Chapter 48

Neurons, Synapses, and Signaling

PowerPoint® Lecture Presentations for

Biology

Eighth Edition

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Divisions of nervous system

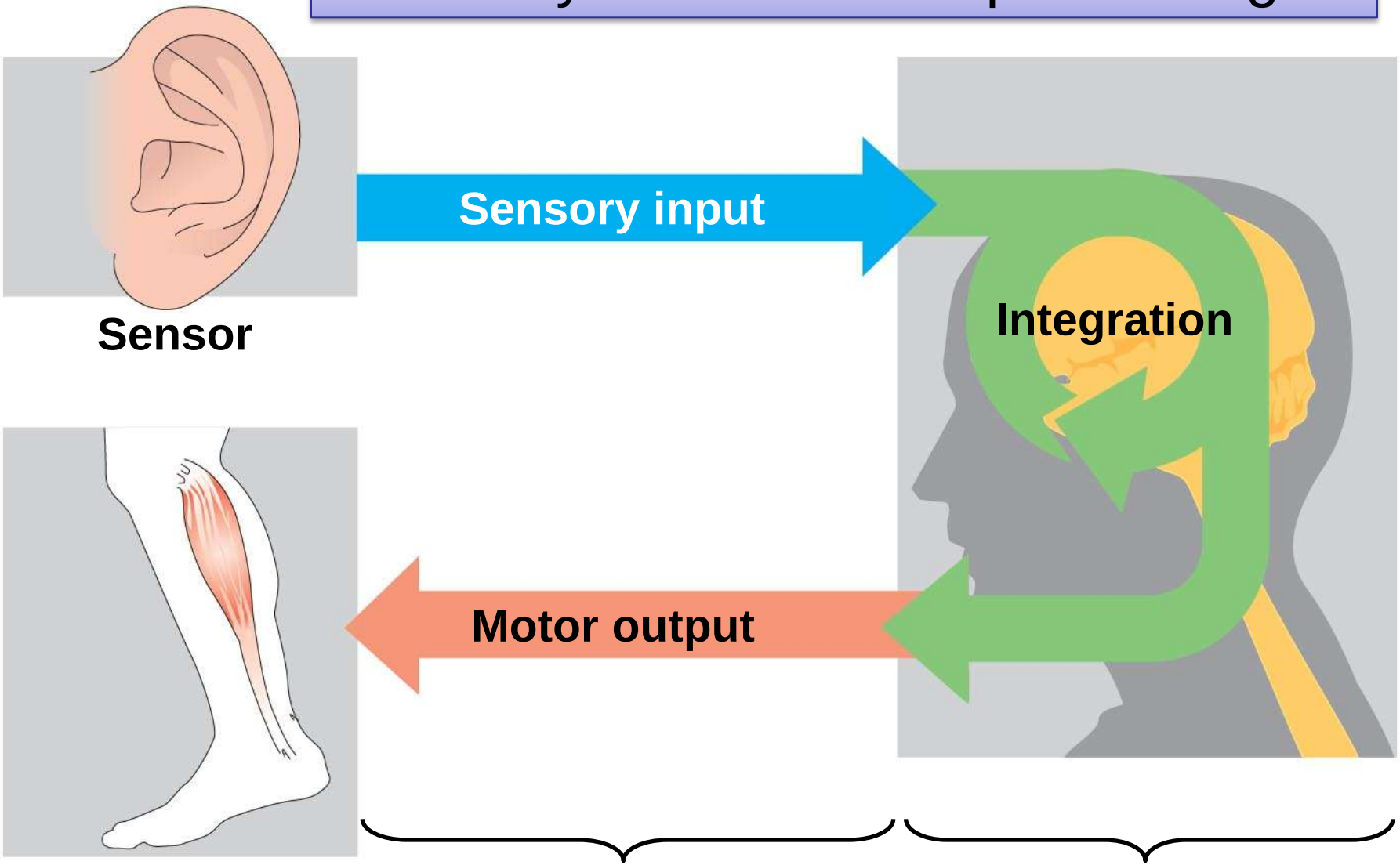
- The main function of nervous system is **to control homeostasis**
- Many animals have a complex nervous system which consists of:
  - A **central nervous system (CNS)** where integration takes place; this includes the brain and a nerve cord
  - A **peripheral nervous system (PNS)**, which brings information into and out of the CNS

