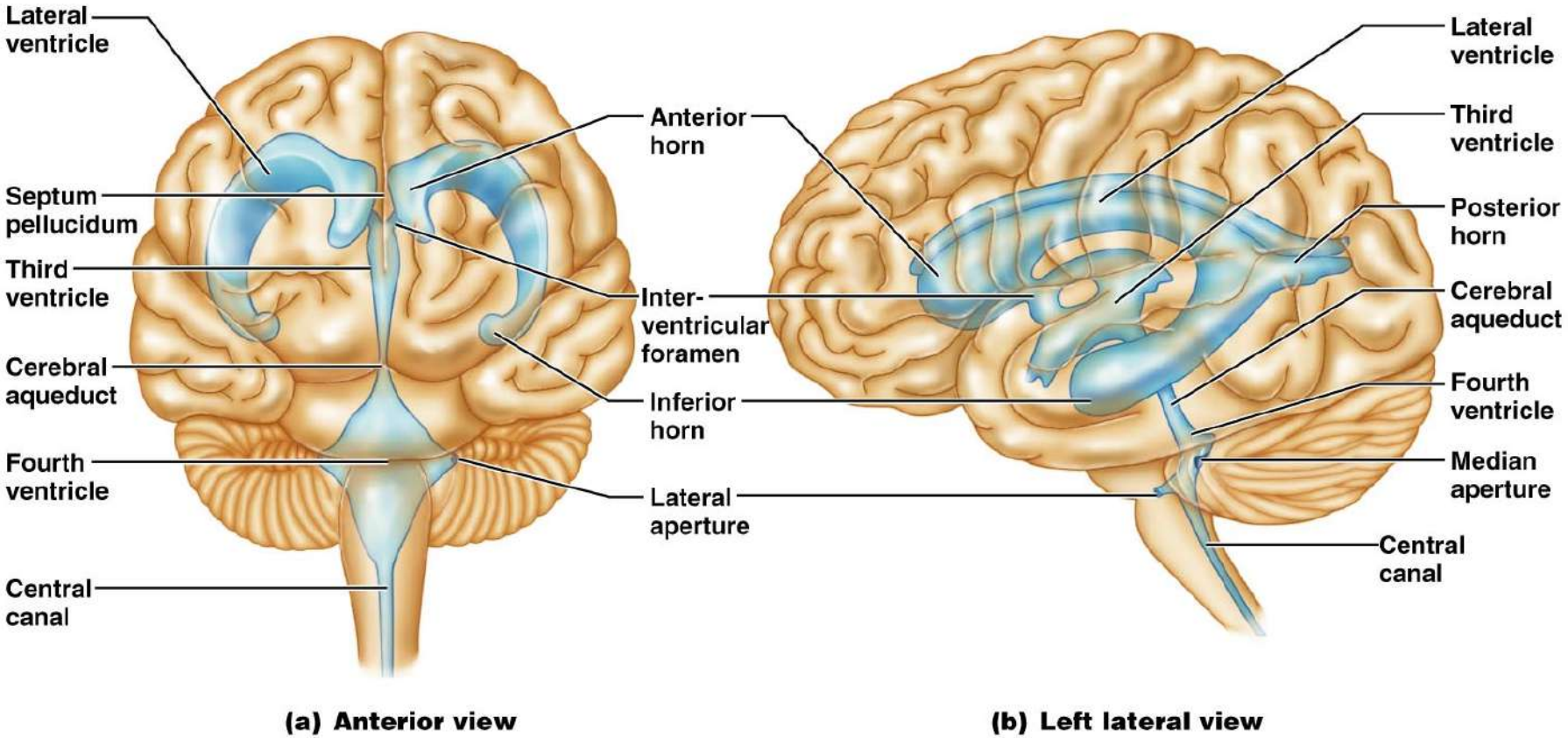


Figure 12.5

Cerebrospinal Fluid (CSF)

- Watery solution similar in composition to blood plasma
- Contains less protein and different ion concentrations than plasma
- Forms a liquid cushion that gives buoyancy to the CNS organs

Cerebrospinal Fluid (CSF)

- Prevents the brain from crushing under its own weight
- Protects the CNS from blows and other trauma
- Nourishes the brain and carries chemical signals throughout it

