Take Home Lessons from Today 9-12-23

1. Neurons are complex cells that have two ends, with an axon in between. One side, containing the cell body or Soma has dendrites that receive input signals from other neurons. The other end, past the long axon, has the effector nerve endings and this is the side that sends signals to other neurons

2. Myelin coats the neuron and helps speed movement of the nerve signal from the dendrite side to the effector nerve ending side

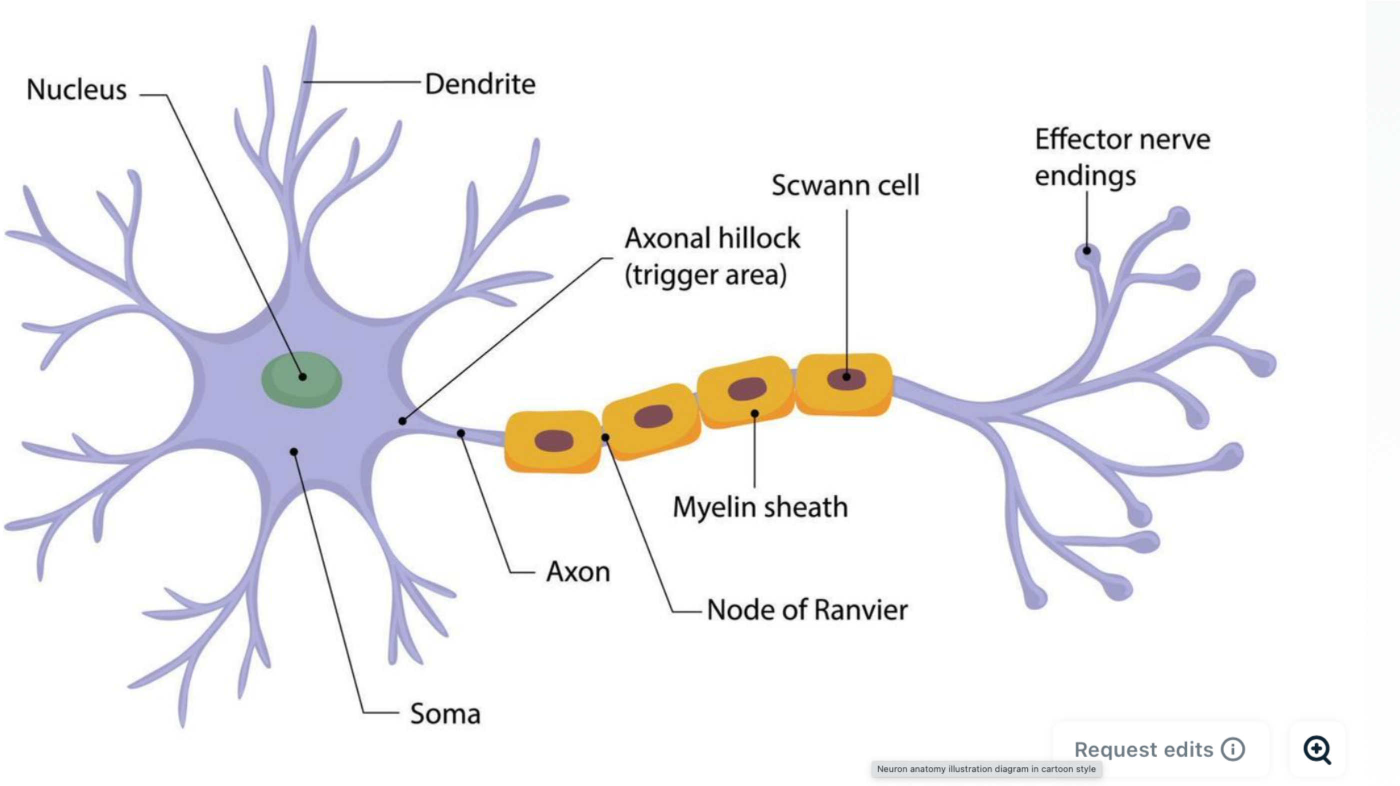
3. The neuron membrane has special pores that only let certain ions move across the membrane, including pores for sodium, potassium and chloride. These pores can be open or closed depending on whether the nerve is firing a signal.

