

The Skin and
MUSCULOSKELETAL
System



PHYSIOLOGY

SLIDES
SHEET

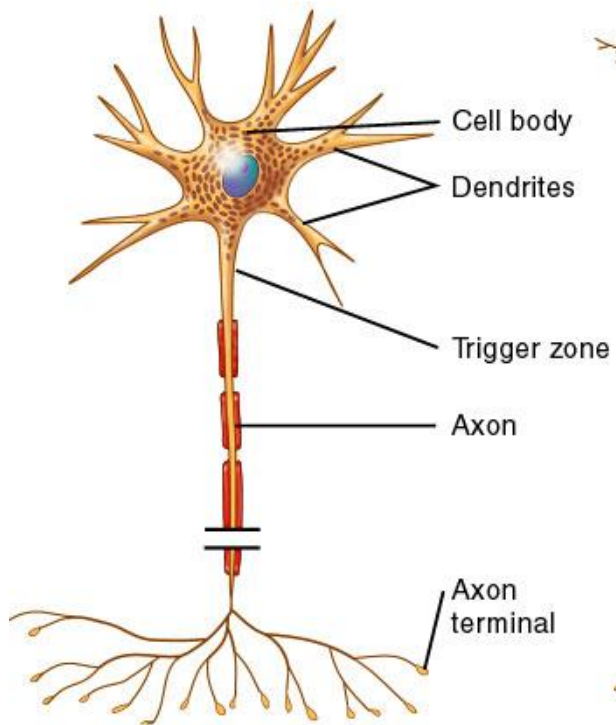
DOCTOR: Dr. M. Khatatbeh
DONE BY:

Number # 1- Membrane Excitability

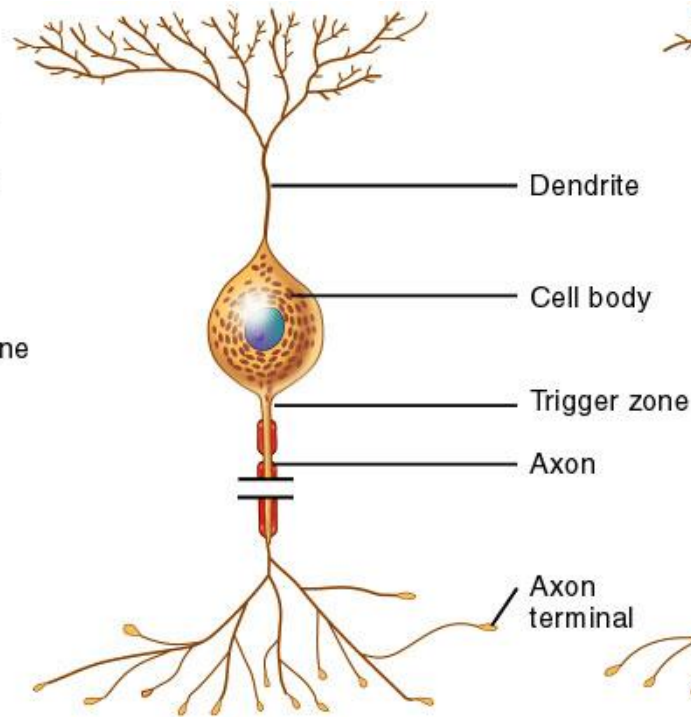
Nerve and Muscle Physiology

Plasma Membranes of Excitable tissues

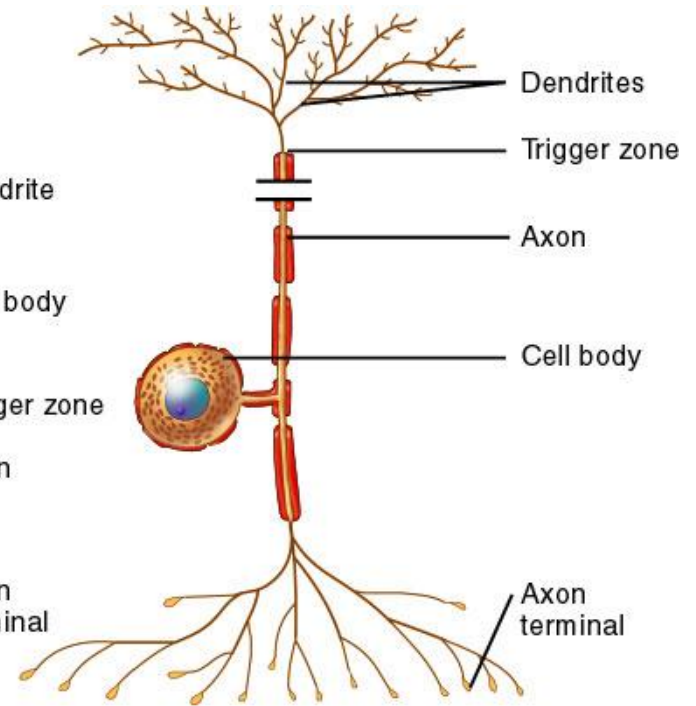
Ref: Guyton, 12th ed: pp: 57-69.
11th ed: **p57-71,**



(a) Multipolar neuron

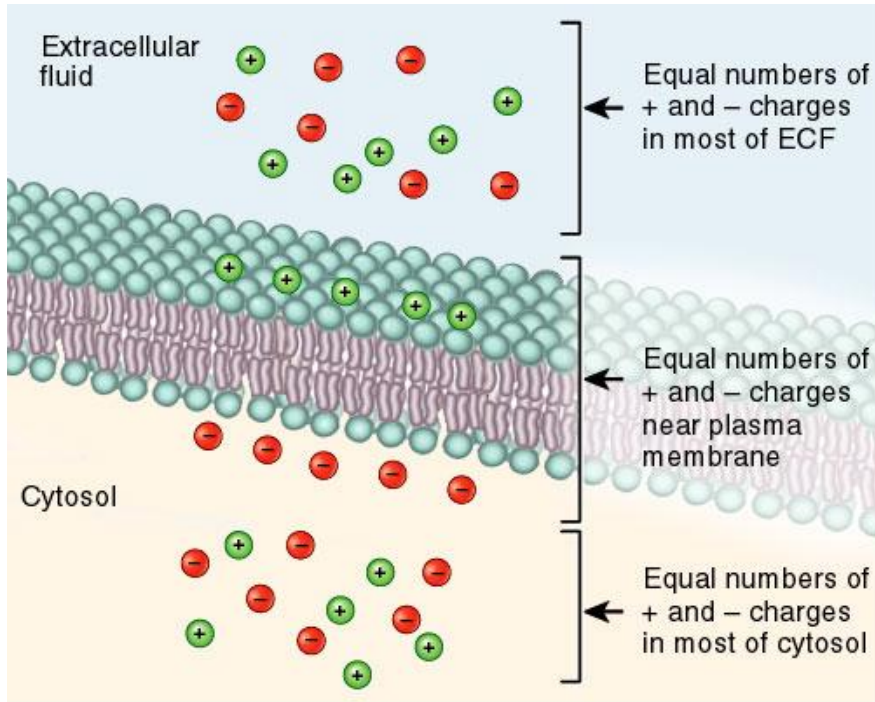


(b) Bipolar neuron

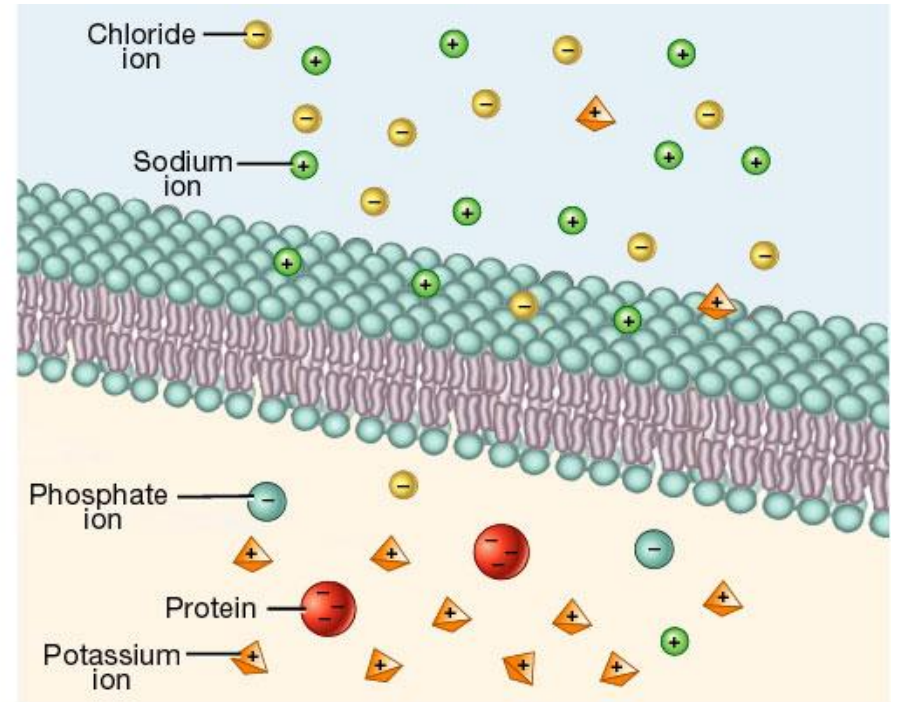


(c) Unipolar neuron

Fig. 12.09a,b



(a) Distribution of charges



(b) Distribution of ions

Nernst equation

$$E = \frac{RT}{ZF} \ln \frac{[C]_{out}}{[C]_{in}}$$

R (Gas Constant) = 8.314472 (J/K·mol)

