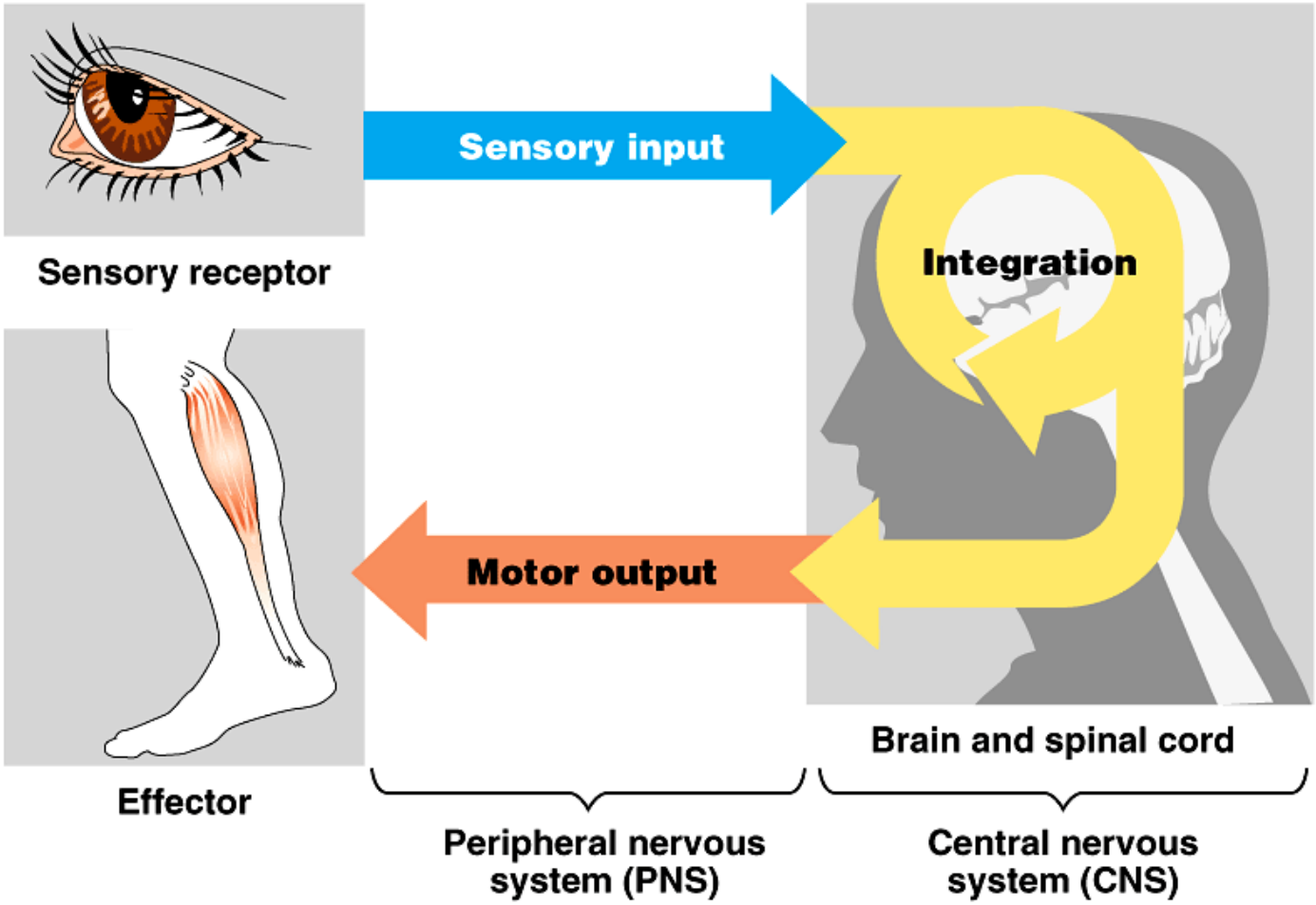
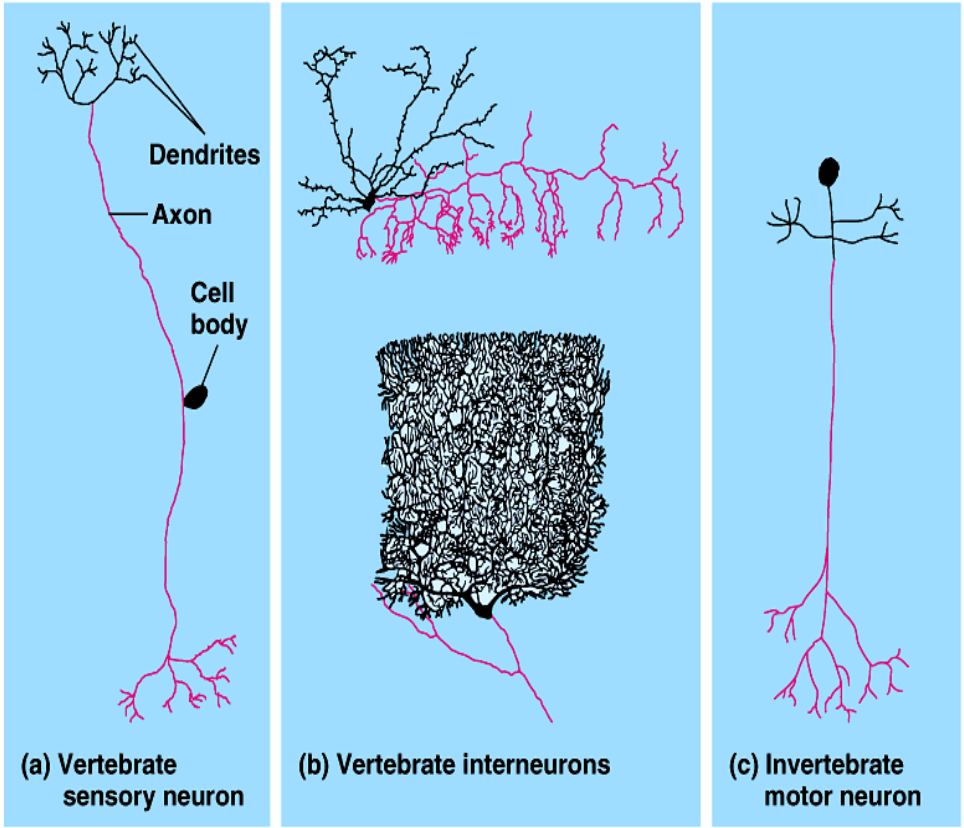
Aim: Nerve Control

