Biology

A Guide to the Natural World

Chapter 27 • Lecture Outline

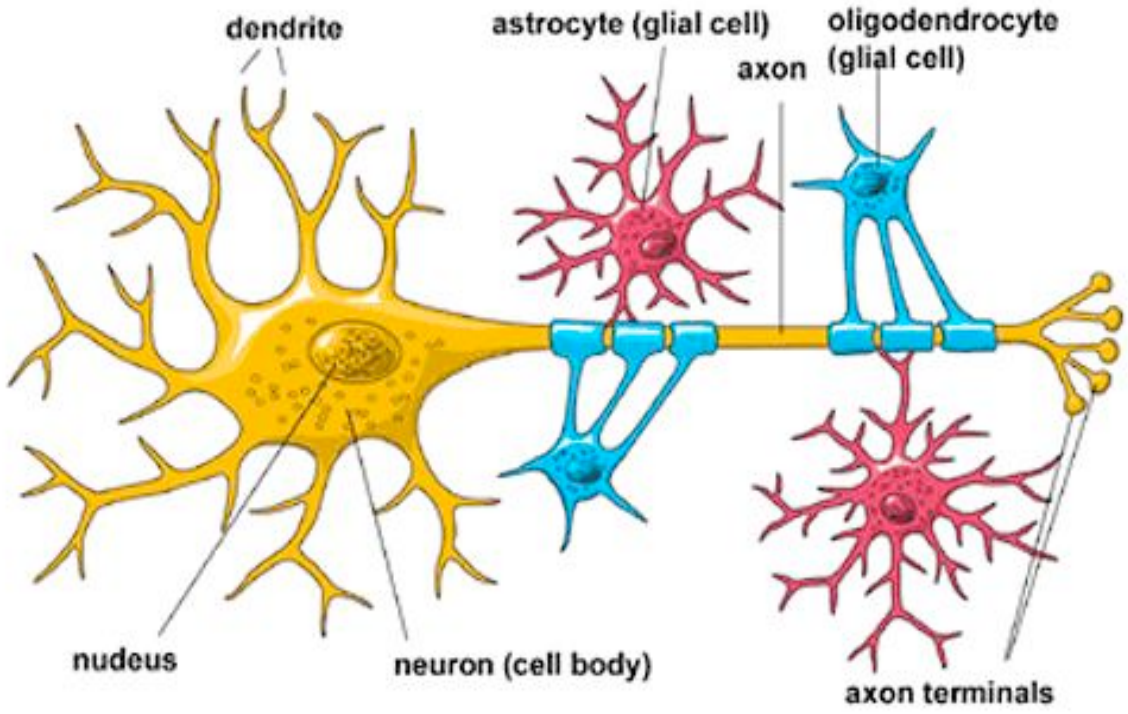
Communication and Control 1: The Nervous System

Fifth Edition

David Krogh

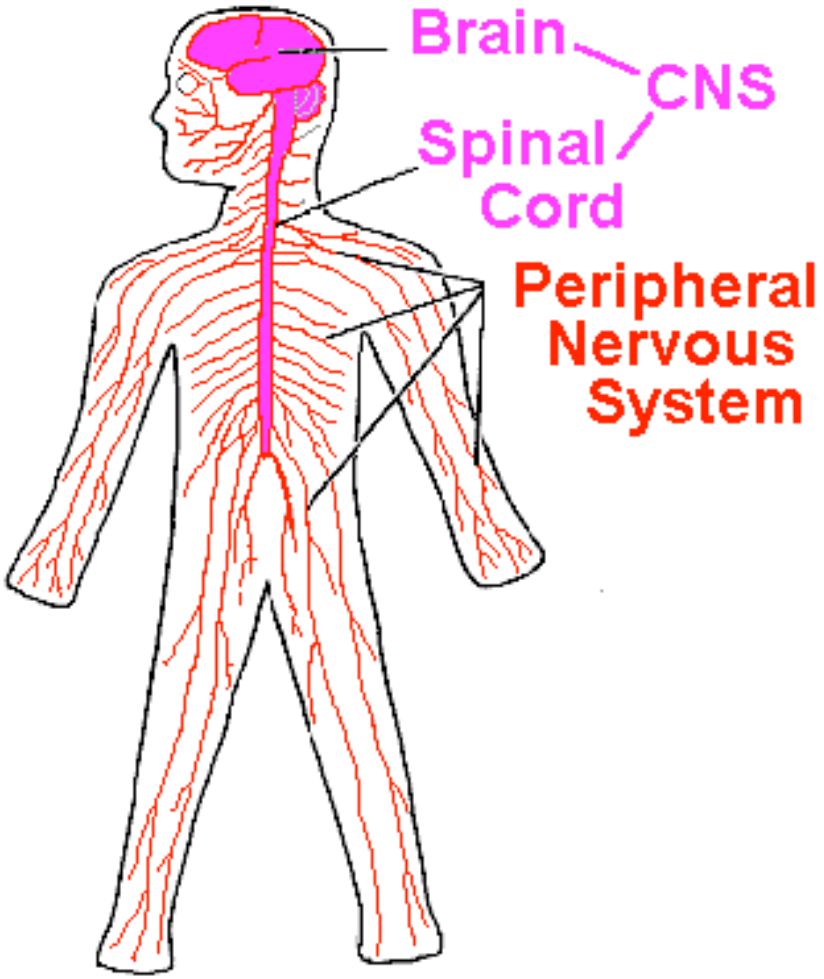
The Nervous System

- Nervous tissue is composed of two kinds of cells:
  - Neurons: transmit nervous system messages.
  - Glial cells: support neurons and modify their signaling.

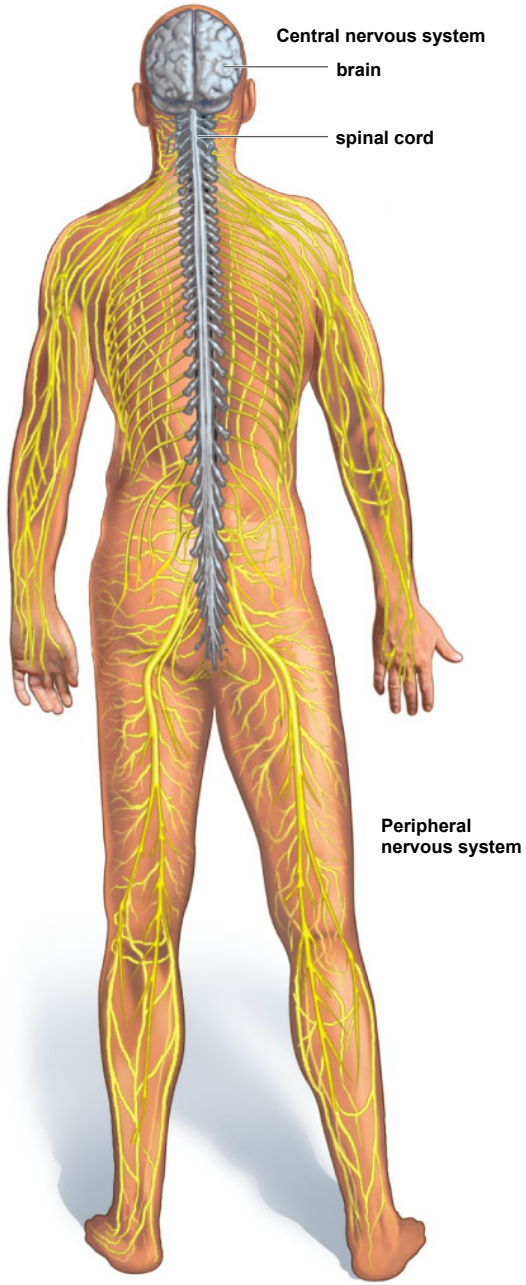


The Nervous System

- The two major divisions of the human nervous system are:
  - The central nervous system (CNS), consisting of the brain and spinal cord.
  - The peripheral nervous system (PNS), which includes all the neural tissue outside the CNS plus the sensory organs.