T (Absolute Temperature) = t °C +
273.15 (°K)

Z (Valence)

F (Faraday's Constant) = 9.6485309×10⁴
(C/mol)

[C]_{out} (Outside Concentration, mM)

[C]_{in} (Inside Concentration, mM)

E_{K^+}

$$E_{eq, K^+} = 61.54 mV \log \frac{[K^+]_o}{[K^+]_i}$$

$$E \text{ (mV)} = - 61 \cdot \log (C_i/C_o)$$

E = Equilibrium potential for a univalent ion

C_i = conc. inside the cell.

C_o = conc. outside the cell.

Goldman Hodgkin Katz equation

$$E_m = \frac{RT}{F} \ln \left(\frac{P_{Na^+} [Na^+]_o + P_{K^+} [K^+]_o + P_{Cl^-} [Cl^-]_i}{P_{Na^+} [Na^+]_i + P_{K^+} [K^+]_i + P_{Cl^-} [Cl^-]_o} \right)$$

i = Conc. inside

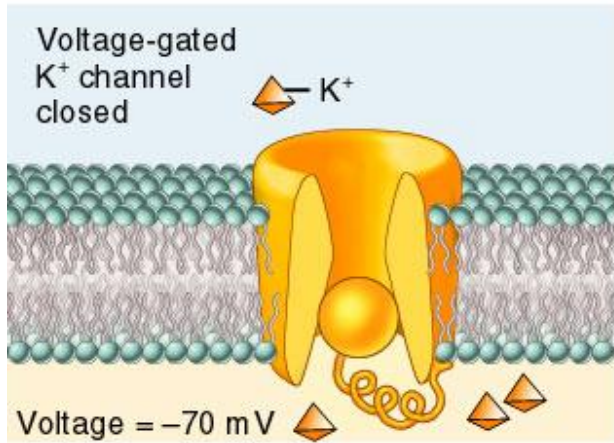
o = Conc. outside

P = permeability of the membrane to that ion.

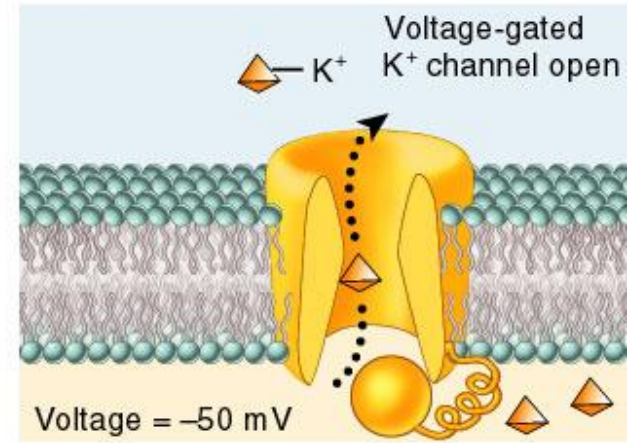
□ Extracellular fluid

■ Plasma membrane

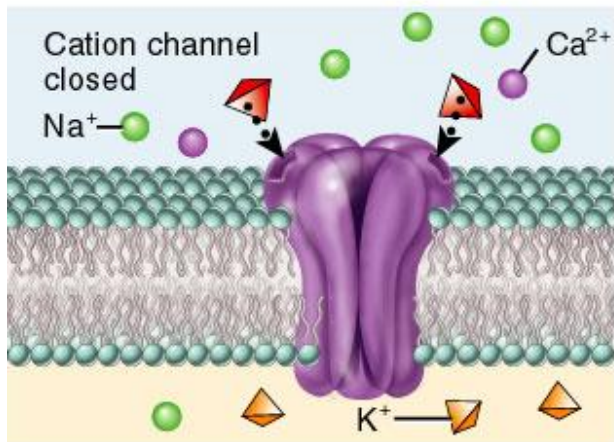
□ Cytosol



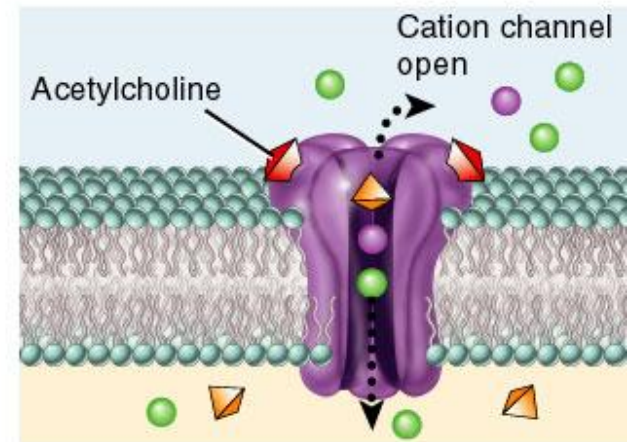
Change in
membrane potential
opens the channel



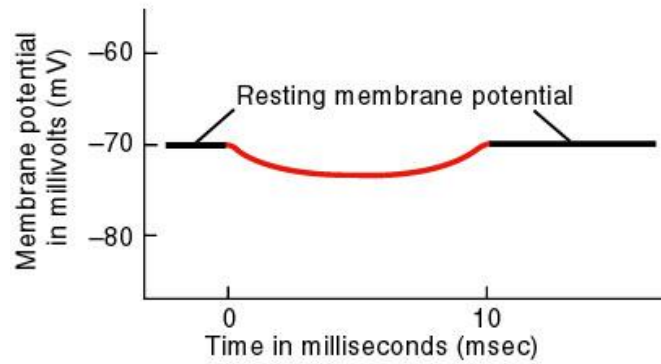
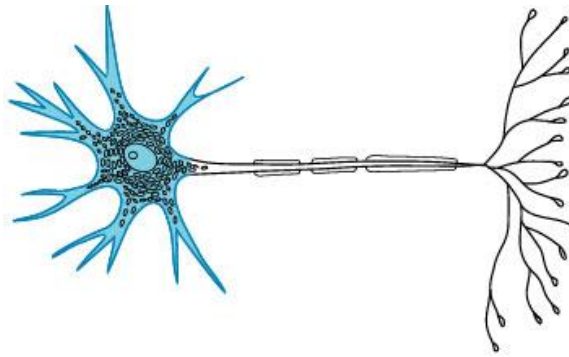
(a) Voltage-gated channel



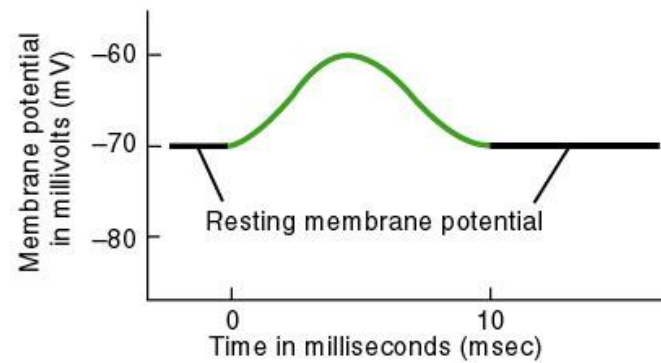
Chemical stimulus
opens the channel



(b) Ligand-gated channel



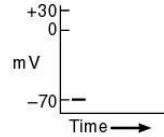
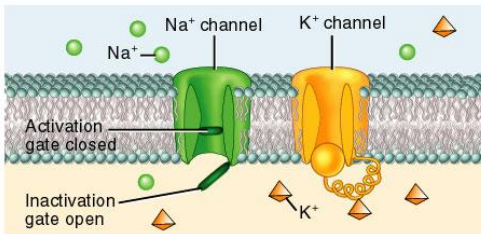
(a) Hyperpolarizing graded potential