Nervous Coordination

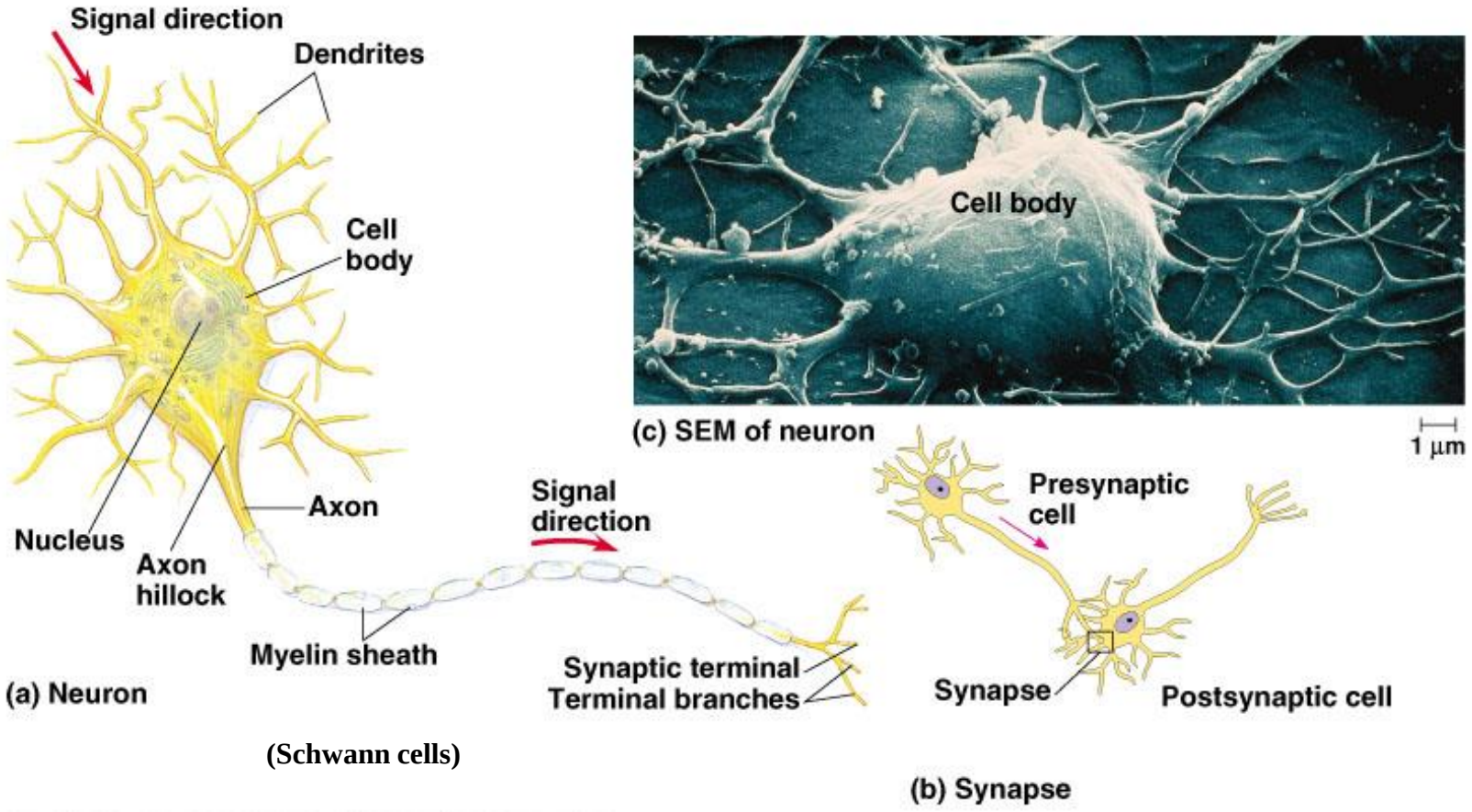


Types of neurons

- Sensory neurons (afferent) receive initial stimuli.
- Interneurons (associative) are located in the brain or spinal cord.
- Motor neurons (efferent) stimulate effectors (muscles/glands that perform a response.)