(a) The nervous system has two components



(b) How these two components interact

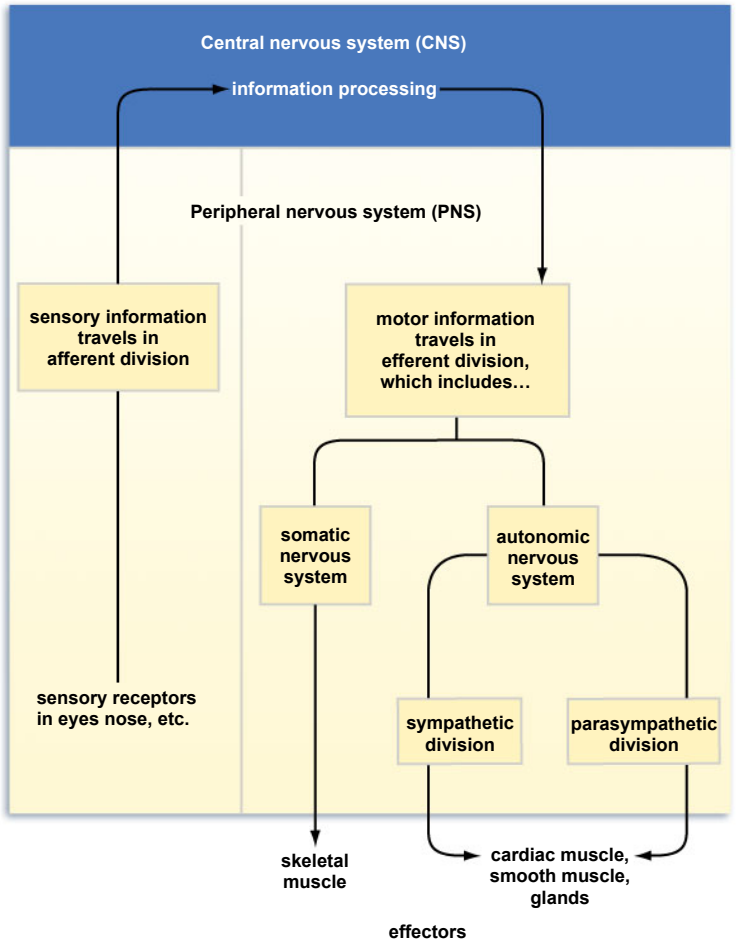
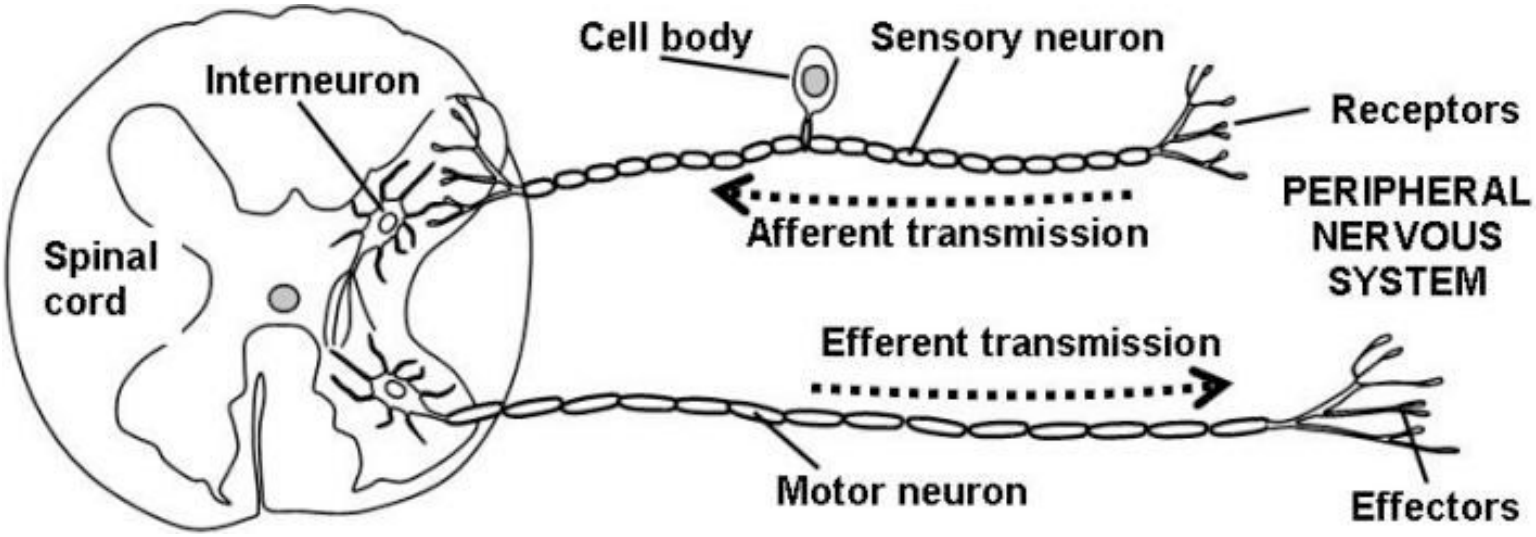


Figure 27.1

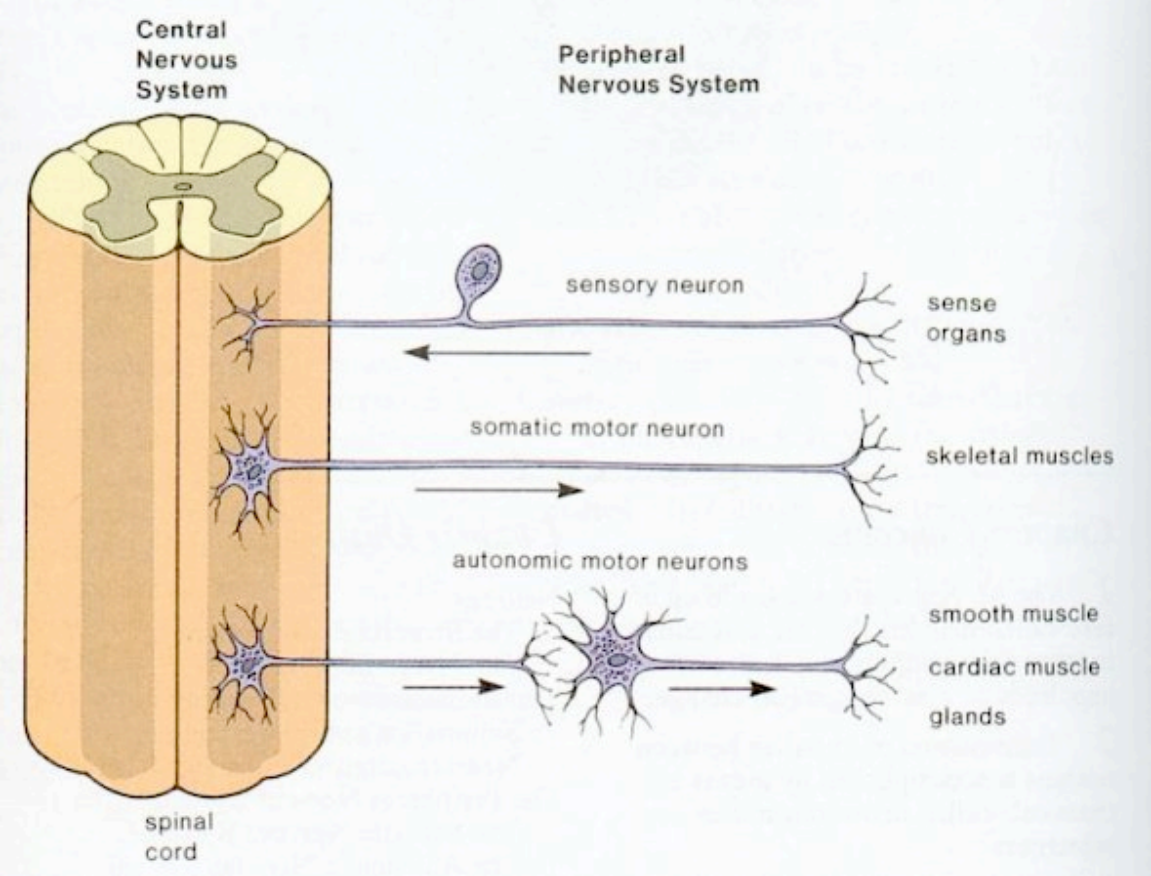
Divisions of the Nervous System

- The PNS has an **afferent division**, which brings sensory information to the CNS; and an **efferent division**, which carries action (motor) commands to the body's "effectors"—muscles and glands.



Divisions of the Nervous System

- Within the PNS's efferent division are two subsystems:
  - The somatic nervous system, which provides voluntary control over skeletal muscles.
  - The autonomic nervous system, which provides involuntary regulation of smooth muscle, cardiac muscle, and glands.



Divisions of the Nervous System

- The autonomic system is further divided into the **sympathetic division**, which generally has stimulatory effects; and the **parasympathetic division**, which generally facilitates routine maintenance activities.

27.2 Cells of the Nervous System

Cells of the Nervous System

- There are three types of neurons:
  - sensory neurons
  - motor neurons
  - interneurons

