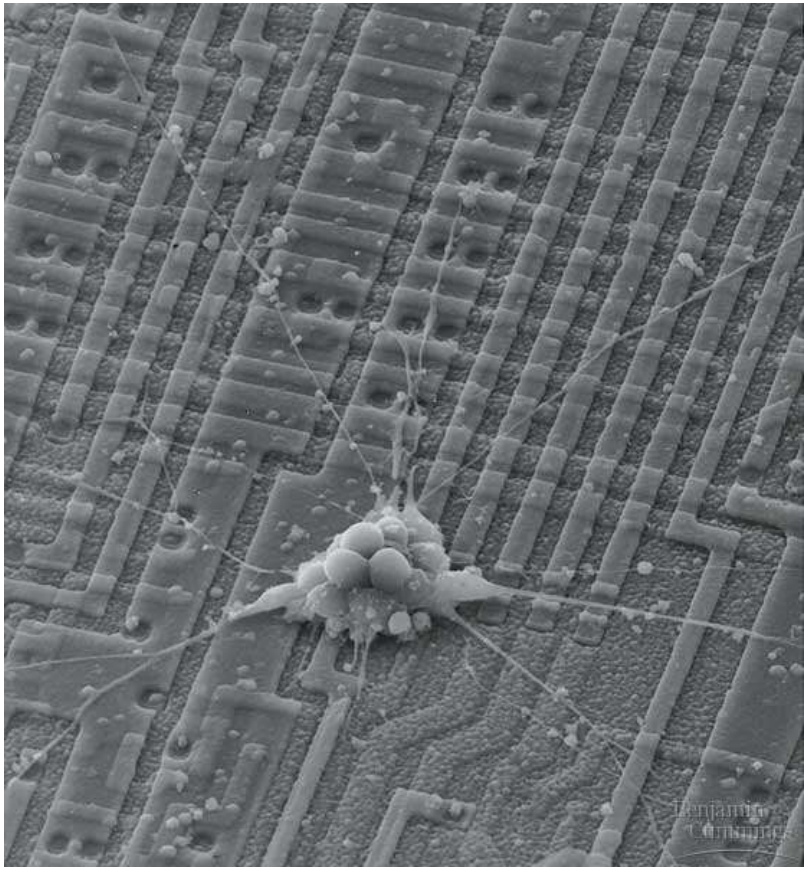
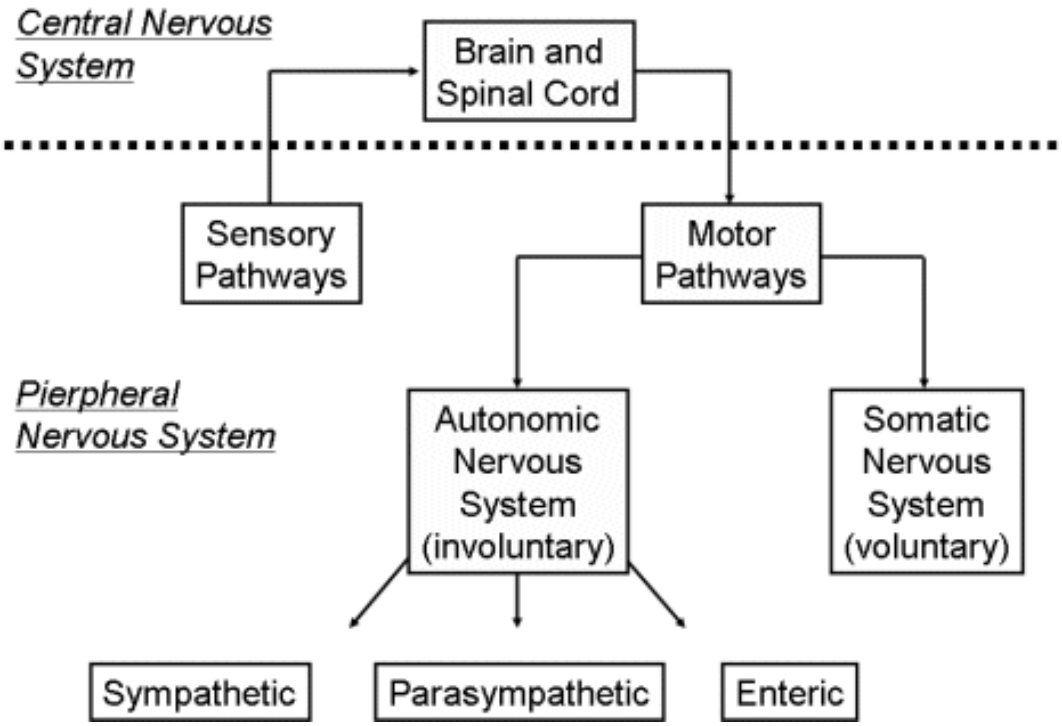


- *Nervous System*

Day 6 Objectives

- Describe how nervous systems transmit information.
- What is the function and location of the following parts of a neuron: cell body, axon, dendrite?
- What is the benefit of the myelin sheath?
- How does the Schwann cell improve signal propagation?
- What are the three main functions of the neuron?
- How are neurons polarized?
- How do neurons become depolarized?
- How is energy used to move sodium and potassium in order to maintain membrane potential?
- What is the significance of the synapse in nerve signal propagation?
- How are epinephrine and norepinephrine used in signal propagation?
- What is the final result of nerve cell signal transmission?
- How can neurons be used to stimulate?
- How can neurons be used to inhibit?

