**Please enter the following:**

Class Time: 9:30 Team (Table) No. 18 Trio Letter (A, B, or C): B Recorder: Lindsey

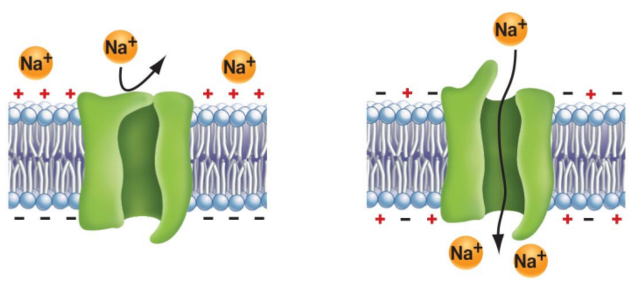
## ALA – Neurons

Please work on this **in trios**. Add your answers to this file (please keep it as a Word file if possible—convert to PDF if you are unable to save as a Word file. **Mac user? Please do NOT submit ALAs as a "Pages" file**.), **save to desktop or some other location**, then attach when submitting your assignment through Blackboard **(be sure you submit this assignment ONLY when you are asked to do so during class)**. Only one person **per trio** should submit. All team members should write a copy of your answers so you have them to study from (or the recorder might email the completed file to other members of your trio). You may use your book, internet, or any other resources you wish to answer these questions. Be sure to ask Dr. C or one of the teaching assistants if you need help!

**PLEASE COMPLETE THE "IN CLASS FOR NEURON ALA" SURVEY *AFTER* YOUR TRIO COMPLETES THIS ALA!!! YOU MUST COMPLETE THIS SURVEY BEFORE LEAVING CLASS TO RECEIVE CREDIT FOR THIS ASSIGNMENT.**

A neuron at rest maintains a resting potential. Although several types of ions and other molecules play a part in establishing a resting potential, a resting neuron has an overall **negative** charge relative to its surrounding environment (~ -70 mV) and there is a high concentration of **$Na^+$ outside the neuron** and a high concentration of **$K^+$ inside the neuron** (due to active transport by the Na/K pump).

In addition to the Na/K pump, the cell membrane of neurons also contains voltage-gated $Na^+$ and $K^+$ channels. These are proteins that remain "closed" when the membrane is polarized (a neuron at rest), but "open" when the membrane becomes depolarized. When the gates are open, they allow $Na^+$ or $K^+$ to move across the membrane (therefore, these voltage-gated channels play a role in facilitated diffusion).




A B

1. Consider the images above, which illustrate voltage-gated $Na^+$ gates in the membrane of a neuron. Does "A" represent a neuron at rest or one that is transmitting an action potential?

At rest.

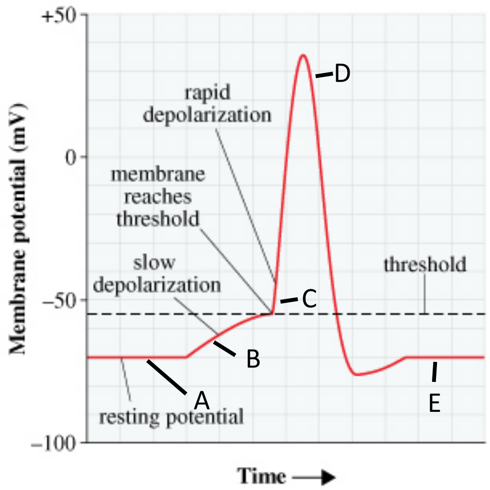
2. Consider image "B". Will the neuron become MORE polarized or DEPOLARIZED (i.e., would the overall charge of the neuron become more negative or positive compared to its resting potential)?

It becomes more depolarized.

3. If a $K^+$ gated channel located in a neuron membrane were to open, would the neuron become MORE polarized or DEPOLARIZED (i.e., would the overall charge of the neuron become more negative or more positive compared to its resting potential)?

Depolarized.

Most neurons will “fire” (i.e., they will send an action potential) once their membranes are depolarized to a certain level (the “threshold” level). Under most circumstances, once an axon’s membrane potential reaches threshold (about -55 mV in mammals), an action potential is automatically triggered. The graph below shows the changes in membrane potential that occur in an axon membrane that is initially at resting potential. The regions labeled with letters “A” – “E” will be used to fill in the table below.