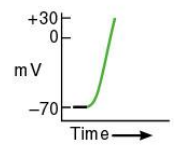
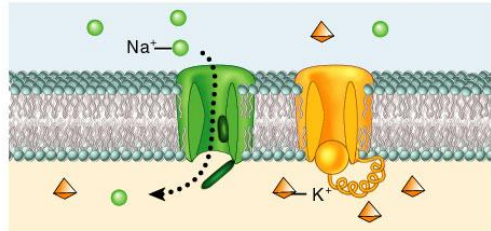
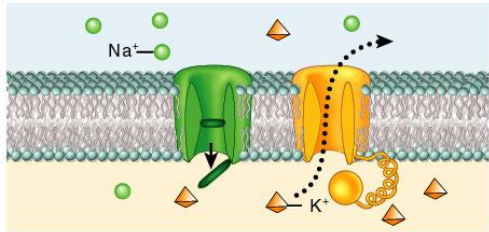
(b) Depolarizing graded potential

□ Extracellular fluid ■ Plasma membrane □ Cytosol

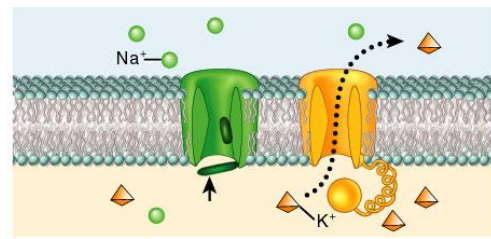
1. Resting state:
All voltage-gated Na⁺ and K⁺ channels are closed.



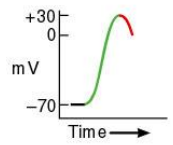
2. Depolarizing phase:
Depolarization to threshold opens Na⁺ channel activation gates. Na⁺ inflow further depolarizes the membrane, opening more Na⁺ channel activation gates.

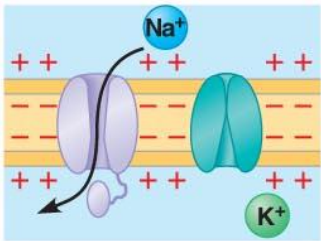


4. Repolarization continues:
K⁺ outflow restores resting membrane potential. Na⁺ channel inactivation gates open. Return to resting state when K⁺ gates close.

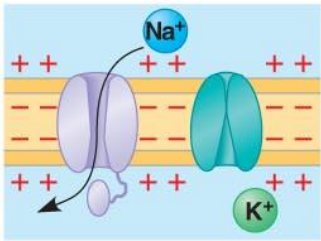


3. Repolarizing phase:
Na⁺ channel inactivation gates close and K⁺ channels open. Outflow of K⁺ causes repolarization.

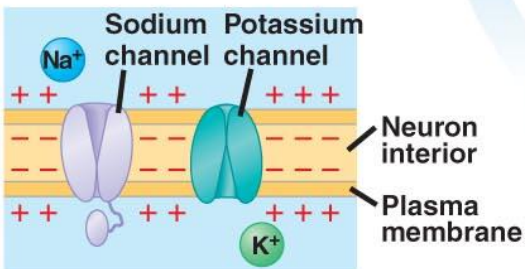




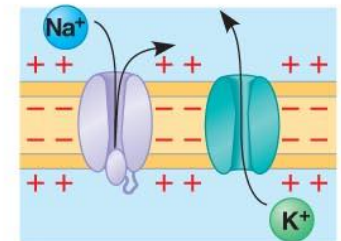
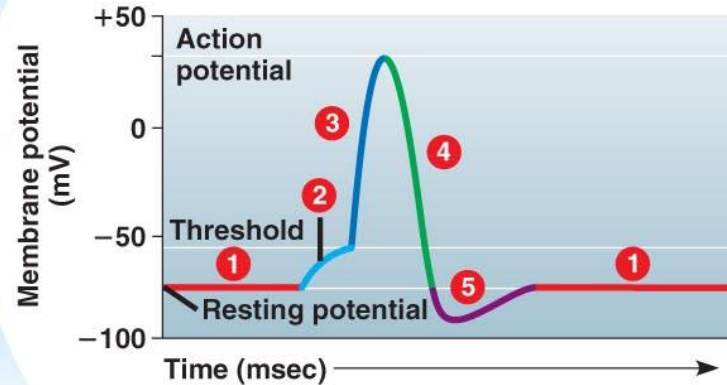
- 3** Additional Na^+ channels open, K^+ channels are closed; interior of cell becomes more positive.



- 2** A stimulus opens some Na^+ channels; if threshold is reached, action potential is triggered.

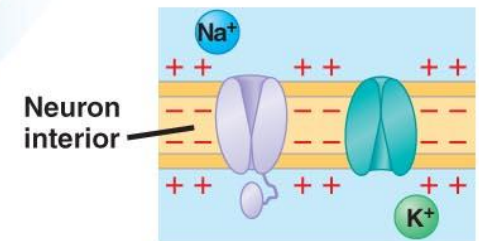


- 1** Resting state: voltage-gated Na^+ and K^+ channels closed; resting potential is maintained.

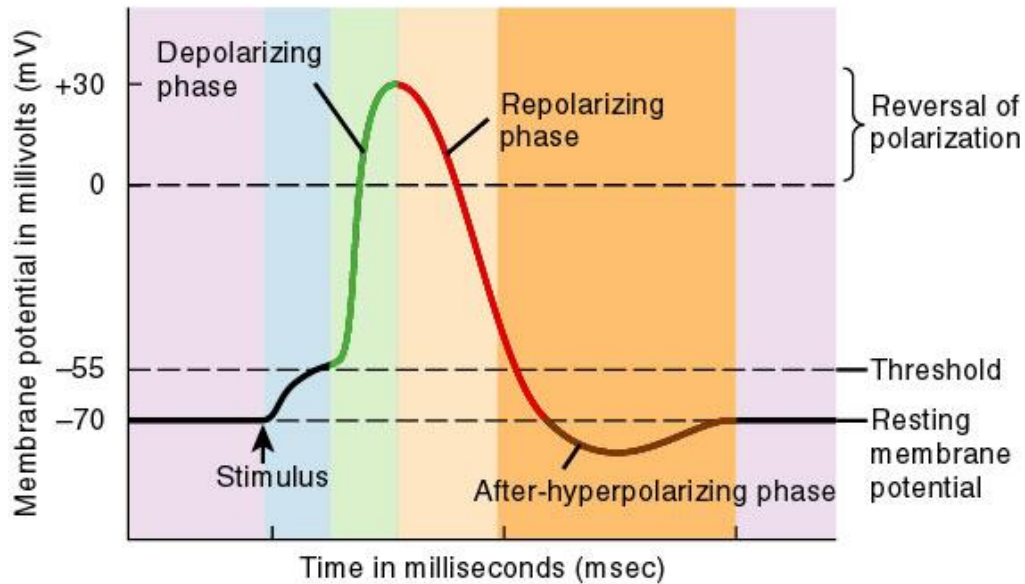
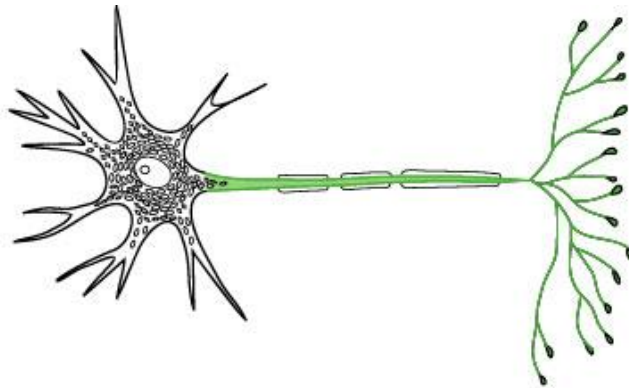


- 4** Na^+ channels close and inactivate. K^+ channels open, and K^+ rushes out; interior of cell more negative than outside.

- 5** The K^+ channels close relatively slowly, causing a brief undershoot.