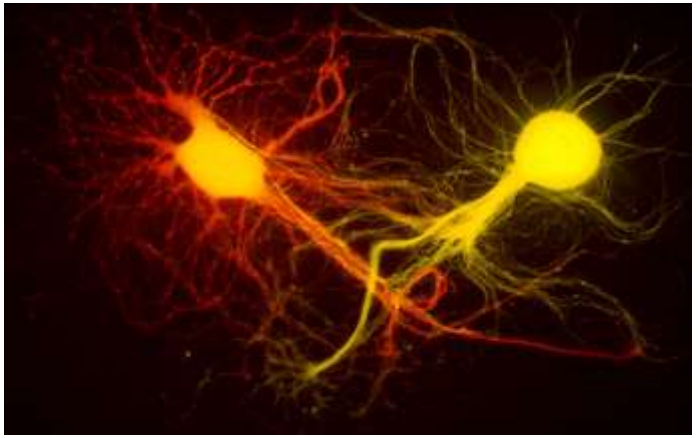
QOD

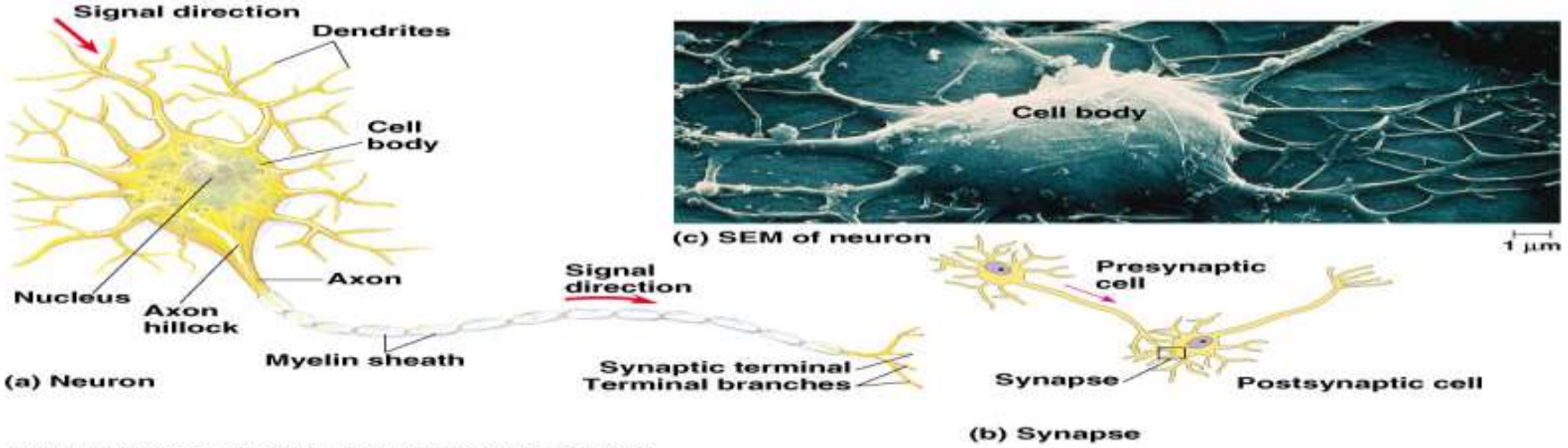


- What is the basic functional unit of the nervous system?

Structural Unit of Nervous System

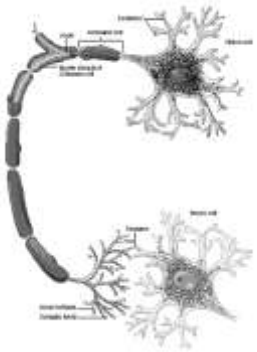
- Neuron~ structural and functional unit
- Cell body~ nucleus and organelles
- Dendrites~ impulses from tips to neuron
- Axons~ impulses toward tips
- Myelin sheath~ supporting, insulating layer
- Schwann cells~PNS support cells
- Synaptic terminals~ neurotransmitter releaser
- Synapse~ neuron junction