4. In the resting state, there are more sodium ions and chloride ions on the outside of the neuron, and more potassium ions on the inside of the neuron. This creates a potential (imbalance) across the membrane in the resting state. This is like compressing a chemical spring. Nerve firing simply involves opening pores in a defined way so that the amount of sodium ions and potassium ions can get closer to equilibrium levels i.e. same amount on each side of the membrane (releasing the chemical spring).

5. A special molecular pump (a protein) uses the energy from ATP to create and maintain this gradient by pumping the sodium out and the potassium into the neuron. (Compressing the chemical spring so it is ready fire again)

6. When the neuron receives a signal, some sodium pores open and some sodium diffuses in. If this happens enough and from the right dendrites, it triggers a full opening of all local pores, even more sodium rushes in, eventually triggering the potassium pores to open so potassium rushes out. These balance the soidum and potassium chemical springs, then the special molecular pump kicks in and restores the resting state along this part of the membrane. This process is called an “action potential”.

7. The signal is propagated in one direction down the axon as the process in 6) is repeated until the effector nerve endings are reached and they fire (stay tuned on what that means).


Nucleus
Dendrite
Effector nerve endings
Scwann cell
Axonal hillock (trigger area)
Myelin sheath
Axon
Node of Ranvier
Soma
Request edits
Neuron anatomy illustration diagram in cartoon style

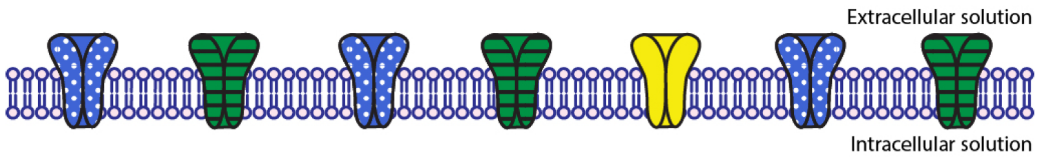


Figure 2.2. The phospholipid bilayer with embedded ion channels. The dotted, blue channels represent sodium channels; the striped, green channels represent potassium channels; the solid yellow channels represent chloride channels. 'Membrane with Channels' by Casey Henley is licensed under a Creative Commons Attribution Non-Commercial (CC-BY-NC) 4.0 International License.

