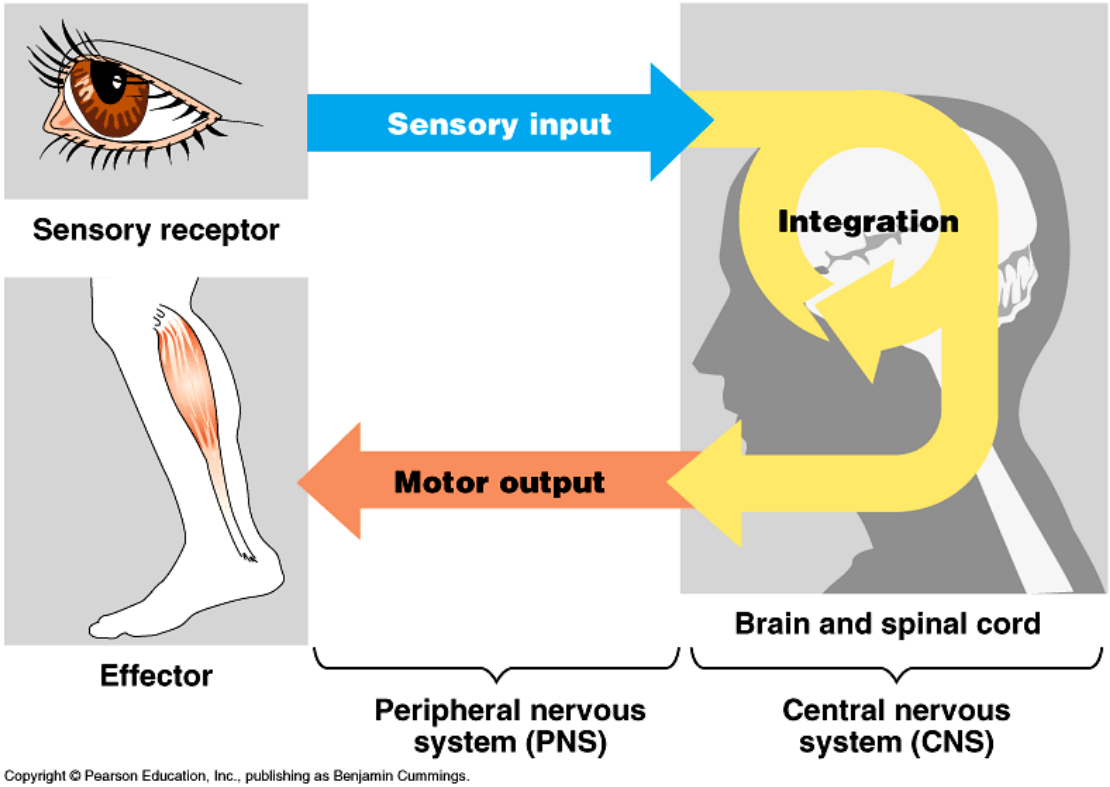
Nervous Systems

Three Main Functions:

1. Sensory Input
2. Integration
3. Motor Output



Two Main Parts of Vertebrate Nervous Systems

- **Central nervous system (CNS)**
  - brain and spinal cord
  - integration
- **Peripheral nervous system (PNS)**
  - network of nerves extending into different parts of the body
  - carries sensory input to the CNS and motor output away from the CNS

Two Cell Types in Nervous Systems

- Neurons
  - Cells that conduct the nerve impulses
- Supporting Cells
  - Neuroglia

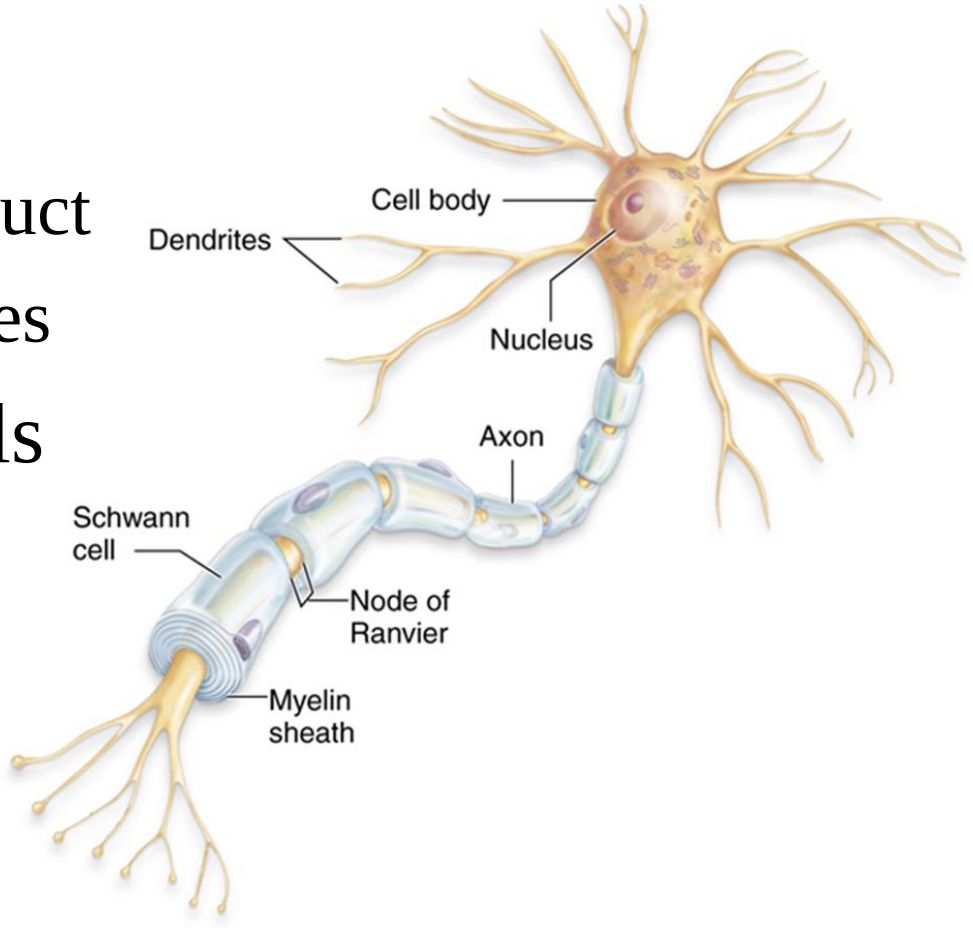
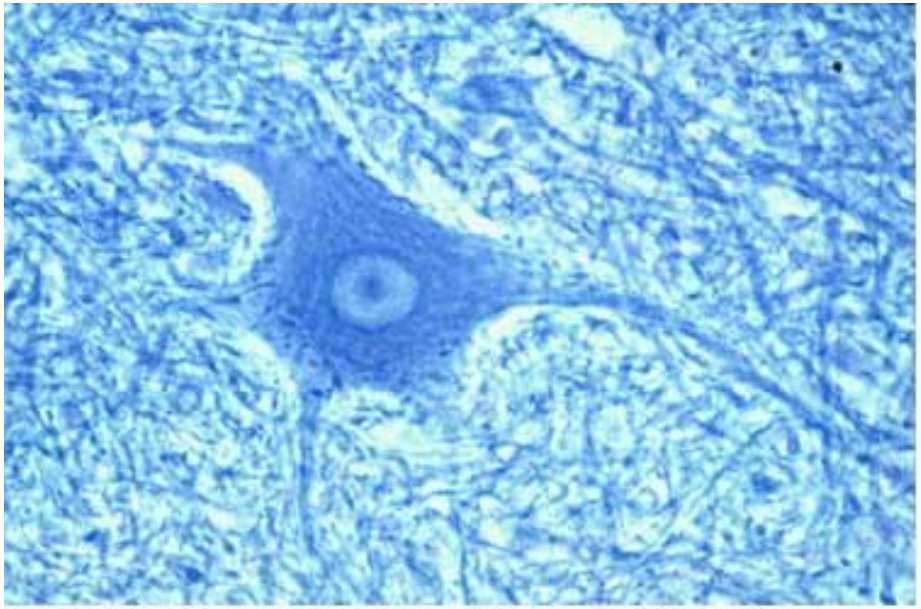
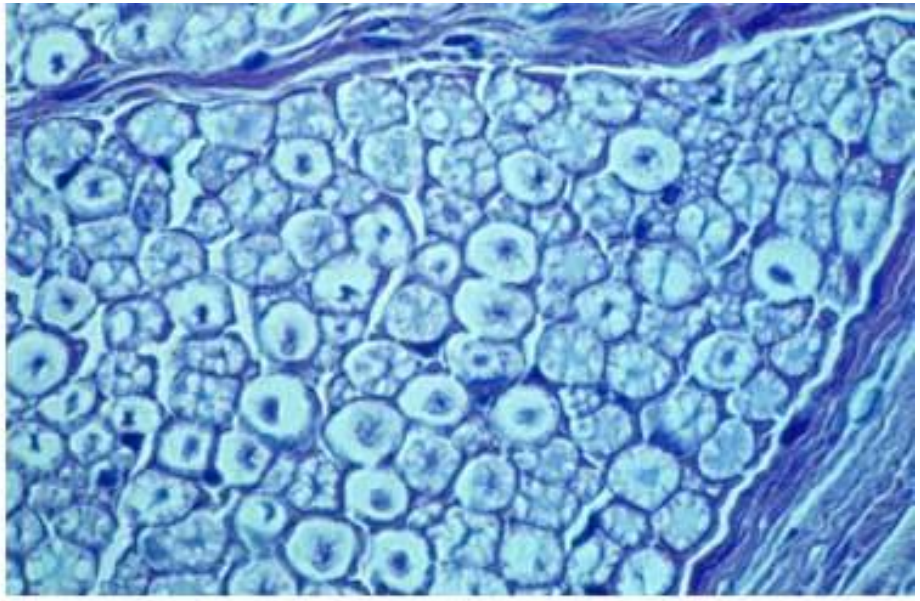