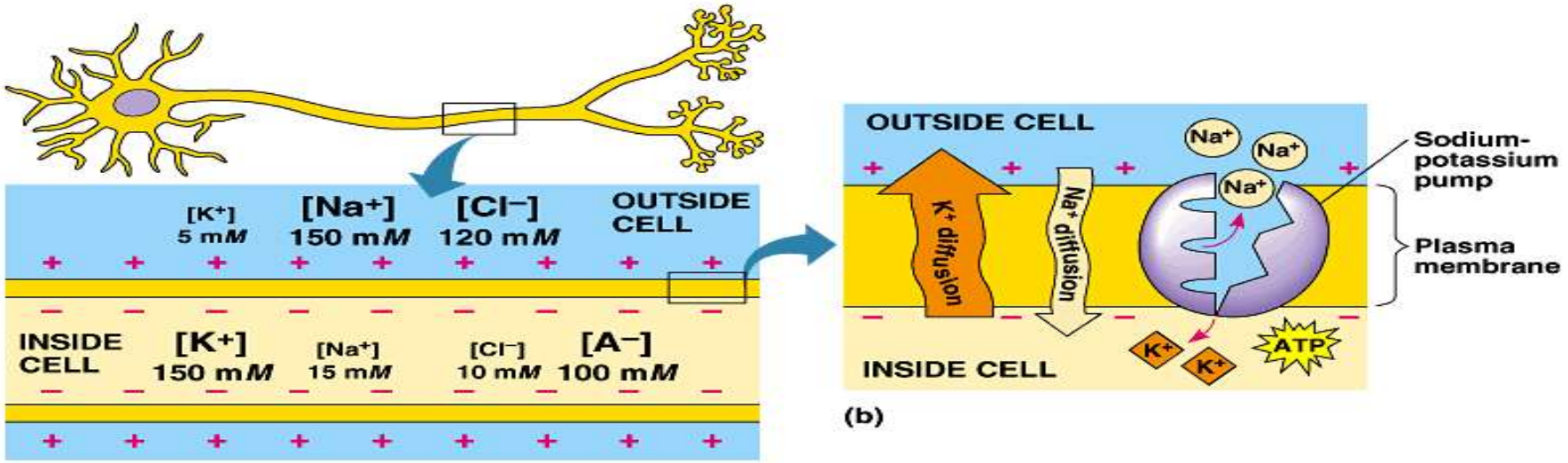
Background information

- Membranes are semi permeable – some things move through more readily than others
- Channel provide passage for impermeable substances
- Diffusion – movement from high to low concentration
- Against concentration gradient takes energy (ATP)
- Concentration Gradient represents potential energy



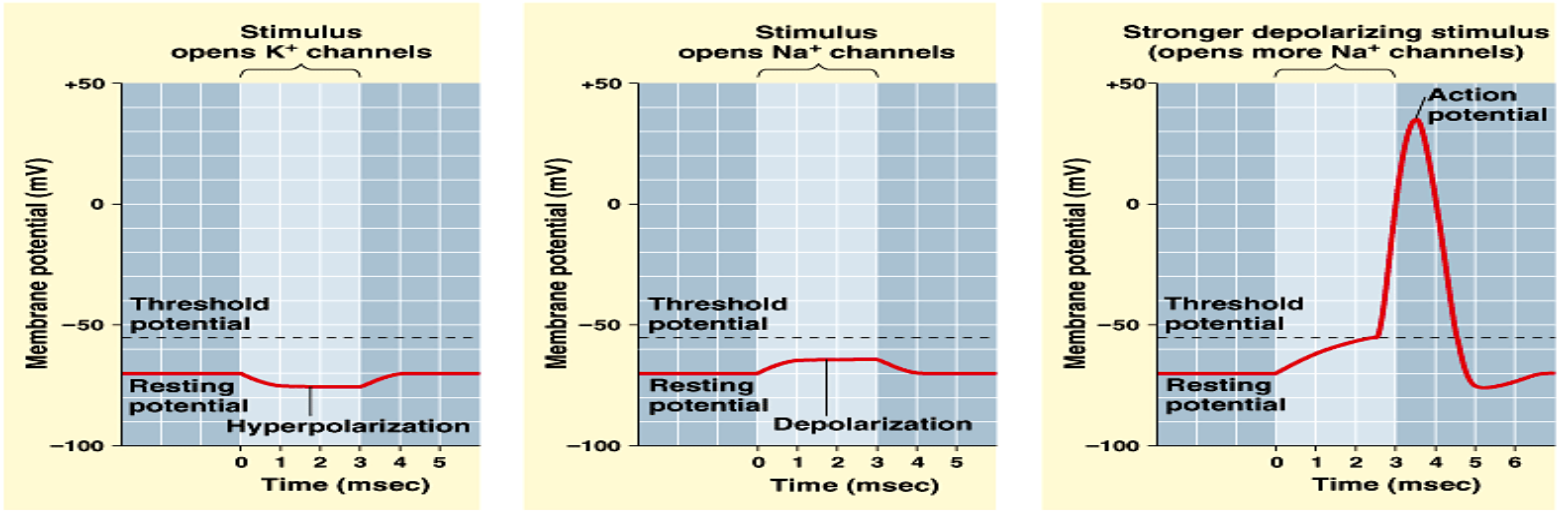
Neural signaling, I

- **Membrane potential (voltage differences across the plasma membrane)**
- **Intracellular/extracellular ionic concentration difference**
- **K+ diffuses out (Na+ in); large anions cannot follow….selective permeability of the plasma membrane**
- **Net negative charge of about -70mV**