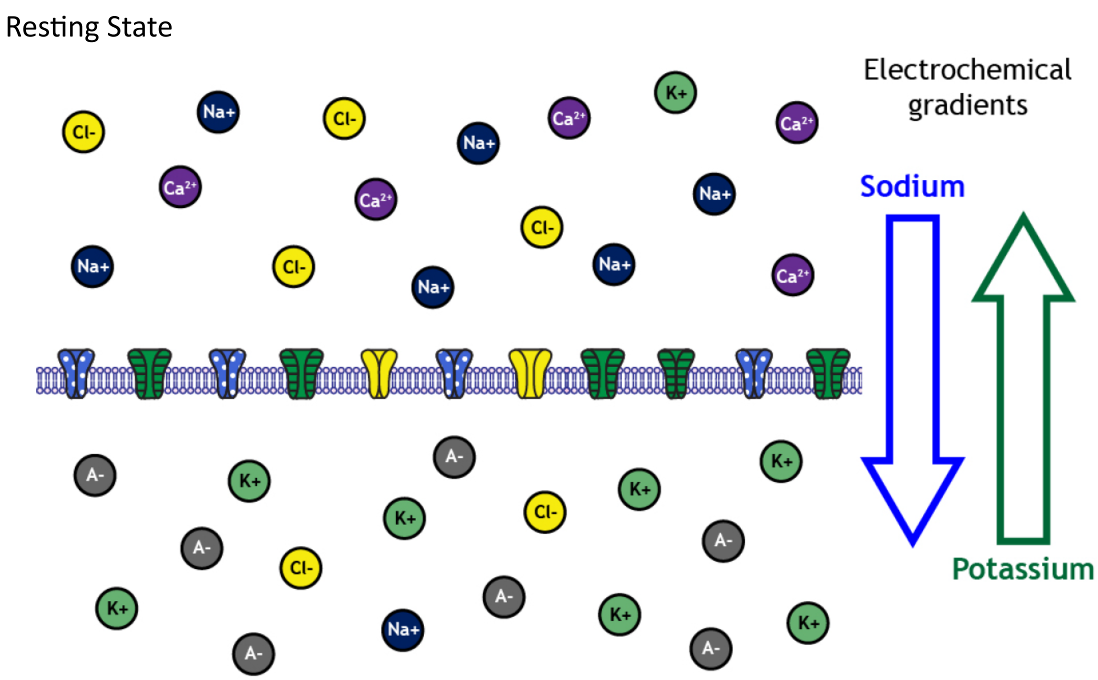


Figure 3.5. The distribution of ions on either side of the membrane lead to electrochemical gradients for sodium and potassium that drive ion flow in different directions. If the membrane is permeable to sodium, ions will flow inward. If the membrane is permeable to potassium, ions will flow outward. The dotted, blue channels represent sodium channels; the striped, green channels represent potassium channels; the solid yellow channels represent chloride channels. 'Gradients Across Membrane' by Casey Henley is licensed under a Creative Commons Attribution Non-Commercial Share-Alike (CC BY-NC-SA) 4.0 International License.