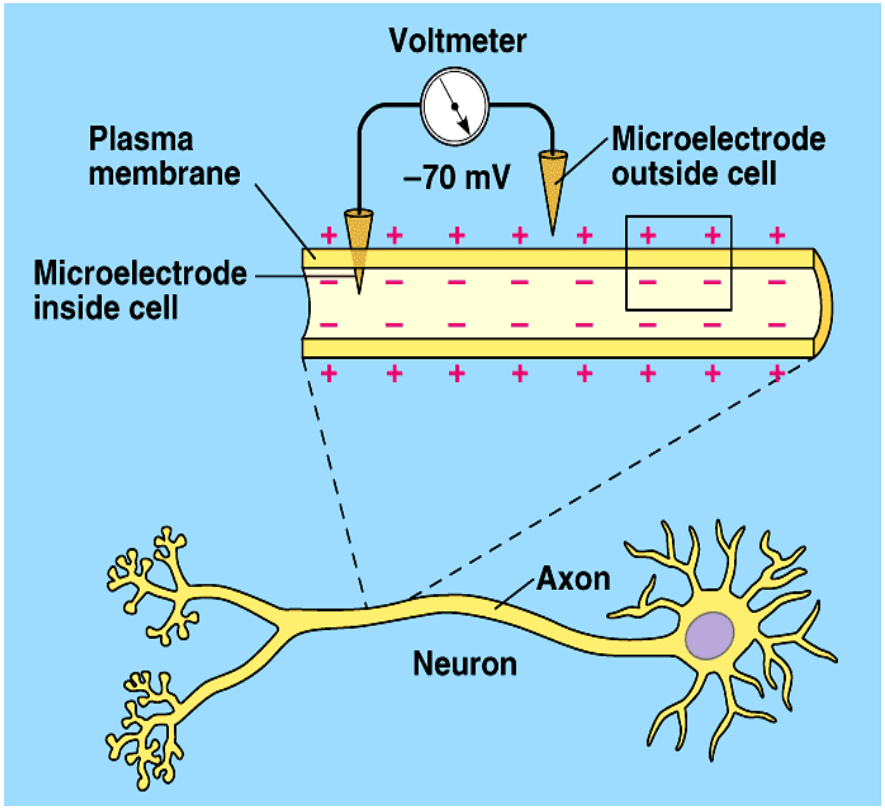


Neuron Structure



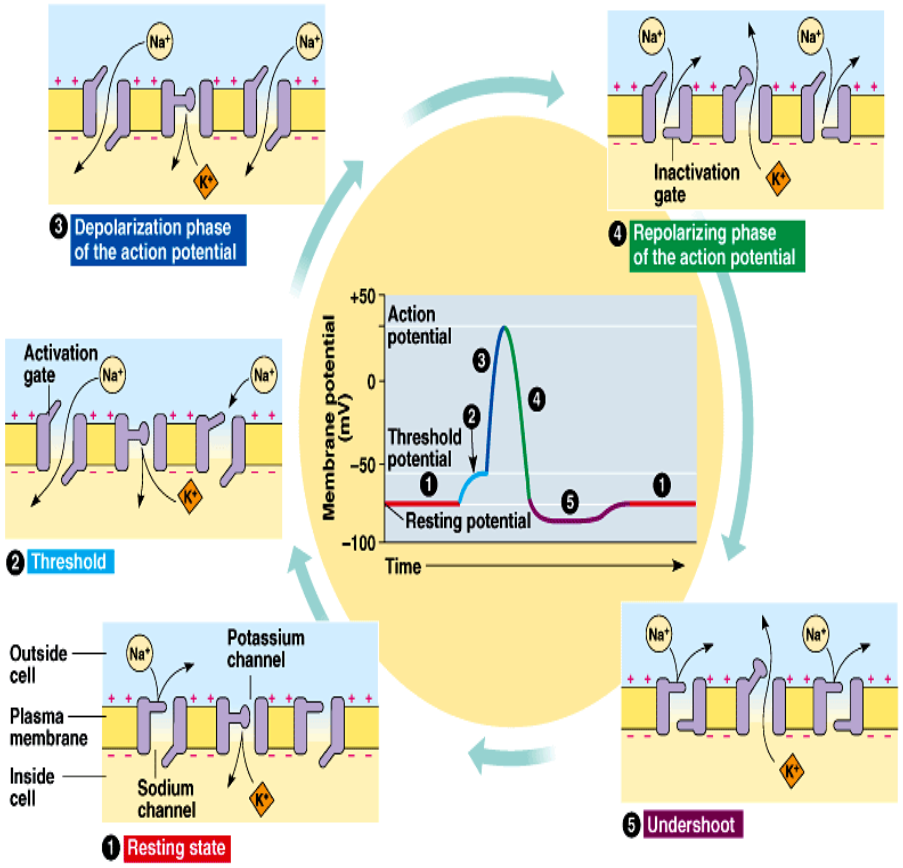
Membrane Potentials

- **Every cell has a voltage, or membrane potential, across its plasma membrane**
  - Anions are more concentrated within a cell.
  - Cations are more concentrated in the extracellular fluid
  - An unstimulated cell usually have a **resting potential** of -70mV.



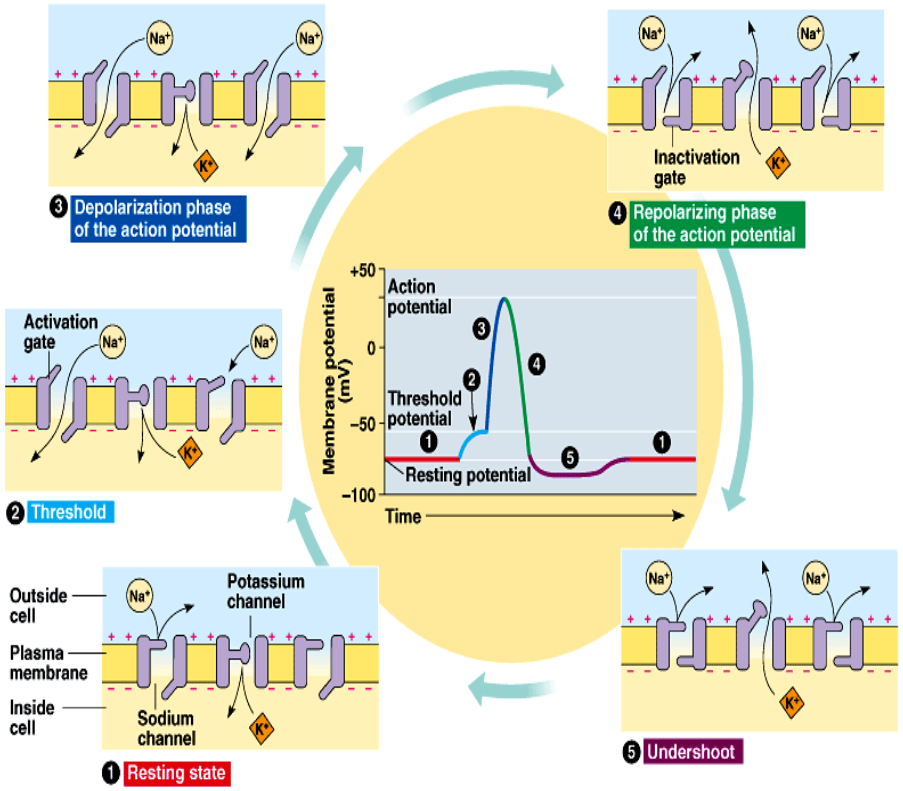
Transmission of a nerve impulse

- Resting potential (-70 millivolts)
- Stimulus causes gated ion channels to open. Na+ ions rush in.
- Depolarization begins (-70 → 0 millivolts.



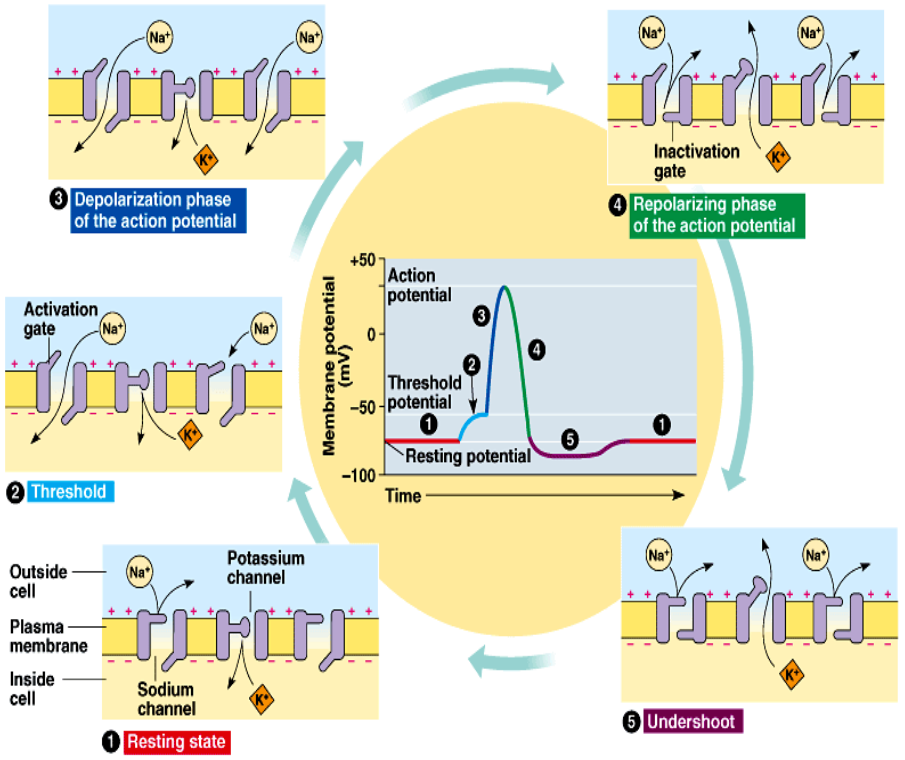
Transmission of a nerve impulse

- If threshold level (summation of stimuli) is reached, an action potential is reached and the electrical impulse moves across the length of the neuron. (All-or-none-response).