Neural signaling, II

- **Excitable cells~ cells that can change membrane potentials (neurons, muscle)**
- **Resting potential~ the unexcited state of excitable cells**
- **Gated ion channels (open/close response to stimuli): photoreceptors; vibrations in air (sound receptors); chemical (neurotransmitters) & voltage (membrane potential changes)**
- **<u>Graded Potentials (depend on strength of stimulus)</u>:**
- **1- Hyperpolarization (outflow of K+); increase in electrical gradient; cell becomes more negative**
- **2- Depolarization (inflow of Na+); reduction in electrical gradient; cell becomes less negative**



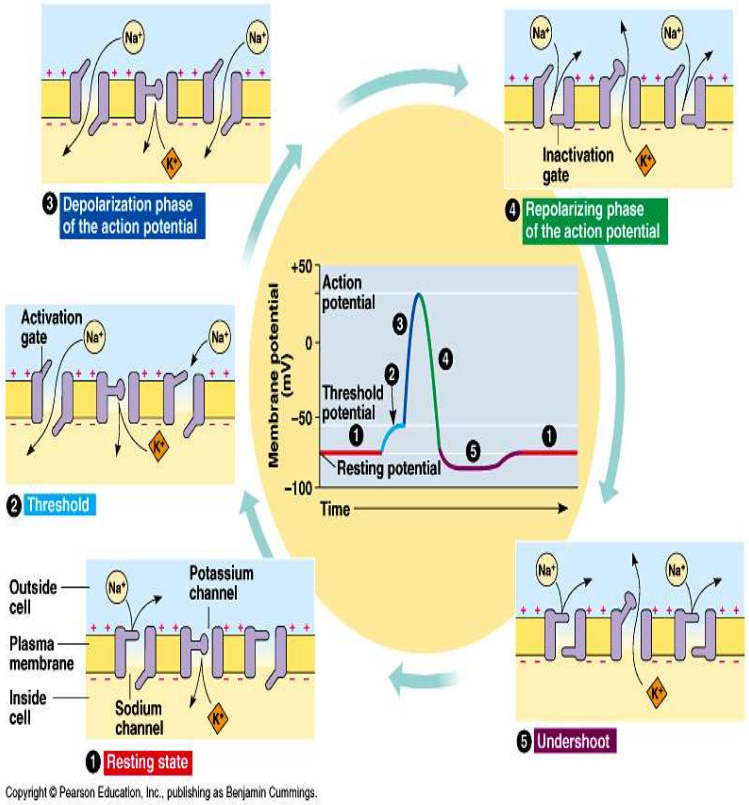
(a) Graded potential: hyperpolarization

(b) Graded potential: depolarization

(c) Action potential

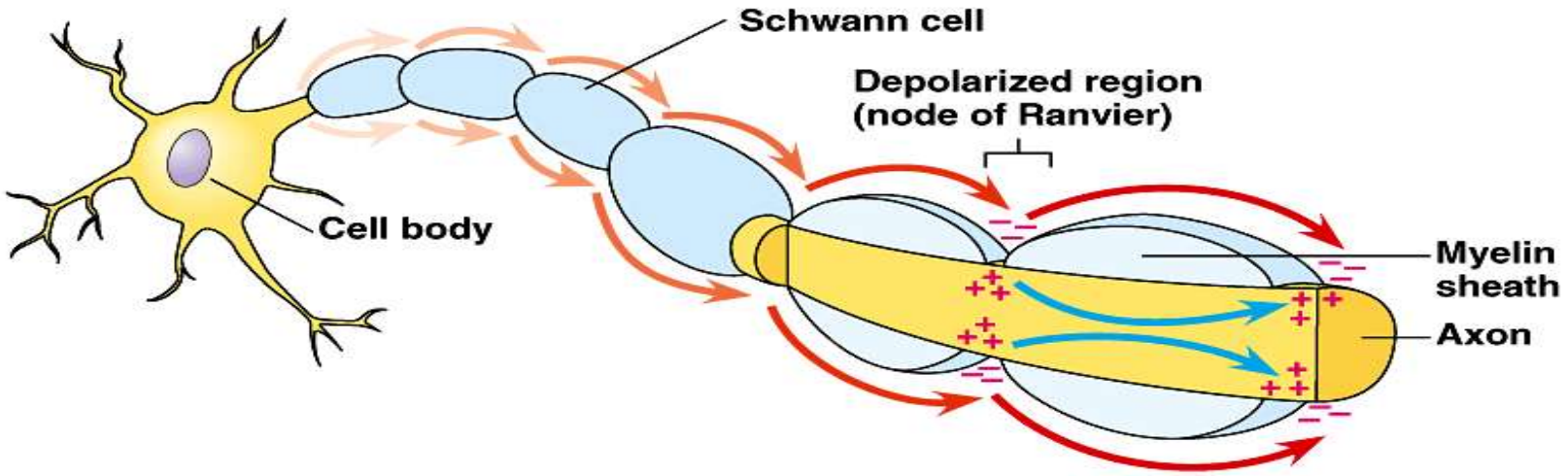
Neural signaling, III

- **Threshold potential:** if stimulus reaches a certain voltage (-50 to -55 mV)….
- The ***action potential*** is triggered….
- Voltage-gated ion channels (Na+; K+)
- 1-**Resting state** •both channels closed
- 2-**Threshold** •a stimulus opens some Na+ channels
- 3-**Depolarization** •action potential generated •Na+ channels open; cell becomes positive (K+ channels closed)
- 4-**Repolarization** •Na+ channels close, K+ channels open; K+ leaves •cell becomes negative