Peripheral nervous system

- **Sensors** detect external stimuli and internal conditions and transmit information along **sensory neurons to CNS**
- Sensory information is sent to the brain or **ganglia**, where **interneurons** integrate the information
- **Motor output** leaves the brain or ganglia via **motor neurons**, which carry nerve impulses away **from CNS** and trigger muscle or gland activity

Fig. 48-3

Summary of information processing



Overview: Lines of Communication

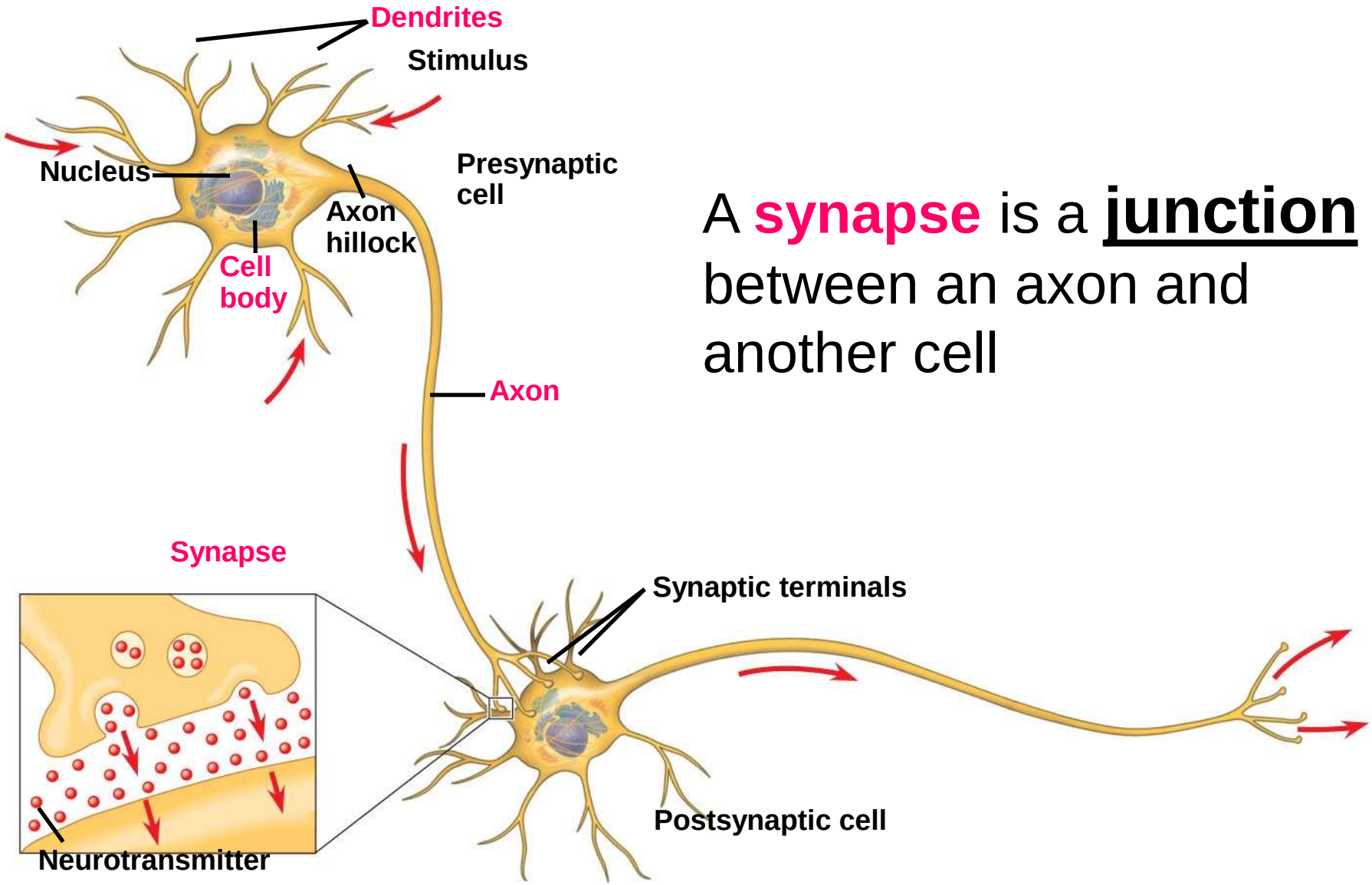
- **Neurons** are nerve cells that **transfer information** within the body
- Processing of information takes place in simple **clusters of neurons** called **ganglia** or a more complex organization of neurons called a **brain**

