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**Unit 5: Nervous System**

**CELL TRANSPORT AND NEURON SIMULATION**

**Part I: Membrane Channels Simulation**

1. Go to <http://phet.colorado.edu/en/simulation/membrane-channels> and click “Download.”
2. Click “Show Concentrations” on the right-hand side of the screen that pops up to see the levels of each ion on each side of the cell membrane.
3. Introduce some green ions—click on the top red button on the left side of the screen to release some green ions into the simulation.
   1. **How do the green ions move? Can they pass through the cell membrane?**
4. Add a green ion leakage channel—drag the green leakage channel from the bottom left of the screen to any place along the cell membrane. Observe the movement of the green ions.
   1. **Now, how do the green ions move? Is this diffusion or active transport?**
5. Remove the green ion leakage channel by dragging it off the cell membrane and out of the simulation window.
6. Add a green gated channel by dragging it from the bottom right of the screen to any place along the cell membrane. Open the gated channel by clicking the “Open (Green) Channels” button on the right side of the screen.
   1. **Before the gated channel was open, could ions pass through the cell membrane?**
   2. **After the gated channel was open, could ions pass through the cell membrane?**
7. Add a blue ion leakage channel by dragging it from the bottom left onto the cell membrane.
   1. Can green ions pass through the blue leakage channel? Why or why not?
8. Introduce some blue ions—click on the bottom red button on the left side of the screen to release some blue ions into the simulation.
9. Add a blue ion gated channel. Open both gated channels.
   1. **What do you observe about the movement of green and blue ions in this simulation?**
10. Let’s make this membrane more like the cell membrane of a neuron. Press the “Reset All” button to reset the simulation. Re-check the “Show Concentrations” button.
11. For our purposes, the top of the screen will represent the outside of the cell and the bottom of the screen will represent the inside of the cell. Green ions will represent Na+ (sodium), and blue ions will represent K+ (potassium).
12. Add three potassium (blue) leak channels and one sodium (green) leak channel to the cell membrane. Do not release ions yet.
13. Add one potassium gated channel and one sodium gated channel to the cell membrane. Keep all gated channels closed.
14. Release an equal amount of sodium and potassium ions into the simulation using the red buttons along the left side. Keep all gated channels closed.
    1. **Immediately after releasing the ions, what are the levels of sodium and potassium inside and outside the cell?**
    2. **Wait a few seconds (you can speed up the simulation using the slider along the bottom of the window if you wish). How are the sodium and potassium levels changing?**
    3. **What would happen if the sodium potassium pump was also included?**
    4. **What step of an action potential does this represent?**
15. Start the action potential—open the sodium (green) gated channel.
    1. **What step of an action potential does this represent?**
16. Close the sodium gated channel and open the potassium (blue) gated channel.
    1. **What step of an action potential does this represent?**
17. Keep the potassium gated channel open longer than you kept the sodium channel open.
    1. **What step of an action potential does this represent?**
18. Close the potassium gated channel. Keep all gated channels closed.
    1. **What step of an action potential does this represent?**

When you are finished, download the simulation at <https://phet.colorado.edu/en/simulation/neuron> to see the steps of an action potential in a stimulated neuron. Look for the features we just observed!