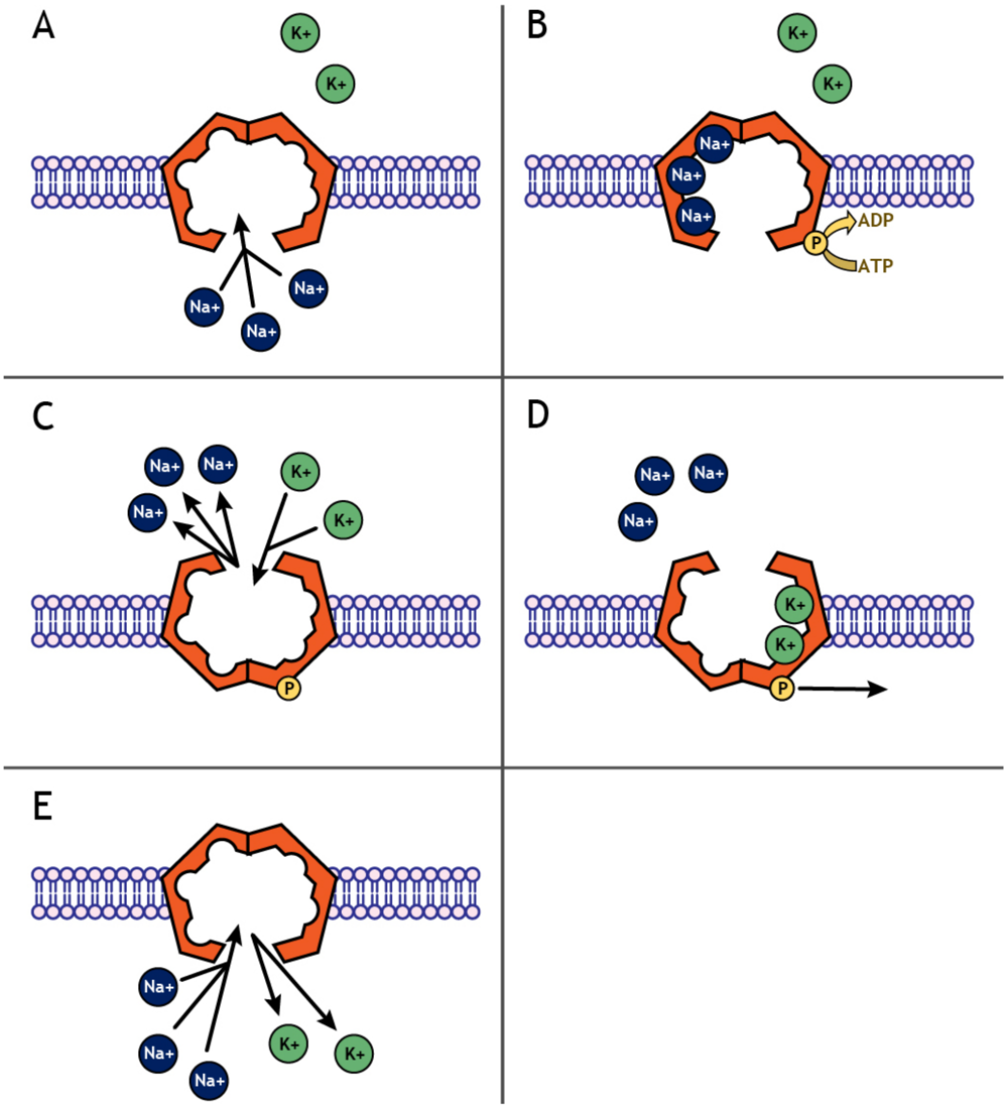


Figure 4.5. The sodium-potassium pump is embedded in the cell membrane and uses ATP to move sodium out of the cell and potassium into the cell, maintaining the electrochemical gradients necessary for proper neuron functioning. A) Three intracellular sodium ions enter the pump. B) ATP is converted to ADP, which leads to a conformational change of the protein, closing the intracellular side and opening the extracellular side. C) The sodium ions leave the pump while two extracellular potassium ions enter. D) The attached phosphate molecule then leaves, causing the pump to again open toward the inside of the neuron. E) The potassium ions leave, and the cycle begins again.