Neuron Structure and Function

- Most of a neuron's organelles are in the **cell body**
- Most neurons have **dendrites**, highly branched extensions that *receive* signals from other neurons or stimuli
- The **axon** is typically a much longer extension that *transmits* signals to other cells at synapses

Fig. 48-4

Neuron structure and organization

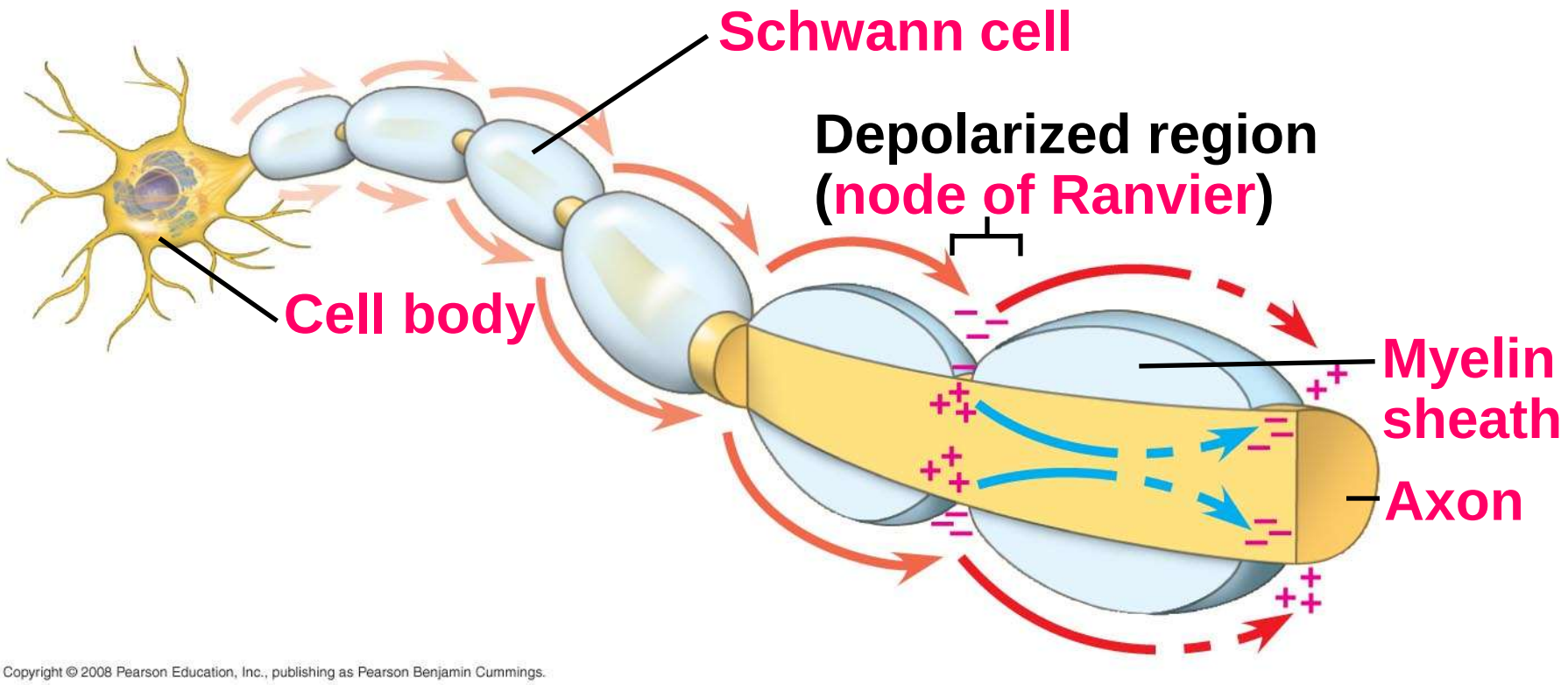


A **synapse** is a **junction** between an axon and another cell

Neuron Structure and Function

- **Synapse**: where neuron interacts with another cell to transmit a nerve impulse
- Most neurons are nourished or insulated by cells called **glia**
- **Schwann cells** of glia produce mielin sheath, which **increases speed of transmission.**
- Nodes of Ranvier: are gaps in myelin sheath