Circulation of CSF

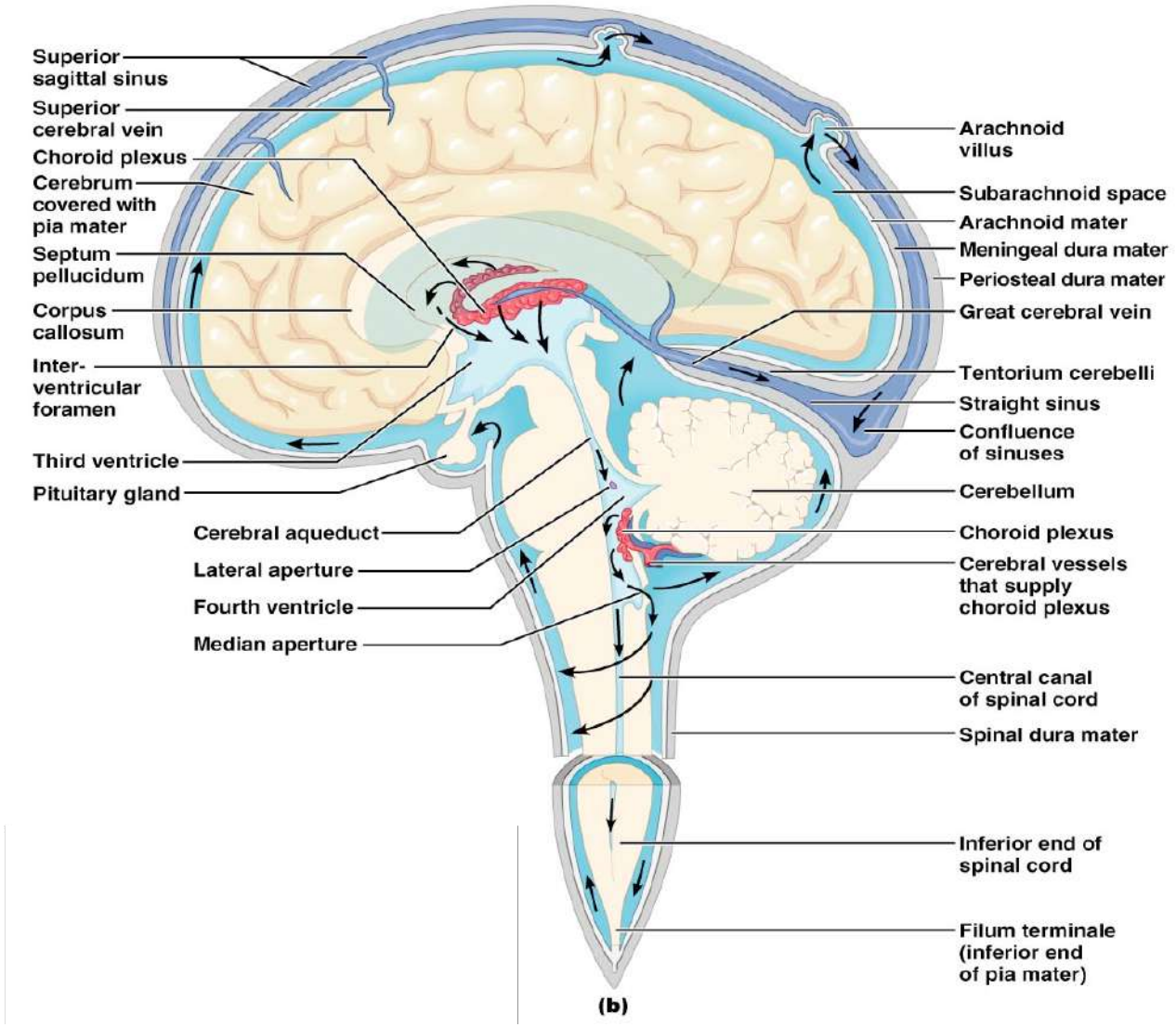


Figure 12.26b

PNS in the Nervous System

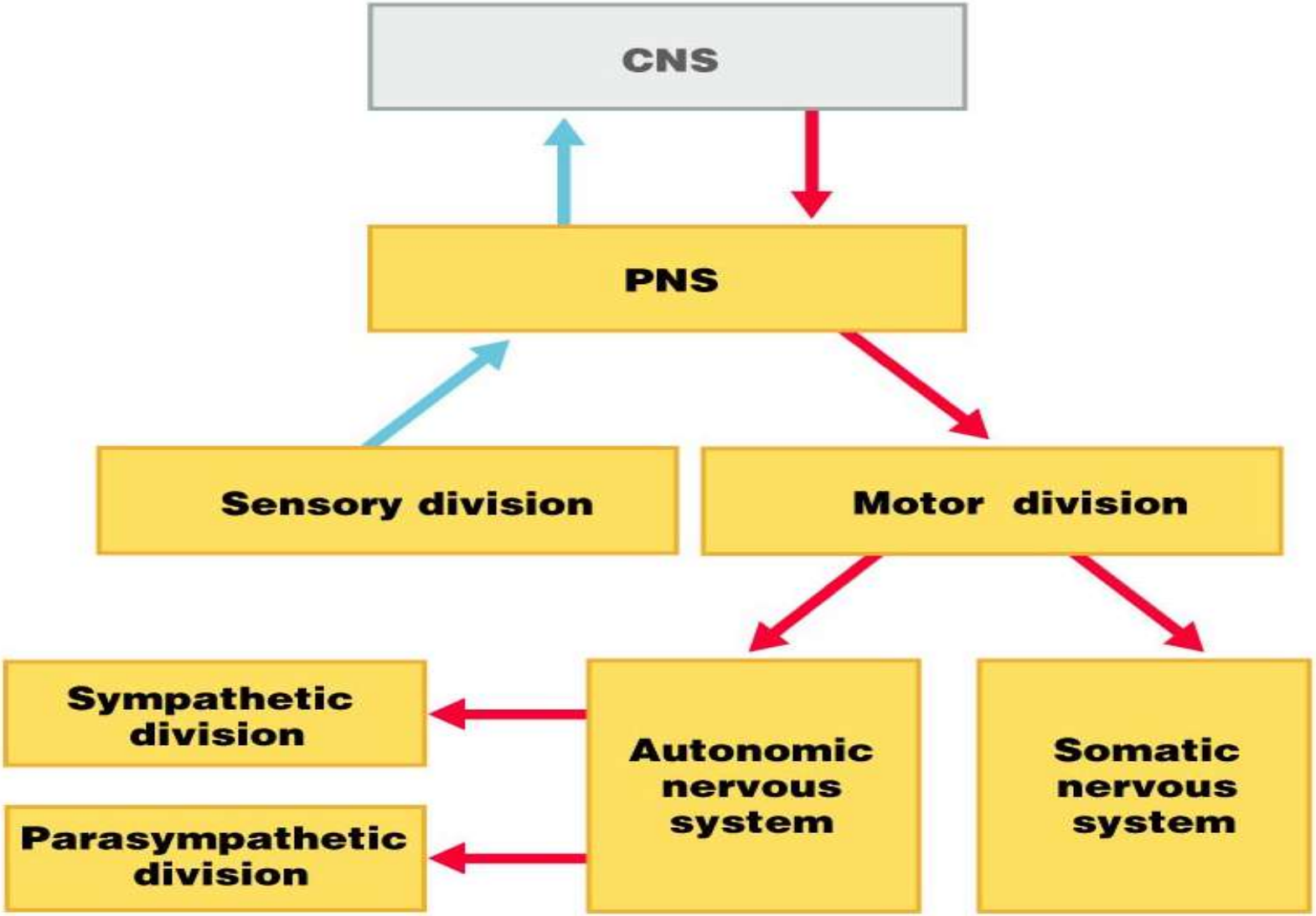


Figure 13.1