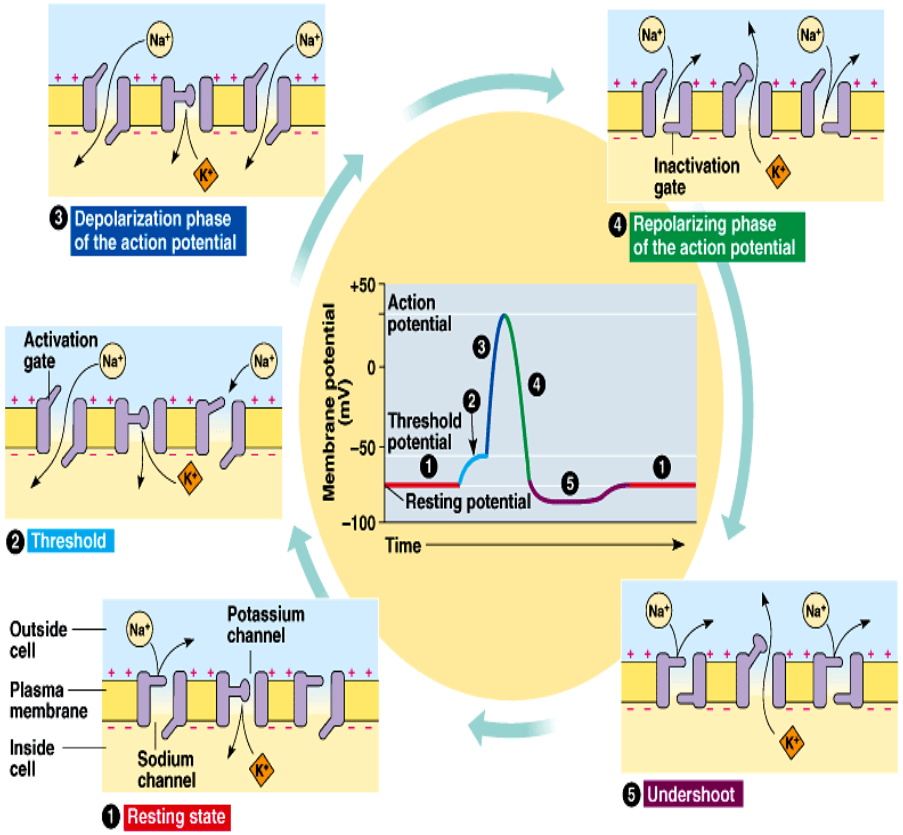
Transmission of a nerve impulse

- Repolarization – In response to inflow of Na+, K+ gated channels open and K+ exits the cell.
- This continues until the cell becomes hyperpolarized. (more negative inside than before)



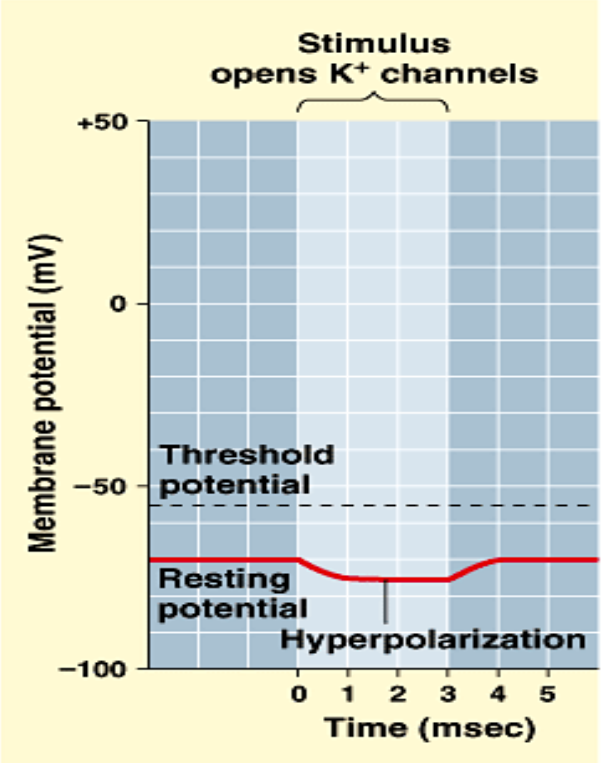
Transmission of a nerve impulse

- Refractory period:
- During this time, a neuron will not respond to a new stimulus.
- Sodium-potassium pumps use ATP to reestablish a resting potential. Na+ is pumped out; K+ is pumped in.



Summary of impulse activity

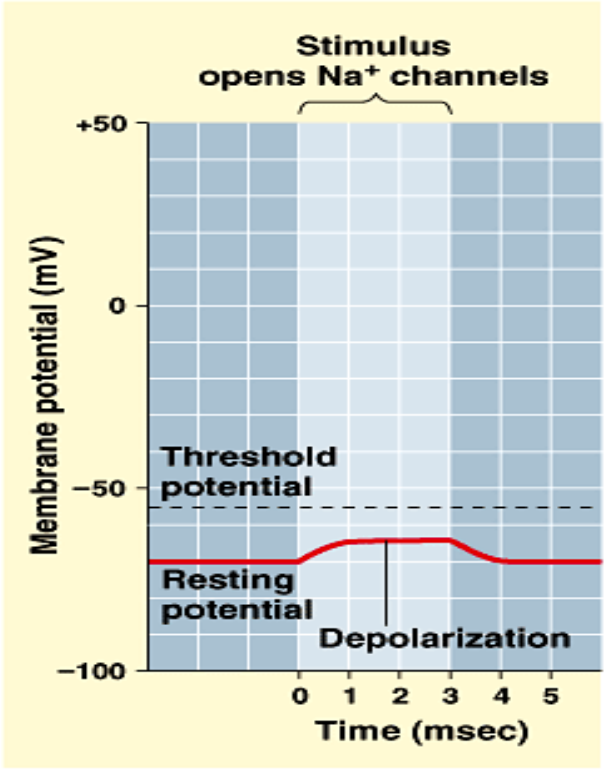
- **Hyperpolarization**
- Gated K^+ channels open $\rightarrow$ K^+ diffuses out of the cell $\rightarrow$ the membrane potential becomes more negative.