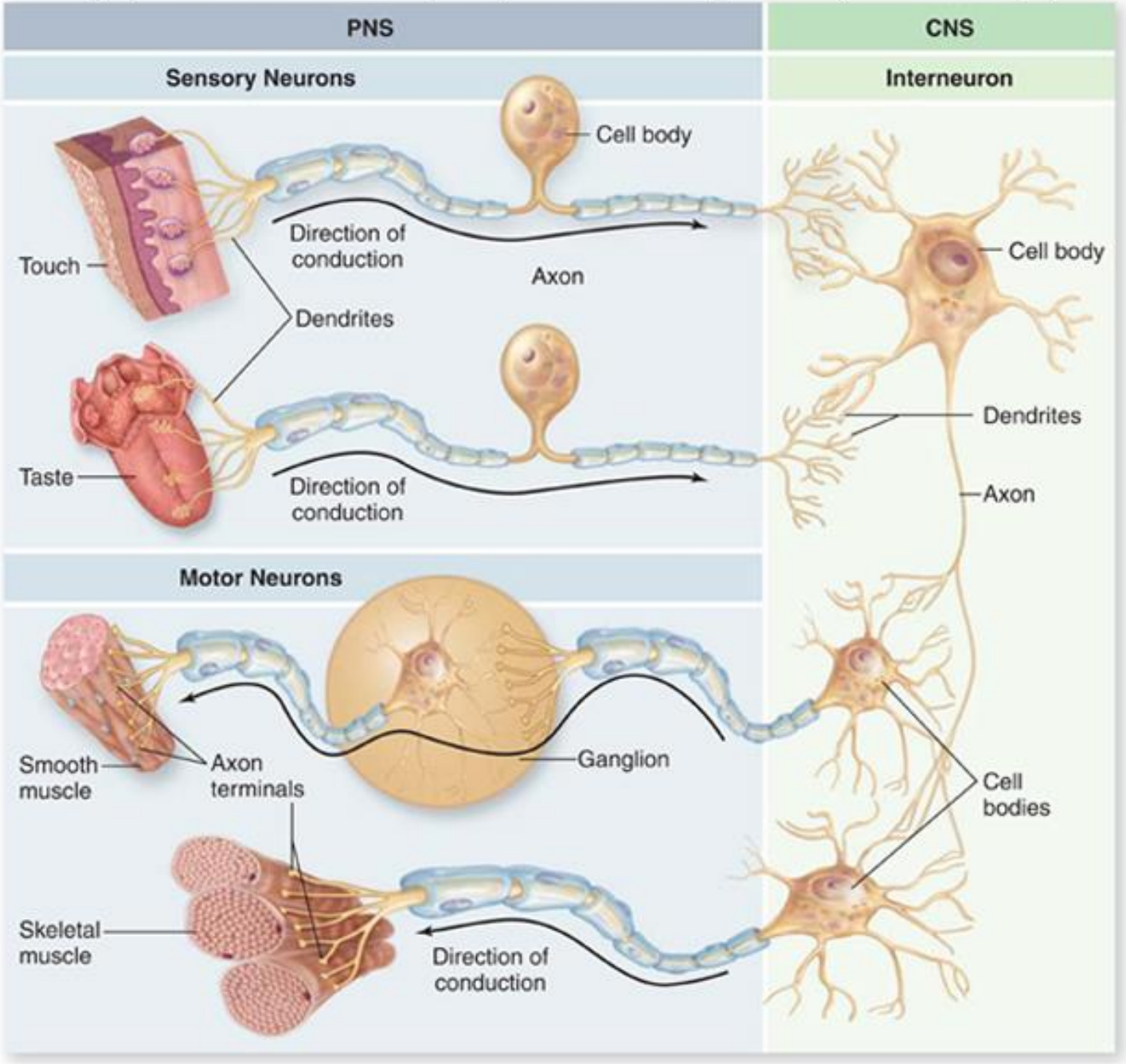
Figure 48.2x Neurons





Three Major Types of Nerve Cells

- **Sensory neurons**
  - communicate info about the external or internal environment to the CNS
- **Interneurons**
  - integrate sensory input and motor output
  - makes synapses only with other neurons
- **Motor neurons**
  - convey impulses from the CNS to effector cells



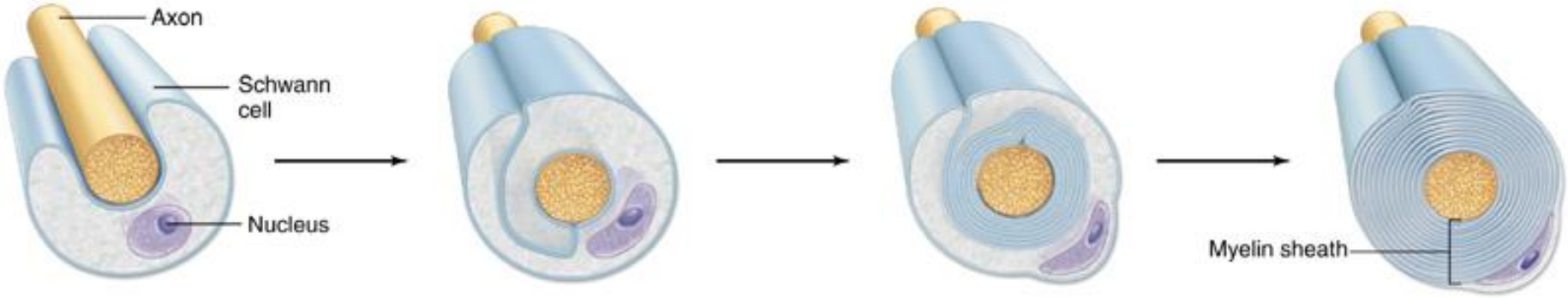
Supporting Cells - Neuroglia

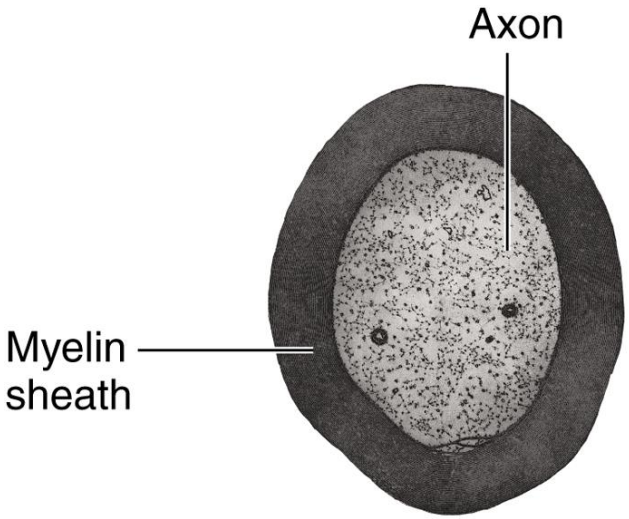
- provide neurons with nutrients, remove wastes