Structure of a Nerve

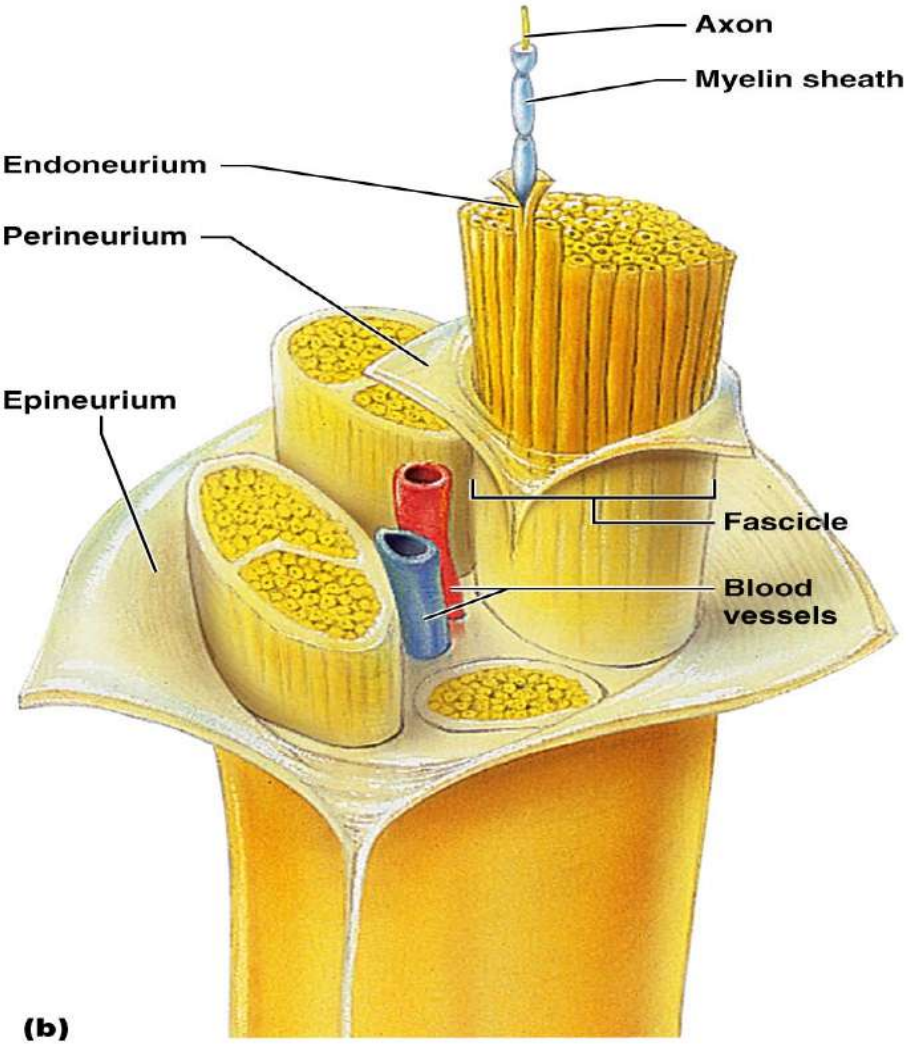


Figure 13.3b

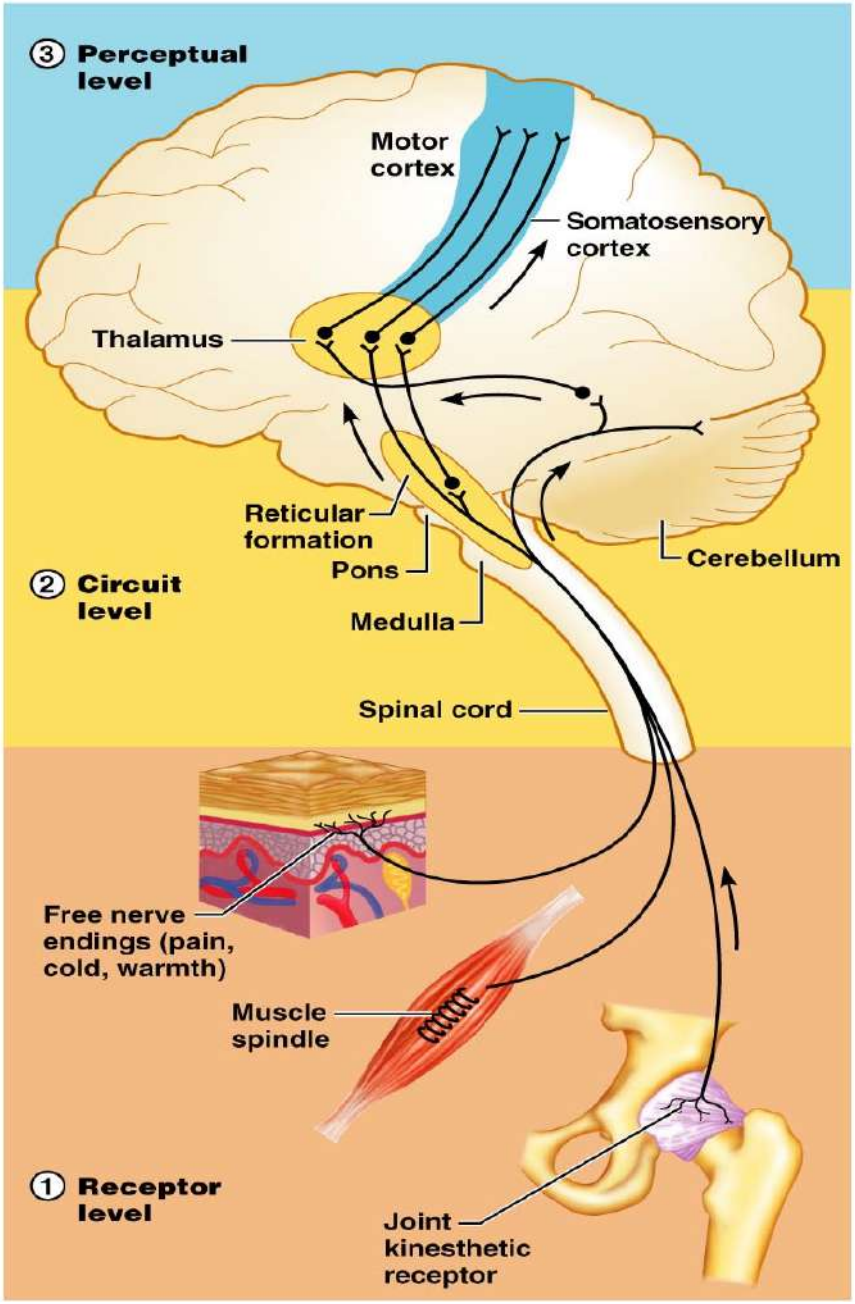
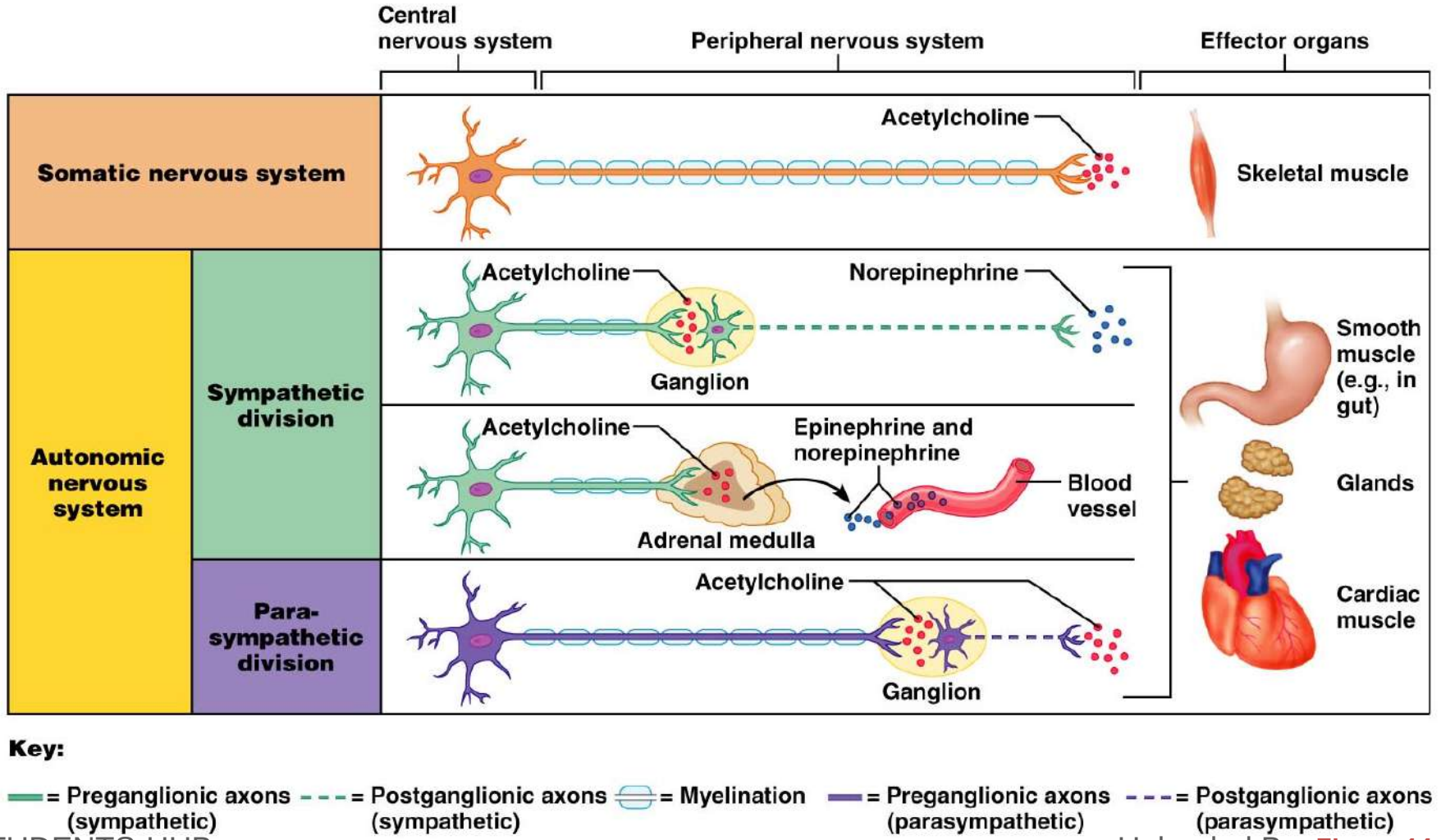