Cells of the Nervous System

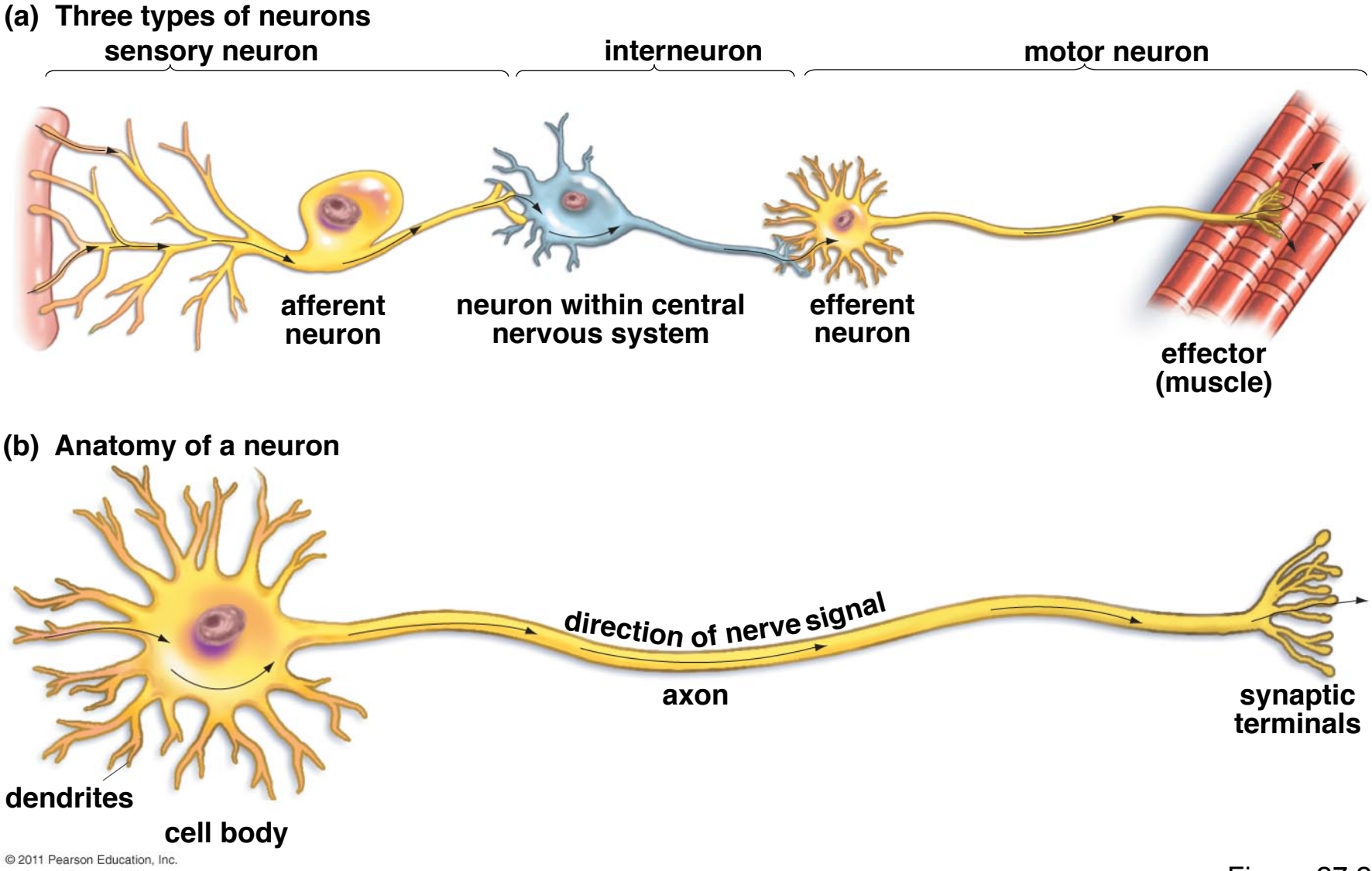


Figure 27.2

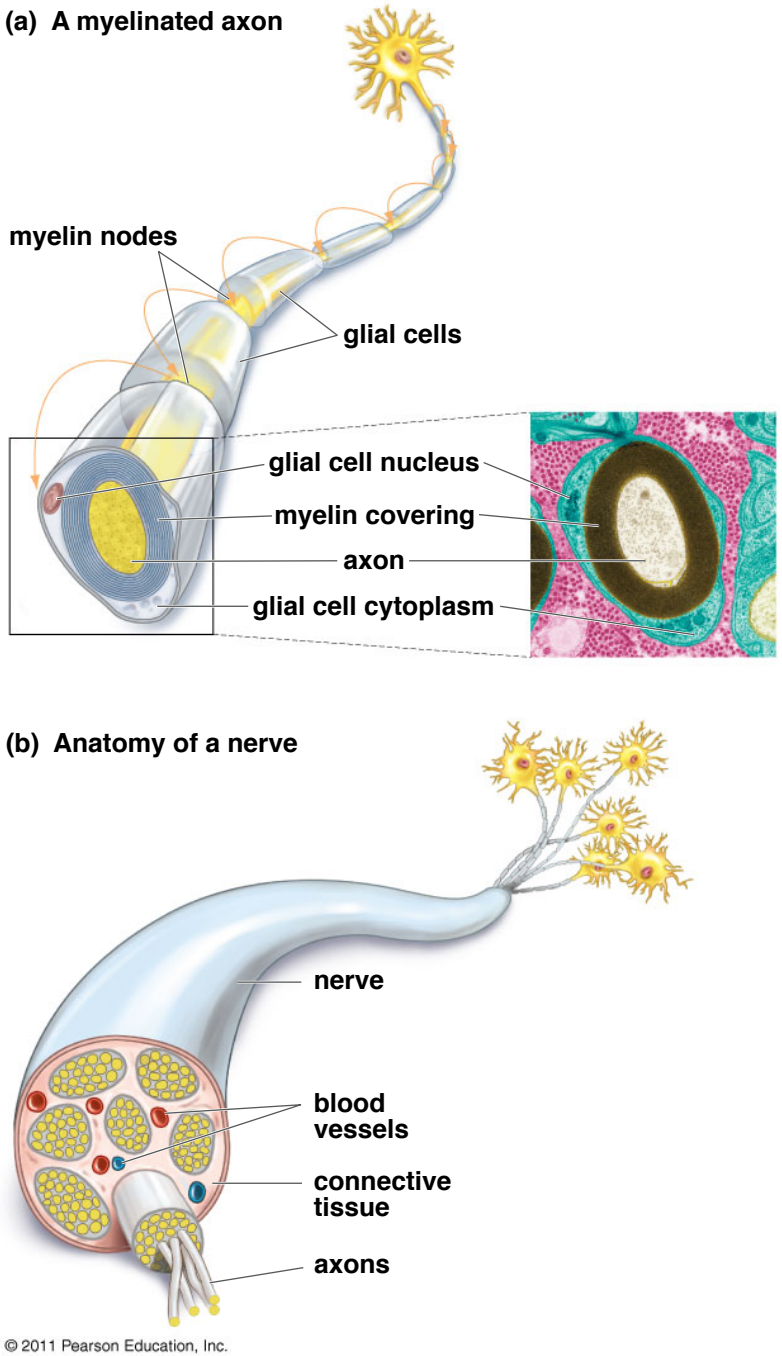


Figure 27.3

Cells of the Nervous System

- A nerve is a bundle of axons in the PNS that transmits information to or from the CNS.

27.3 Nervous-System Signaling

Nervous System Communication

- Nervous system communication can be conceptualized as working through a two-step process:
  1. signal movement down a neuron's axon
  2. signal movement from this axon to a second cell across a structure known as a synapse