Two important types in vertebrates

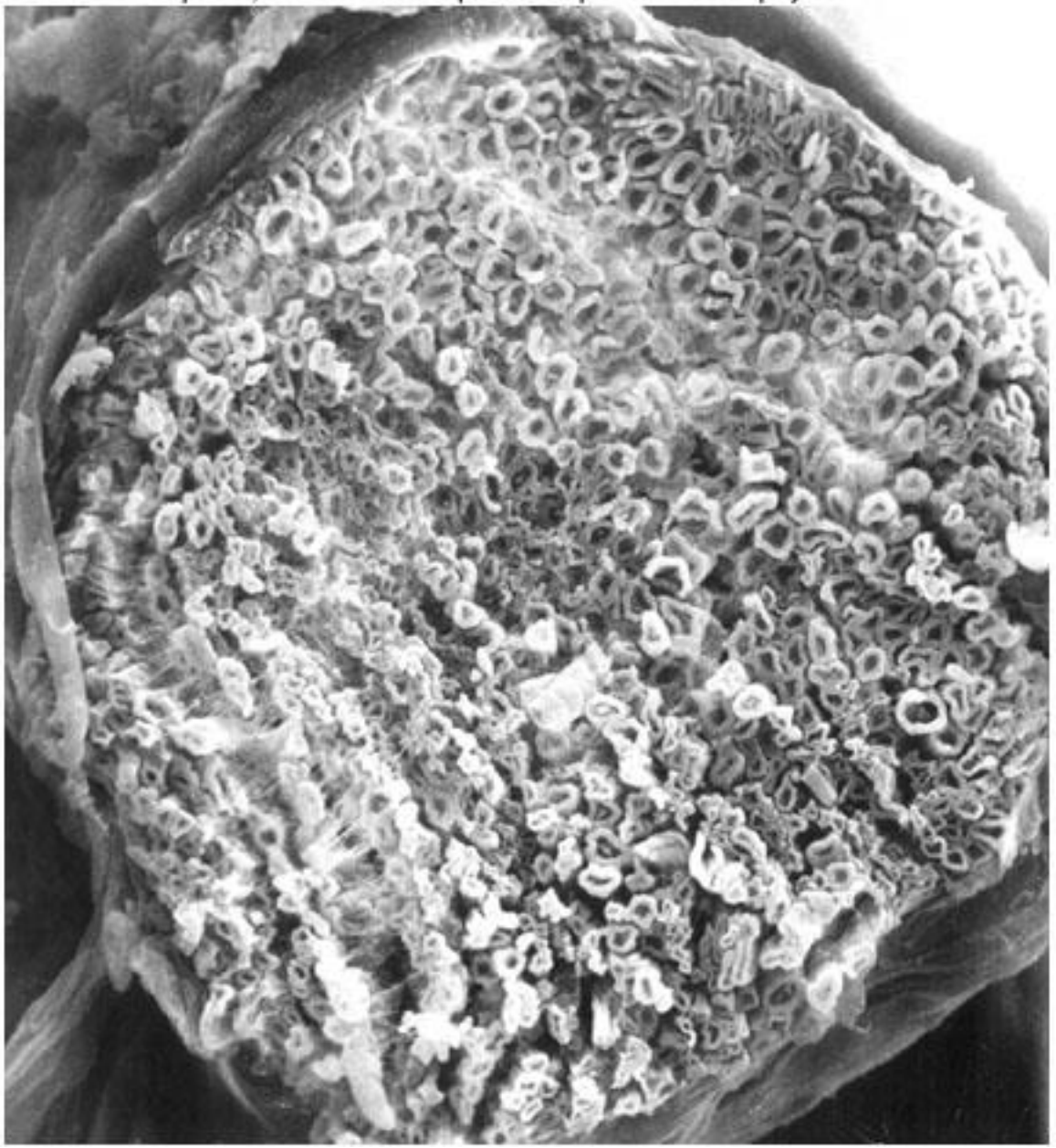
- **Oligodendrocytes** – myelin sheath in CNS
- **Schwann cells -**myelin sheath in PNS