Figure 13.2

Comparison of Somatic and Autonomic Systems



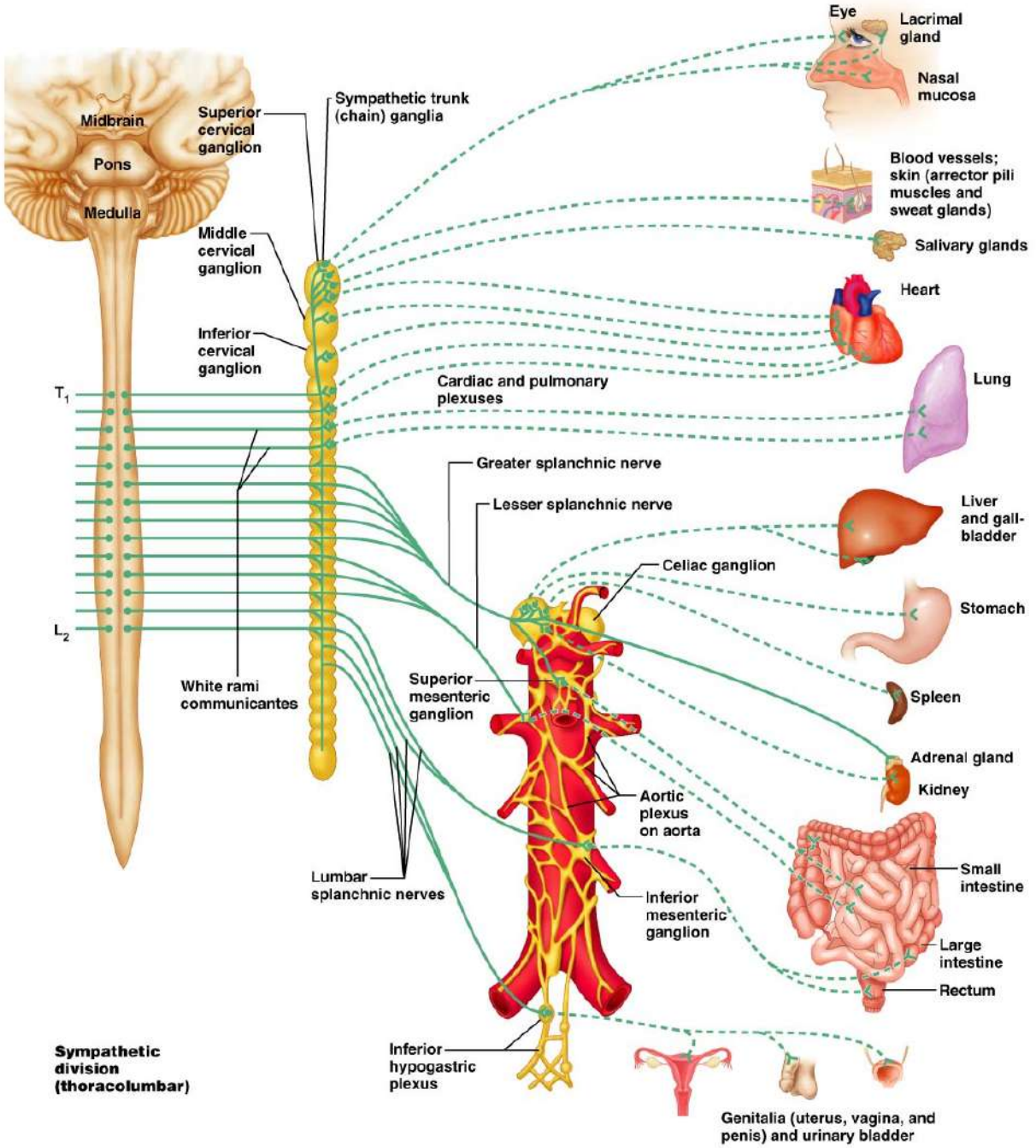


Figure 14.5

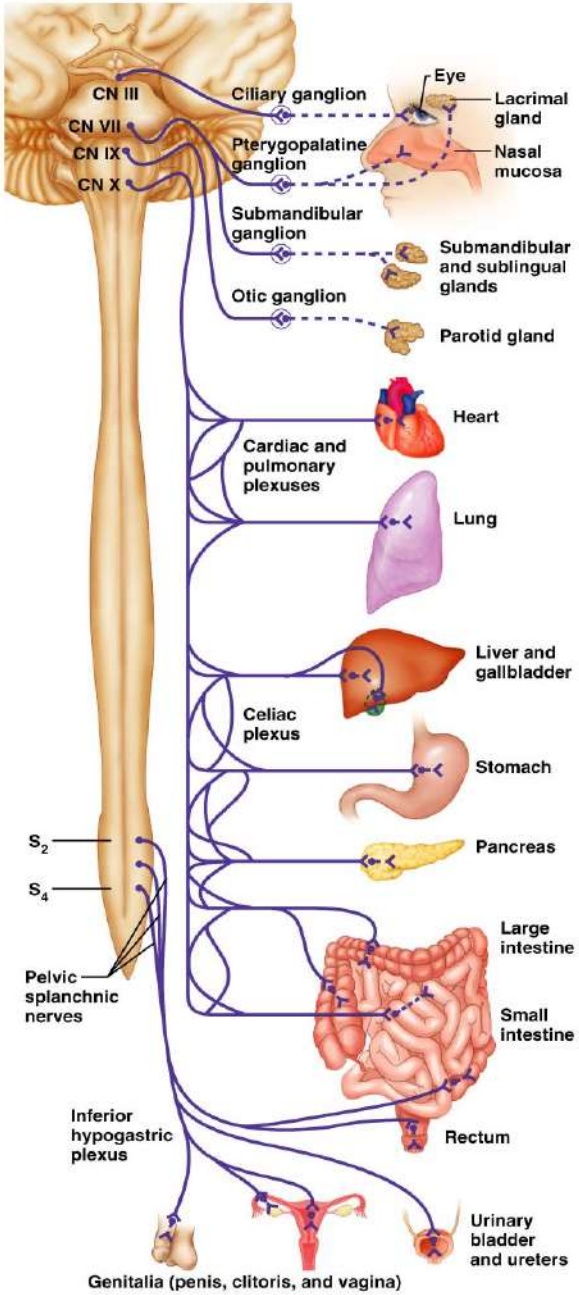


Figure 14.4

Cranial Nerves

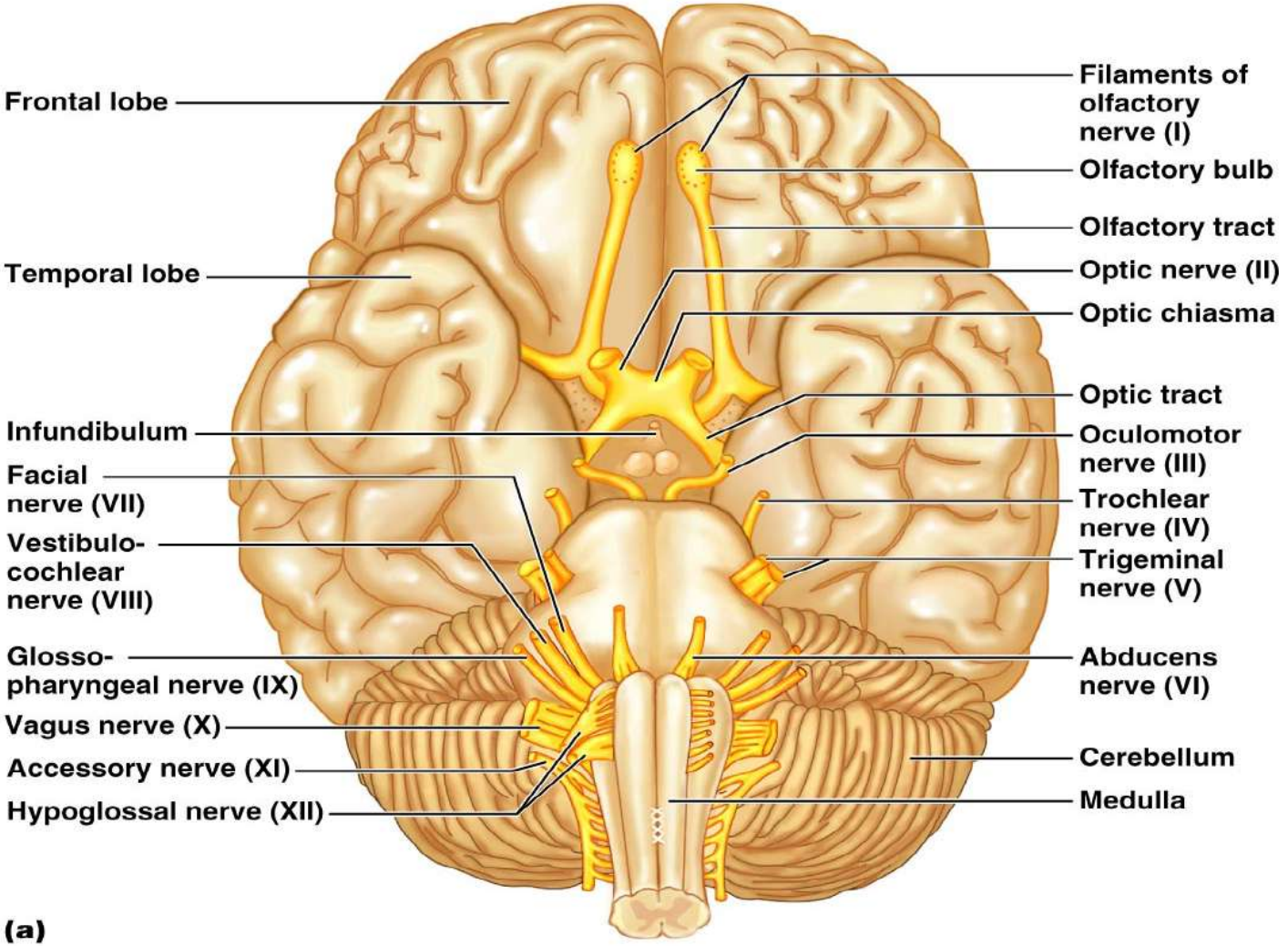


Figure 13.5a

Summary of Function of Cranial

Cranial nerves I – VI	Sensory function	Motor function	PS* fibers
I Olfactory	Yes (smell)	No	No
II Optic	Yes (vision)	No	No
III Oculomotor	No	Yes	Yes
IV Trochlear	No	Yes	No
V Trigeminal	Yes (general sensation)	Yes	No
VI Abducens	No	Yes	No

Cranial nerves VII – XII	Sensory function	Motor function	PS* fibers
VII Facial	Yes (taste)	Yes	Yes
VIII Vestibulocochlear	Yes (hearing and balance)	Some	No
IX Glossopharyngeal	Yes (taste)	Yes	Yes
X Vagus	Yes (taste)	Yes	Yes
XI Accessory	No	Yes	No
XII Hypoglossal	No	Yes	No