Fig. 48-13



Concept 48.2: Ion pumps and ion channels maintain the resting potential of a neuron

- Every neuron has a voltage (difference in electrical charge) across its plasma membrane called a **membrane potential (action potential)**
- Flow of ions produces electric currents in body: move across membrane through channels down electrochemical gradient

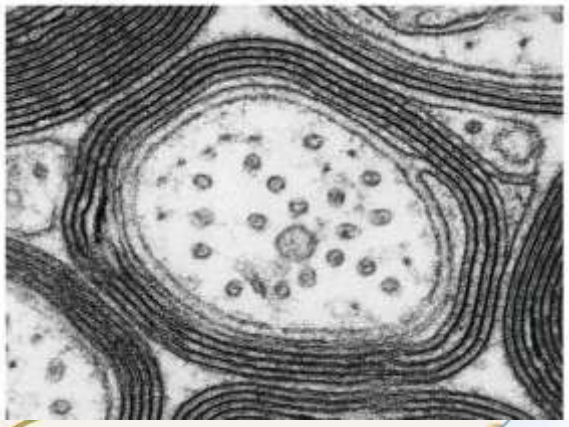
- Inside of membrane is more negative compared to the outside of the membrane

- Sodium-potassium pumps maintain K^+ and Na^+ gradients across the plasma membrane

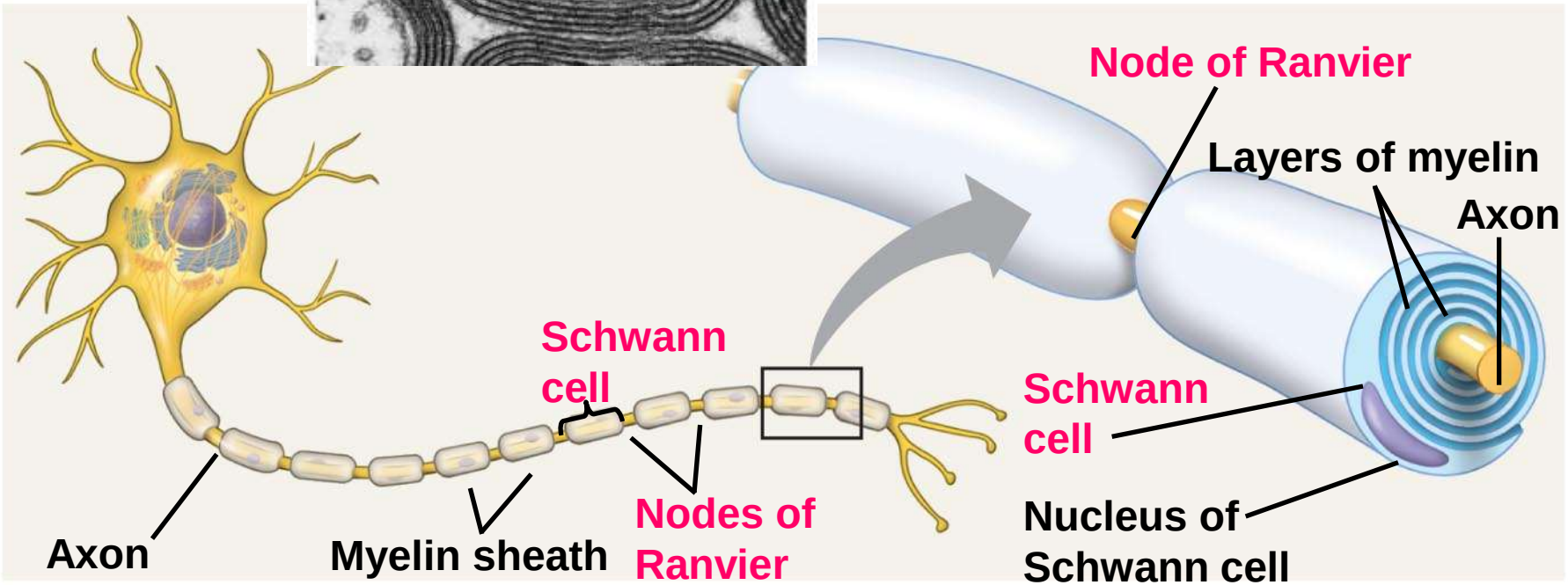
Conduction Speed

- The **speed of an action** potential **increases with the axon's diameter**
- In vertebrates, axons are insulated by a **myelin sheath**, which **causes an action potential's speed to increase**
- Myelin sheaths are made by glia—**oligodendrocytes** **in the CNS** and **Schwann cells** **in the PNS**

