

Name: \_\_\_\_\_ Period: \_\_\_\_\_ Date: \_\_\_\_\_

Open **peebedu.com** and navigate to **Membrane Explorer**. Click the **Explore the Membrane!** button to begin. Read the introduction popup, which categorizes molecules by their ability to cross the phospholipid bilayer: small nonpolar molecules freely cross, small polar molecules have limited passage, and ions and large polar molecules need channels.

## Part 1 – Model Evaluation (MAPP Framework)

*Scientific models are simplified representations of complex biological phenomena. Use the MAPP framework below to evaluate the Membrane Permeability Explorer as a scientific model.*

### M – Mode

What type of model is the Membrane Permeability Explorer? Describe how this computational simulation represents the selective permeability of a phospholipid bilayer. In your answer, identify at least three specific simulation elements and explain what each one is designed to show about membrane structure or transport.

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### A – Accuracy

**(a)** Identify two things this simulation represents **accurately** about membrane permeability. For each, name the specific simulation feature and explain what property of the plasma membrane it demonstrates.

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**(b)** Identify two things this simulation **oversimplifies or leaves out** about plasma membrane structure and transport. Consider what you cannot observe in the simulation that would be important for a complete understanding of how substances cross biological membranes.

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## **P – Purpose**

What is the learning goal of this simulation? Explain how the Membrane Permeability Explorer is designed to help you understand why the plasma membrane is selectively permeable. In your answer, connect at least one specific simulation feature to a biological function that depends on selective permeability.

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## **P – Permanency**

Could this model change with new scientific evidence? Describe one way that new discoveries might change or improve a simulation like the Membrane Permeability Explorer. Explain why scientific models, including computational simulations, are revised as new evidence becomes available.

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## **Small-Group Discussion**

With your group, discuss the following:

- What are the strengths of this simulation as a model for membrane permeability?
- What are its limitations?
- If you could add one feature to improve this simulation, what would it be and why?
- How does the simulation help you connect molecular properties (size, polarity, charge) to membrane behavior?

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## Part 2 – NGSS Questions

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1.

*Simulation Task: Click **Add O<sub>2</sub>** three times and **Add Na<sup>+</sup>** three times to place molecules in the extracellular space. Click **Run** and observe both molecule types for 15 seconds. Watch the concentration readouts on each side of the membrane.*

Describe the difference in how O<sub>2</sub> and Na<sup>+</sup> interact with the phospholipid bilayer. Explain why the nonpolar interior of the membrane allows some molecules to cross freely while blocking others.

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HS-LS1-2

2.

*Simulation Task: While the simulation is still running with Na<sup>+</sup> stuck on one side, click the **Na<sup>+</sup> Channel** button to insert a channel protein into the membrane. Observe the movement of Na<sup>+</sup> ions and the concentration readout changes.*

Describe what happened to the Na<sup>+</sup> ions after the channel was added. Explain why channel proteins are necessary for ions to cross the membrane and describe the direction of net ion movement relative to the concentration difference.

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HS-LS1-2

3.

*Simulation Task: Click **Reset** to clear all molecules. Add **Water** five times and click **Run**. Observe the water molecules for 10 seconds. Then click the **Aquaporin (Water)** button and observe the change in transport rate.*

Compare how water molecules moved before and after the aquaporin channel was added. Explain why water, even though it is a small molecule, benefits from channel proteins to cross the membrane more efficiently.

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HS-LS1-2

4.

*Simulation Task: Click **Reset**. Add **Glucose** five times and **Add Protein** two times. Click **Run** and observe both. Then click the **Glucose Channel** button and observe what changes for each molecule type.*

Describe what happened to the glucose molecules and the protein molecules after the glucose channel was added. Explain why channel proteins are specific to certain molecules and why very large molecules such as proteins cannot use these channels.

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HS-LS1-2

5.

*Simulation Task: Click **Reset**. Add **O<sub>2</sub>** three times and **Add K<sup>+</sup>** three times. Click **Run**. Then increase the **Temperature** slider to its maximum value and observe how the speed of molecular movement and membrane permeability change.*

Describe how increasing temperature affected the movement of molecules and their ability to cross the membrane. Explain why temperature changes the behavior of both the molecules and the membrane itself.

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HS-LS1-3

6.

*Simulation Task: Click **Reset**. Add one of each molecule type: O<sub>2</sub>, Water, Glucose, and Na<sup>+</sup>. Add the **Na<sup>+</sup> Channel** and **Glucose Channel**. Click **Run** and observe how each molecule type interacts with the membrane differently.*

In the box below, draw a labeled cross-section of the membrane showing: (1) the phospholipid bilayer with heads and tails labeled, (2) a small nonpolar molecule passing directly through the bilayer, (3) an ion passing through a channel protein, and (4) a large polar molecule being blocked. Label all four components.

*Draw your diagram here.*

HS-LS1-2

7.

*Simulation Task: Click **Reset**. Add **Na<sup>+</sup>** five times and **Add K<sup>+</sup>** five times. Click **Run**, then add the **Na<sup>+</sup> Channel** and **K<sup>+</sup> Channel**. Observe the ions moving down their concentration gradients through the channels without any energy input from the cell.*

The simulation shows ions moving through channels without energy input. However, living cells must often move ions against their concentration gradient to maintain proper cell function. Explain why moving molecules against a concentration gradient requires the cell to use energy, and describe how this energy-requiring transport is essential for processes such as nerve signaling or muscle contraction.

HS-LS1-7