(b) *PS = parasympathetic

Cranial Nerve I: Olfactory

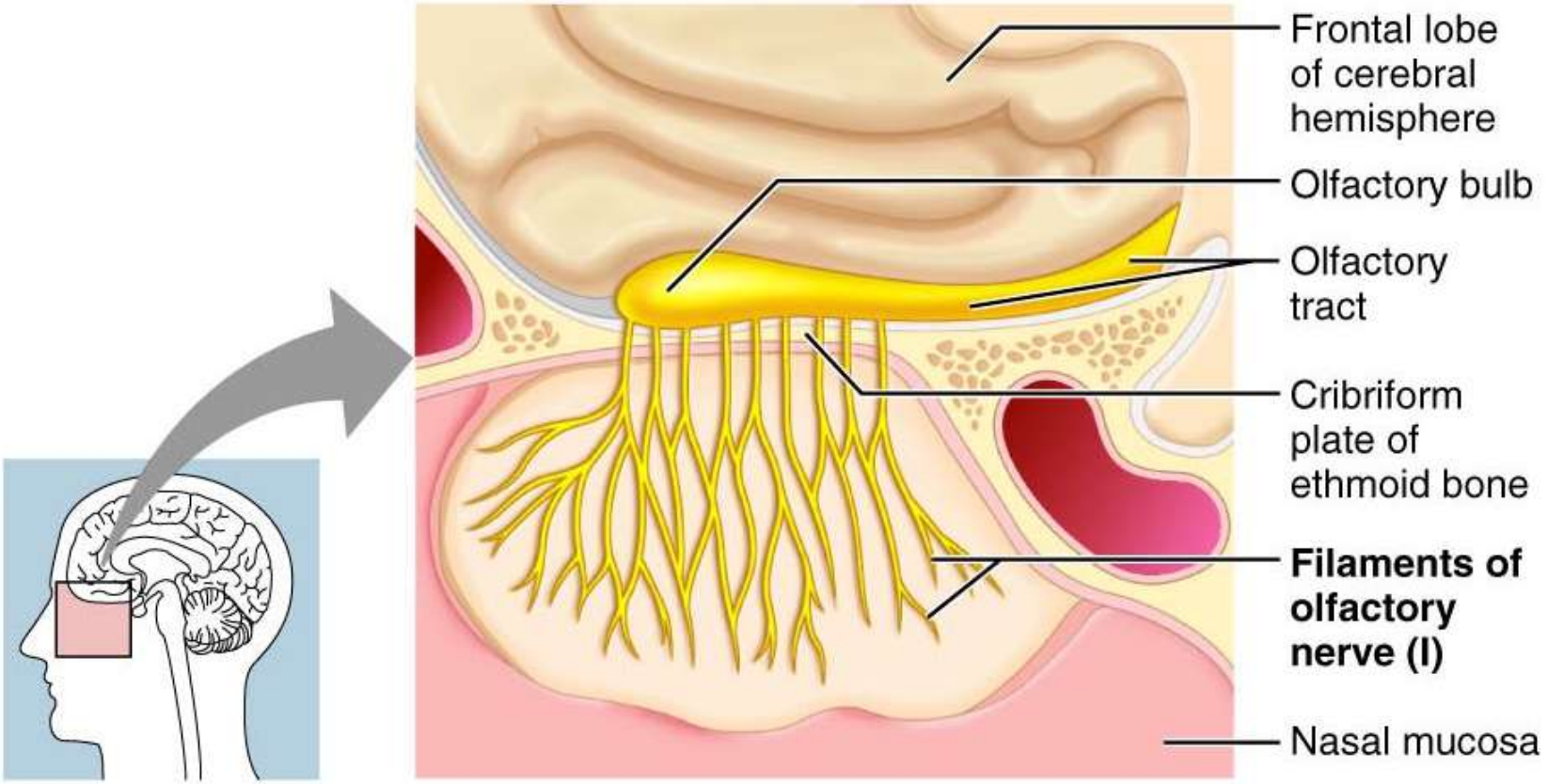


Figure 13.2

Cranial Nerve II: Optic

