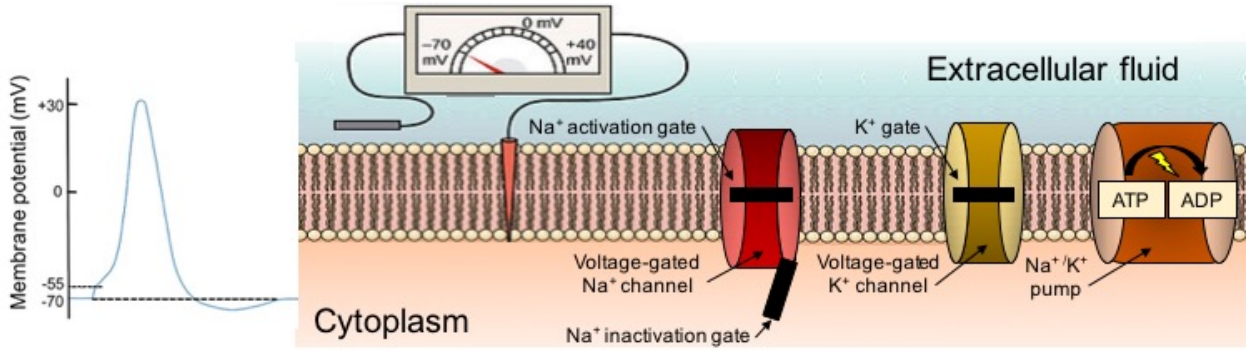
How Ion Movement Creates an Action Potential

Changes in ion permeability along an axon results in selective ion flow across the cell membrane, ultimately leading to changes in membrane potential. These voltage changes are responsible for nerve action potentials created by a stimulus. In this activity, you will draw what is happening at each step of the action potential to gain a better understanding of how ion movement is integral to the function of nerve cells.

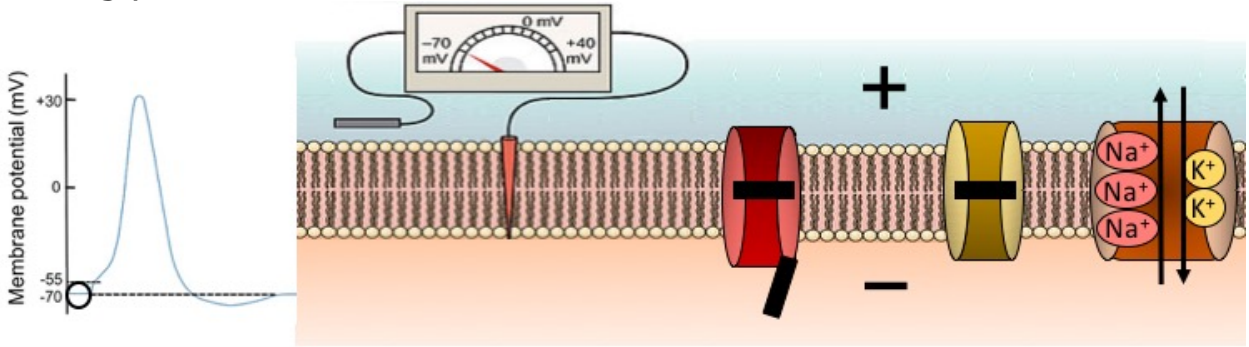
Below is a labelled diagram of a very small portion of the cell membrane. You will notice that to the left there is a graph of the action potential curve, in the center there is a voltmeter displaying the membrane potential in mV, and to the right are the two channel and one carrier proteins used by the Na^+ and K^+ ions to cross the membrane.



For each blank diagram:

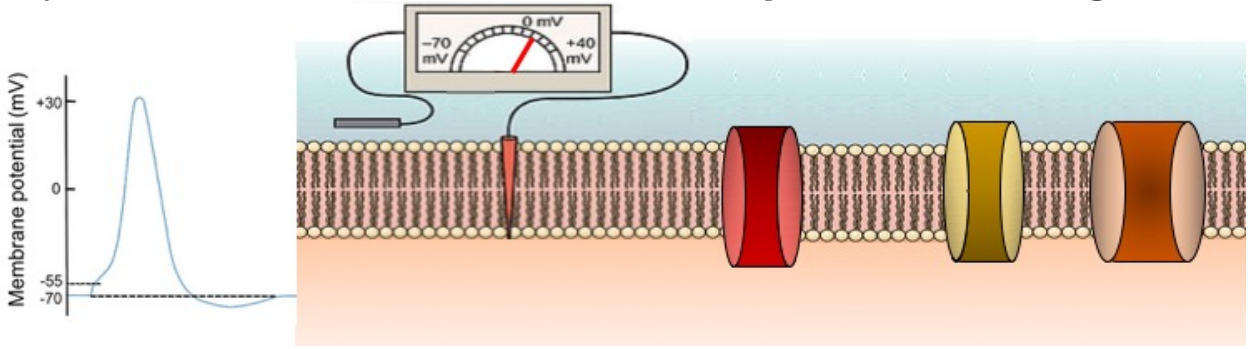
1. **Read the voltmeter and circle the location on the graph that is depicted**
2. **Draw the position (open/closed) of the 3 gates on the channel proteins**
3. **Identify which ions are moving across the membrane using arrows to depict the direction and proteins facilitating this movement**
4. **Identify the relative charges of the cytoplasm and extracellular fluid**