- 5-**Undershoot** •both gates close, but K+ channel is slow; resting state restored
- **Refractory period**~ insensitive to depolarization due to closing of Na+ gates



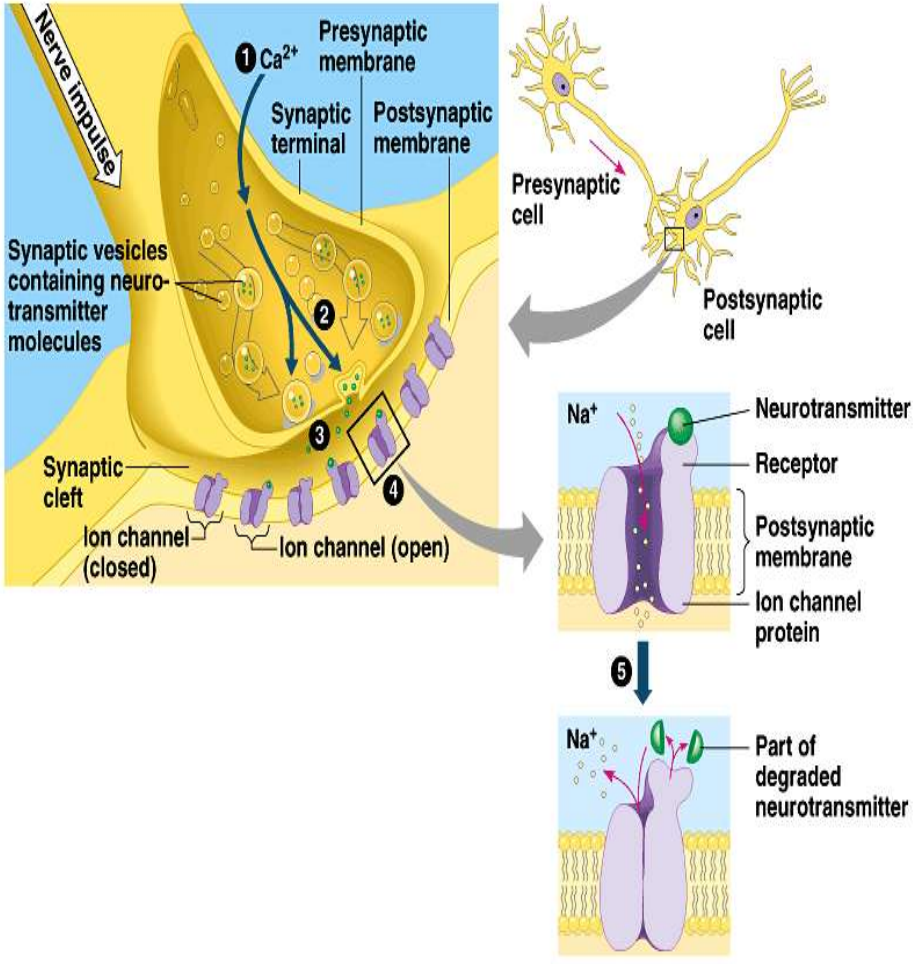
Neural signaling, IV

- **"Travel" of the action potential is self-propagating**
- **Regeneration of "new" action potentials only after refractory period**
- **Forward direction only**
- **<u>Action potential speed</u>:**
- **1-Axon diameter (larger = faster; 100m/sec)**
- **2-Nodes of Ranvier (concentration of ion channels); saltatory conduction; 150m/sec**



Synaptic communication

- Presynaptic cell: transmitting cell
- Postsynaptic cell: receiving cell
- Synaptic cleft: separation gap
- Synaptic vesicles: neurotransmitter releasers
- Ca+ influx: caused by action potential; vesicles fuse with presynaptic membrane and release….
- Neurotransmitter



Neurotransmitters

- Acetylcholine (most common)
  - skeletal muscle
- Biogenic amines (derived from amino acids)
  - norepinephrine
  - dopamine
  - serotonin
- Amino acids
- Neuropeptides (short chains of amino acids)
  - endorphin

Neurons of Thirsty Mouse

- Link to video: http://www.hhmi.org/bulletin/spring-2015/got-thirst-here-s-why
- ***When stimulated with blue light, mice drink with zeal, even if the water is presented in an unfamiliar bowl.***

