Topic 1 - Class 2
Resting Membrane Potential and Formation and Transmission of an action potential
Pre-Class Reading Assignment

1. Read pgs 415-419

2. Define the following terms

a. Action potential
b. Resting potential
c. Facilitated diffusion
d. Active transport
e. Gated ion channel
f. Sodium potassium pump
g. Depolarization
h. Repolarization
i. Hyperpolarization
j. Refractory period
k. Salutatory conduction
l. Threshold level
m. All or none response

3. What is a polarized membrane?

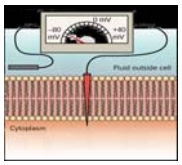
4. What causes the inside of a neuron to become negatively charged?

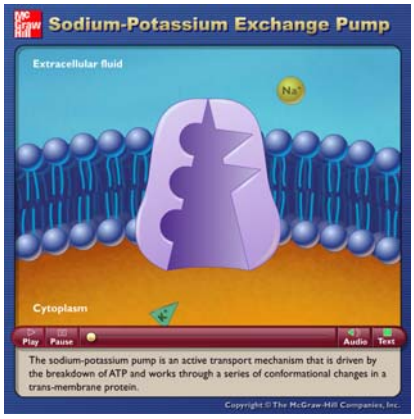
5. Why does the polarity of a cell membrane reverse during an action potential?

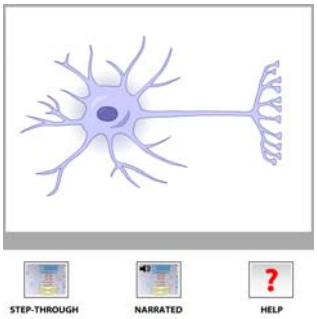
6. Why do nerve impulses move faster along myelinated nerve fibres?

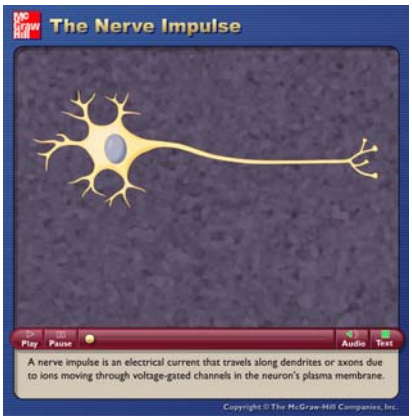
Resting Membrane Potential

- Nerve cells are unique b/c they are **charged cells**.
- have a rich supply of + ive and - ive ions
  - Positive ions - sodium, potassium, calcium
  - Negative ions - chloride, proteins
- Nerve impulses are created by movement of ions across the cell membrane of the neuron
- A nerve impulse is called an **action potential**.
- Neuron at rest has more -ive ions inside the neuron than outside and more +ive ions outside than inside
- Charge separation across membrane is due to:
  - Action of sodium-potassium exchange pump
    - Pumps 3 Na^+ out and 2 K^+ in
  - Diffusion of potassium across membrane
    - Membrane is "leaky" to K^+ ions
  - Impermeability of membrane to -ive ions like chloride (Cl^-)









Generating an Action Potential (neuron signal)

■ A stimulus at the dendrites causes voltage-gated sodium gates to open and the neuron starts to be depolarized

■ If the stimulus is strong enough, then sufficient Na+ will enter the neuron to cause an action potential

■ Step by Step of Action Potential

1. Depolarization reaches **threshold level**
2. More voltage-gated Na^+ channels open allowing Na^+ to enter the cell increasing the **depolarization**
3. K^+ channels begin to open and allow K^+ out of the cell
4. Na^+ channels close
5. K^+ ions continue to leave cell returning the membrane to its original potential
6. K^+ channels close and Na^+ channels reset
7. Na-K pump returns ion concentrations to normal resting membrane potential concentrations

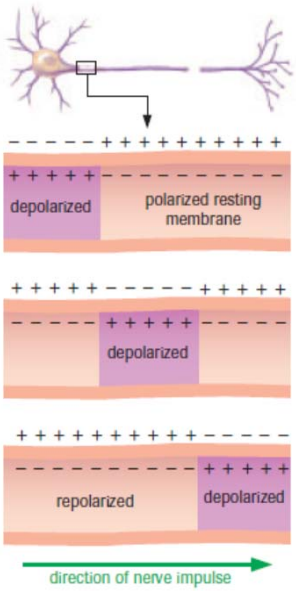
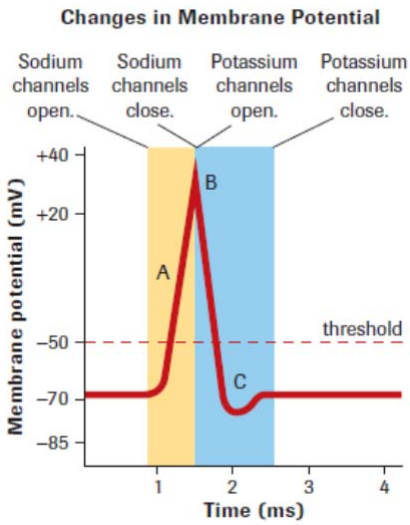


Figure 6
Successive action potentials along a section of axon cause a wave of depolarization along the cell membrane.