Fig. 48-12a



Myelinated axon (cross section)



Action potentials are formed only at **nodes of Ranvier**, gaps in the myelin sheath where voltage-gated Na+ channels are found

Synapses

- Junctions between 2 neurons and or neuron and affector
- **Presynaptic neuron**: conducts impulse toward synapse
- The **synaptic (axonal) terminal** of presynaptic neuron passes information across the synapse in the form of chemical messengers called **neurotransmitters**
- Neurotransmitters are located in **synaptic vesicles**
- The **neurotransmitter** diffuses across the **synaptic cleft** and is received by the **postsynaptic cell**

Synaptic terminals on the cell body of a postsynaptic neuron (colorized SEM)

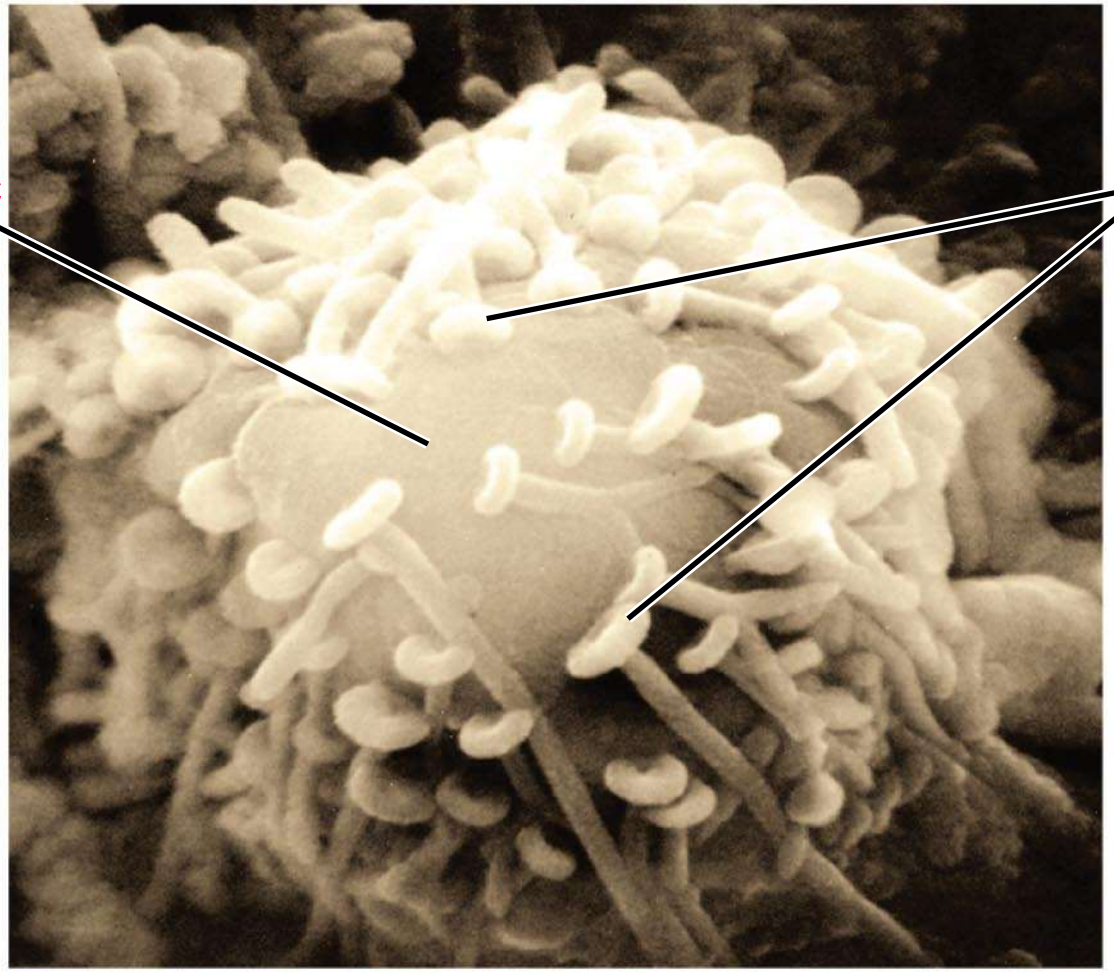
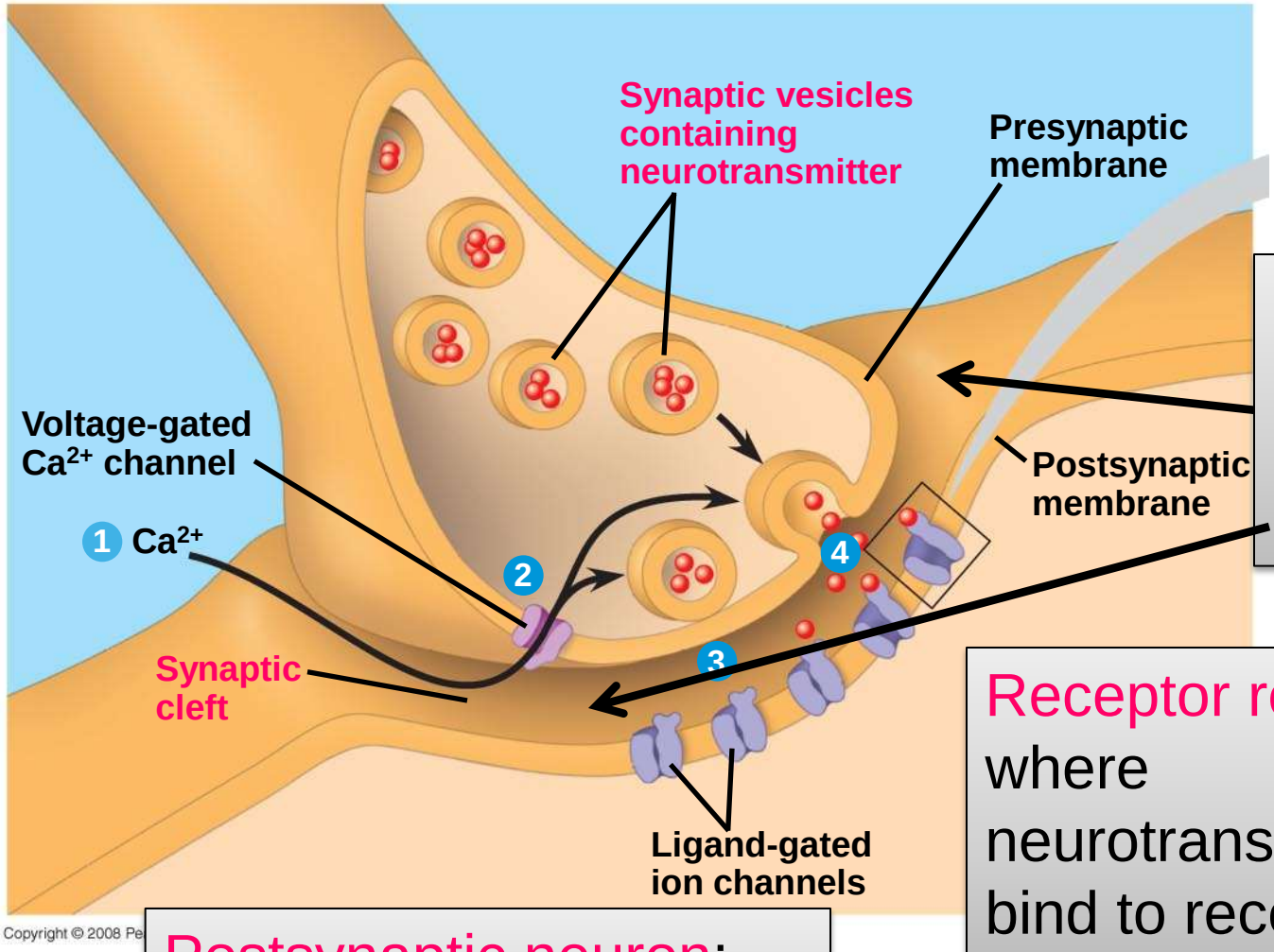


Fig. 48-15

A chemical synapse



synaptic cleft: separates membranes of 2 neurons

Receptor region: where neurotransmitters bind to receptors

Postsynaptic neuron: conducts impulse away from synapse

Impulse transmission at synapse

- Nerve impulse reaches axonal terminal, causes synaptic vesicles to release neurotransmitter
- Neurotransmitter diffuses across cleft and binds to receptors on postsynaptic membrane
- May produce action potential if threshold reached

Questions ?