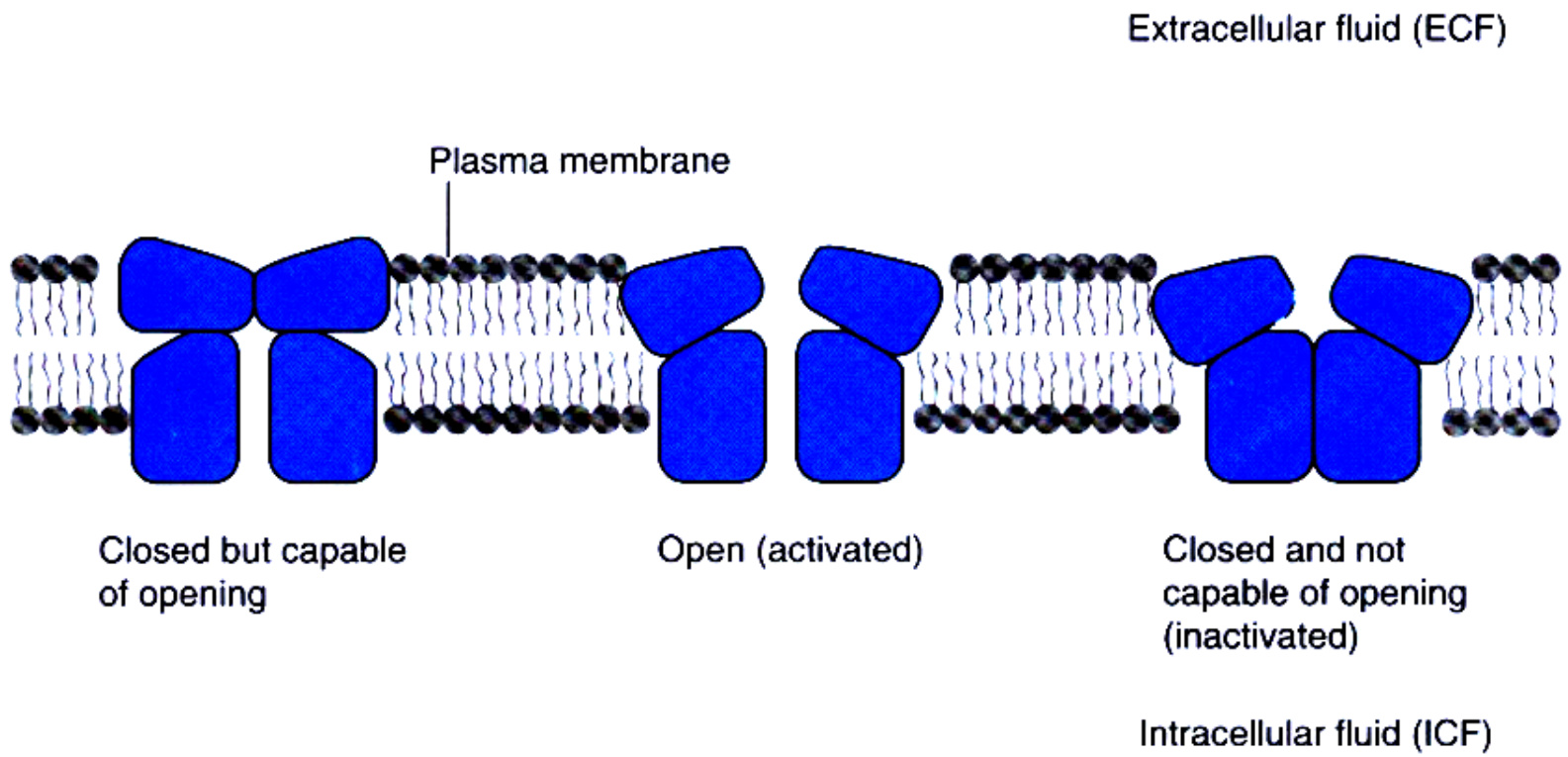
- 1** Return to resting state.



Key:

- Resting membrane potential: Voltage-gated Na^+ channels are in the resting state and voltage-gated K^+ channels are closed
 - Stimulus causes depolarization to threshold
 - Voltage-gated Na^+ channel activation gates are open
 - Voltage-gated K^+ channels are open; Na^+ channels are inactivating
 - Voltage-gated K^+ channels are still open; Na^+ channels are in the resting state
- Absolute refractory period
- Relative refractory period