Myelin Sheath Formation





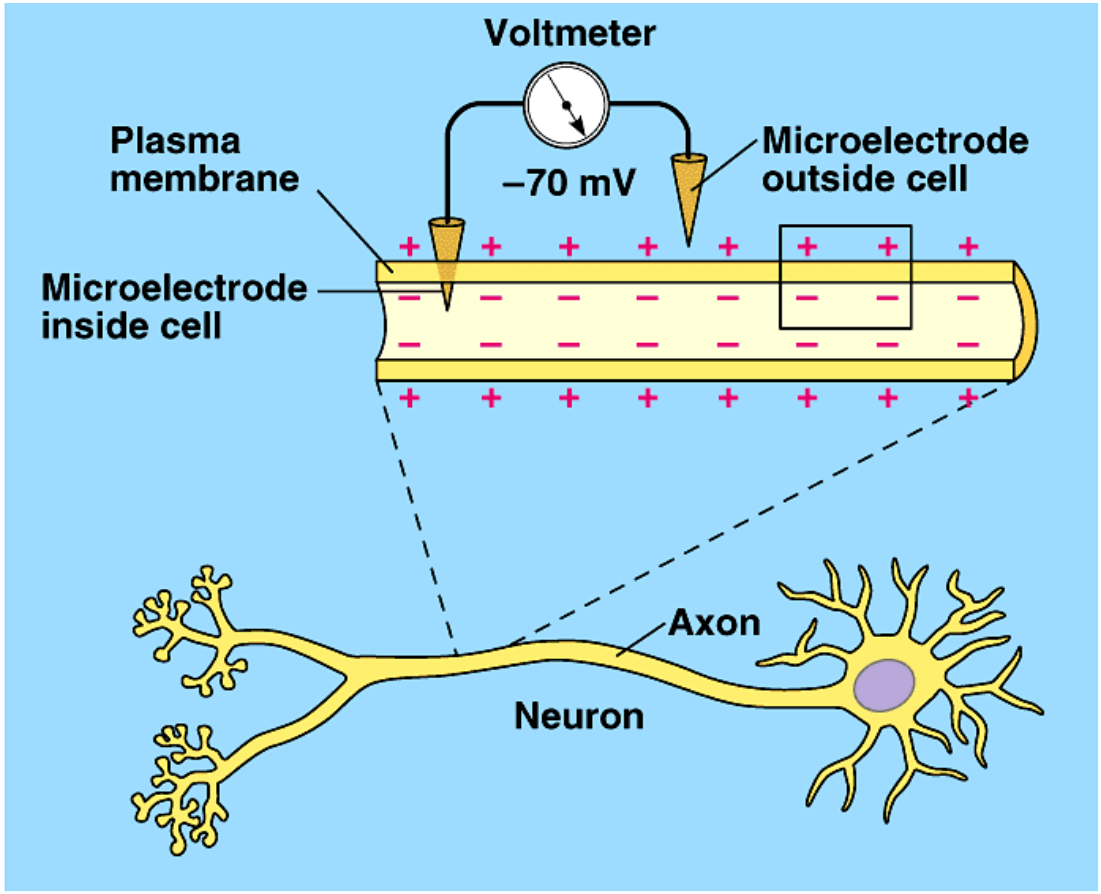
Nerves in the Peripheral Nervous System

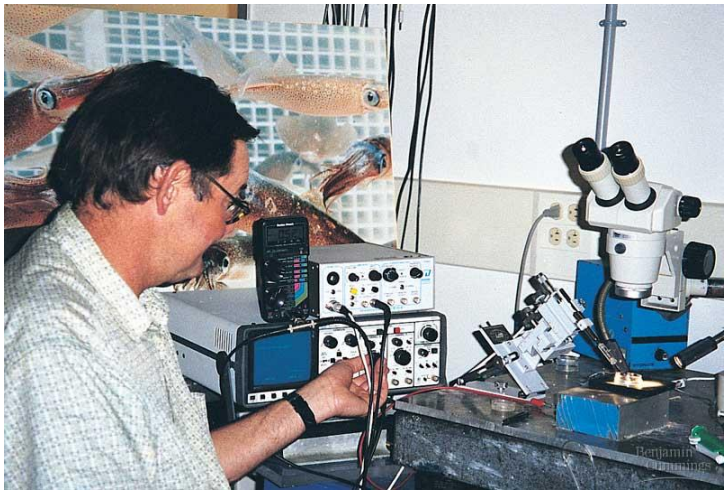


Conduction of the Nerve Impulse

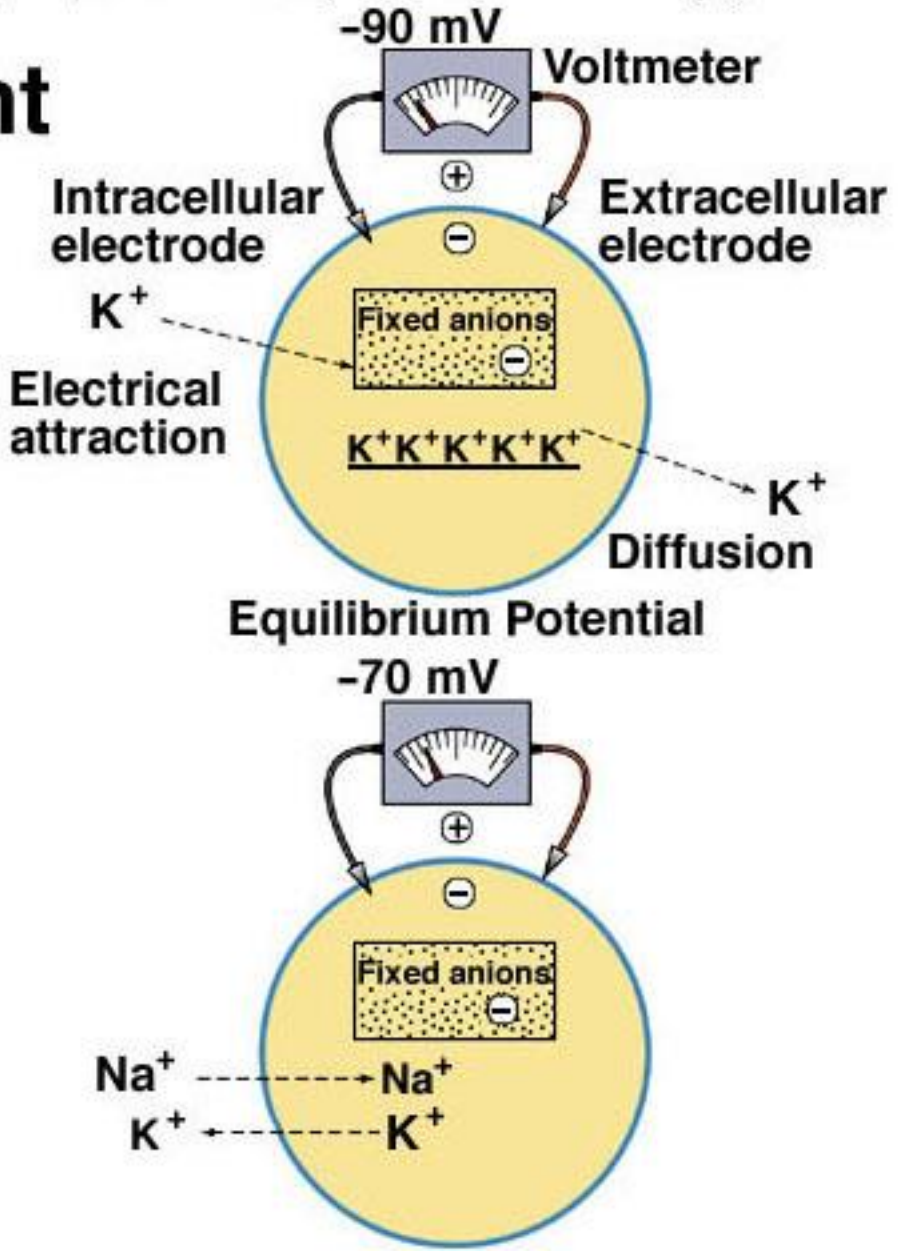
- Membrane Potential
  - Voltage measured across a membrane due to differences in electrical charge
  - Inside of cell is negative wrt outside
- Resting potential of neuron = -70 mV

