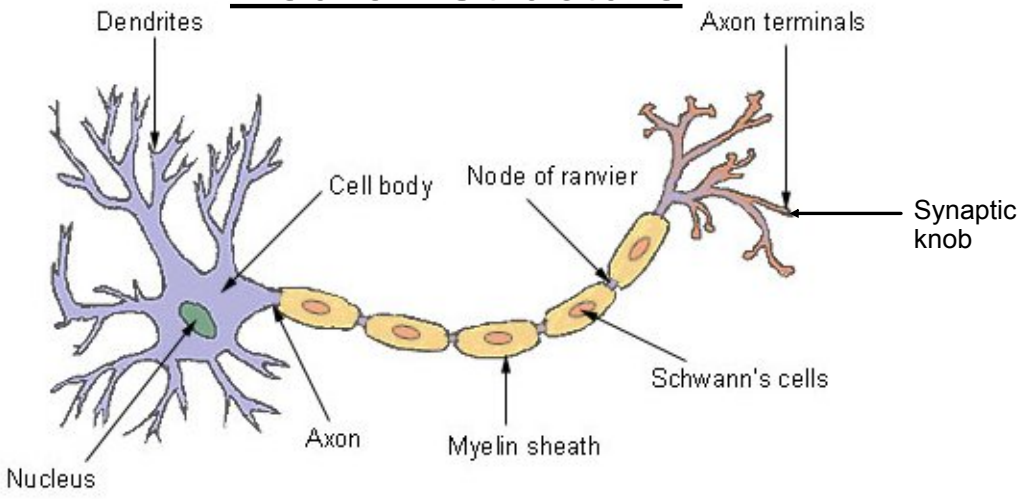
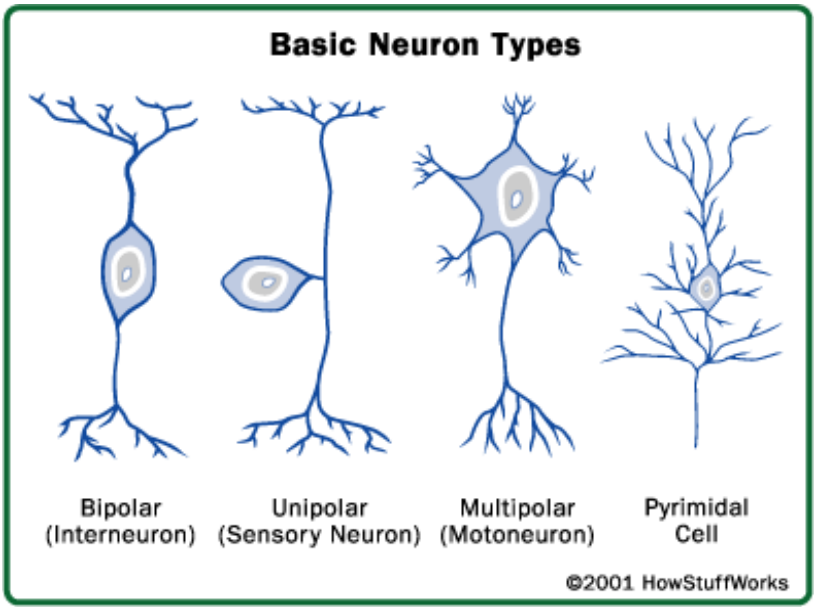
Nerve Cells: the structure and function of neurons

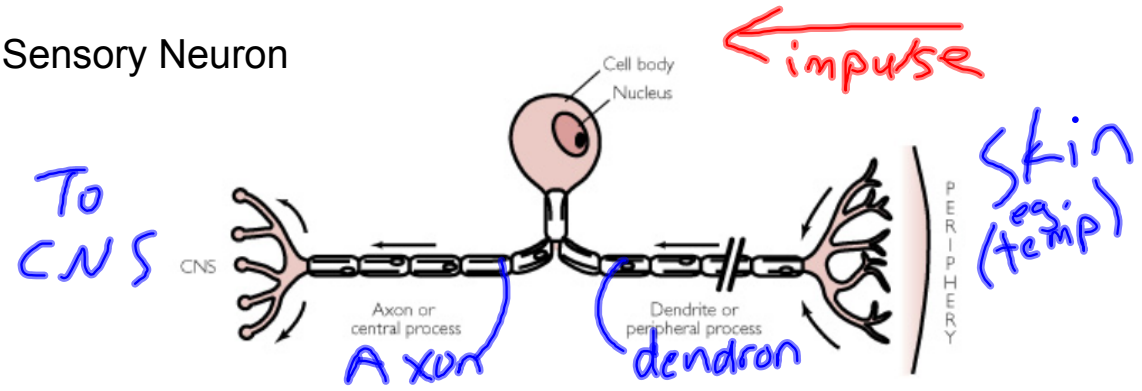
Neuron Structure



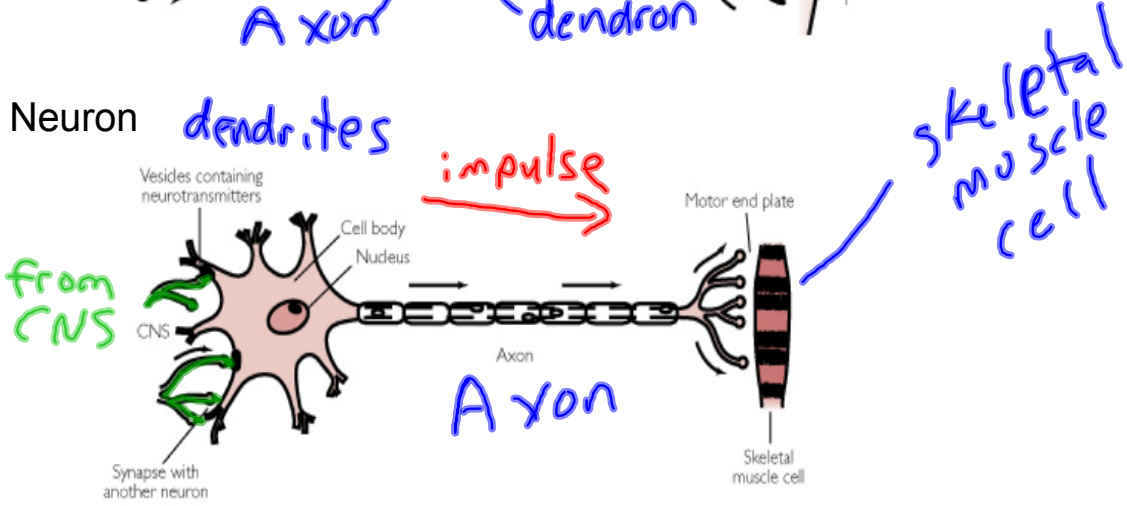


Neurons

Sensory Neuron



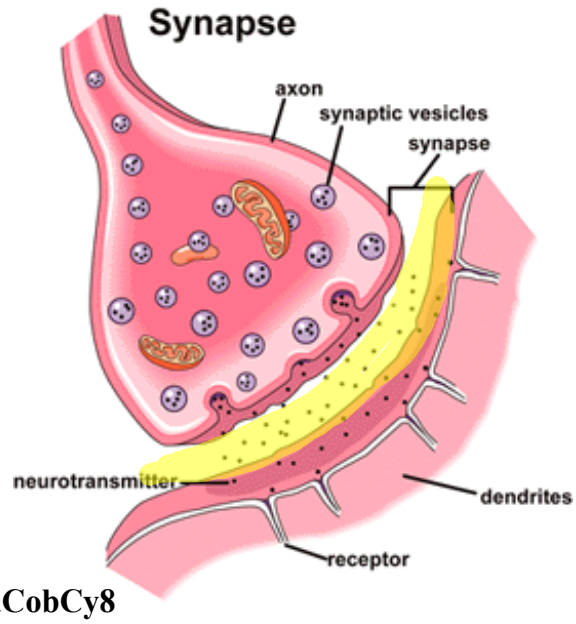
Motor Neuron



Neuron to Neuron: The Synapse

The space or gap between neurons is bridged by the rapid release of chemicals called **neurotransmitters**. These chemicals can stimulate the next neuron in a path or muscle cells.

Once the neurotransmitter has conveyed its message (binds to the receptor of the dendrite) it is destroyed.

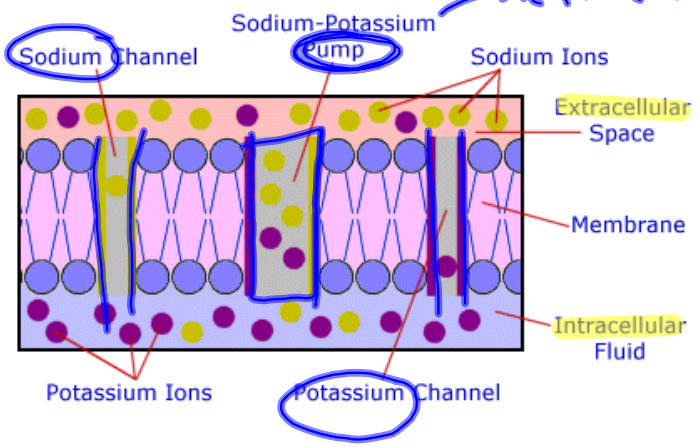


http://www.youtube.com/watch?v=YwN9aCobCy8

http://www.youtube.com/watch?v=-SHBnExxub8&feature=related

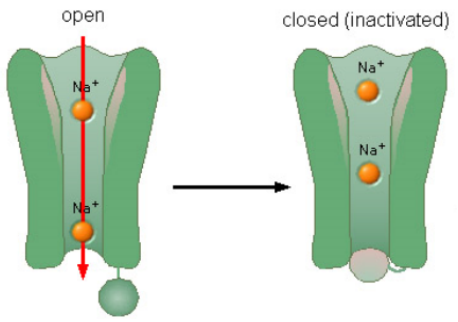
Nerve Signals: Transmitting an Impulse

Like all cells, nerve cells are bathed in extracellular fluid. This fluid has a high concentration of sodium ions and a low concentration of potassium ions. By controlling the movement of Na^+ ions and K^+ ions into and out of the cell, the cell membrane generates a wave impulse.

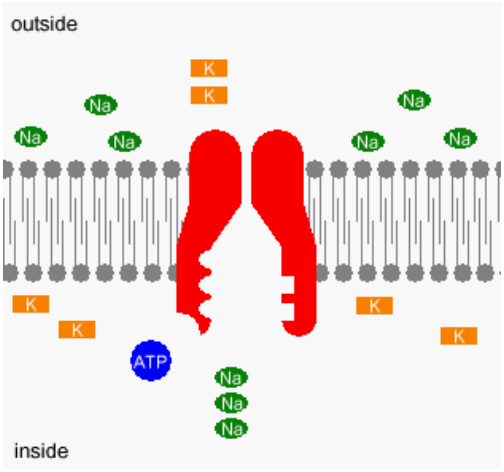


Neurons

The cell membrane of a neuron has sodium channels, proteins that opens to allow Na^+ ions into the cell as the impulse travels along the cell.



It also has a sodium-potassium pump, which uses ATP to maintain the concentration gradients of high [Na^+] outside of the cell and high [K^+] inside of the cell.



http://www.youtube.com/watch?v=YA4Eng4CyZg&feature=related

Neurons at Rest

When the neuron is at rest (not transmitting an impulse) the outside of the cell is positively charged compared to the inside of the cell. This is due to the uneven distribution of cations (+) and anions (-) across the membrane.

Outside of the cell:

- high [Na^+]
- low [K^+]

overall positive charge

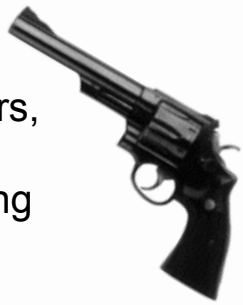
Inside of the cell:

- high [K+]
- low [Na+]
- many large and negatively charged proteins, amino acids, phosphates and sulfates that cannot exit the cell

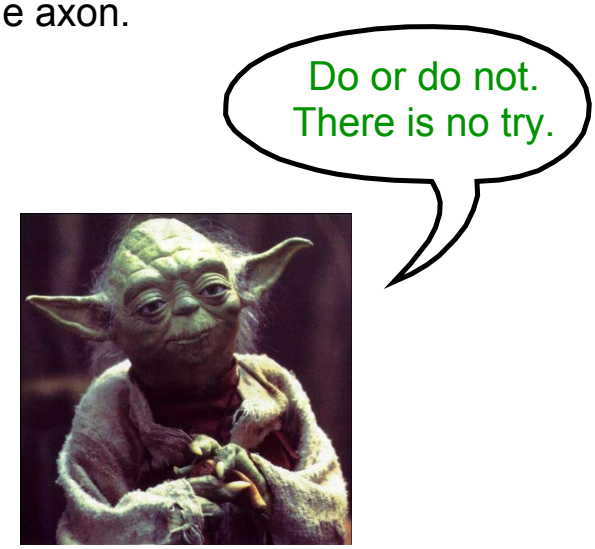
overall negative charge

This creates electric potential (potential energy!). The difference in charge is **-70mV**, called the **resting potential**. The membrane is *polarized* at rest. The closed ***Na channel*** and ***Na K pump*** maintain this state.

Firing Neurons: All-or-None



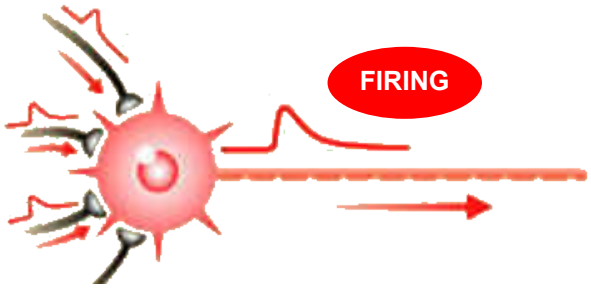
Sufficient stimulation (chemicals such as neurotransmitters, light, heat, mechanical distortion of the cell membrane or electrical current) will trigger a wave of depolarization along the axon.



The neuron either fires or it does not. The strength of the response is uniform along the length of the neuron.

Depolarization: The Action Potential

- A nerve impulse begins when sufficient stimulus changes the leakiness of the cell membrane in a small, localized area. The Na^+ channels open, allowing the Na^+ ions to leak into the cell, making it more positively charged (depolarized).
- The Na^+ channels remain open for only a millisecond. The Na^+ ions diffuse through the body of the cell, triggering neighbouring Na^+ channels to open and so carrying the wave of depolarization.
- This patch of reversed charge, known as the action potential, travels along the length of the cell.



Repolarization

- Almost at the exact time the Na+ channels open, the membrane becomes more permeable to K+, and these ions rush out of the cell. The Na K pump works furiously to re-establish the concentrations of ions at the resting potential.
- Each area of the membrane repolarizes quickly, so that the minimum time between impulses, called the refractory period, is only about 0.001s.

http://www.youtube.com/watch?v=G9rHAM0gIn8

http://www.youtube.com/watch?v=yQ-wQsEK21E&feature=related

Use your text pages 147-150 to answer the following:

1) Describe a Node of Ranvier. How does it increase the speed of an impulse?
2)Can nerve cells regenerate? Explain why/why not.
3) What are cholinesterase and acetylcholine? How are they related?
4) Describe how *Valium* works.