(a) Graded potential: hyperpolarization

Summary of impulse activity

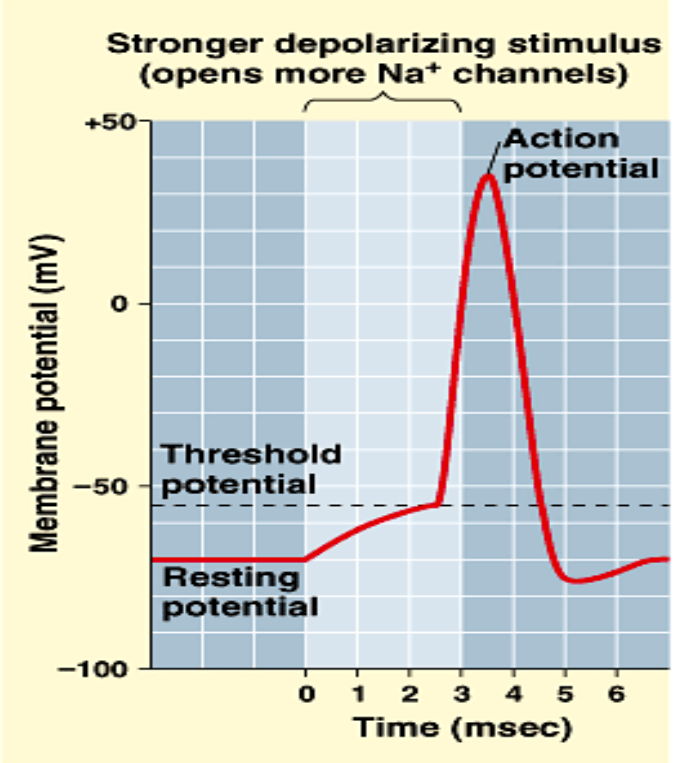
- **Depolarization.**
- Gated Na^+ channels open $\rightarrow$ Na^+ diffuses into the cell $\rightarrow$ the membrane potential becomes less negative.



(b) Graded potential: depolarization

Summary of impulse activity

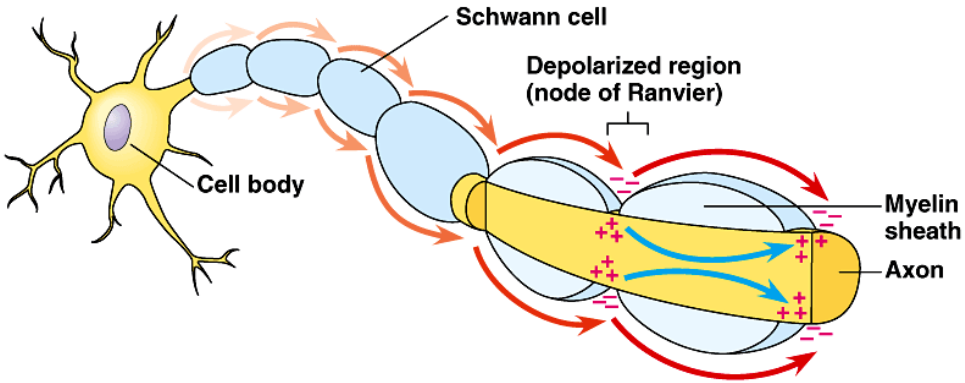
- The Action Potential: All or Nothing Depolarization.
- If graded potentials sum to ≈-55mV a **threshold potential** is achieved.
- This triggers an **action potential.**
- Axons only.