Figure 48.6 Measuring membrane potentials

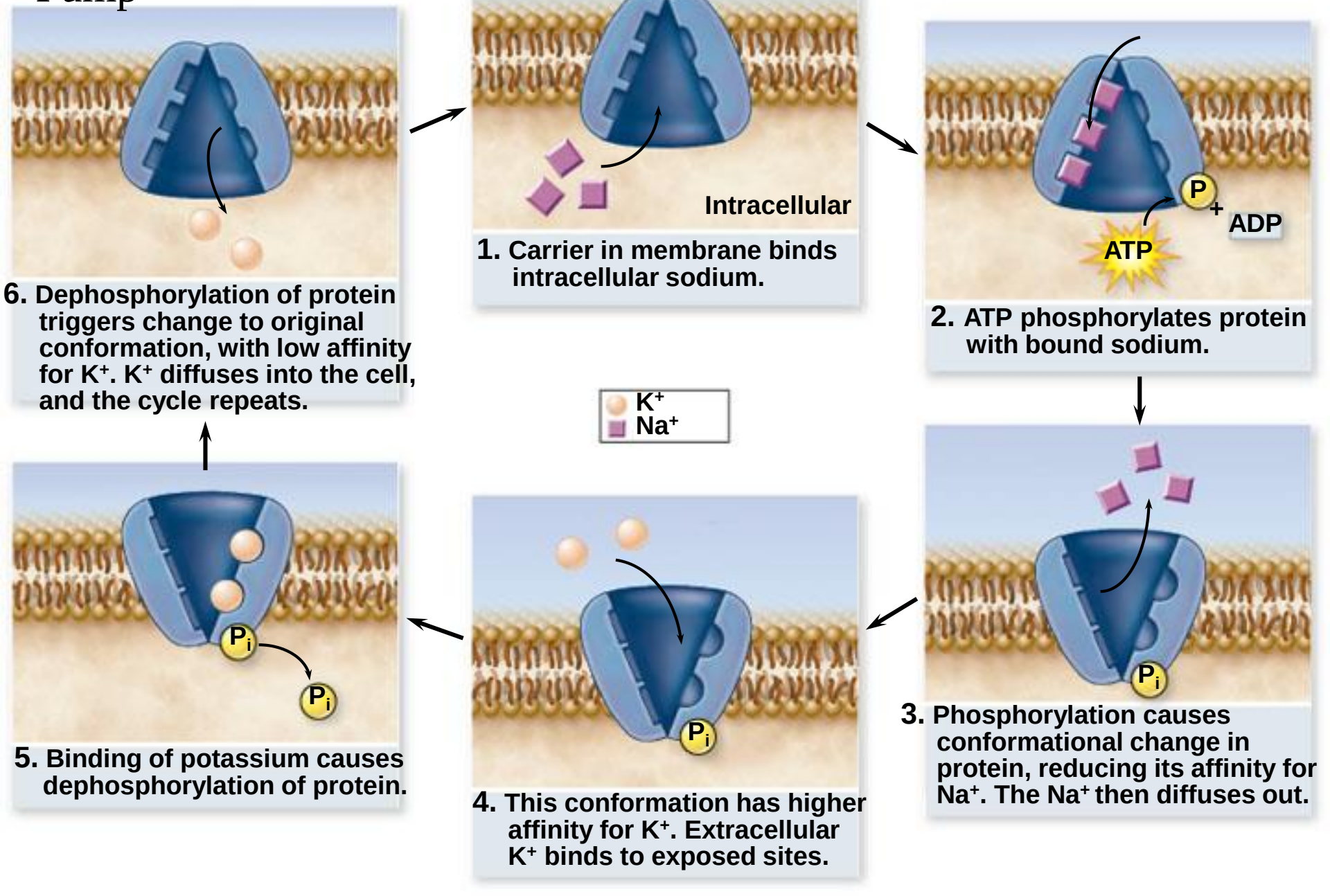




Establishment of Resting Membrane Potential

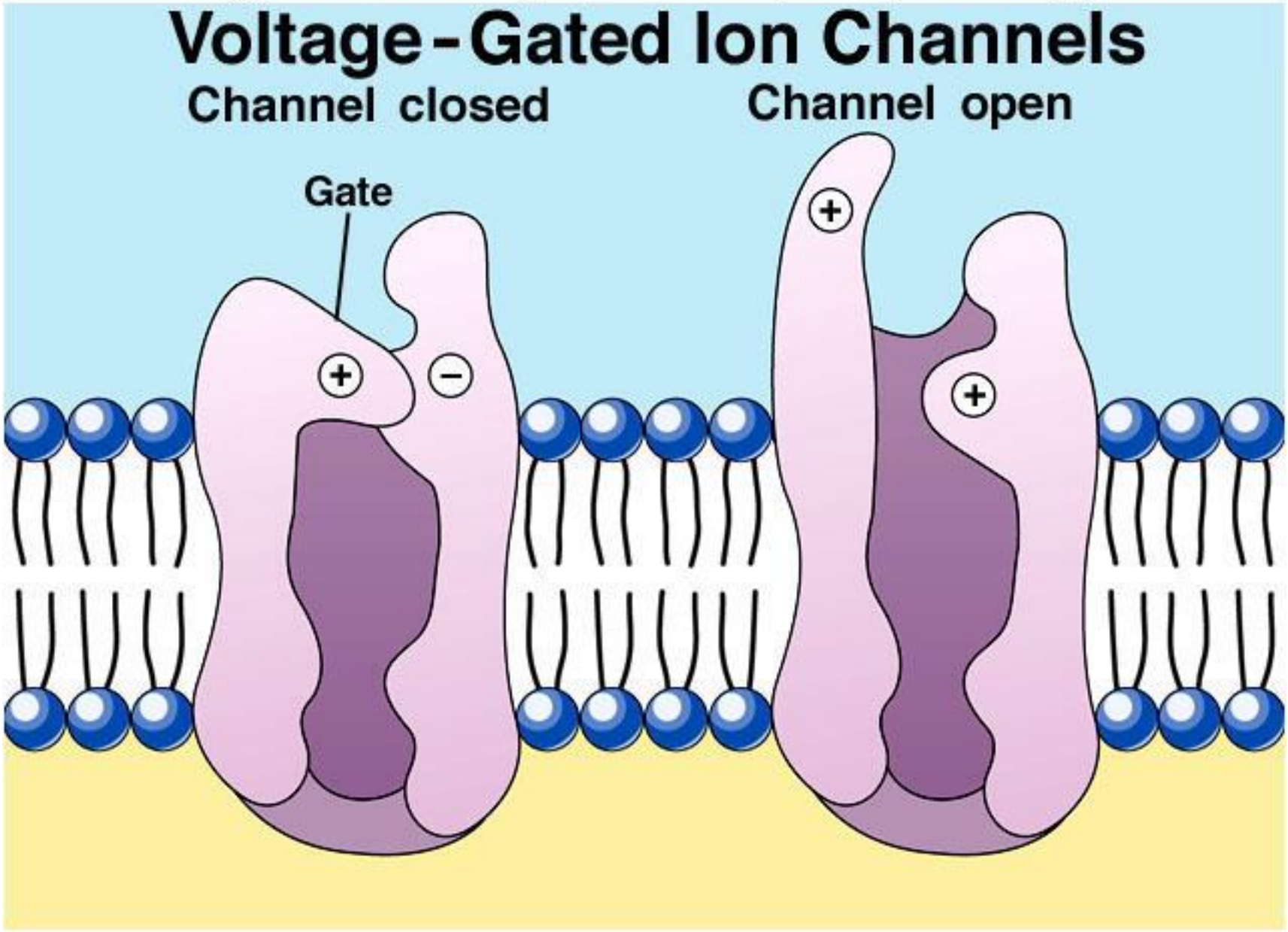


Sodium-Potassium Pump



Excitable Cells

- Neurons & muscle cells
- Have gated ion channels that allow cell to change its membrane potential in response to stimuli



Gated Ion Channels

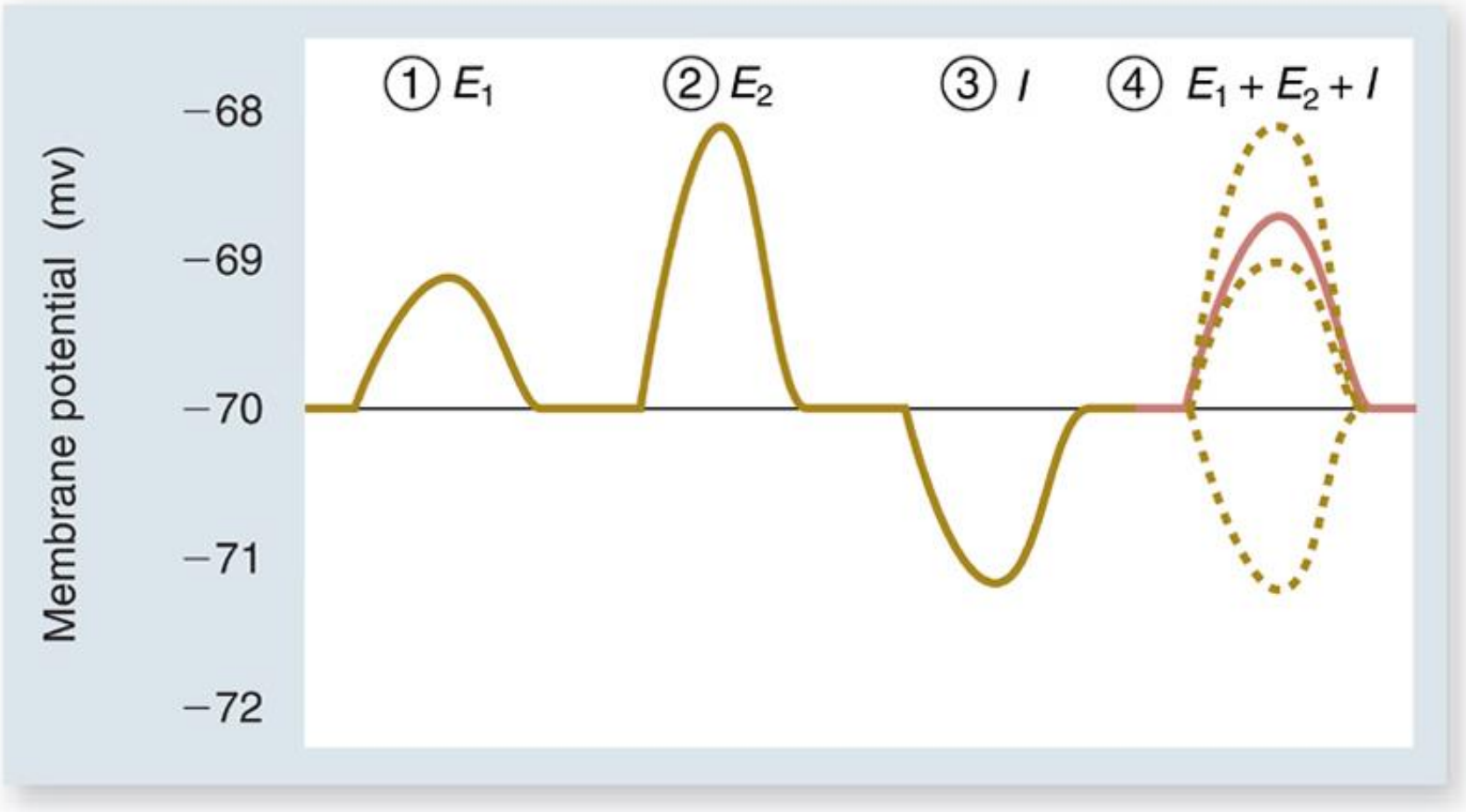
- Some stimuli open K+ channels
  - K+ leaves cell
  - Membrane potential more negative
  - **hyperpolarization**
- Some stimuli open Na+ channels
  - Na+ enters cell
  - Membrane potential less negative
  - **depolarization**

Gated Ion Channels

- Strength of stimuli determines how many ion channels open

  = graded response

Nerve Impulse Transmission

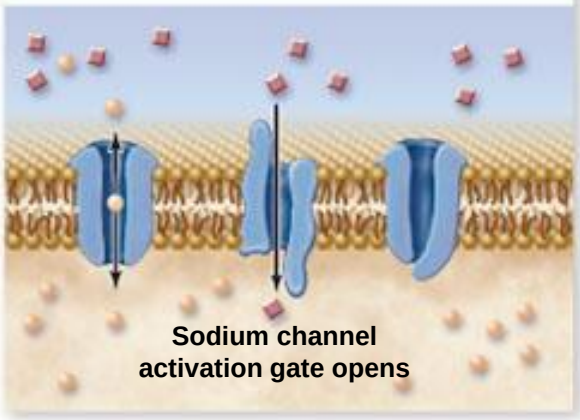


Action Potentials

- Occur once a threshold of depolarization is reached
  - -50 to –55 mV
- **All or none response** (not graded)
  - Magnitude of action potential is independent of strength of depolarizing stimuli
- Hyperpolarization makes them less likely