Conformations of Voltage-Gated Na⁺ Channels



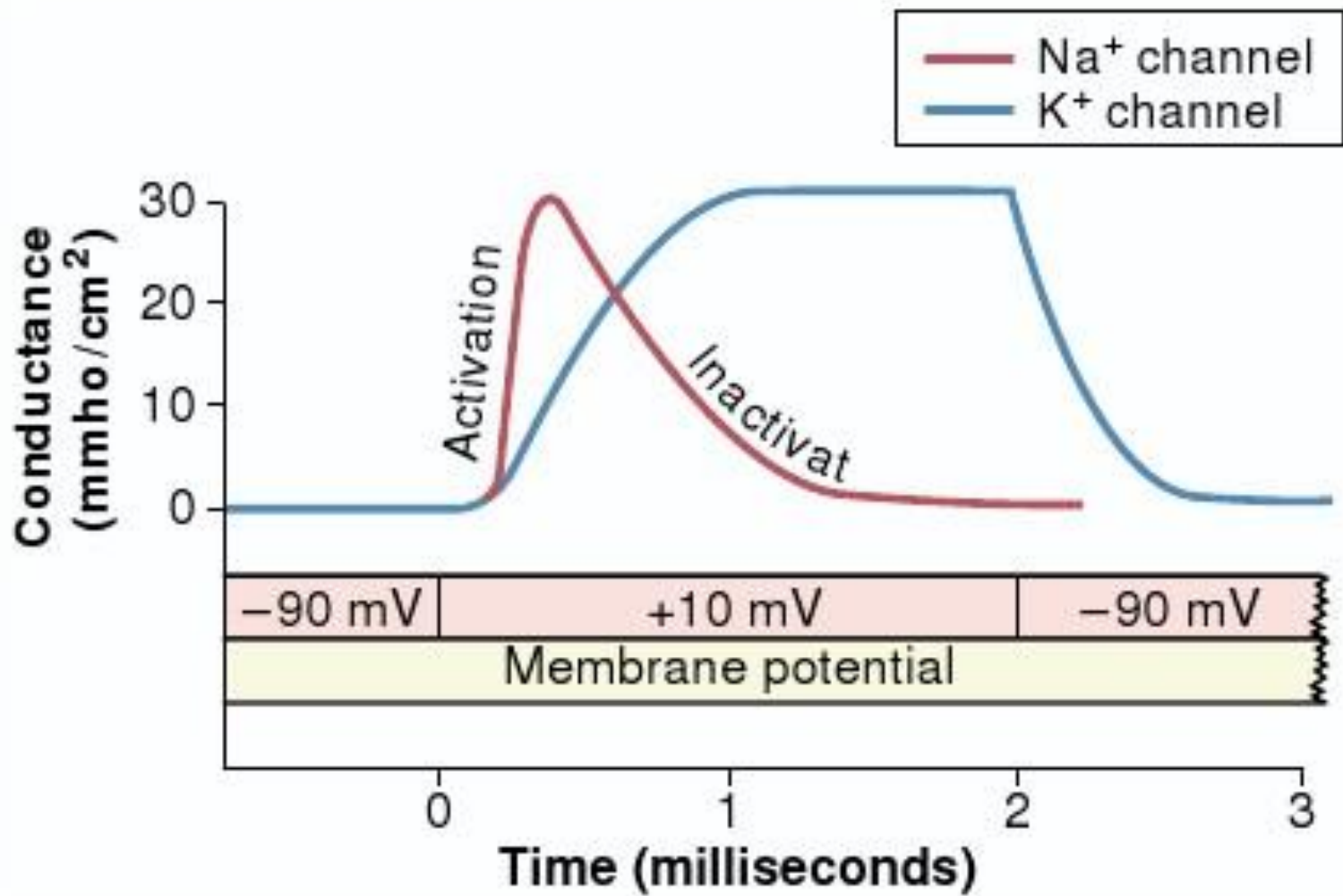
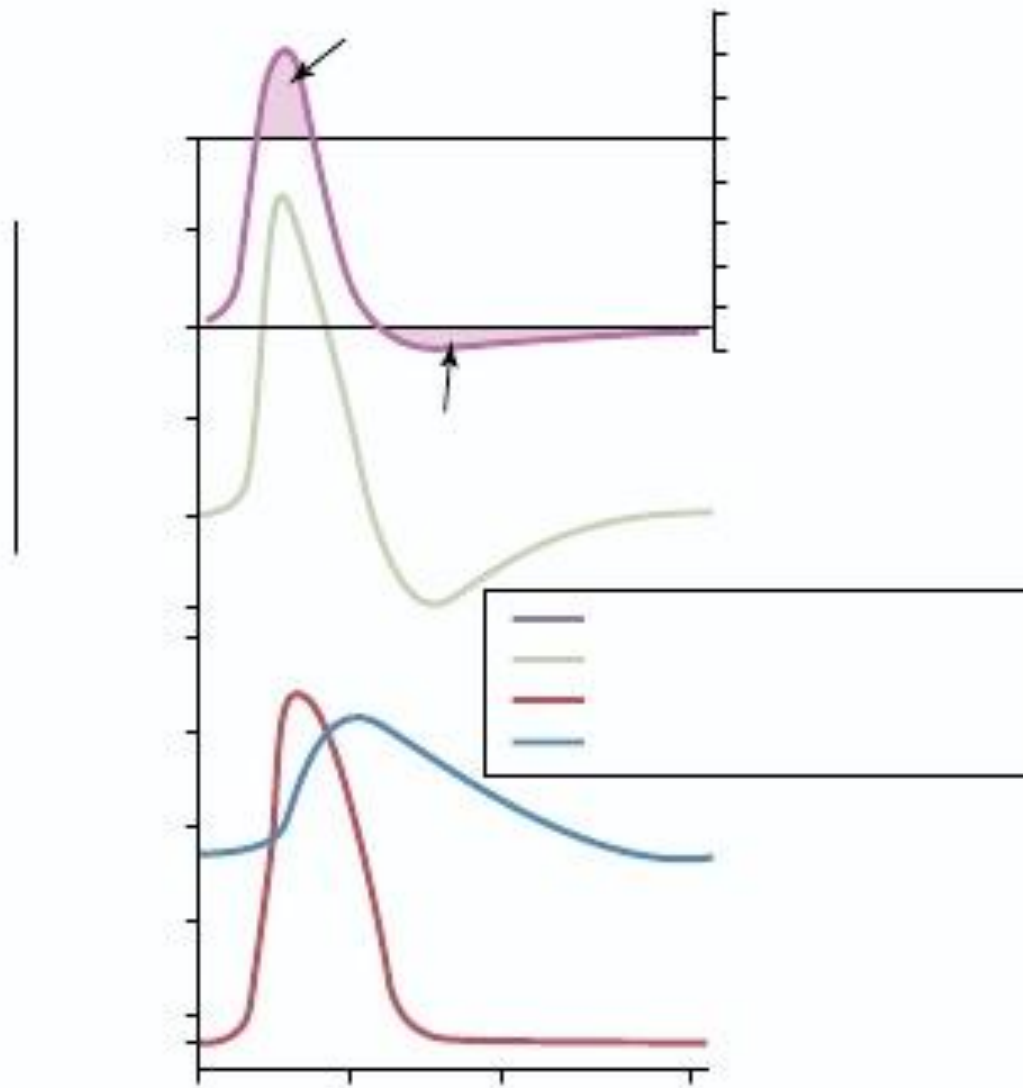
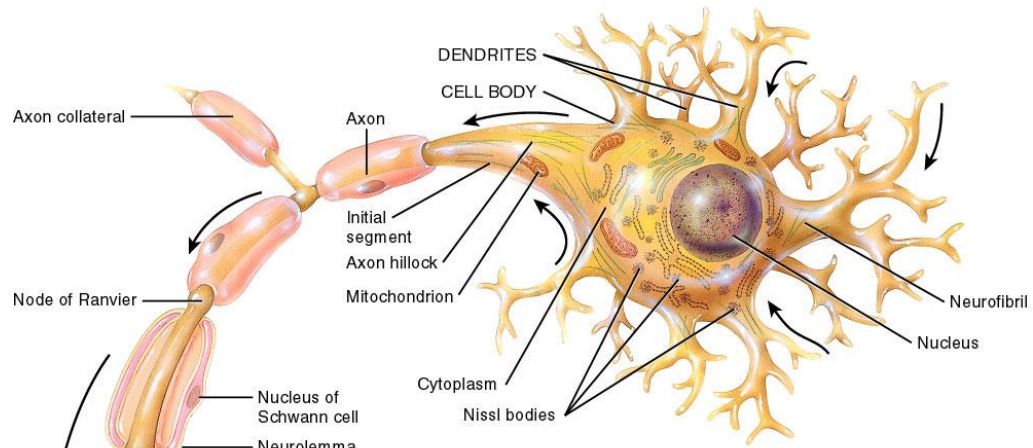
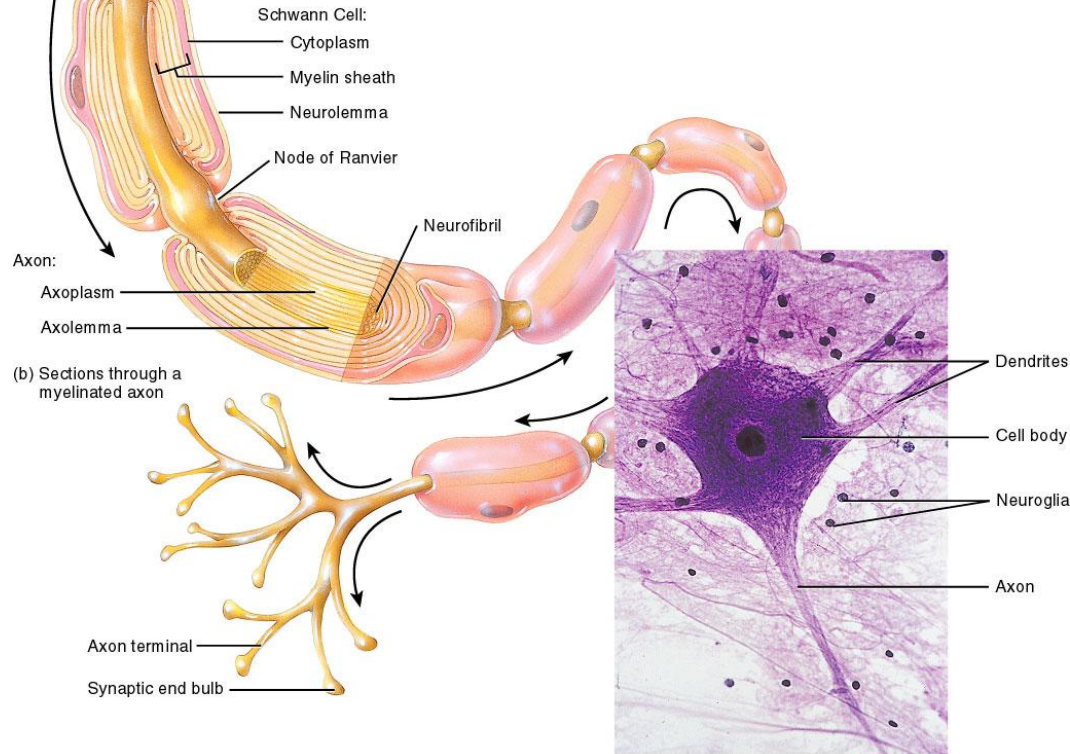