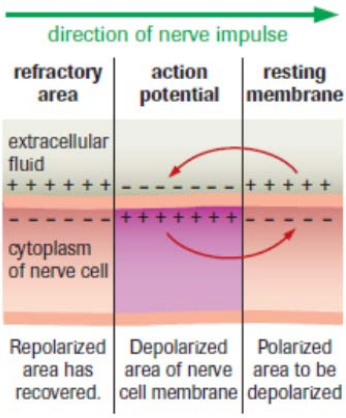
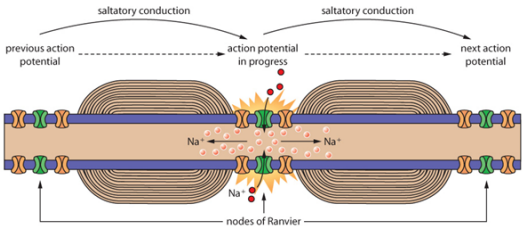
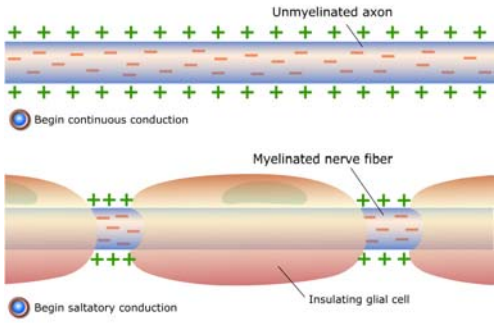


Figure 5
The movement of a nerve impulse. Red arrows indicate ions attracted to adjacent ions with opposite charges.

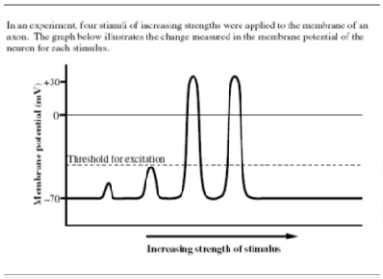
Saltatory Conduction

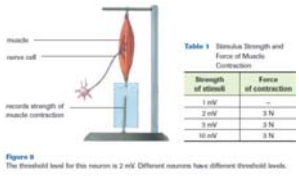




Threshold Level and the All or none response

- Threshold level - minimum level of stimulus required to produce an action potential
- Aspects of the all-or-none law:
  - If the stimulus is too low there is no action potential (this is the "none" part)
  - If the stimulus is above a threshold the action potential is always the same size- it does not get larger for stronger stimuli
  - As the action potential travels along the axon it does not die out, but stays the same size





Strength of stimuli	Force of contraction
1 mV	–
2 mV	3 N
5 mV	3 N
10 mV	3 N

How do we know the difference between different intensities of stimuli (light, heat, squeeze, etc)?

- The greater the stimuli
- the more neurons that "fire" which the brain interprets as a more intense stimuli.
- the greater the frequency of the impulses

Figure 9
Neuron B has a higher threshold level than neuron A and will not fire until the glass rod is heated above 40 °C. The brain interprets both the number of neurons excited and the frequency of impulses.

Topic 1 - Class 2

Resting Membrane Potential and Formation and Transmission of an action potential

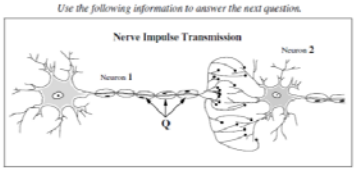
Review Sheet

Movement of hair cells in normal ears opens tiny pores called ion channels in the nerve cell membrane. This process begins impulse transmission along the auditory nerve.

Nerve impulse transmission continues along the nerve cell membrane as

A. a wave of depolarization
B. a negative feedback loop
C. a diffusing wave of summation
D. the active transport of an electrical potential

Use the following information to answer the next question.



If the structures labelled **Q** were absent, what effect on neural transmission would be expected?

A. The axon would not release acetylcholine.
B. The axon would be not become depolarized.
C. The speed of transmission would be reduced.
D. Cholinesterase would not be secreted to deactivate acetylcholine.

Some people report they have a high pain tolerance. Explain this in terms of threshold levels.

What is the all-or-none response?

What changes take place along a nerve cell membrane as it moves from a resting potential to an action potential to a refractory period?

In Figure 14, which area(s) of the graph indicate(s) the opening of Na+ ion channels and the diffusion of Na+ ions into the nerve cells? Explain your answer.

In Figure 14, repolarization occurs in which areas? Explain your answer.

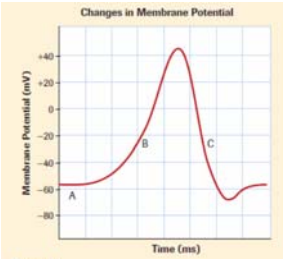
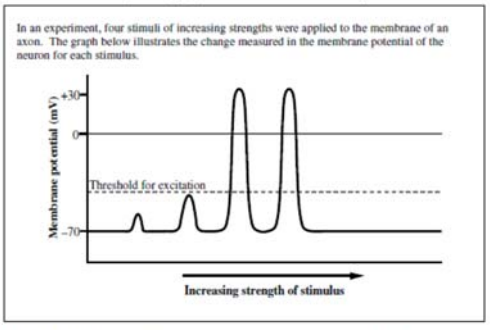


Figure 14
Action potential

Use the following information to answer the next question.

In an experiment, four stimuli of increasing strengths were applied to the membrane of an axon. The graph below illustrates the change measured in the membrane potential of the neuron for each stimulus.



Which of the following statements gives an accurate interpretation of the results of this experiment?

A. Most stimuli produce a nerve impulse.
B. A nerve impulse has a variety of strengths.
C. A stimulus must reach a threshold level to initiate a nerve impulse.
D. The greater the stimulus, the greater the strength of the nerve impulse produced.