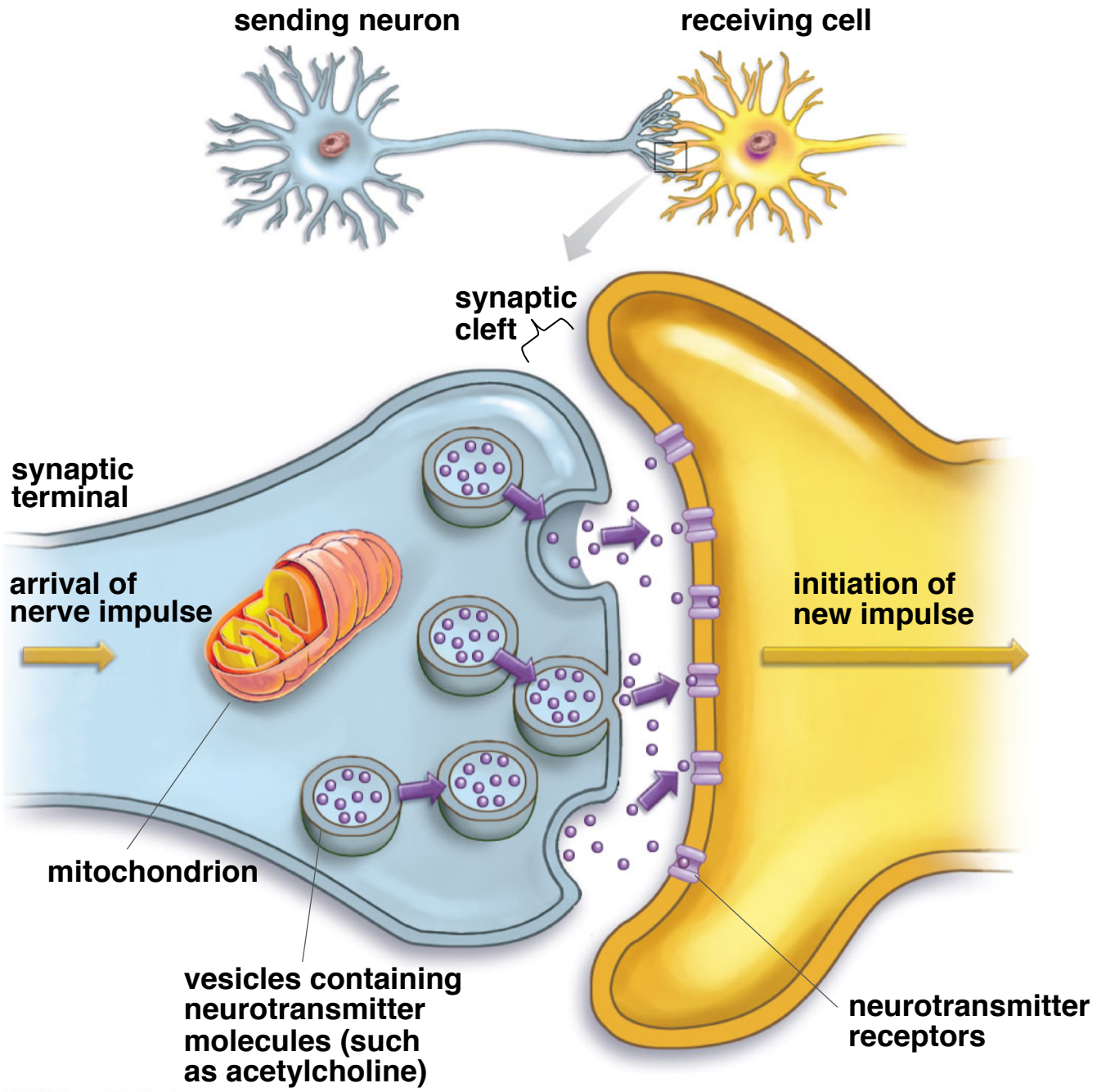


Figure 27.5

27.4 The Spinal Cord

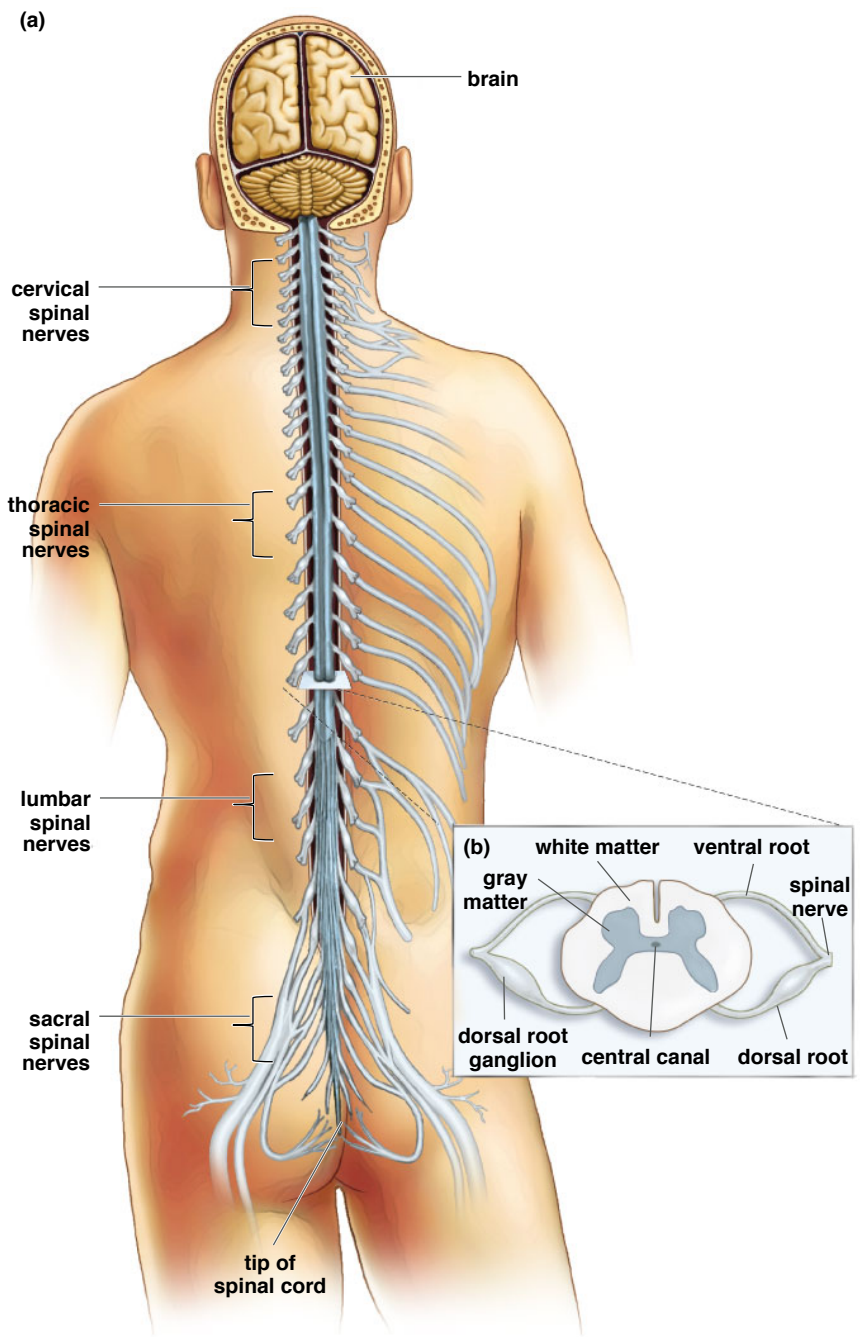


Figure 27.6

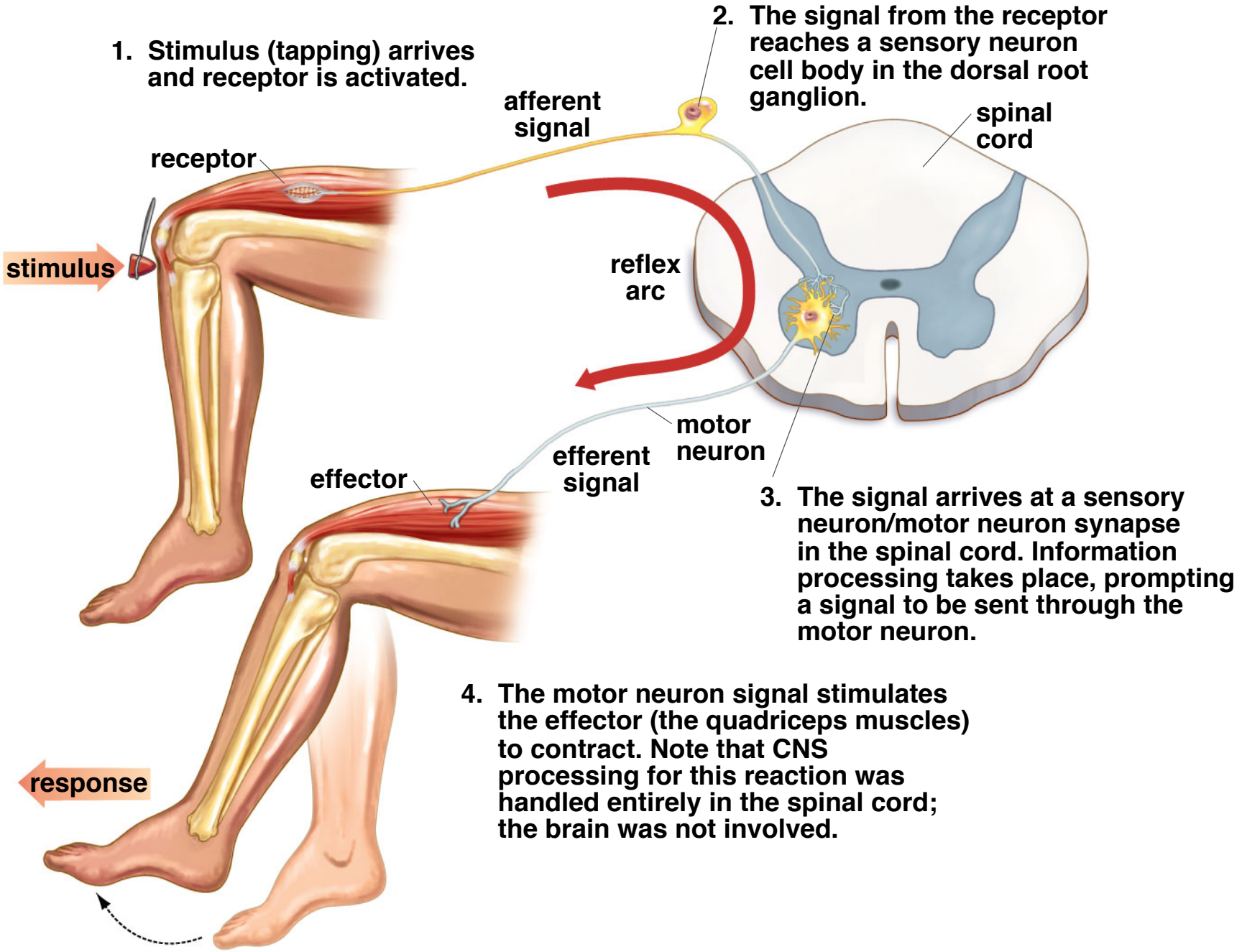


Figure 27.7

27.5 The Autonomic Nervous System

The Autonomic Nervous System

- The sympathetic division of the autonomic nervous system is often called the fight-or-flight system because it generally prepares the body to deal with emergencies.

The Autonomic Nervous System

- The parasympathetic division is often called the rest-and-digest system because it conserves energy and promotes digestive activities.
- Most organs receive input from both systems.