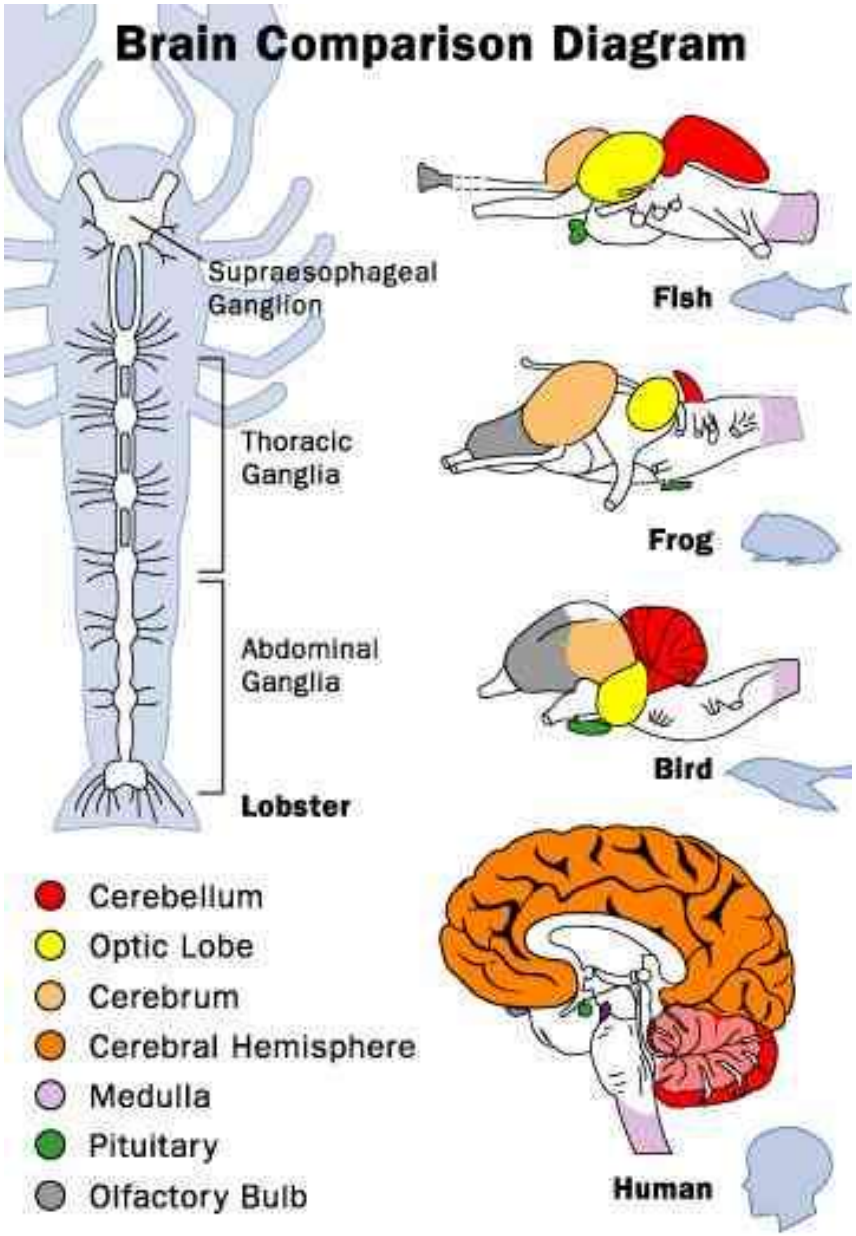
Day 7 Objectives

- What is the significance of the regions of the vertebrate brain?
- How does the amygdala control the brain?

QOD

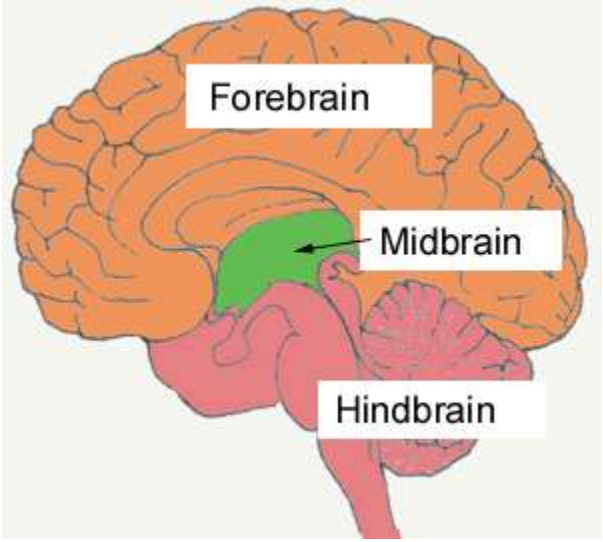
- Which region of the human brain do you think evolved first? Support your idea with evidence.