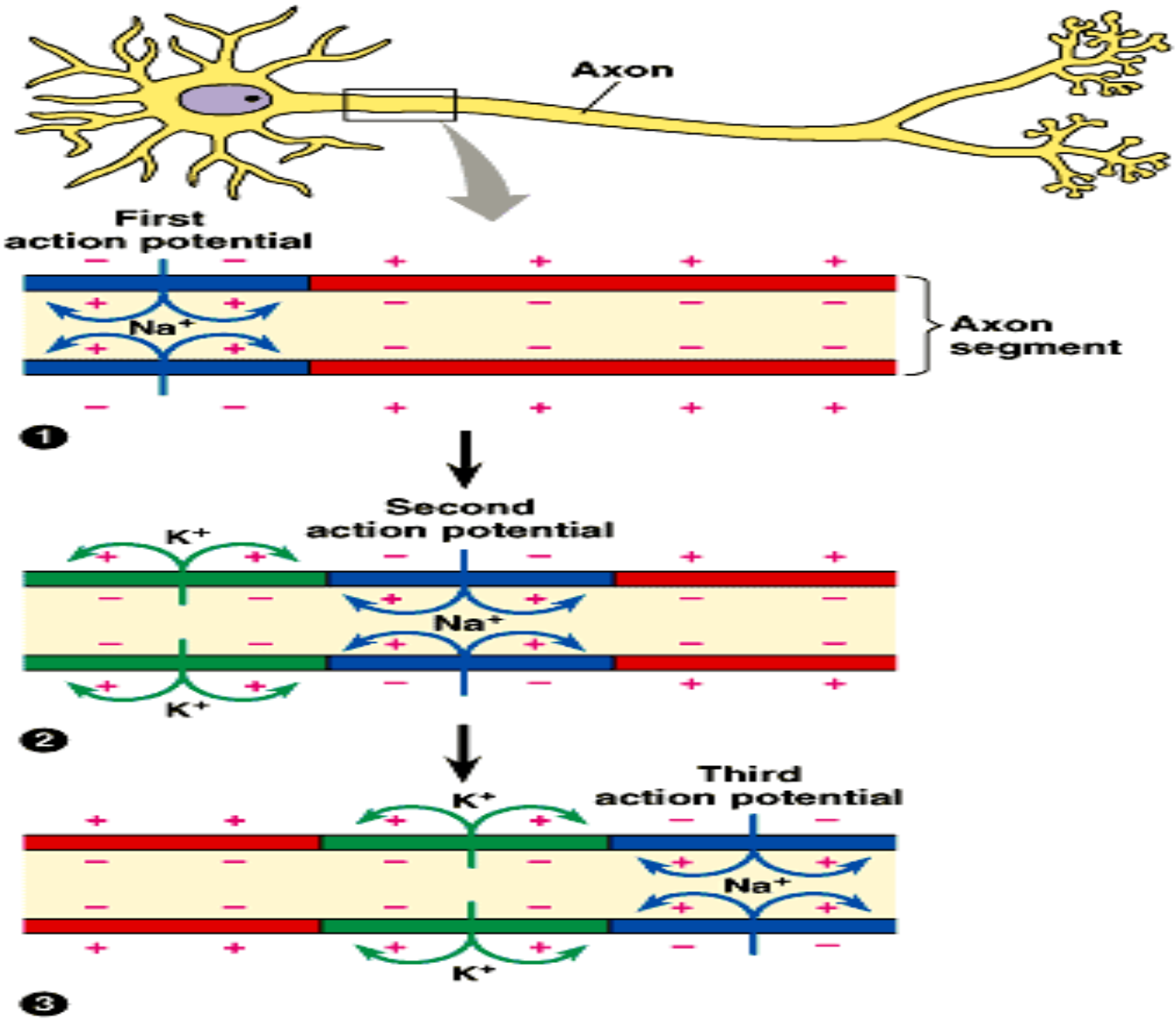


(c) Action potential

Summary of impulse activity

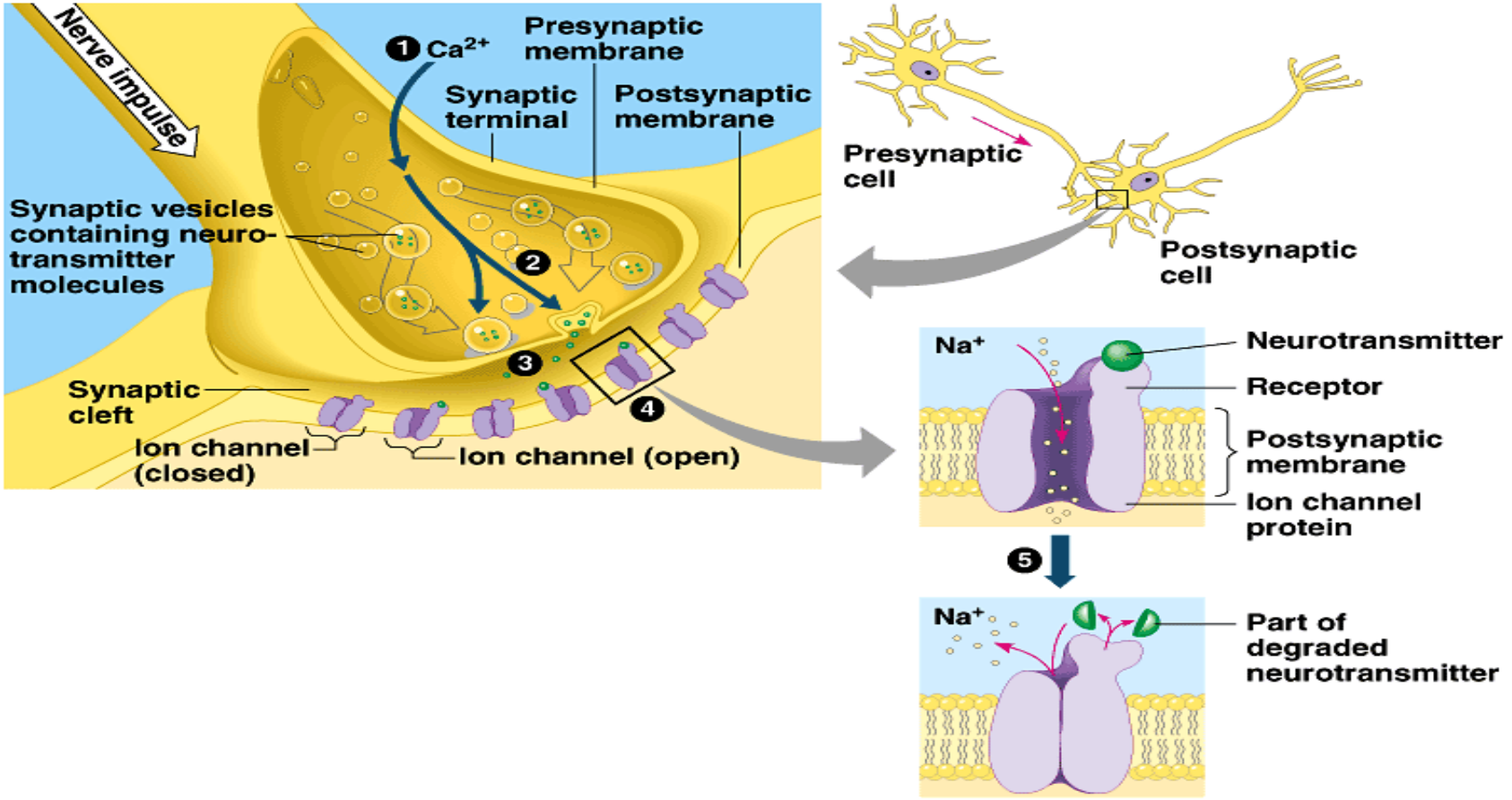
- **Saltatory conduction.**
- In myelinated neurons only unmyelinated regions of the axon depolarize.
- Thus, the impulse moves faster than in unmyelinated neurons.




Axon
First
action potential
Na+
Axon
segment
1
Second
action potential
K+
Na+
K+
2
K+
Third
action potential
Na+
K+
3