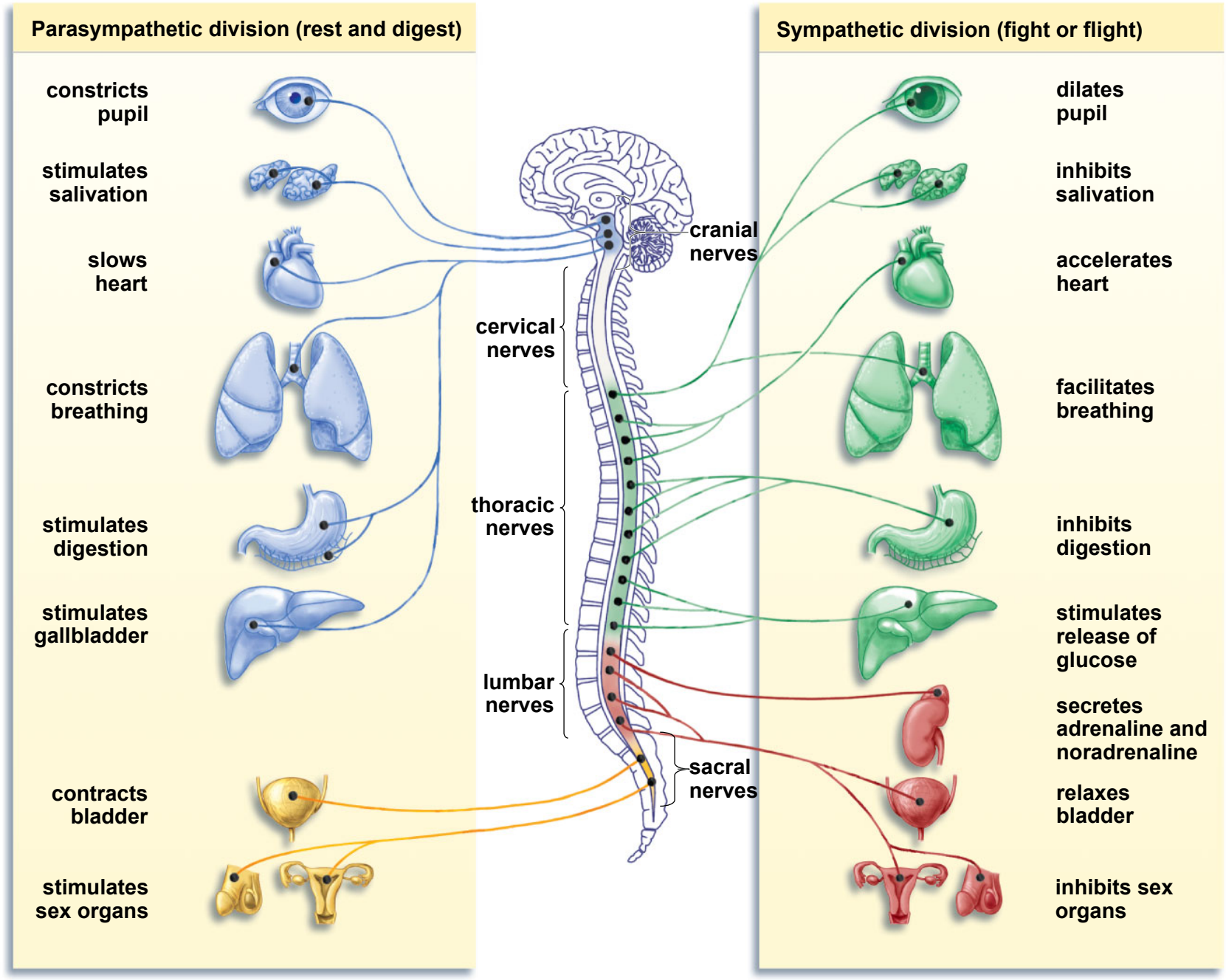


Figure 27.8

27.6 The Human Brain

The Human Brain

- There are six major regions in the adult brain:
  - cerebrum
  - cerebellum
  - thalamus
  - hypothalamus
  - midbrain
  - pons
  - medulla oblongata

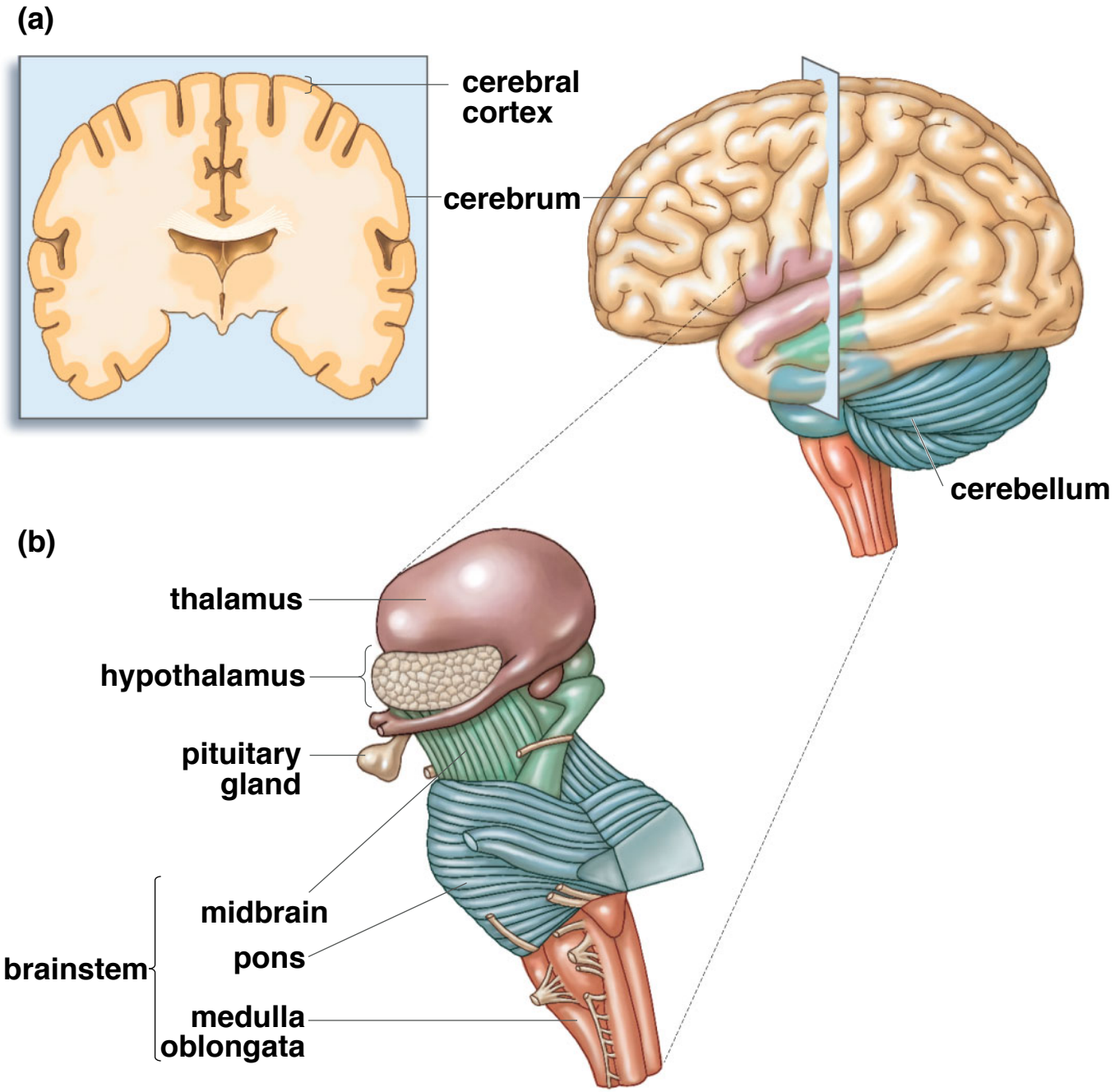


Figure 27.9

The Human Brain

- The hypothalamus is critical to regulating drives and maintaining homeostasis, in part through its regulation of hormonal release.
- The brainstem is a collective term containing:
  - The midbrain
  - Pons
  - Medulla oblongata

The Human Brain

- The midbrain helps maintain muscle tone and posture.
- The pons serves primarily to relay messages between the cerebrum and the cerebellum.
- The medulla oblongata helps regulate such involuntary functions as breathing and digestion.

Table 27.1

Major Regions of the Human Brain

Region	Location	Functions In
Cerebrum	Topmost portion of brain; fills most of the skull and is draped over other regions of the brain	Reasoning, planning, memory, processing of sensory information; issuance of voluntary motor commands
Cerebellum	At the base of the skull, between the cerebrum and medulla oblongata	Refinement of motor commands; maintenance of balance
Thalamus	Beneath cerebrum, covered by it	Reception of sensory information and transmission of it to the cerebral cortex for processing
Hypothalamus	Beneath thalamus, above brainstem	Regulation of drives and the maintenance of homeostasis, often by interaction with the hormonal system
Midbrain	Upper brainstem	Maintenance of muscle tone and posture through control of involuntary muscle responses
Pons	Mid-brainstem	Transmission of messages between the cerebrum and cerebellum
Medulla oblongata	Lower brainstem	Regulation of breathing, blood pressure, and digestion