Figure 5-9

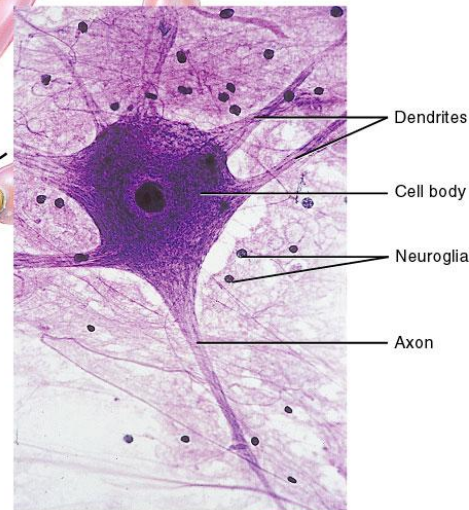




(a) Parts of a motor neuron

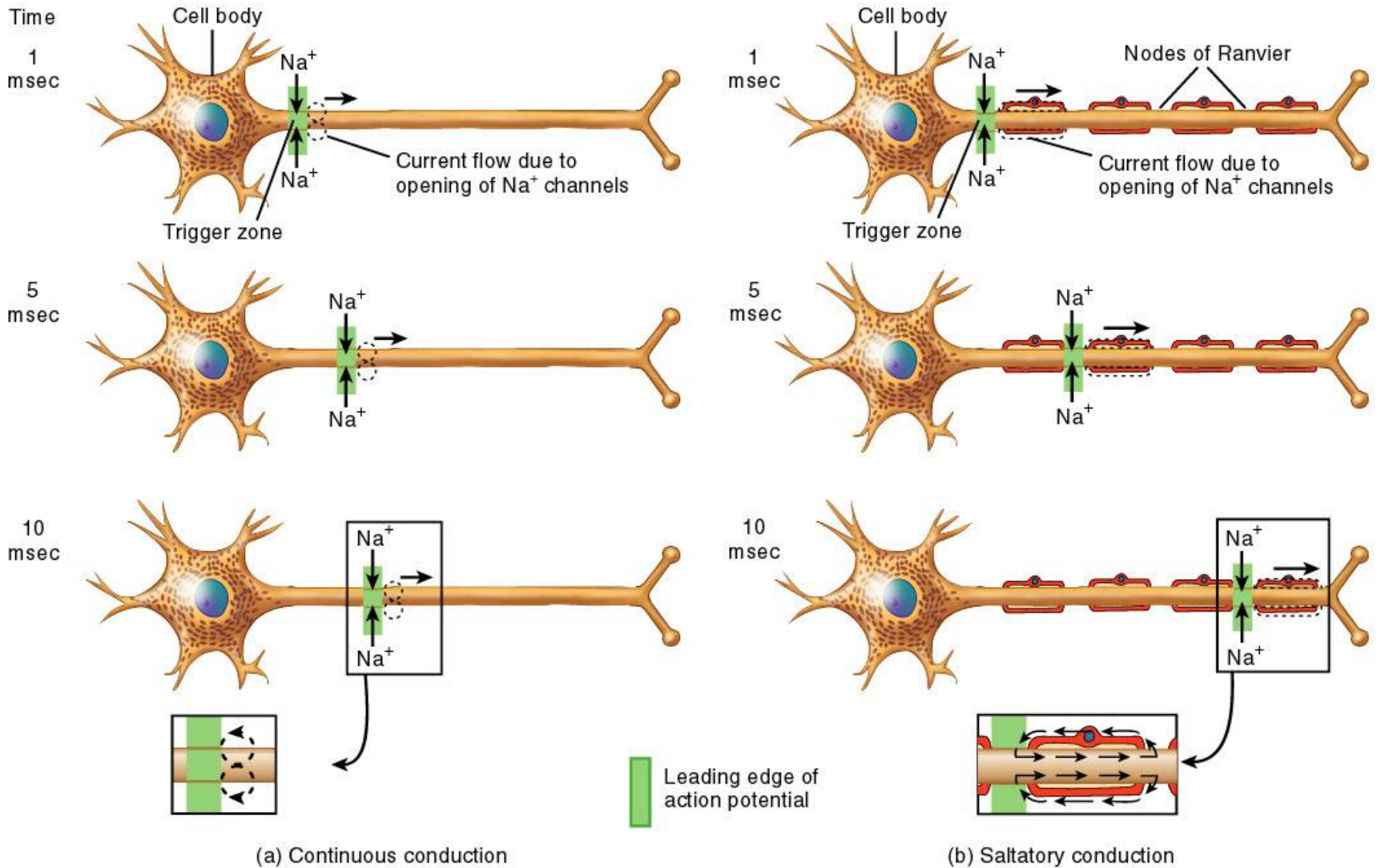


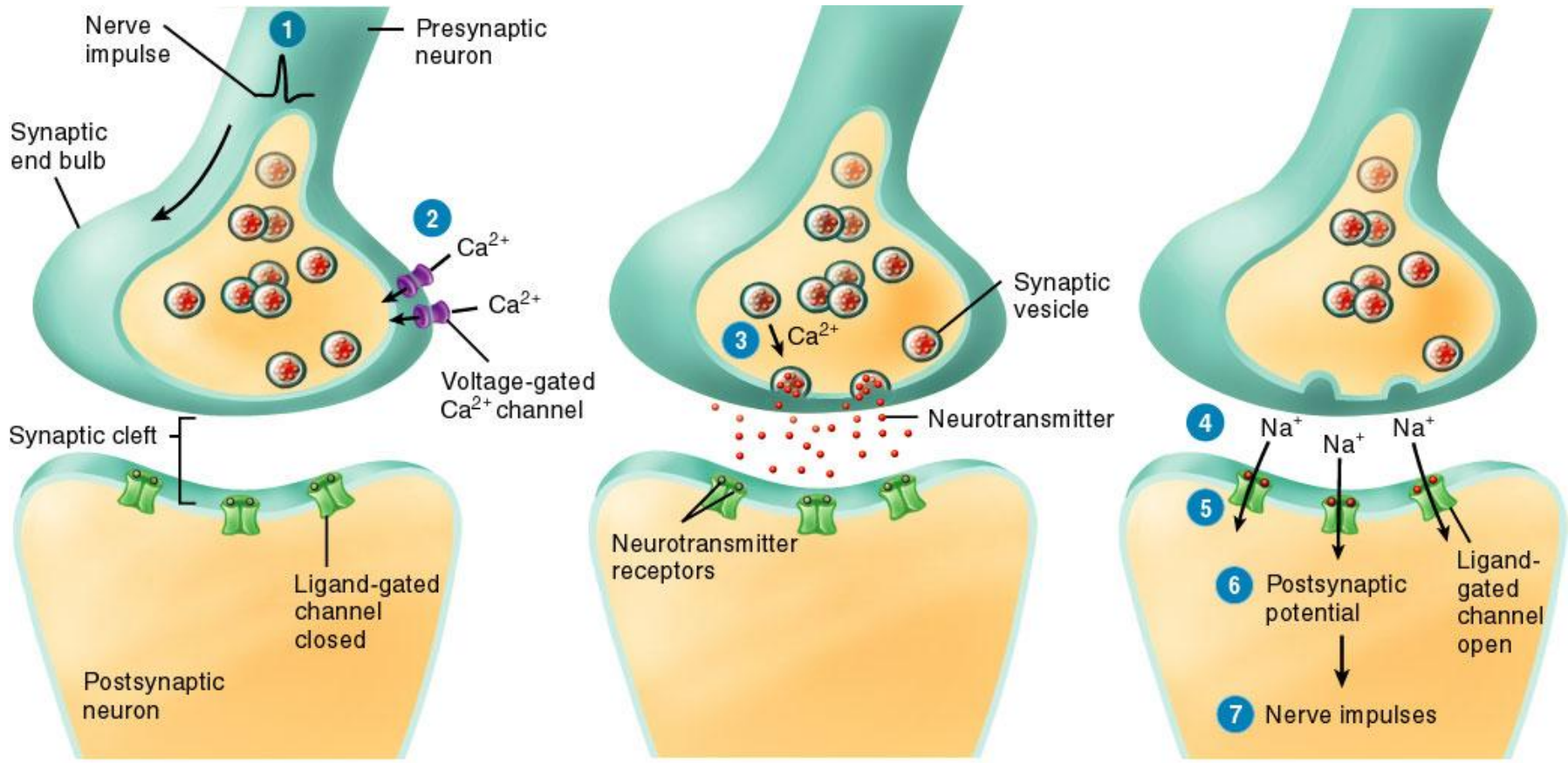
(b) Sections through a myelinated axon



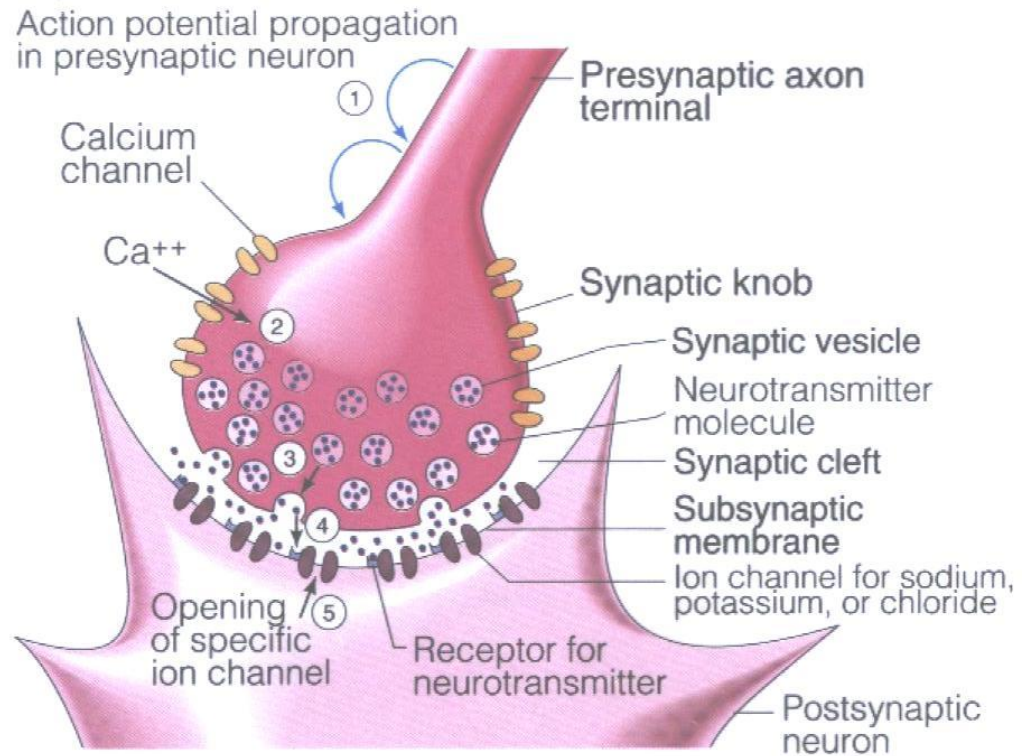
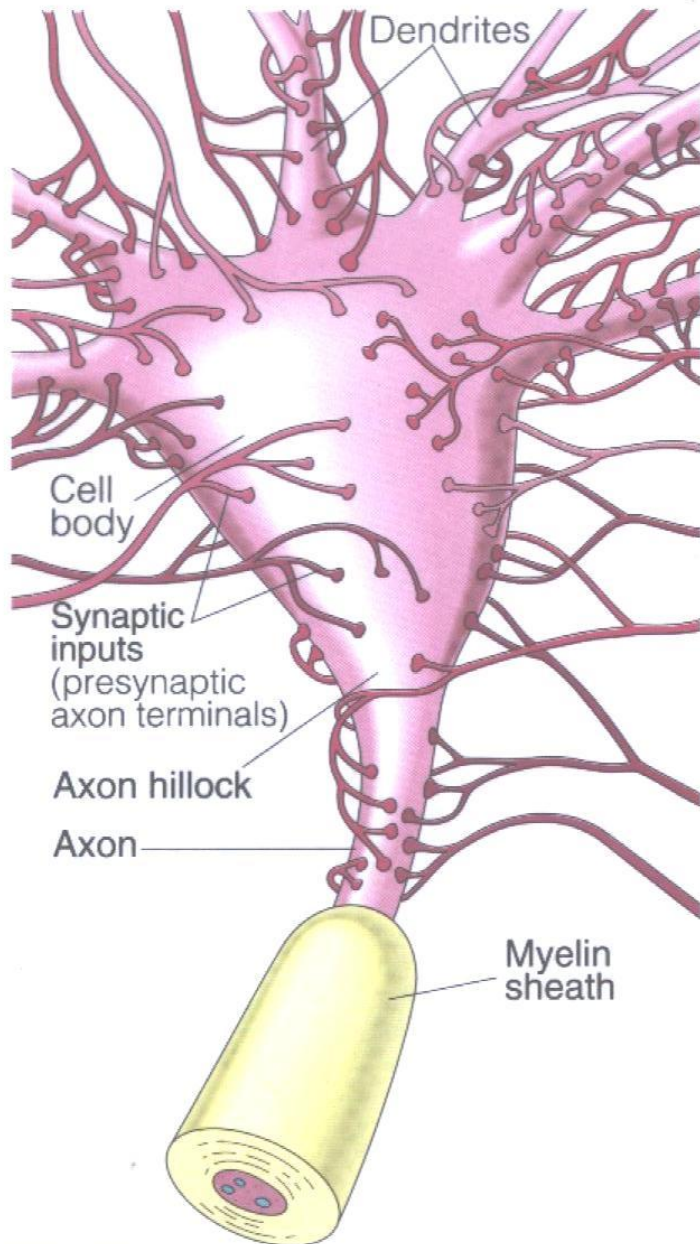