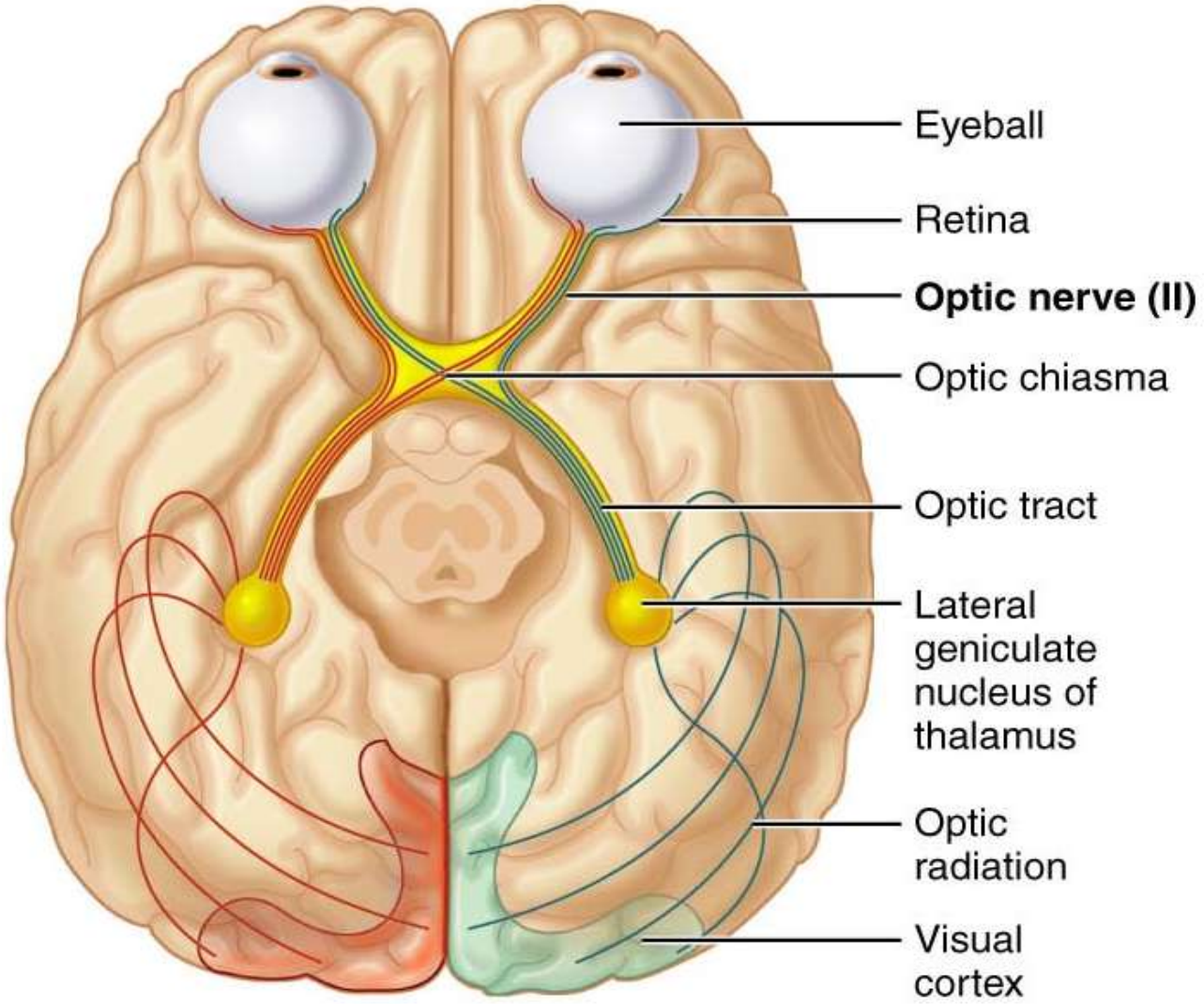


Figure from Table 13.2

Cranial Nerve III: Oculomotor

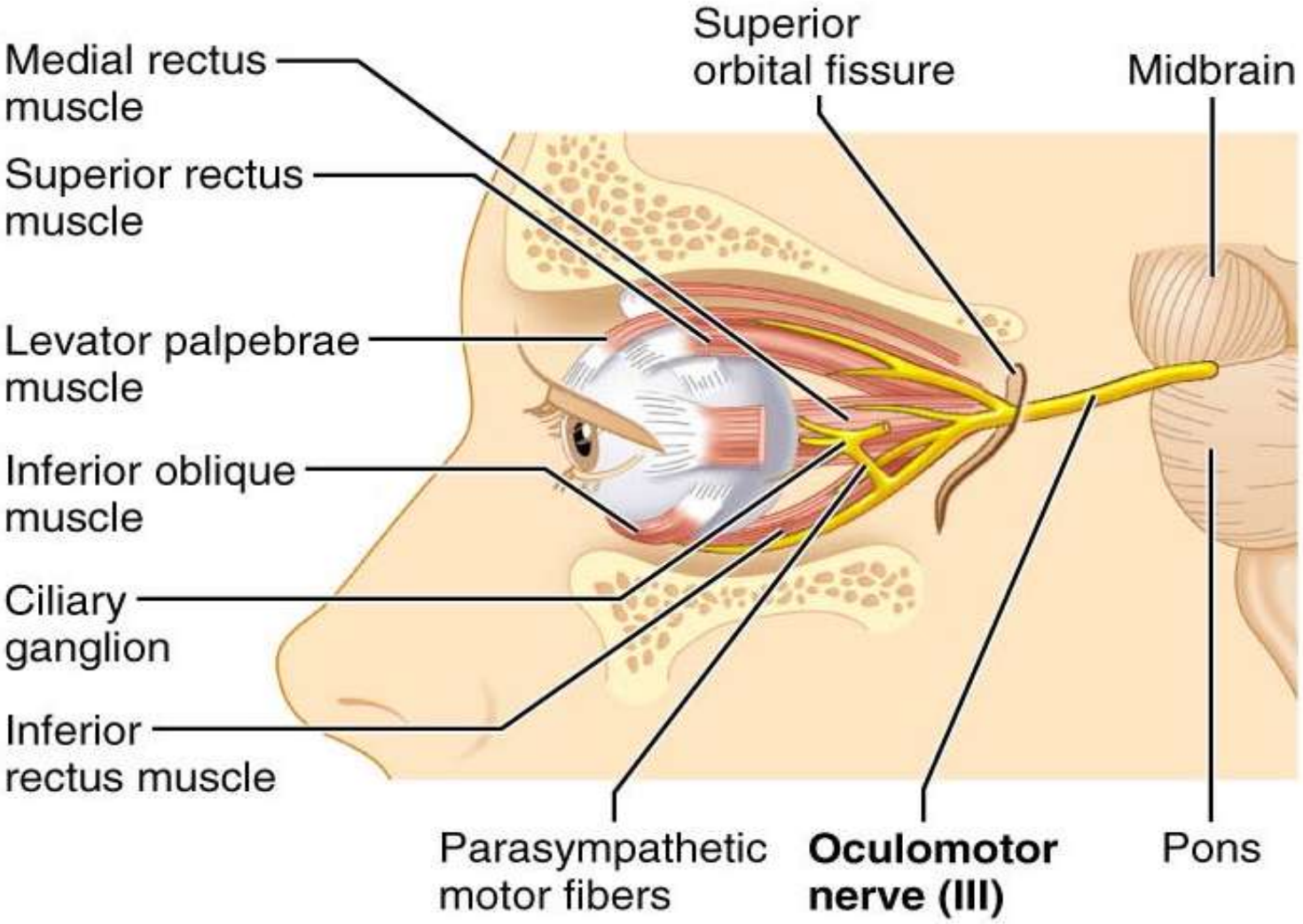