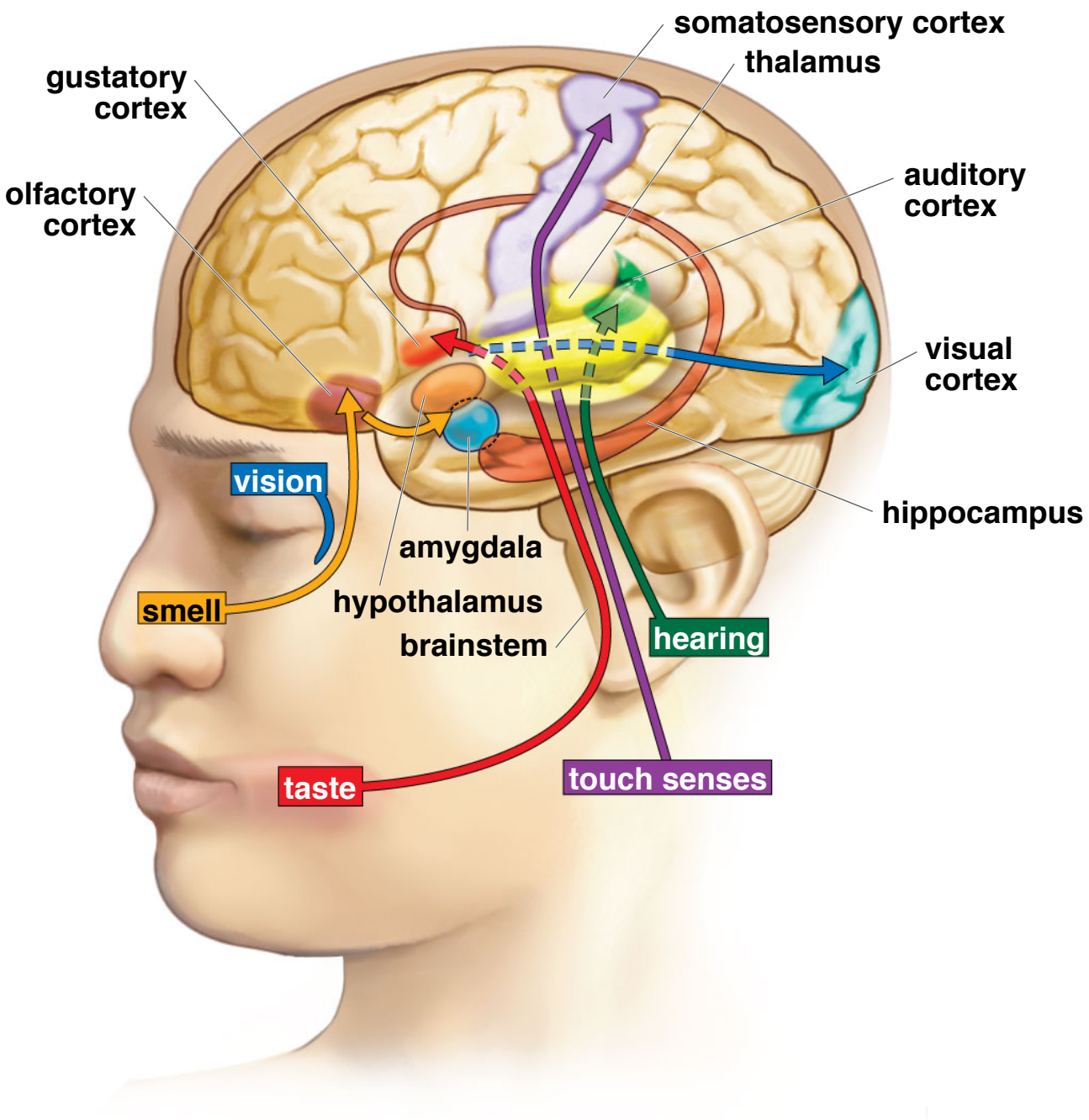


Figure 27.10

27.7 Our Senses

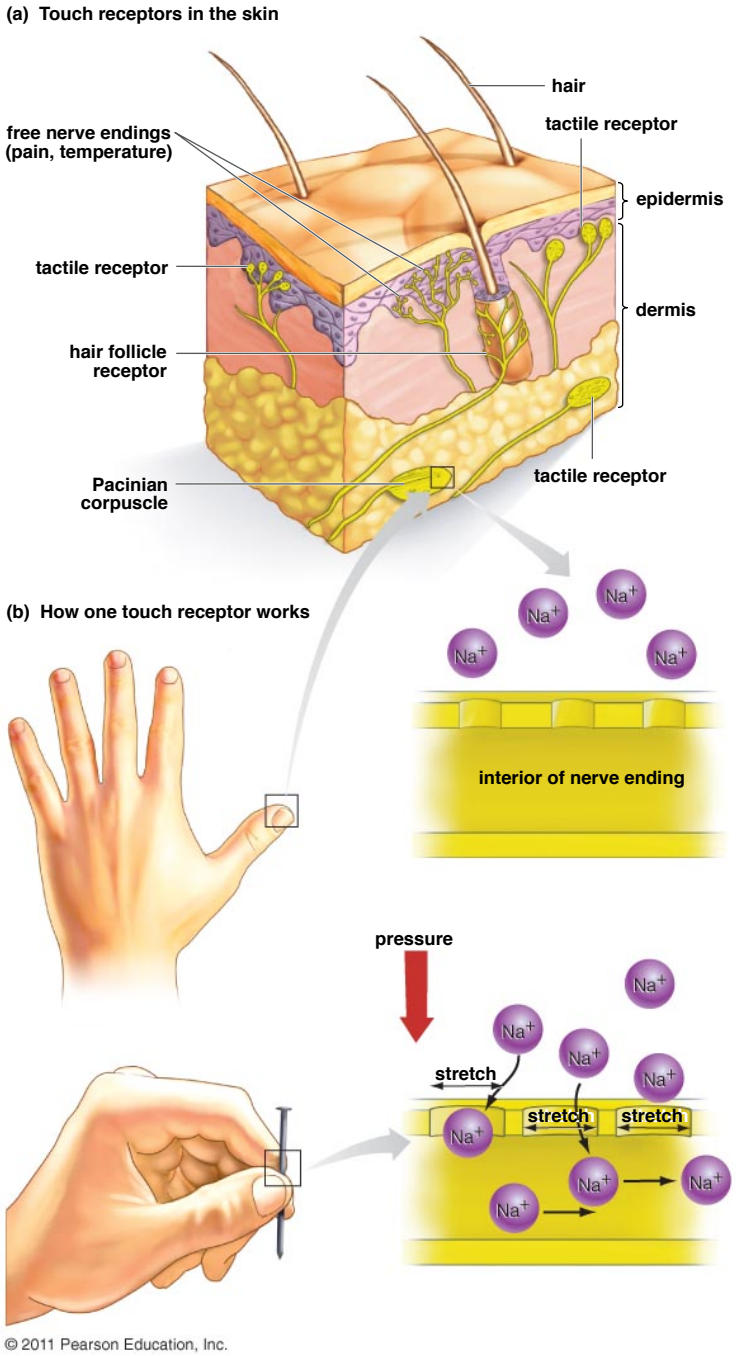


Figure 27.11

27.9 Smell

Our Sense of Smell

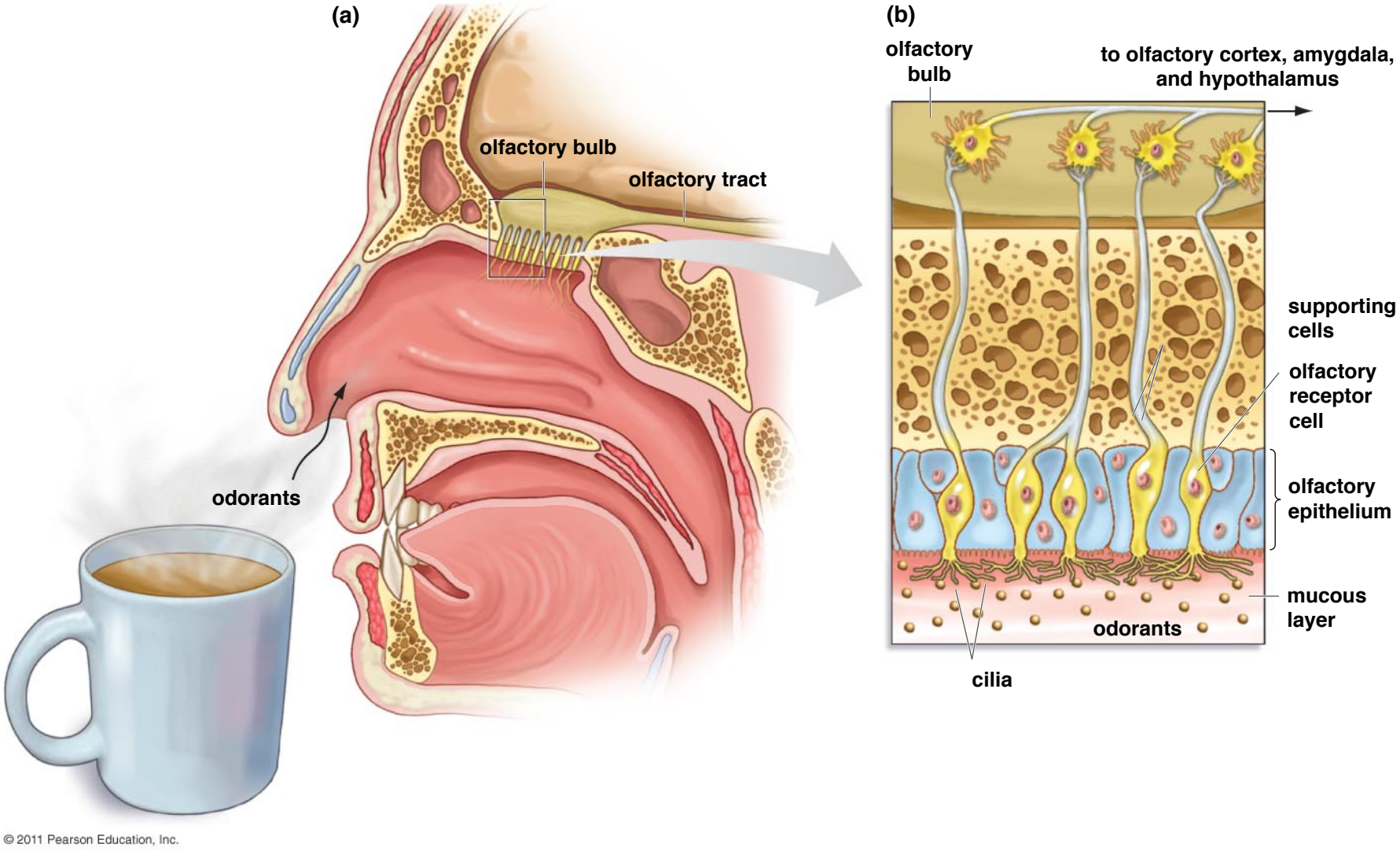


Figure 27.12

27.10 Taste

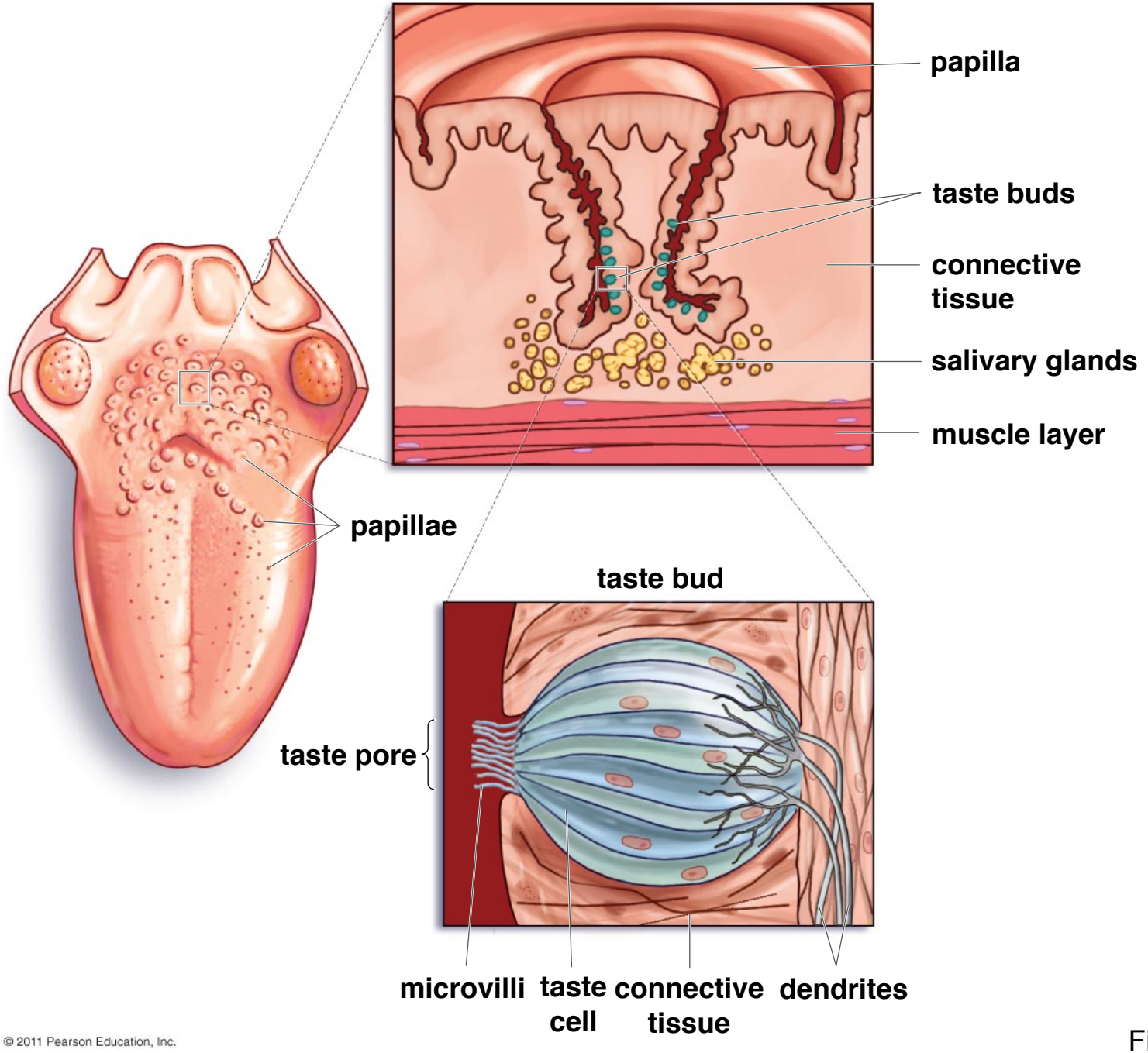


Figure 27.13

Our Sense of Taste

- The neurons that receive input from taste cells vary in their response to different tastants.
- The brain makes sense of the pattern of input it gets from these neurons, thus yielding the large number of tastes we experience.