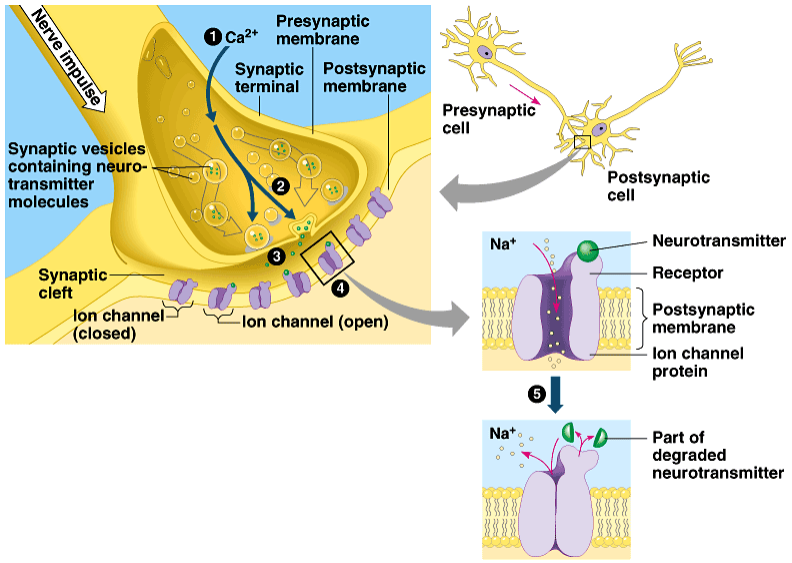
Synapses

- **Chemical or electrical communication between cells occurs at synapses**



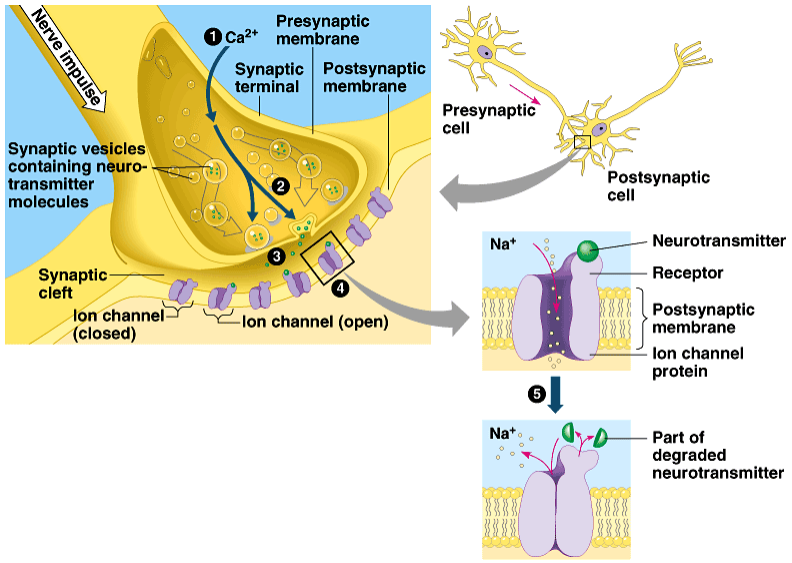
EPSP (Excitatory postsynaptic potentials)

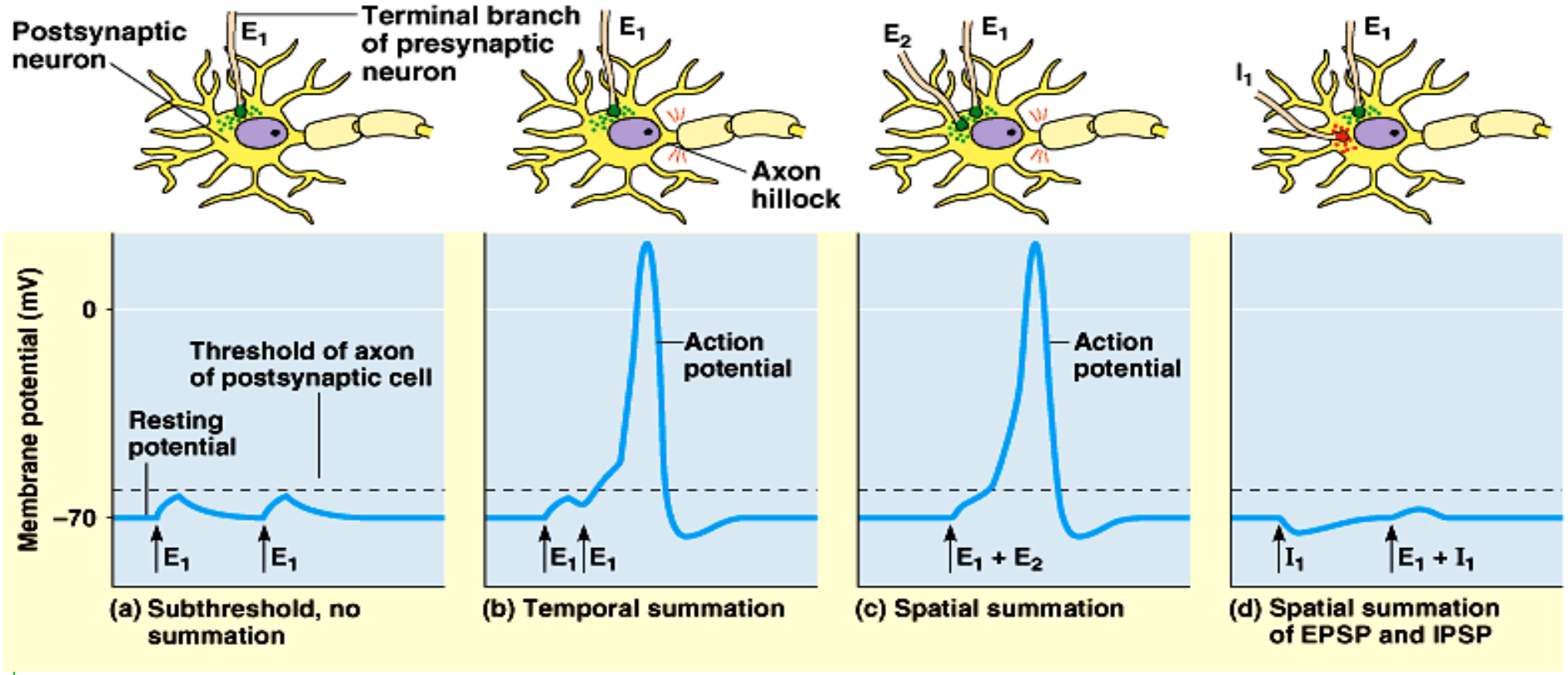
- **Excitatory postsynaptic potentials (EPSP)** depolarize the postsynaptic neuron.
- The binding of neurotransmitter to postsynaptic receptors open gated channels that allow Na^+ to diffuse into and K^+ to diffuse out of the cell.



Inhibitory postsynaptic potential (IPSP)

- **Inhibitory postsynaptic potential (IPSP)** hyperpolarize the postsynaptic neuron.
- The binding of neurotransmitter to postsynaptic receptors open gated channels that allow K+ to diffuse out of the cell and/or Cl- to diffuse into the cell.





- **Summation**: graded potentials (EPSPs and IPSPs) are summed to either depolarize or hyperpolarize a postsynaptic neuron.

Important Neurotransmitters

- Neurotransmitters are chemicals that operate in the synapse.
- Some important neurotransmitters:
- **Acetylcholine.**
  - Excitatory to skeletal muscle.
  - Inhibitory to cardiac muscle.
  - Secreted by the CNS, PNS, and at vertebrate neuromuscular junctions.

Important Neurotransmitters

Epinephrine and **norepinephrine**.

Can have excitatory or inhibitory effects.

Secreted by the CNS and PNS.

Secreted by the adrenal glands.

- **Dopamine**
  - Generally excitatory; may be inhibitory at some sites.
    - Widespread in the brain.
    - Affects sleep, mood, attention, and learning.