Match the descriptions below with regions “A” – “E” in the graph above. Each graph label may be used more than once.

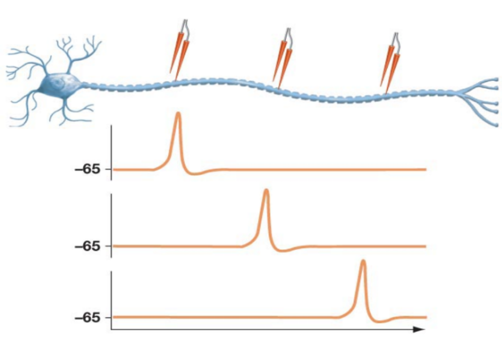
| Event | Graph Label |
|---|---|
| 4. $Na^+$ channels fully open and $K^+$ channels closed. $Na^+$ rapidly enters the cell. | **C** |
| 5. $Na^+$ channels closed and $K^+$ channels open. $K^+$ rapidly leaves the cell. | **D** |
| 6. $Na^+$ channels closed and $K^+$ channels closed. Na/K pump is working. | **E** |
| 7. $Na^+$ channels begin to open (but only slightly). | **B** |

8. The image below is trying to convey the idea that the action potential (depolarization) propagates itself along the neuron. Give an estimate of how fast an action potential can be propagated along a neuron in miles per hour. There is no right or wrong answer here— just give your own estimate!

300 MPH

9. After doing an experiment as instructed in class, what action potential speed did your team come up with?

250 MPH



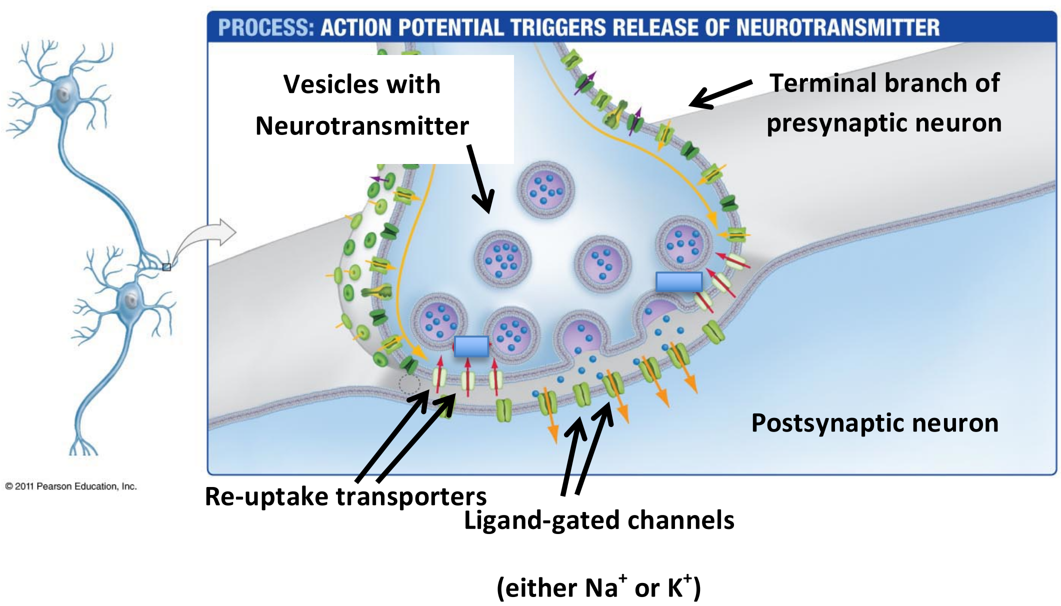

Terminal Branches

**What happens once the action potential reaches the end of the axon (i.e., the terminal branches)?**

Neurons are in constant communication with adjacent neurons via synapses. Synapses are regions where the terminal branches of one neuron (the presynaptic neuron) release neurotransmitters that interact with the dendrites or cell body of another neuron (the postsynaptic neuron). Depending on the events that occur, the postsynaptic neuron is either stimulated to produce an action potential (an Excitatory Post Synaptic Potential, or EPSP), or, is inhibited from producing an action potential (an Inhibitory Post Synaptic Potential, or IPSP).