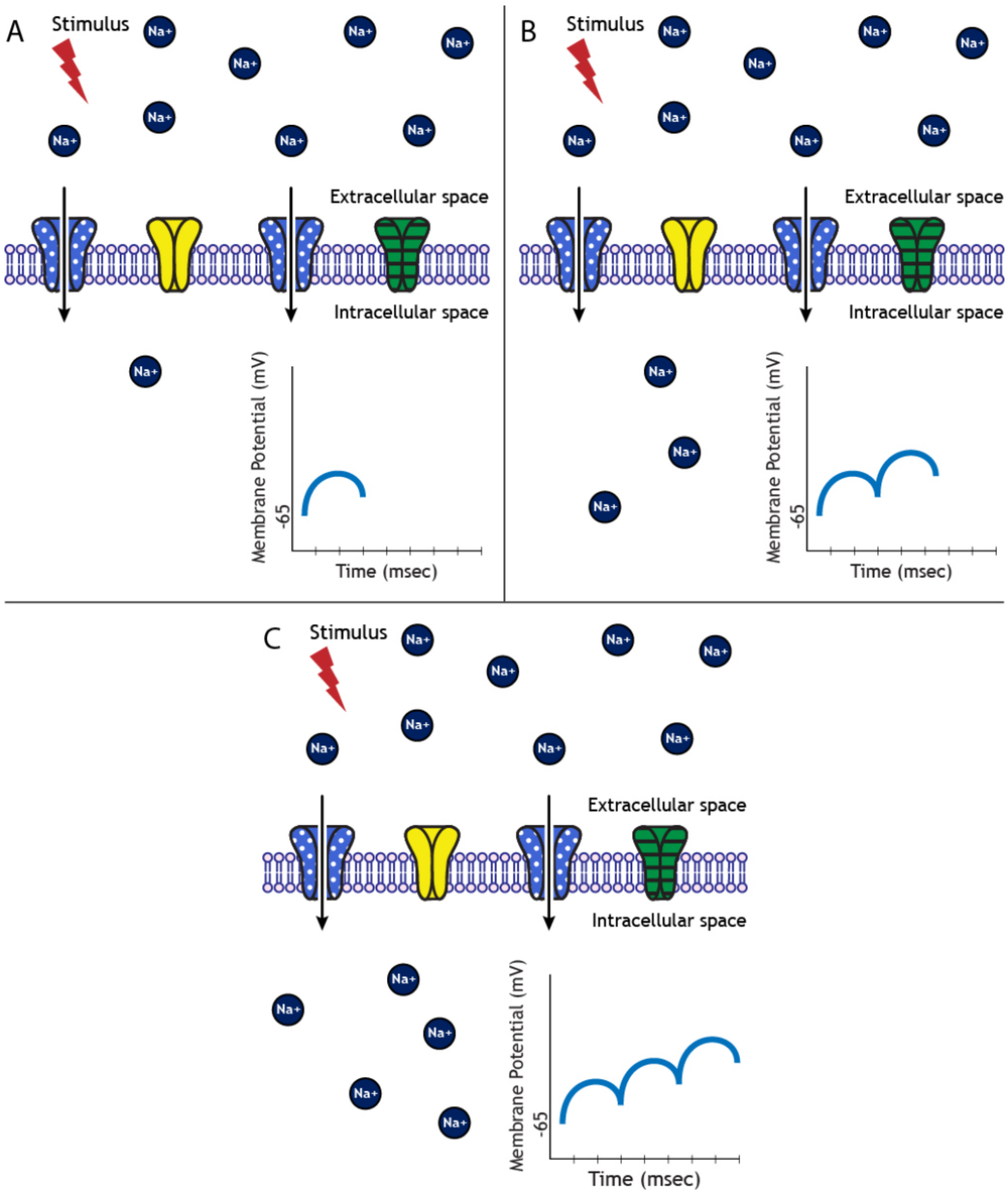


Figure 5.8. Excitatory stimuli that occur quickly in succession lead to summation of EPSPs. This leads to increased depolarization of the membrane potential compared to a single EPSP. The dotted, blue channels represent sodium channels; the striped, green channels represent potassium channels; the solid yellow channels represent chloride channels. 'Summated EPSPs' by Casey Henley is licensed under a Creative Commons Attribution Non-Commercial Share-Alike (CC BY-NC-SA) 4.0 International License.

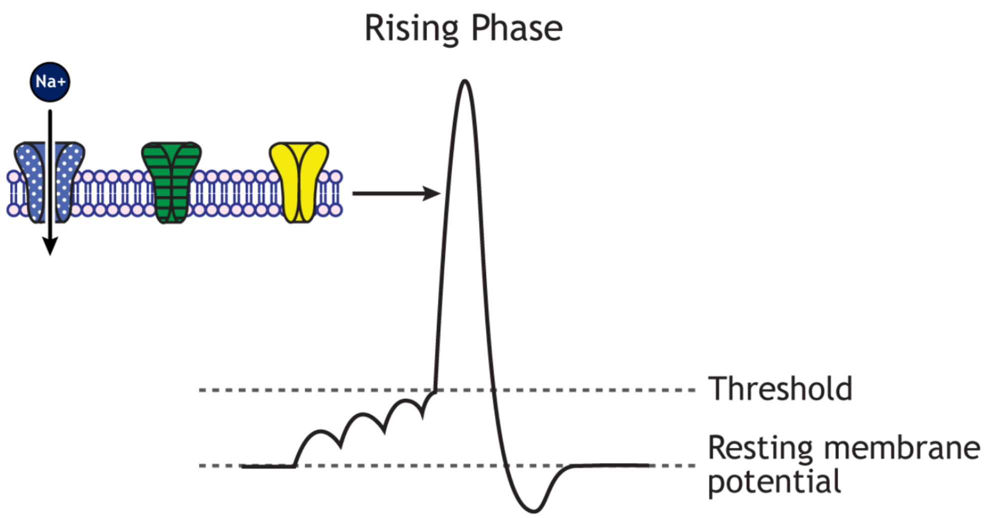


Figure 6.11. Voltage-gated sodium channels open once the cell's membrane potential reaches threshold. The rapid influx of sodium results in a large depolarization called the rising phase. The dotted, blue channels represent voltage-gated sodium channels; the striped, green channels represent voltage-gated potassium channels; the solid yellow channels represent chloride channels. 'Rising Phase' by Casey Henley is licensed under a Creative Commons Attribution Non-Commercial Share-Alike (CC-BY-NC-SA) 4.0 International License.