27.11 Hearing

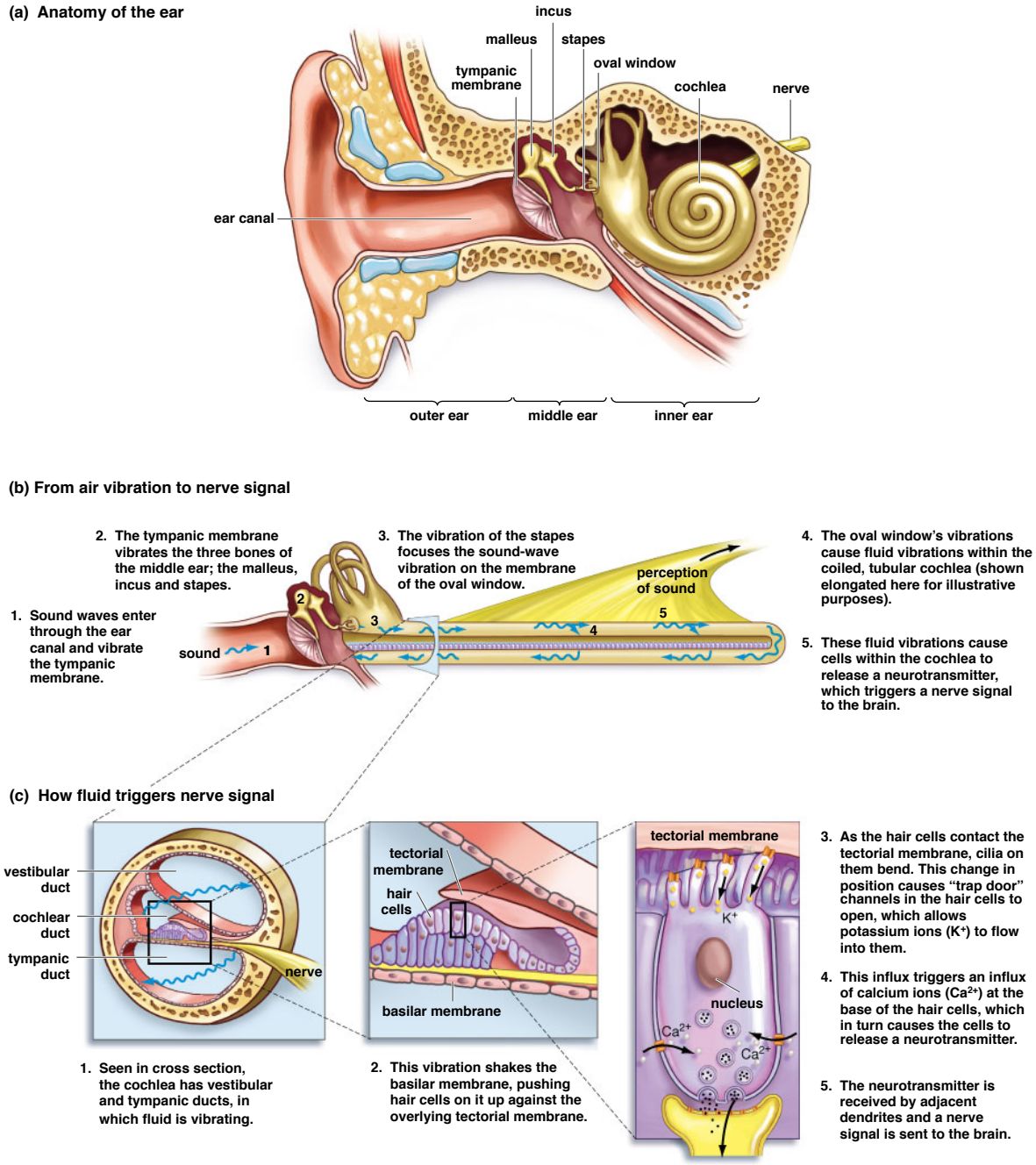


Figure 27.14

27.12 Vision

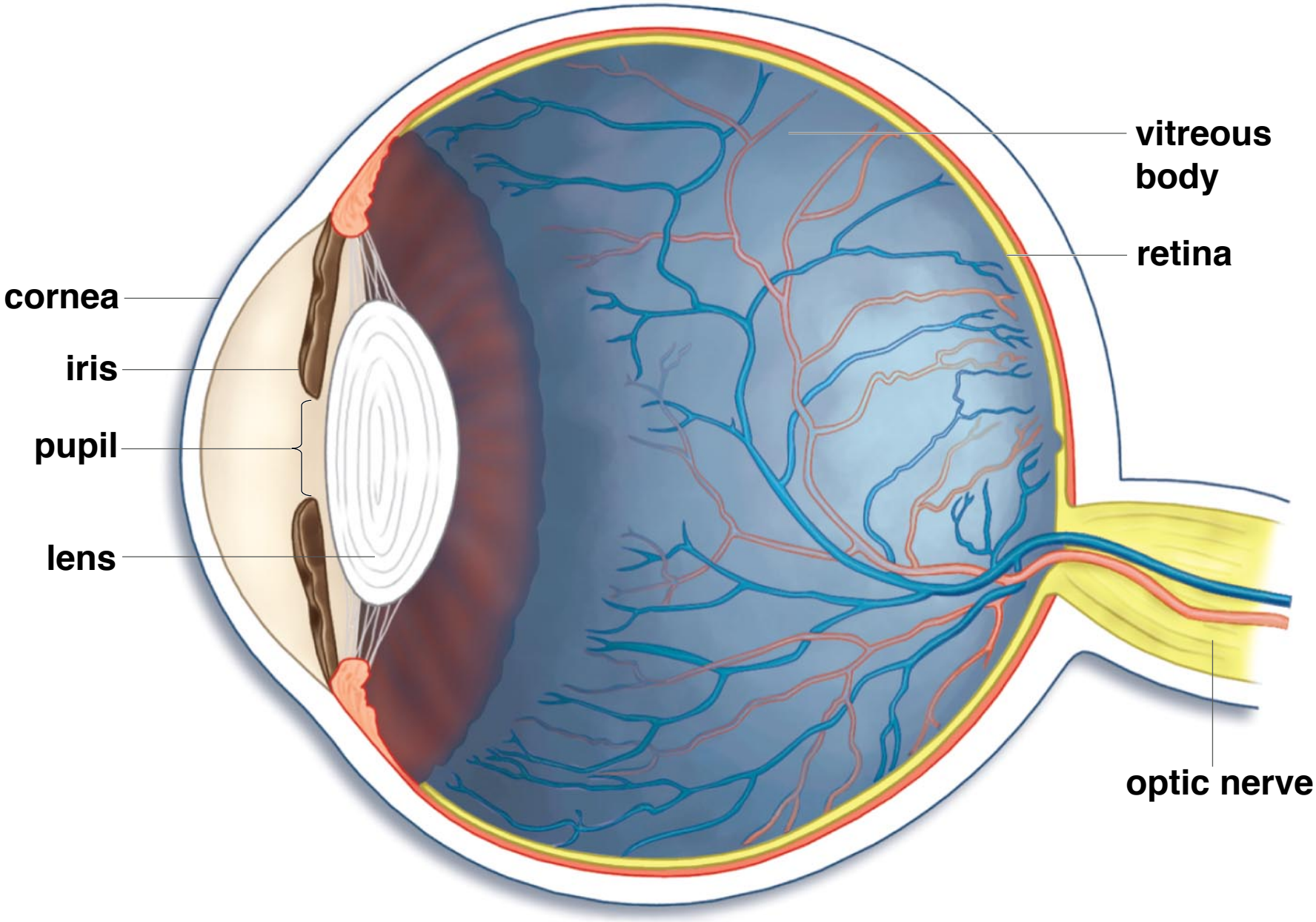


Figure 27.15

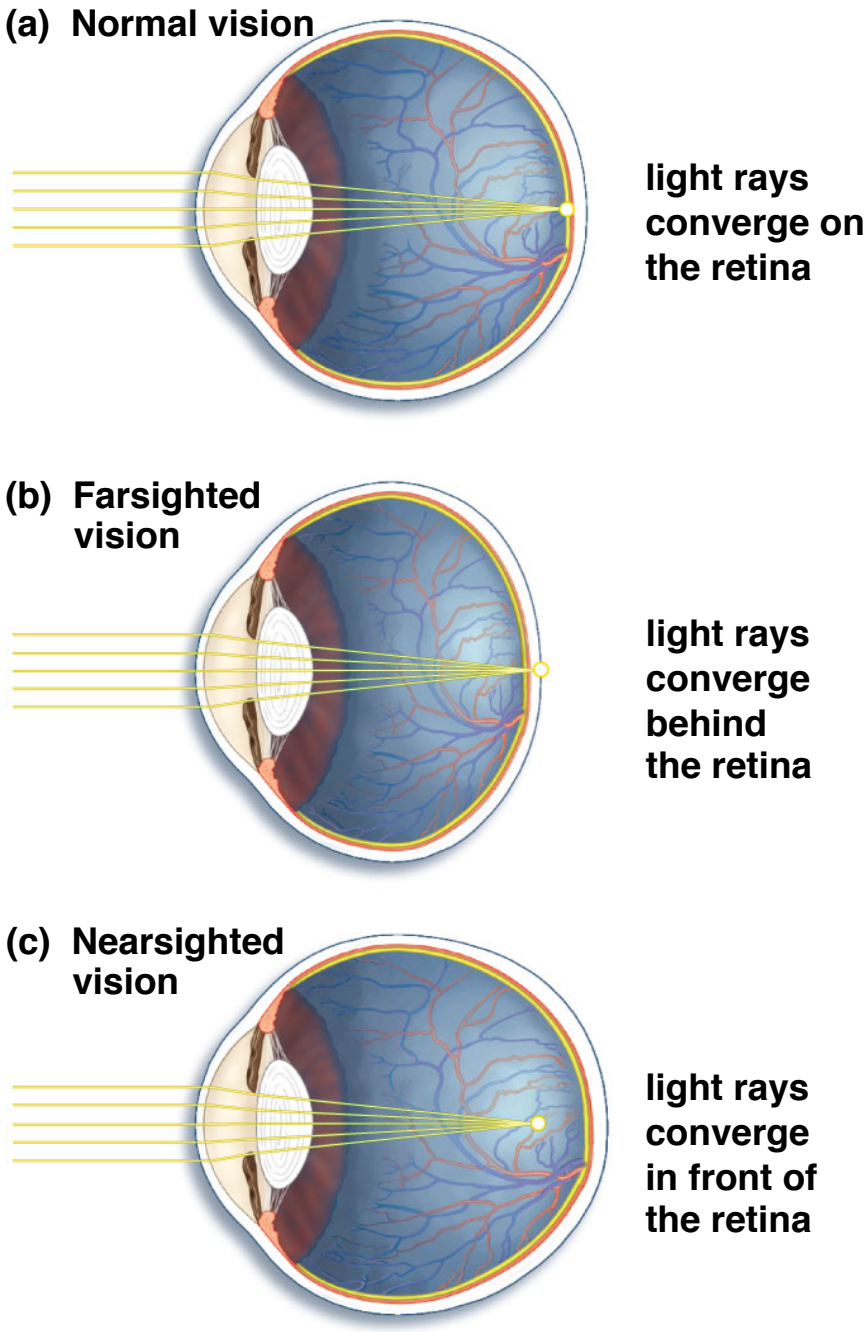
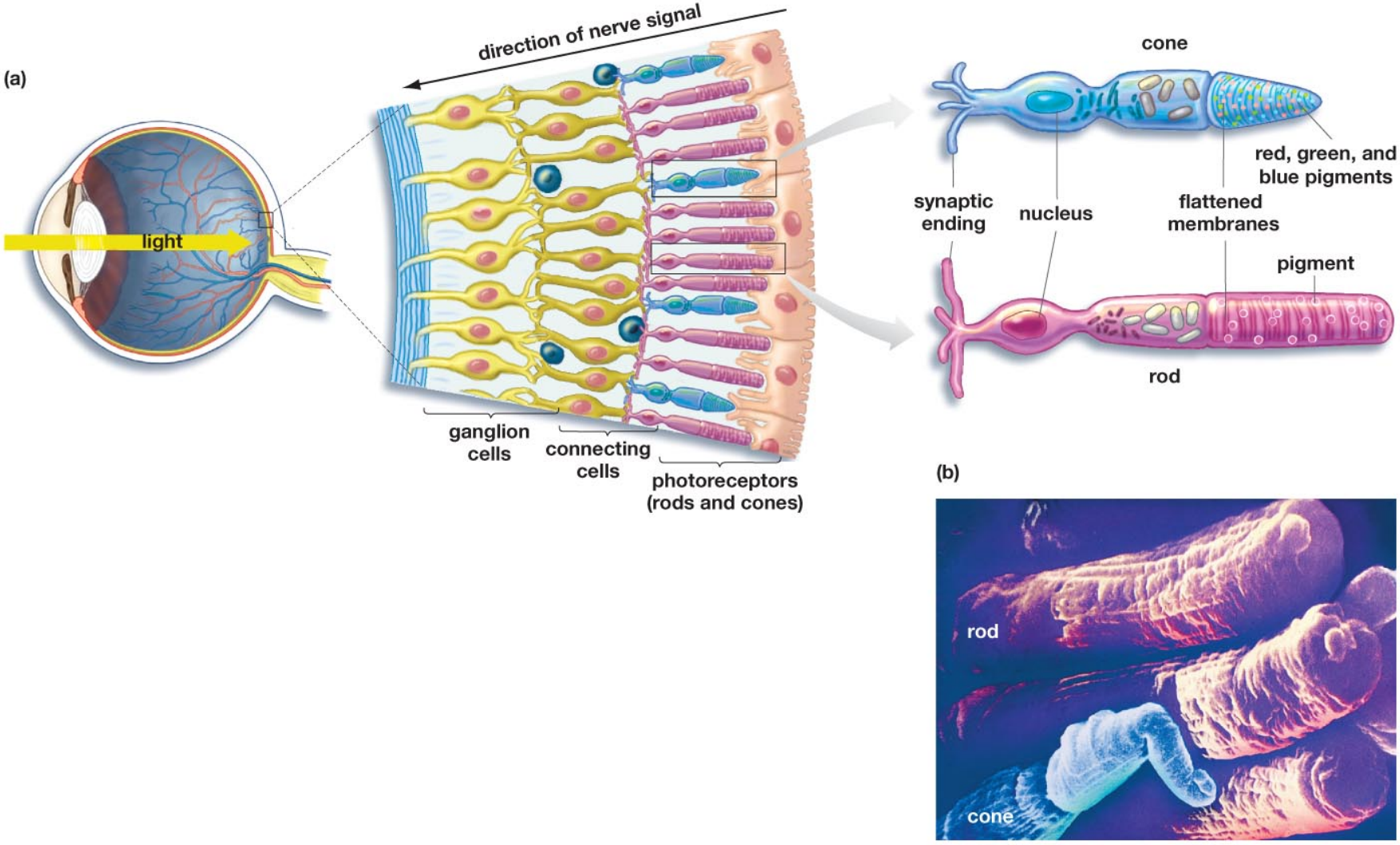


Figure 27.16

Our Sense of Vision

- Light signals are converted to nervous system signals by cells in the retina called photoreceptors, which come in two varieties: **rods** and **cones**.
- Rods function in dim light but are not sensitive to color.
- Cones function best in bright light but are sensitive to color.



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Our Sense of Vision

- These photoreceptors have pigments embedded in membranes within them.
- When light strikes a pigment, it changes pigment shape in a way that prompts a cascade of chemical reactions that results in neurotransmitter release being inhibited between the rod or cone and its adjoining connecting cell.
- This lack of release sends the signal, "Photoreceptor stimulated here."