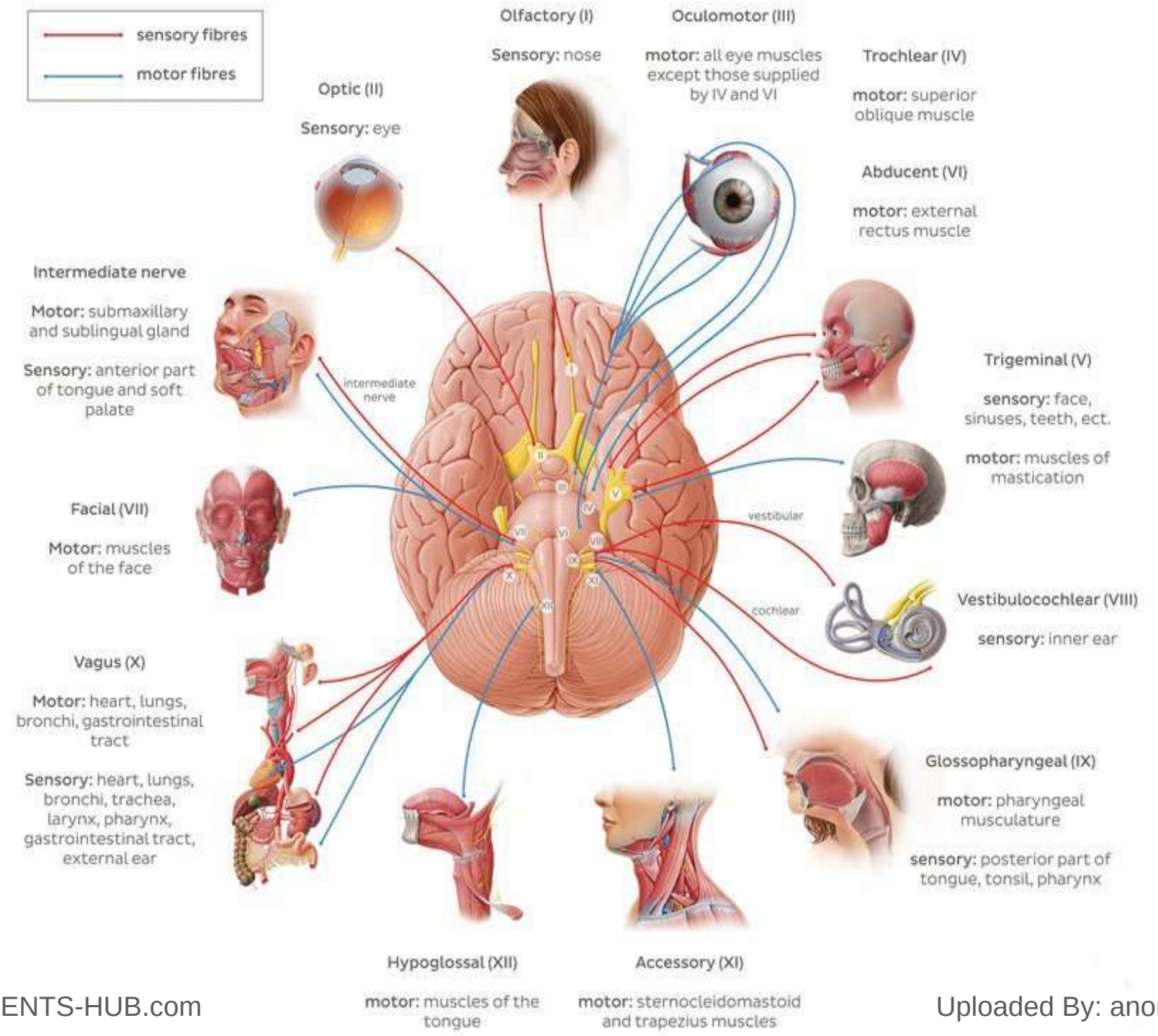
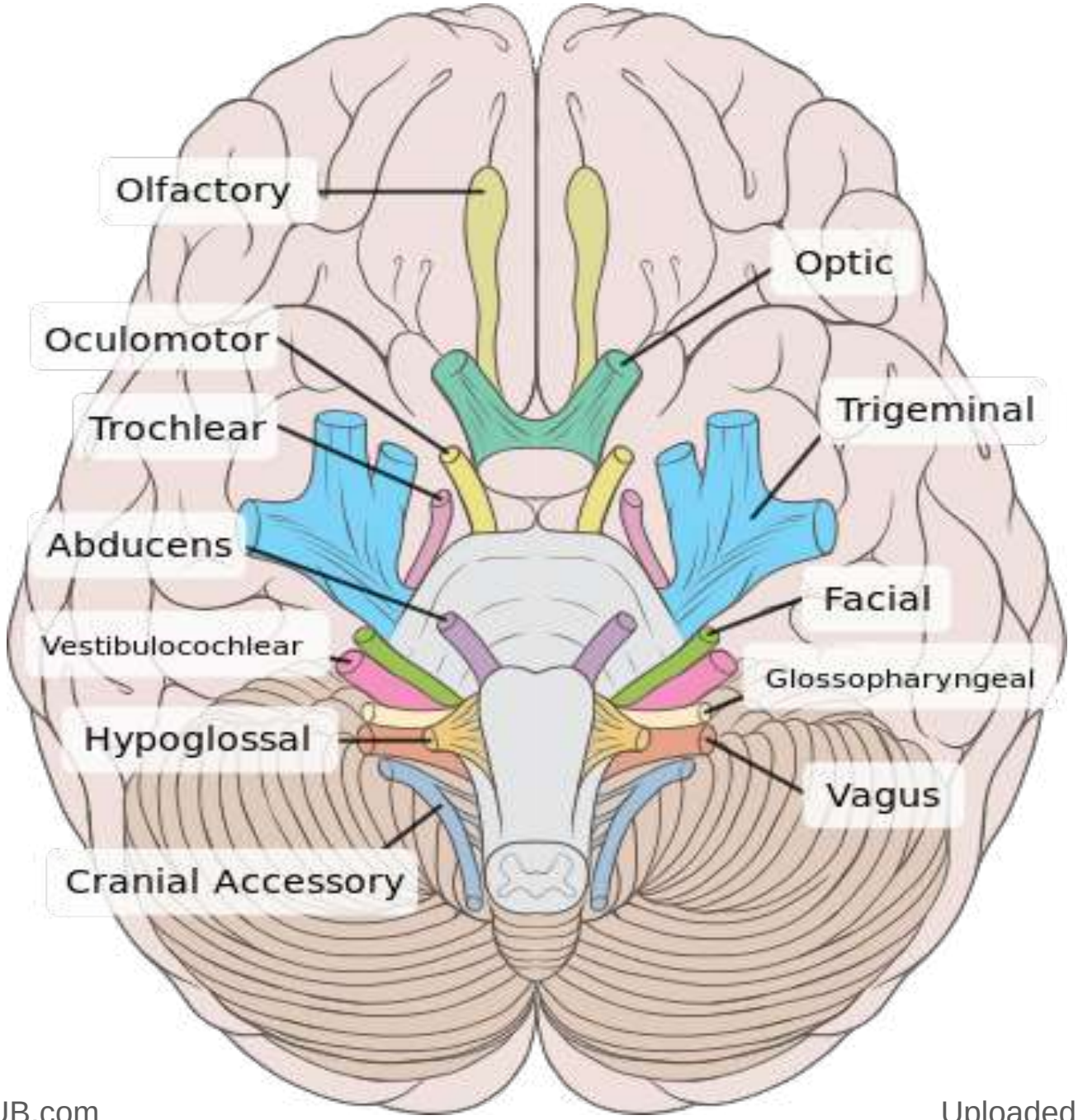
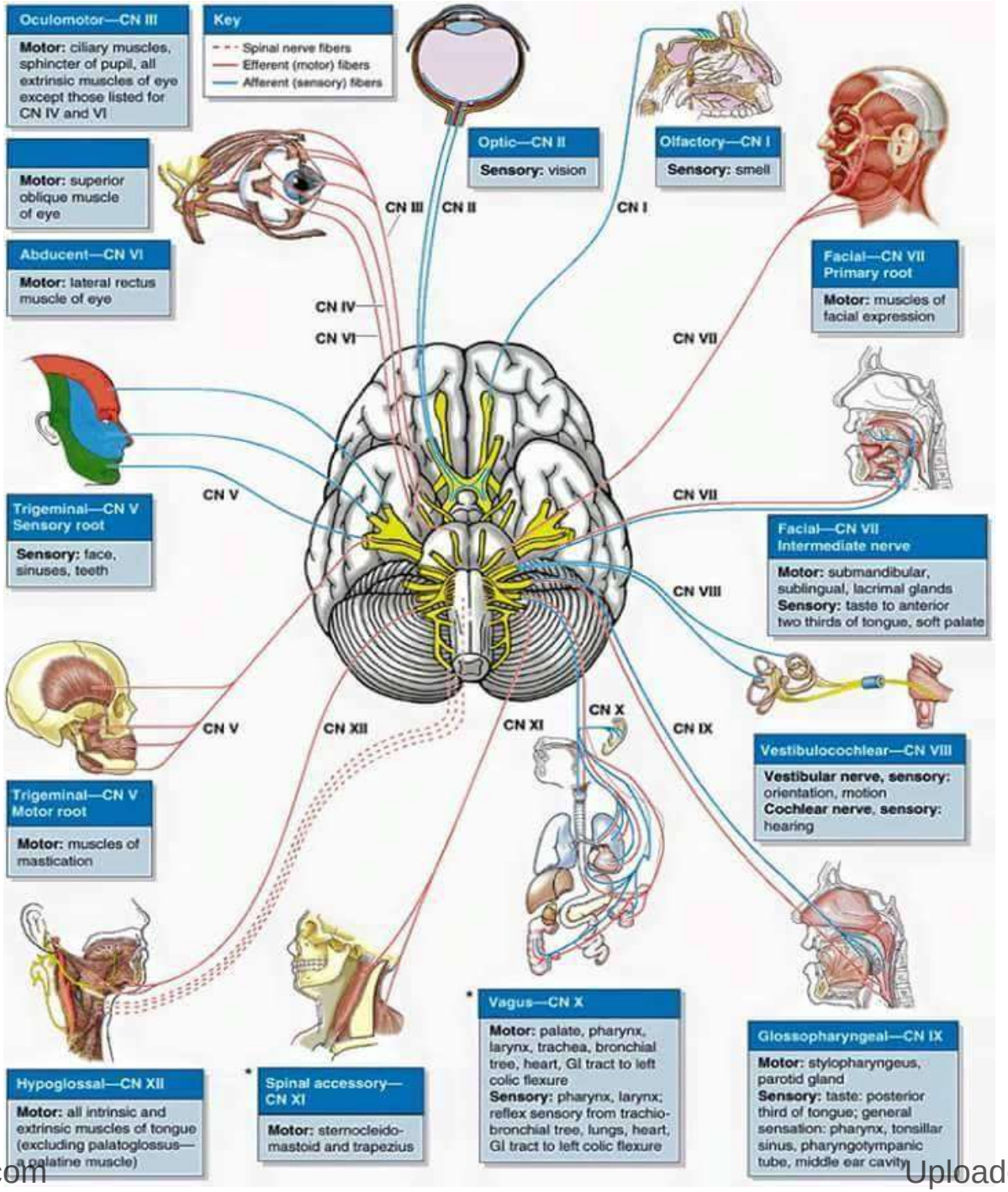