Brain Comparison Diagram



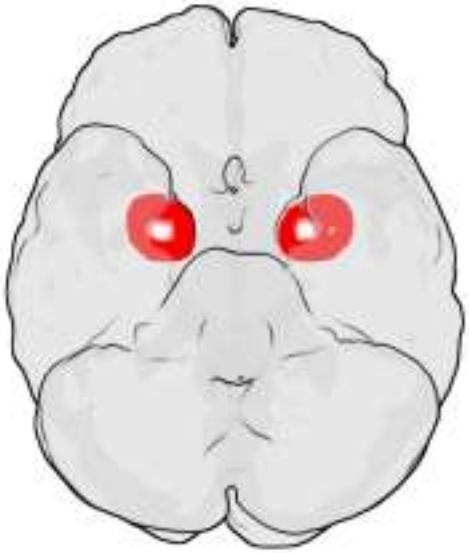
Regions of the Brain

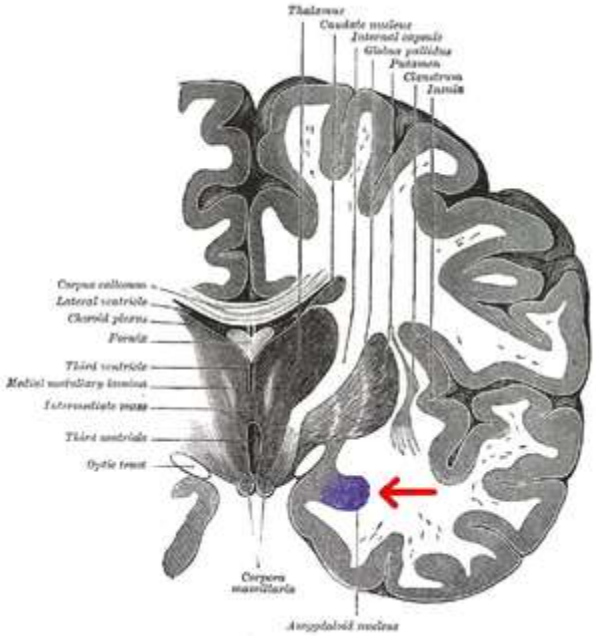
- The brain evolved over time in this order:
  - Hindbrain – most primitive
    - Medulla – breathing
    - Pons - coordination
    - Cerebellum - balance
  - Midbrain
    - Controls senses and arousal
  - Forebrain – most recent
    - Thalamus
    - Limbic system
      - Hypothalamus – thirst hunger temperature
      - Hippocampus - memory
      - Amygdala – emotion



Amygdala

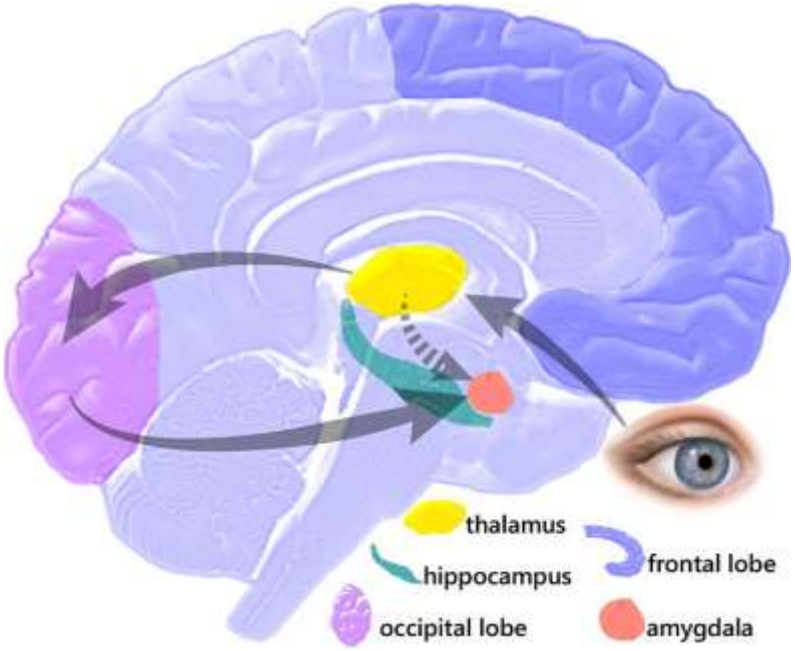
- A region of the brain within the temporal lobe
- Plays a role in emotions and memory