LM 430x

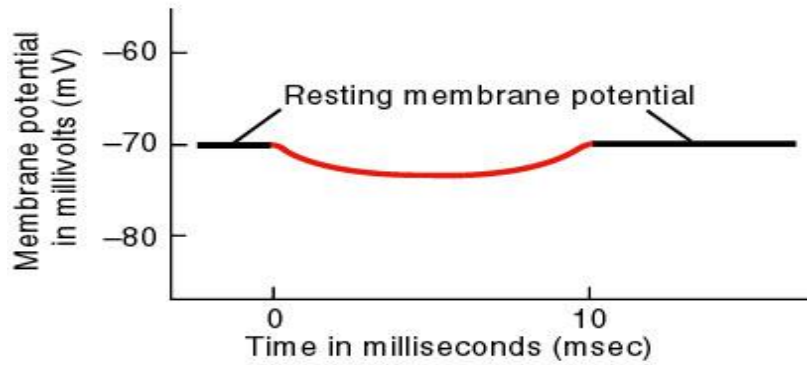
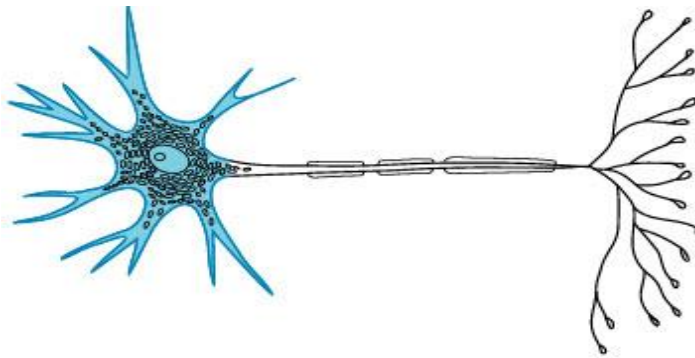
(c) Motor neuron



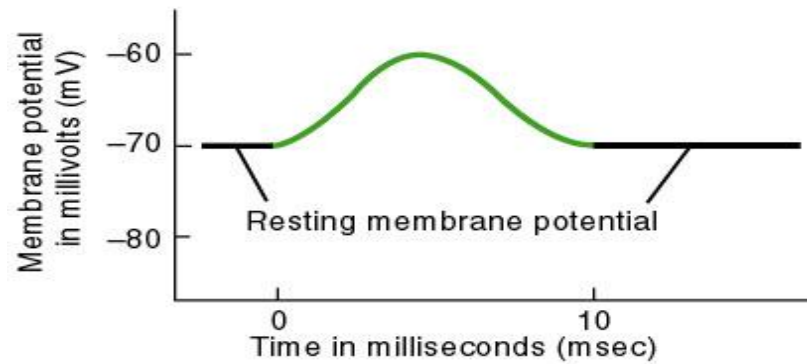


Synaptic Structure and Function

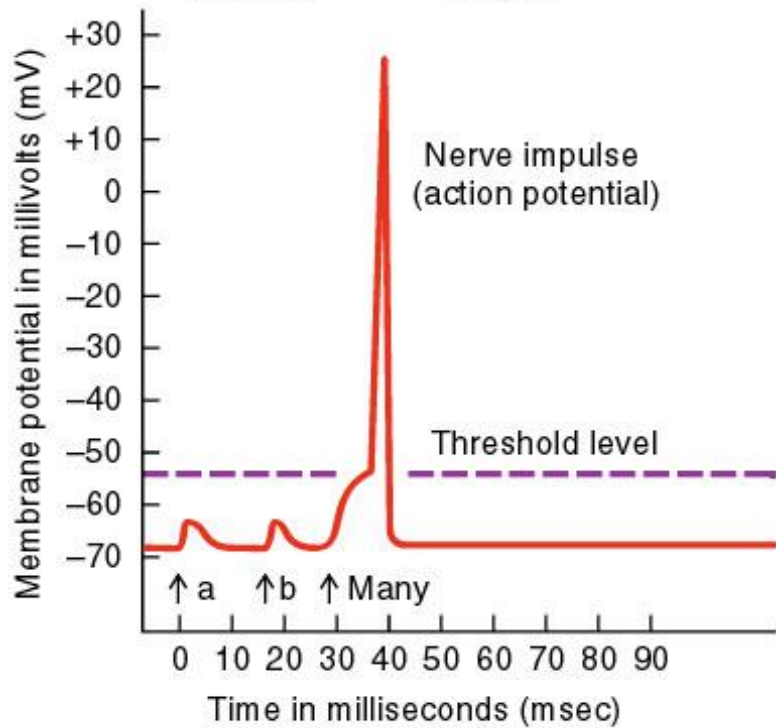
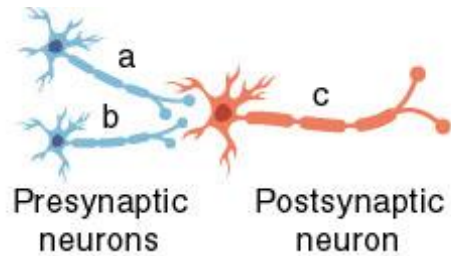




