Membrane Explorer

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.

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.

(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.

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.

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.

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?

Part 2 — Free Response Questions

Conceptual Analysis

Question 1 — Selective Permeability of the Phospholipid Bilayer

> *Simulation Task: Click **Add O_2** three times and **Add Na^+** three times to place molecules in the extracellular space. Click **Run** and observe which molecules cross the bilayer and which do not. Note the concentration readouts for both O_2 and Na^+ on each side of the membrane.*

(A) (1 pt) **Describe** the structural feature of the phospholipid bilayer that determines whether a molecule can freely cross the plasma membrane.

(B) (1 pt) **Explain** why small nonpolar molecules such as O_2 pass freely through the bilayer while ions such as Na^+ cannot.

(C) (1 pt) **Predict** what would happen to the Na^+ concentration readout if you clicked the **Na^+ Channel** button while the simulation is running.

(D) (1 pt) **Justify** your prediction by explaining how embedded channel proteins restore the ability of ions to cross the plasma membrane and why this movement occurs down the concentration gradient without energy input.

EK 2.4.A.1, 2.4.A.2, 2.4.A.3

Analyze Model / Visual Representation

Question 2 — Membrane Structure and Transport

> *Simulation Task: Click **Reset** to clear all molecules. Then click **Add Water** five times and **Add Glucose** five times. Click **Run** and observe both molecule types for 15 seconds without adding any channels. Then click **Aquaporin (Water)** and **Glucose Channel** and observe the changes in transport rate and concentration readouts.*

(A) (1 pt) **Describe** the role of the nonpolar hydrocarbon tails of phospholipids in determining which substances can pass through the plasma membrane and which cannot.

(B) (1 pt) **Explain** the relationship between the size and polarity of a molecule and its ability to cross the phospholipid bilayer.

(C) (1 pt) **Represent** the selective permeability of the plasma membrane.

Draw your diagram here.

(D) (1 pt) **Explain** how the selective permeability of the plasma membrane is essential for maintaining cellular homeostasis.

EK 2.3.A.1, 2.4.A.2, 2.4.A.3