Resting phase *(The above steps 1-4 have been completed here as an example.)*

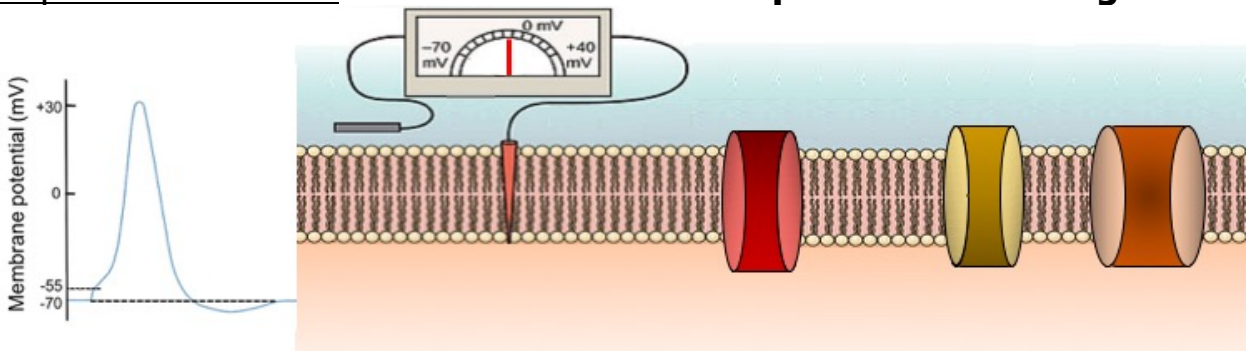


A. Draw location of 10 Na^+ and 10 K^+ ions in the resting phase neuron above.

Depolarization Phase ****Draw steps 1-4 on this diagram****



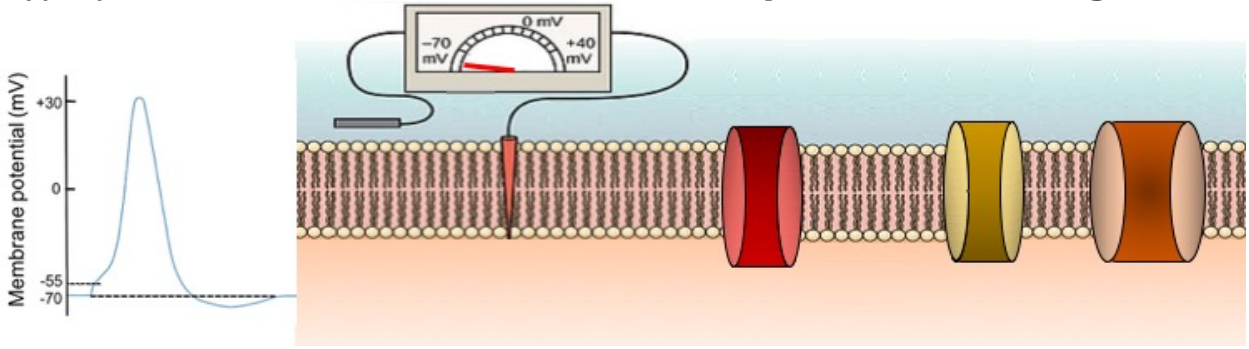
Repolarization Phase ****Draw steps 1-4 on this diagram****



B. Consider this: Very few Na^+ and K^+ ions must cross the membrane to create each action potential. For example, 1 in every 100,000 K^+ must move to shift the membrane potential from +30 mV to −70 mV. Knowing this, draw the predicted location of 10 Na^+ and 10 K^+ ions in the repolarization stage depicted above.

C. Traditionally, African aboriginal tribes smeared their arrows with toxins during hunting. One such toxin is a plant-derived compound called ouabain, which inhibits the Na^+/K^+ pump and eventually leads to paralysis and death. Discuss what happens to the action potentials generated by the neurons over time in an animal that has been shot and explain why this would eventually lead to paralysis.

Hyperpolarization Phase ****Draw steps 1-4 on this diagram****



D. Would a cell at resting membrane potential of –70 mV depolarize or hyperpolarize in the following cases? Why?

i) The neuron becomes more permeable to K^+

ii) Cl^- enters the cell

iii) The neuron becomes more permeable to Ca^{2+}

vi) A small amount of Na^+ leaks into the cell