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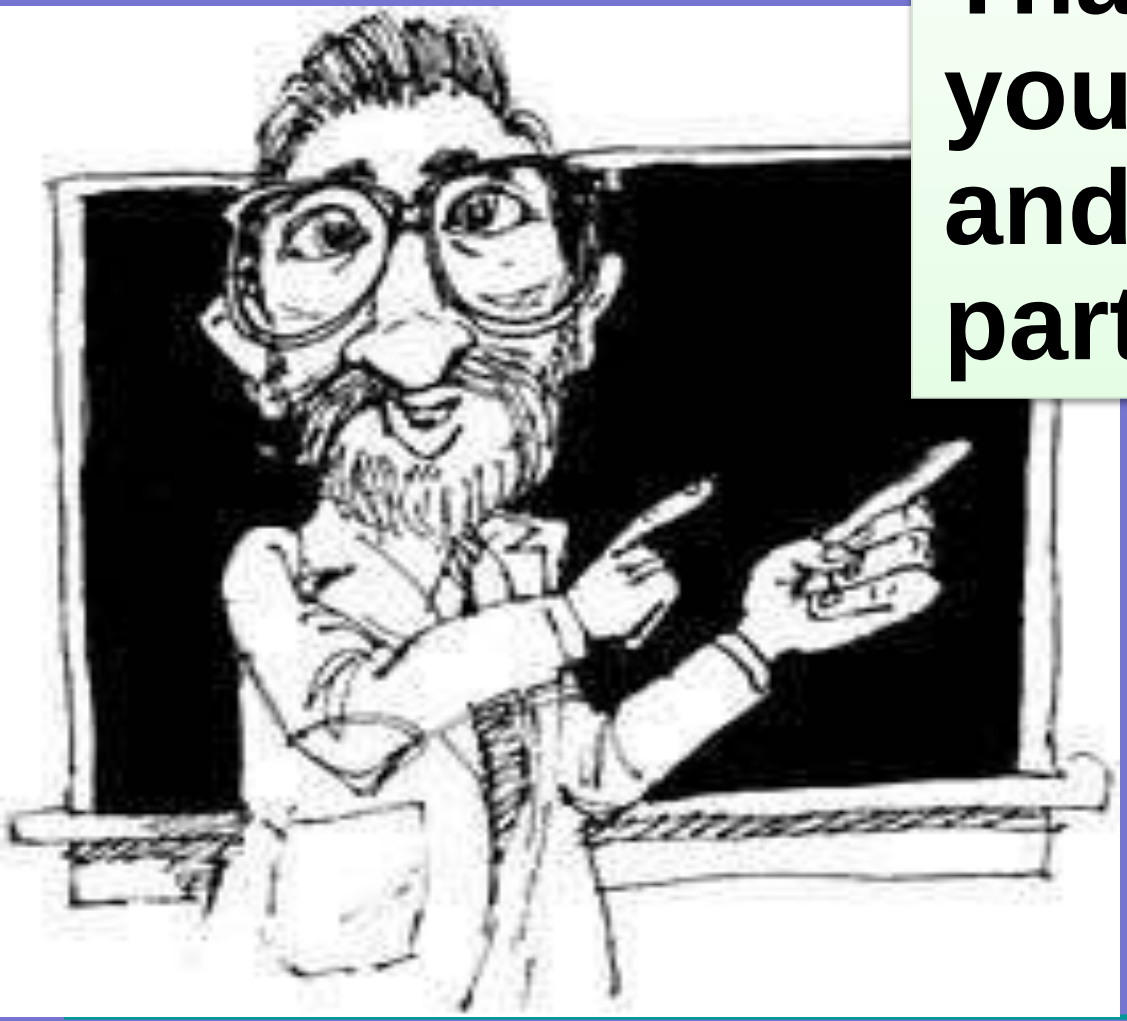

Thank you for your attention and participation!

You should now be able to:

1. Distinguish among the following sets of terms: sensory neurons, interneurons, and motor neurons; and action potential
2. Explain the importance of the sodium-potassium pump
3. Describe the events that lead to the release of neurotransmitters into the synaptic cleft