Amygdala hijack

- The neocortex is the “thinking brain”
- Thoughts are usually filtered through

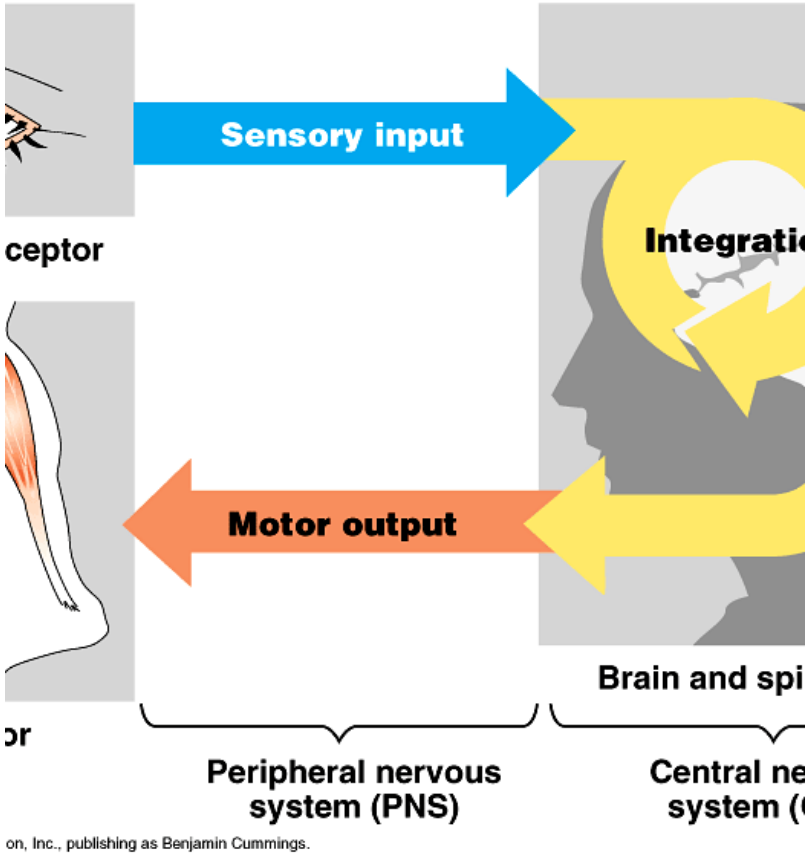


Day 8 Objectives

- Describe how the vertebrate brain integrates information to produce a response
- Different regions of the vertebrate brain have different function, compare and contrast the functions of the forebrain, midbrain and hindbrain

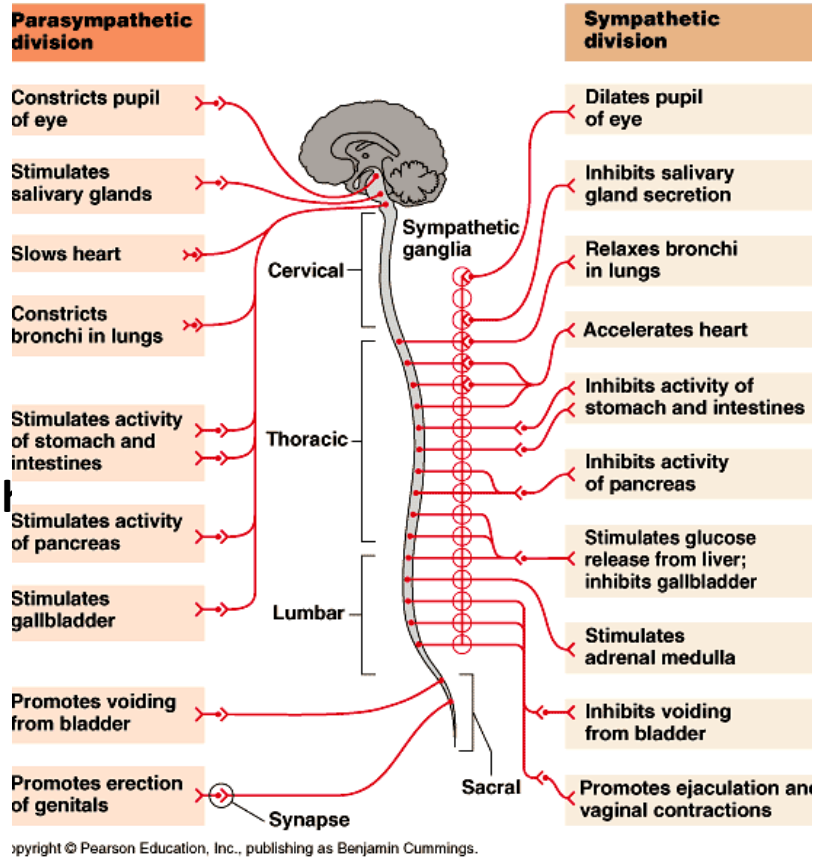
Nervous systems

- Central nervous system (CNS) - brain and spinal cord
- Peripheral nervous system (PNS) - sensory and motor neurons



Vertebrate PNS

- Sensory division
  - Motor division
    - somatic system
      voluntary, conscious control
    - autonomic system
      parasympathetic
      conservation of energy
      sympath
      increase energy consumption



Simple Nerve Circuit

- Sensory neuron: convey information to spinal cord
- Interneurons: information integration
- Motor neurons: convey signals to effector cell (muscle or gland)
- Reflex: simple response; sensory to motor neurons
- Ganglion (ganglia): cluster of nerve cell bodies in the PNS
- Supporting cells/glia: nonconductiong cell that provides support, insulation, and protection