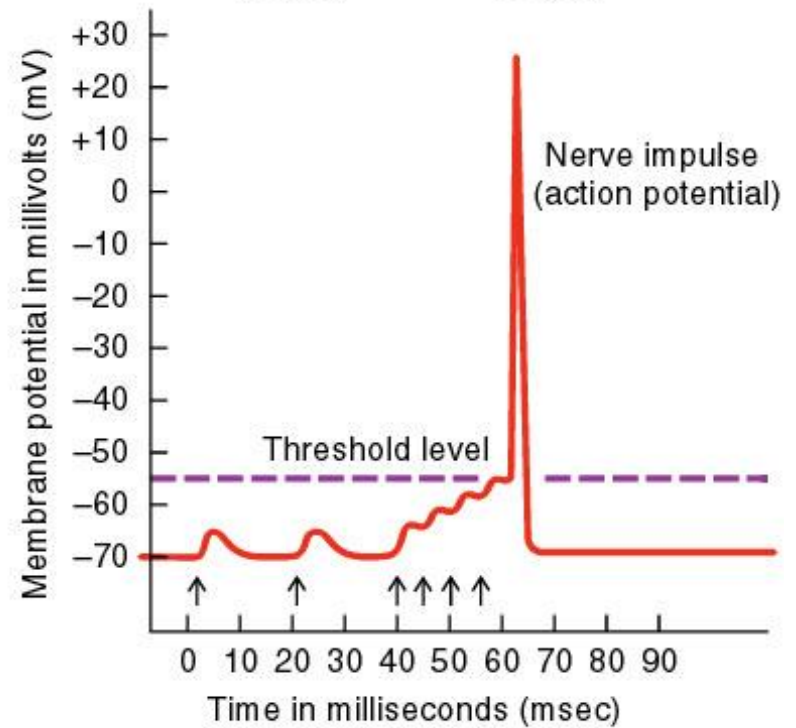
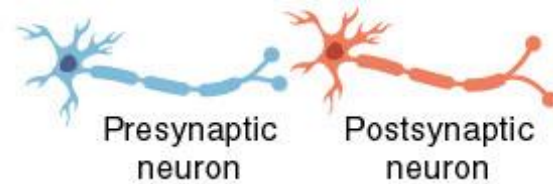
(a) Hyperpolarizing graded potential



(b) Depolarizing graded potential

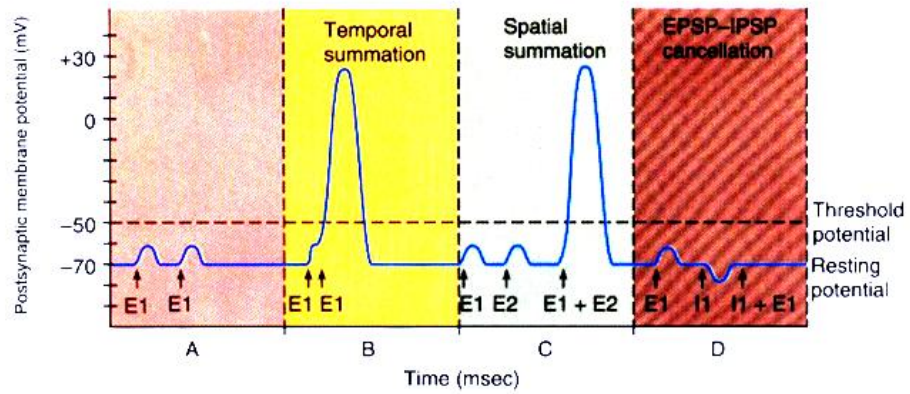
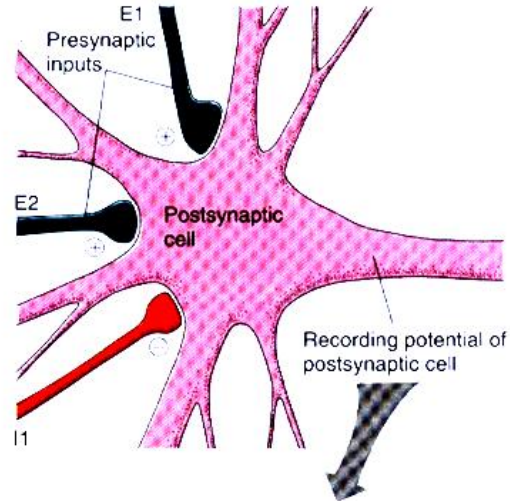


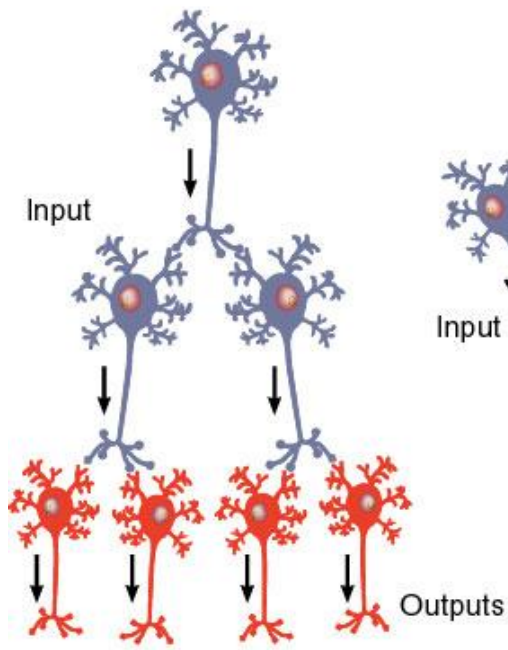
(a) Spatial summation



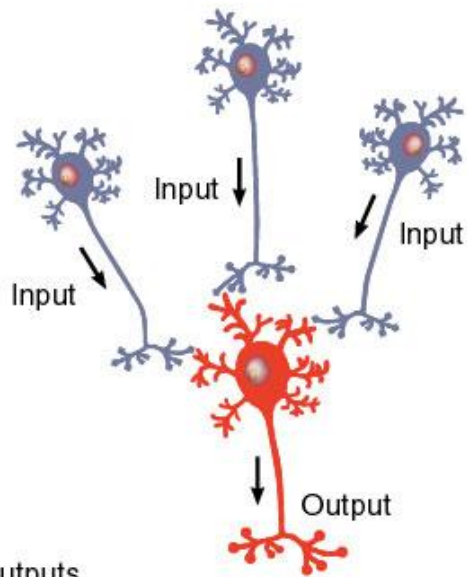
(b) Temporal summation

Determination of Grand Postsynaptic Potential

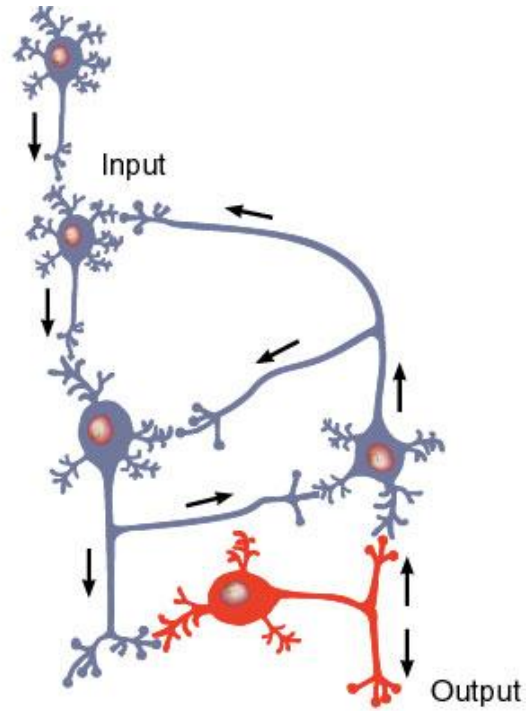




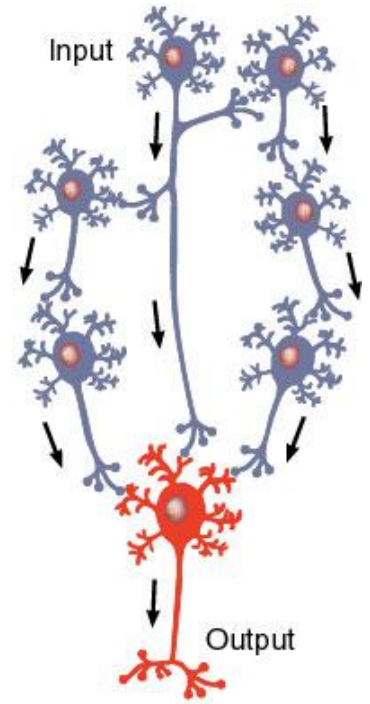
(a) Diverging circuit



(b) Converging circuit



(c) Reverberating circuit



(d) Parallel after-discharge circuit