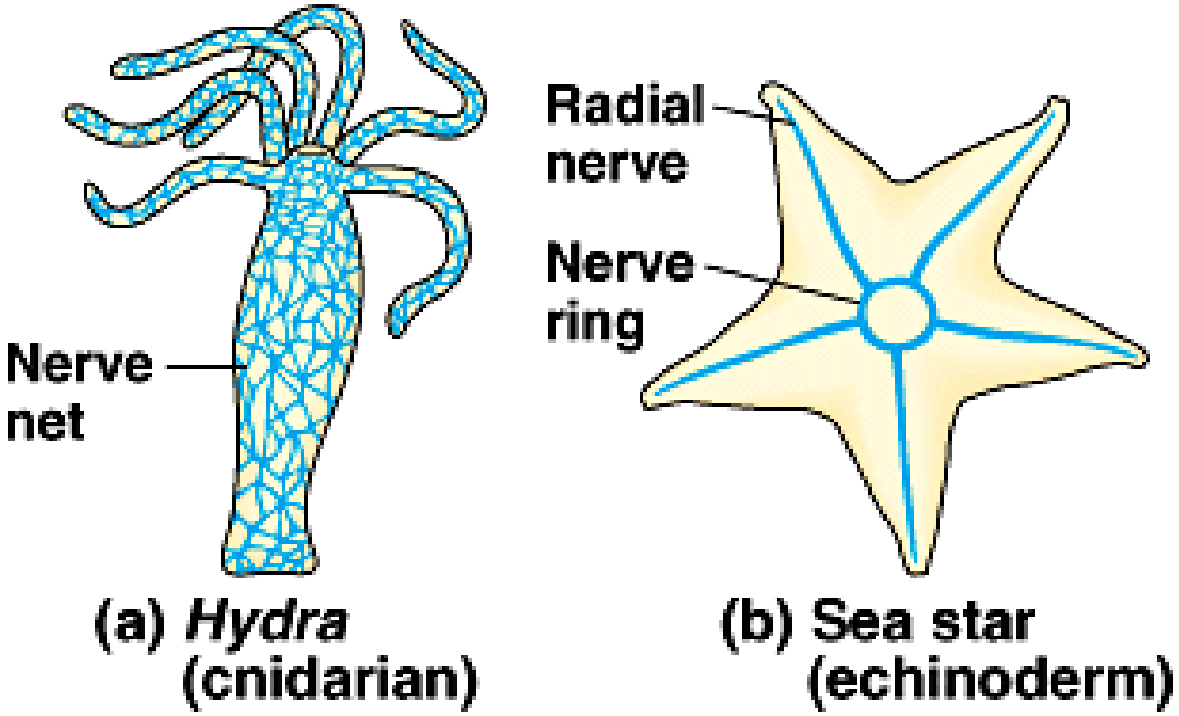
  Low levels = Parkinson's disease

  High levels = schizophrenia.

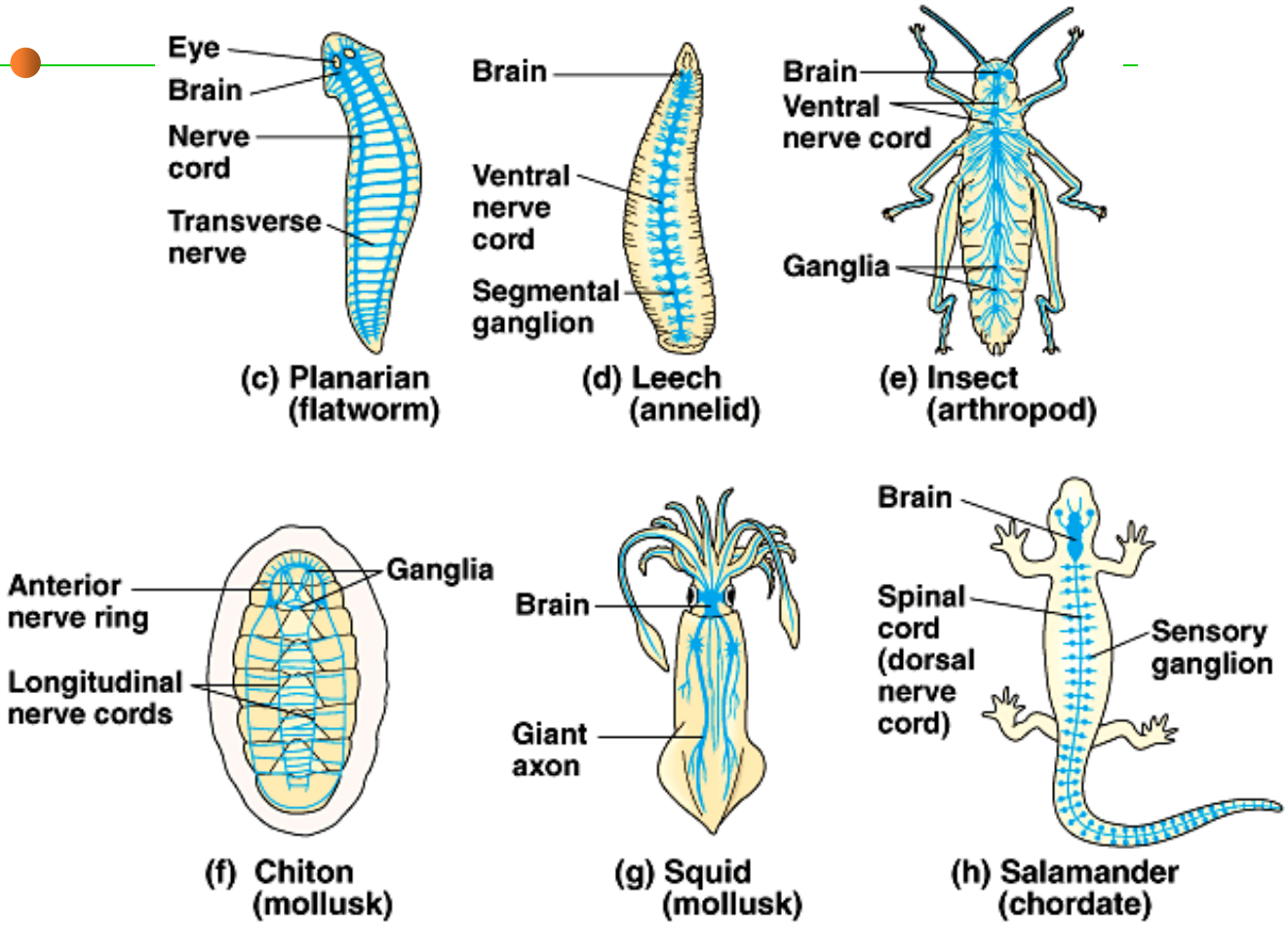
Important Neurotransmitters

- **Serotonin**.
  - Generally inhibitory.
    - Widespread in the brain.
    - Affects sleep, mood, attention, and learning
  - Secreted by the CNS.
  - **Gamma aminobutyric acid (GABA).**
    - Inhibitory.
    - Secreted by the CNS and at invertebrate neuromuscular junctions.

Nervous system evolution



With **cephalization** come more complex nervous systems.



Videos

http://bcove.me/b9m5xxnf

- Prialt, a drug derived from cone snail venom, paralyzes fish by blocking calcium channels at a motor synapse.
- http://bcove.me/jok72b0l
- Prialt does not block the mammalian motor synapse, but blocks the pain pathway in the spinal cord.
- http://media.hhmi.org/hl/09Lect1.html?start=46:54&end=50:54# from **Lecture 1 – From Venoms to Drugs**