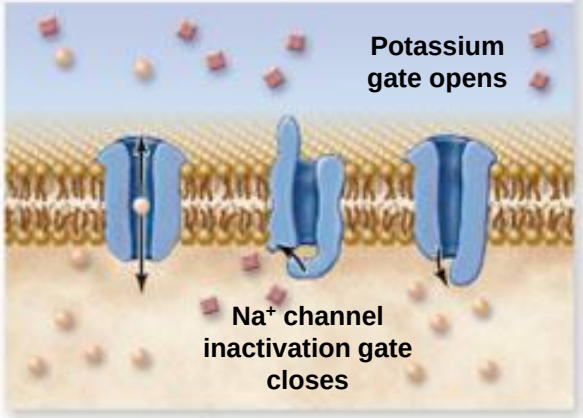
2. Rising Phase

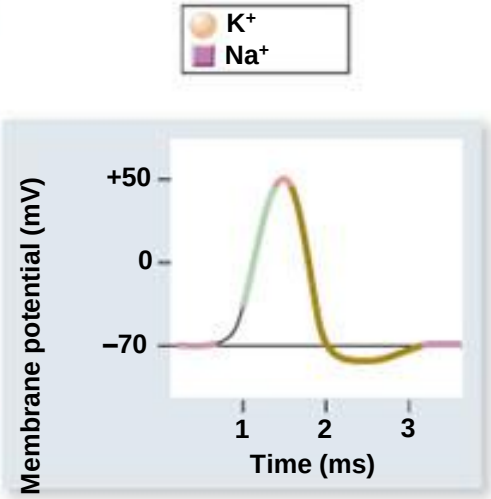
Stimulus causes above threshold voltage



3. Top curve

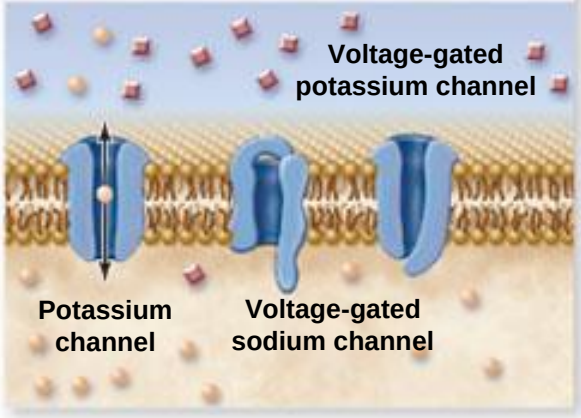
Maximum voltage reached





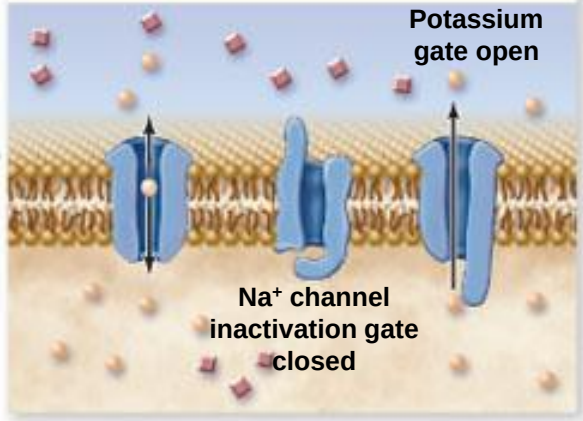
1. Resting Phase

Equilibrium between diffusion of K^+ out of cell and voltage pulling K^+ into cell



4. Falling Phase

Undershoot occurs as excess potassium diffuses out before potassium channel closes



Potassium channel gate closes

Equilibrium restored

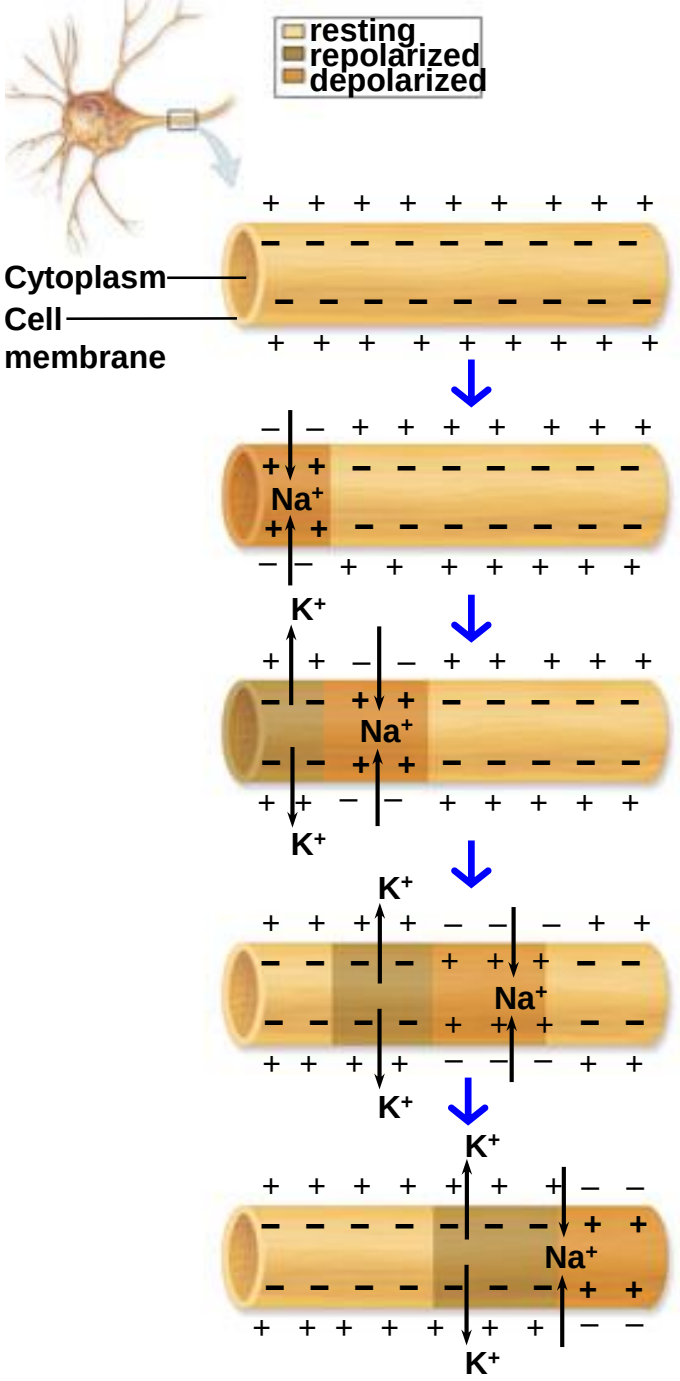
Sodium channel activation gate closes. Inactivation gate opens.

Refractory Period

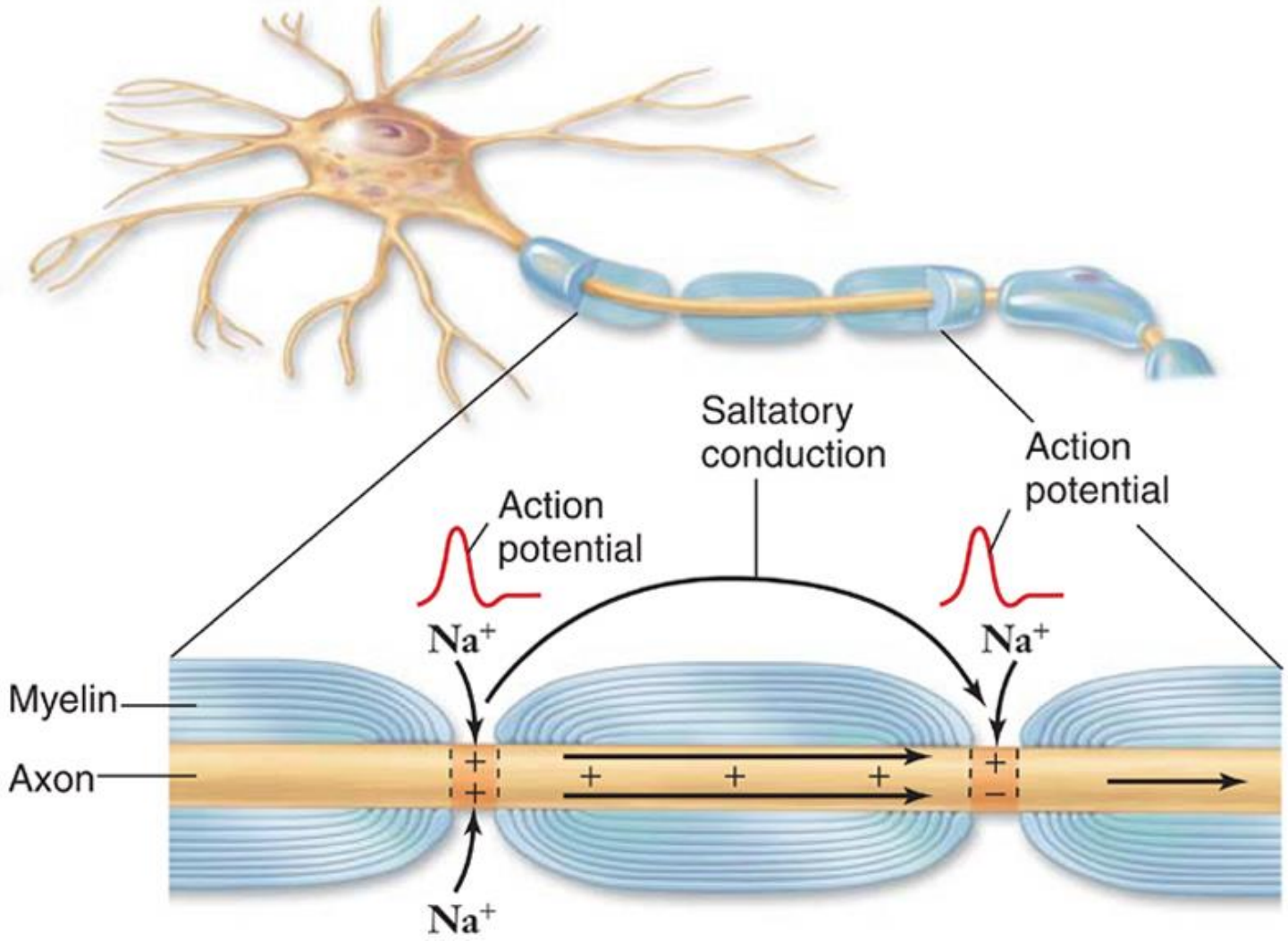
- During undershoot the membrane is less likely to depolarize
- Keeps the action potential moving in one direction