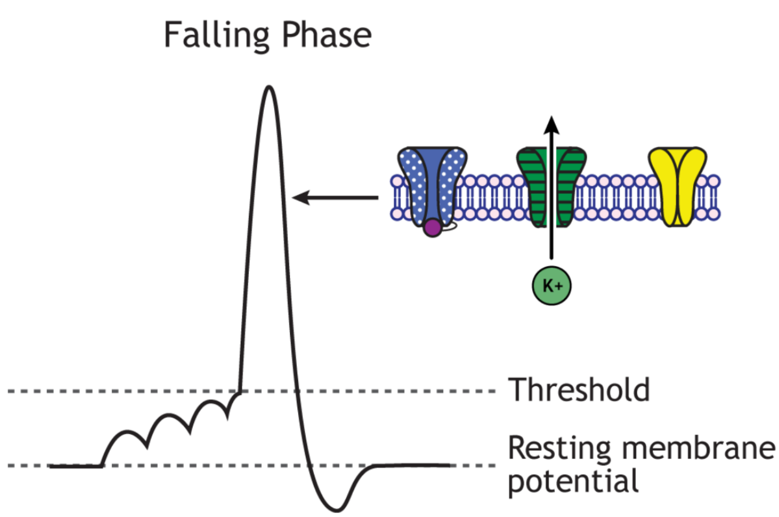


Figure 6.12. After approximately 1 msec, the voltage-gated sodium channels inactivate, which prevents any further ion flow into the cell. Although the voltage-gated potassium channels are activated in response to the cell reaching threshold, their opening is delayed and occurs alone with the sodium channel inactivation. This allows an efflux of potassium ions, which causes the repolarization of the falling phase. The dotted, blue channels represent voltage-gated sodium channels; the striped, green channels represent voltage-gated potassium channels; the solid yellow channels represent chloride channels. 'Falling Phase" by Casey Henley is licensed under a Creative Commons Attribution Non-Commercial Share-Alike (CC-BY-NC-SA) 4.0 International License.

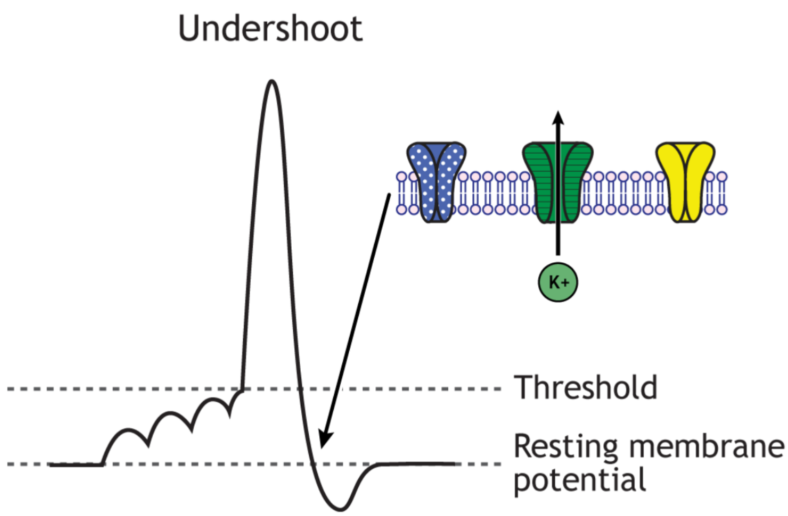


Figure 6.13. Once the cell's membrane potential repolarizes, the voltage-gated sodium channels de-inactivate and return to their closed state. The voltage-gated potassium channels remain open long enough for the undershoot to occur as potassium continues to flow out of the cell. The dotted, blue channels represent voltage-gated sodium channels; the striped, green channels represent voltage-gated potassium channels; the solid yellow channels represent chloride channels. 'Undershoot' by Casey Henley is licensed under a Creative Commons Attribution Non-Commercial Share-Alike (CC-BY-NC-SA) 4.0 International License.

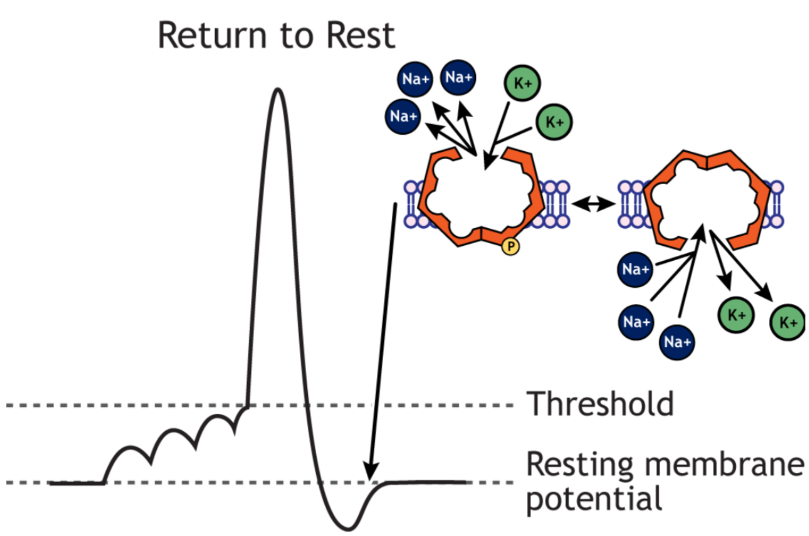


Figure 6.14. Once the voltage-gated potassium channels close, the sodium-potassium pump will work to re-establish the electrochemical gradients and return the cell to its resting membrane potential. 'Return to Rest' by Casey Henley is licensed under a Creative Commons Attribution Non-Commercial Share-Alike (CC-BY-NC-SA) 4.0 International License.