10. The list below indicates the events that occur at a synapse, but they are not listed in order. Indicate the correct sequence of these events by placing the appropriate letter in the table below.
    A. Vesicles release neurotransmitters into synapse.
    B. Neurotransmitter is either broken down by an enzyme or transported back into the presynaptic cell via re-uptake transporters
    C. Neurotransmitter binds with ligand-gated channel.
    D. Receptors open allowing diffusion of ions (e.g., $Na^+$ or $K^+$) across membrane. This will cause either an excitatory post-synaptic potential (EPSP) or an inhibitory post-synaptic potential (IPSP) depending on which ions move across membrane.
    E. Action potential arrives at terminal branch.

| First | Second | Third | Fourth | Fifth |
|---|---|---|---|---|
| E | A | C | D | B |



Consider the post-synaptic responses below.

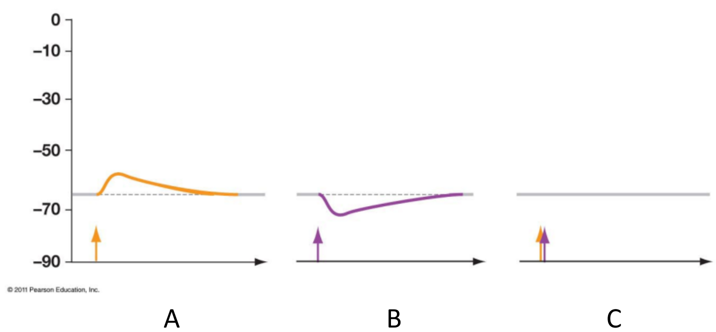
11. Based on the figure below, does "A" represent an EPSP or IPSP?
EPSP

12. Which ligand-gated channel would be most likely to induce the response in "A" if it were to open? ($Na^+$ or $K^+$).
Na+

13. Does "B" represent an EPSP or IPSP?
IPSP

14. Which ligand-gated channel would be most likely to induce the response in "B" if it were to open? ($Na^+$ or $K^+$).
K+

15. "C" illustrates what happens when two presynaptic neurons interact with one postsynaptic neuron at the same time (specifically when the signal in "A" and "B" arrive at a postsynaptic neuron). What can you conclude?
The signals cancelled each other out.

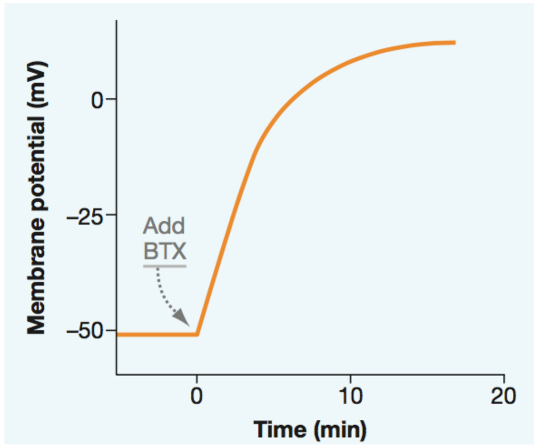



**CASE STUDY: How can a frog kill with its skin?**


Certain species of frogs in the genus *Phyllobates* have a powerful defensive adaptation—their skin can secrete a milky fluid that contains an extremely toxic compound called batrachotoxin (BTX). These frogs, which are found in

Colombia, are known as poison dart frogs because some indigenous Colombian hunters coat the tips of their blowgun darts with the frogs' skin secretions. An animal hit by one of these darts dies quickly. What is the mechanism of action of BTX?

The graph below shows the effect of BTX on the membrane potential of a squid giant axon.




*Source:* Narahashi, T., E. X. Albuquerque, and D. Deguchi. 1971. *The Journal of General Physiology* 58: 54–70.

16. Which of the following is the most likely explanation for the effect of BTX on the squid giant axon? C
    a. Inactivation of $Na^+/K^+$-ATPase (the sodium/potassium pump)
    b. Closing of sodium channels
    c. Opening of sodium channels
    d. Opening of potassium channels

17. As shown by the graph in Question 11, BTX depolarizes the membrane and prevents repolarization. What effect would this have on electrical signaling by the nervous system?

You would not be able to pass signals anymore because your cells would not repolarize and you would become paralyzed.

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