Propagation of Action Potential

- Action potential are very localized events
- DO NOT travel down membrane
- Are generated anew in a sequence along the neuron


resting
repolarized
depolarized
Cytoplasm
Cell membrane
Na+
K+
Na+
K+
K+
Na+
K+
K+
Na+
K+

Saltatory Conduction



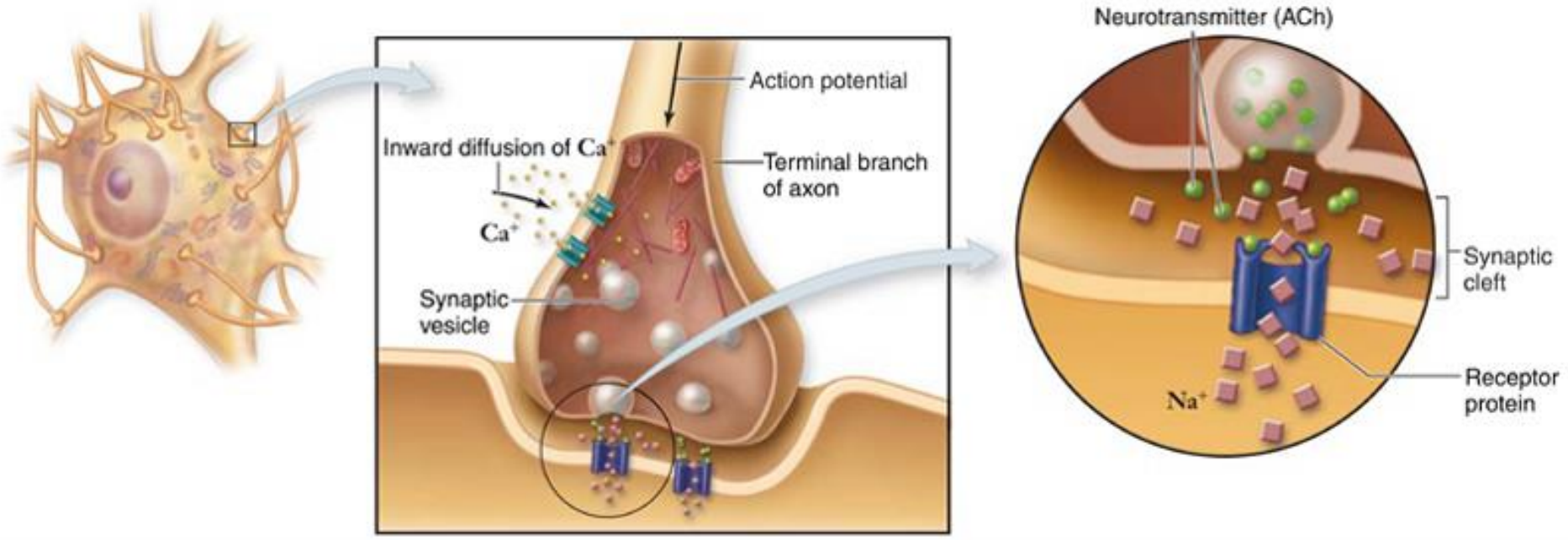
Transfer of Nerve Impulse to Next Cell

- Synapse
  - the gap between the synaptic terminals of an axon and a target cell

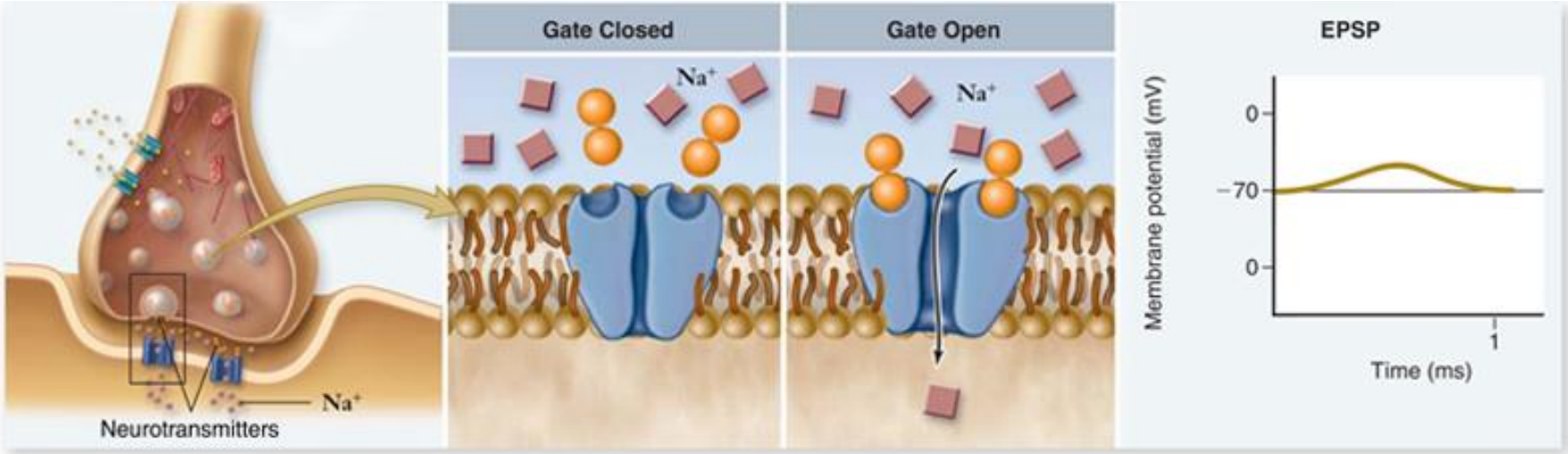
Transfer of Nerve Impulse to Next Cell

- Electrical synapses
  - Gap junctions allow ion currents to continue
- Chemical synapses
  - More common
  - Electrical impulses must be changed to a chemical signal that crosses the synapse