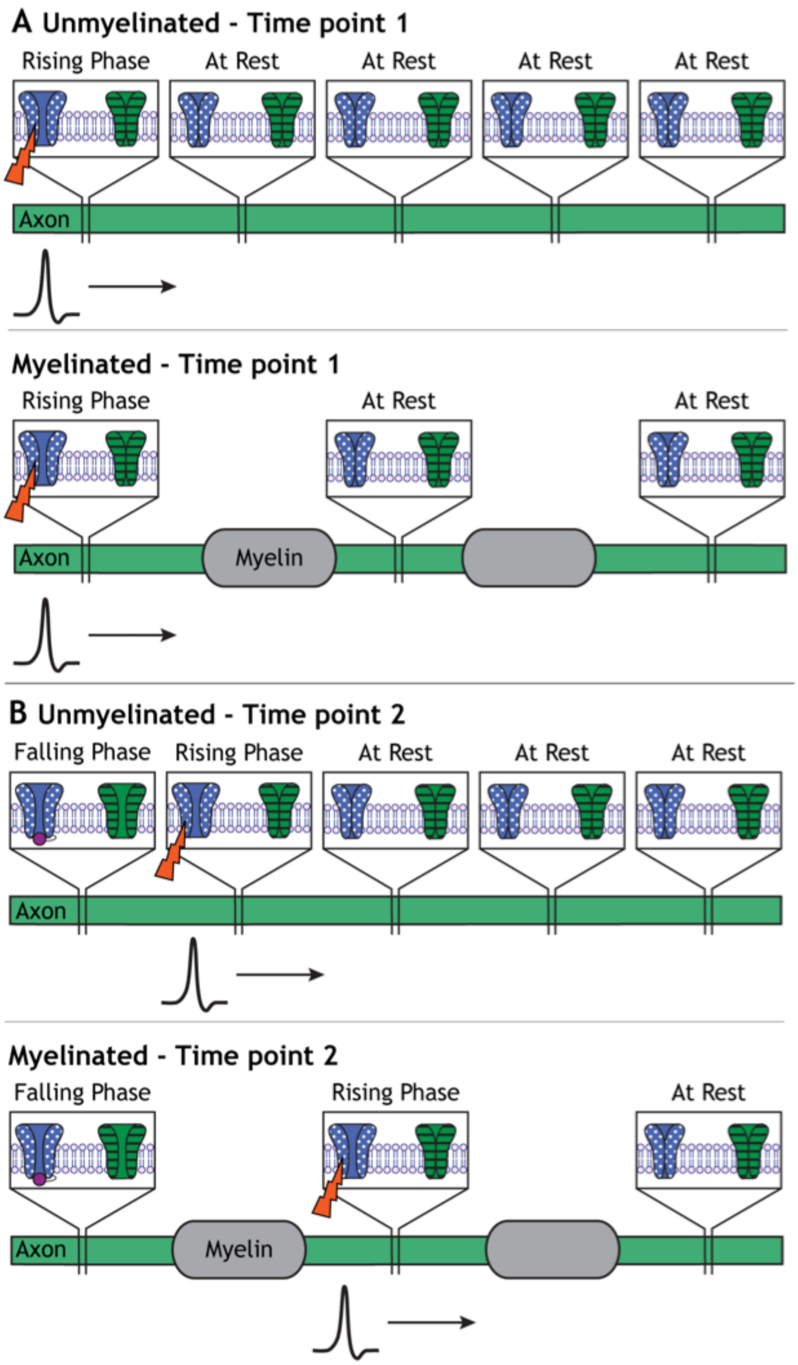


Figure 6.16. The action potential moves down an unmyelinated axon like a wave, opening voltage-gated channels along the length of the axon. In a myelinated axon, though, the action potential is able to skip portions of the axon that are covered by the myelin; the action potential jumps from node to node and travels further down the axon in the same amount of time. The dotted, blue channels represent voltage-gated sodium channels; the striped, green channels represent voltage-gated potassium channels.