Figure II By Table 13.2







Referred Pain

- Pain stimuli arising from the viscera are perceived as somatic in origin
- This may be due to the fact that visceral pain afferents travel along the same pathways as somatic pain fibers

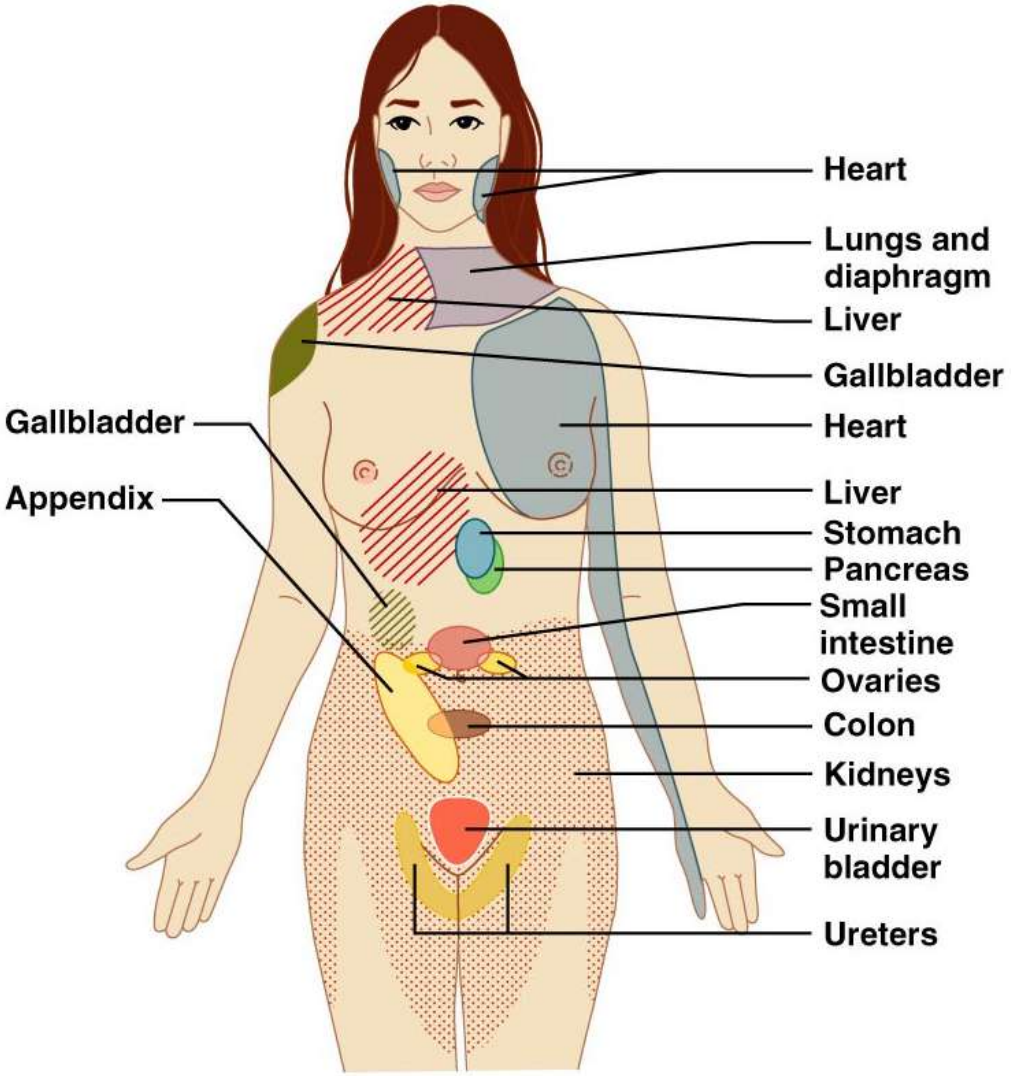


Figure 14.8