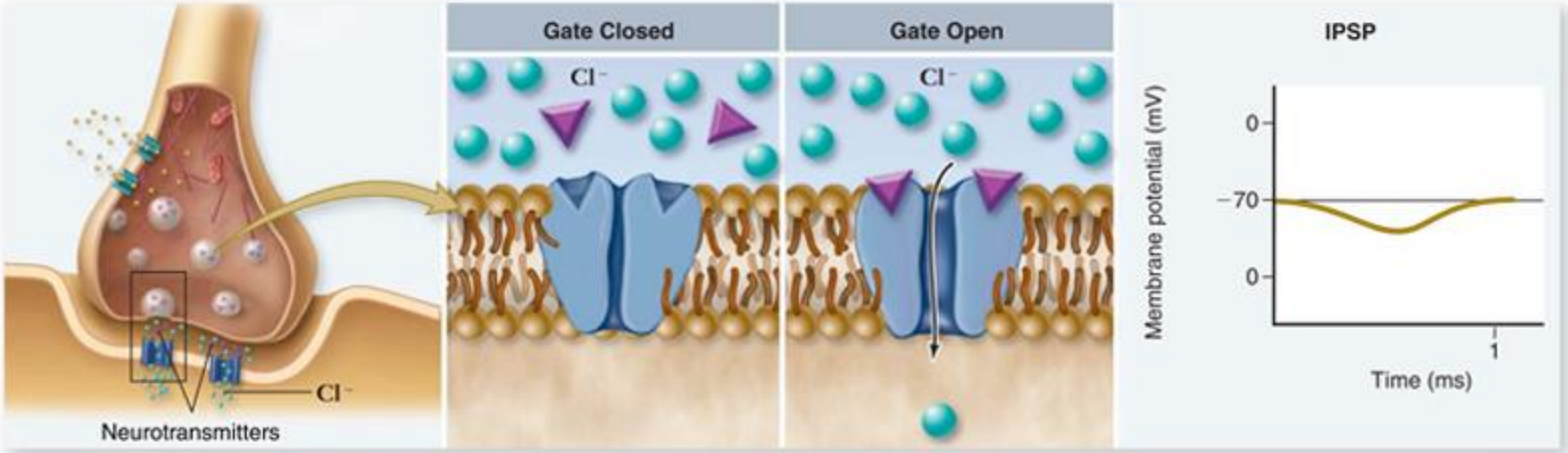
Synapses



Neurotransmitters

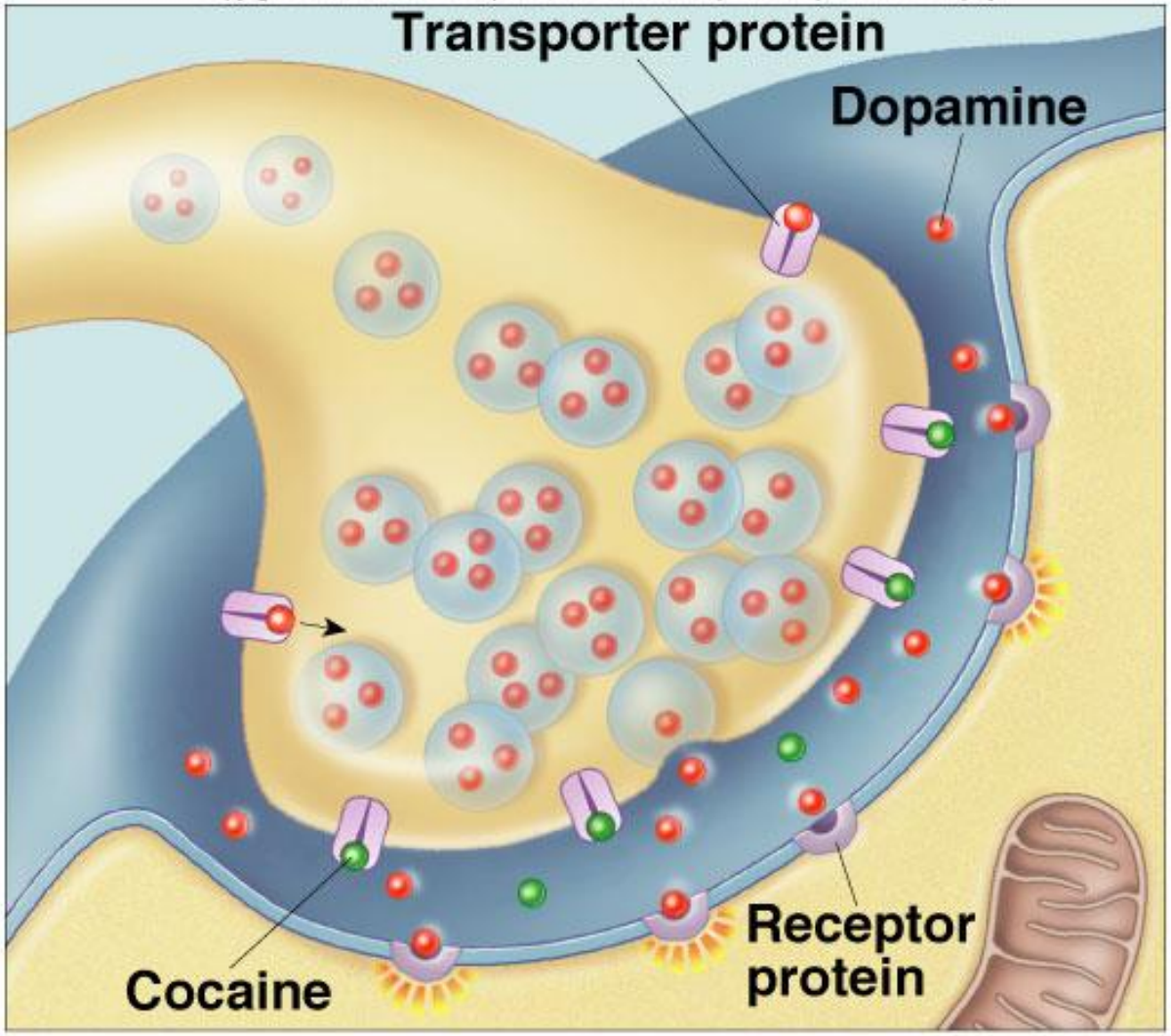


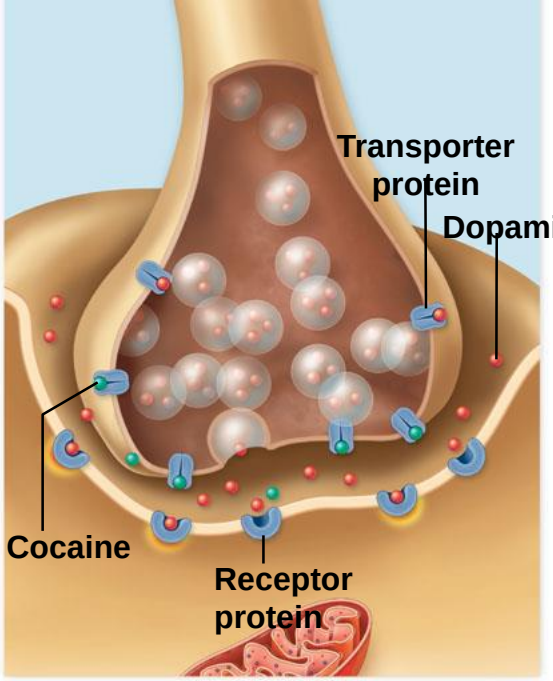
a.

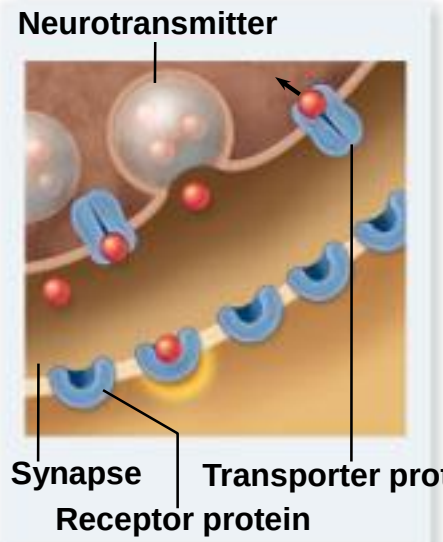


b.

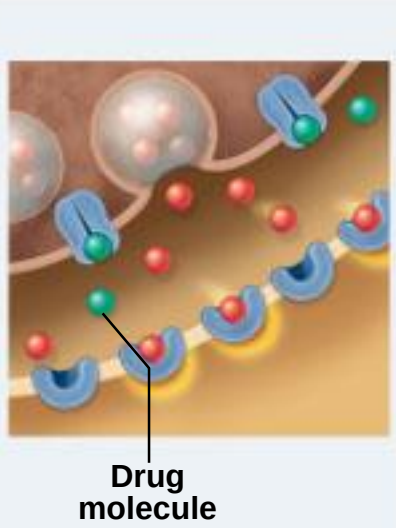
Effects of Cocaine



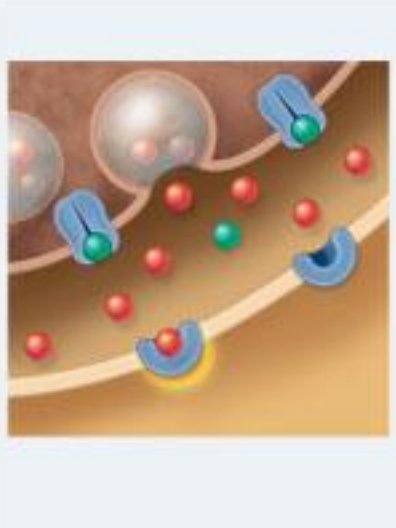




1. Reuptake of neuro-transmitter by transporter at a normal synapse.



2. Drug molecules block transporter and cause overstimulation of the postsynaptic membrane.



3. Neuron adjusts to overstimulation by decreasing the number of receptors.

4. Decreased number of receptors make the synapse less sensitive when the drug is removed.

Diversity of Nervous Systems