

Tips for controls:

- Students drag the channels onto the membrane and then investigate what happens.
- The concentrations graphs are meant to give students qualitative, relative information to help them understand diffusion.

Important modeling notes / simplifications:

- In a real cell, leakage channels are always open, whereas gated channels only open in response to some stimulus. Some gated channels respond to the presence of a certain substance (ligand gated), some respond to a change in membrane potential brought about by changes in ion concentrations (voltage gated), some respond to changes to tension in the cell membrane (mechanically gated), and some respond to light (light gated).
- In real cells, channels do not actively move things through them; they only allow things to diffuse through them. This is true in the simulation too, though in some cases it may appear that an ion is being pulled across a channel. Teachers should make sure that students understand that the motion through the channels is passive – a result of diffusion - and that membrane channels do not ‘pump’ anything across the membrane.

Insights into student use / thinking:

- These are the learning goals for which the sim was designed:
 - ✓ Predict when particles will move through the membrane and when they will not.
 - ✓ Identify which particle type will diffuse depending on which types of channels are present.
 - ✓ Predict the rate of diffusion based on the number and type of channels present.
- At present, we do not have any particular identified problems that students have with using the sim to learn the goals.

Suggestions for sim use:

- For tips on using PhET sims with your students see: [Guidelines for Inquiry Contributions](#) and [Using PhET Sims](#)
- The simulations have been used successfully with homework, lectures, in-class activities, or lab activities. Use them for introduction to concepts, learning new concepts, reinforcement of concepts, as visual aids for interactive demonstrations, or with in-class clicker questions. To read more, see [Teaching Physics using PhET Simulations](#)
- For activities and lesson plans written by the PhET team and other teachers, see: [Teacher Ideas & Activities](#)
- Gold Star Activities: