Name: _____   **Period:** _____   **Date:** _____

> Open **peebedu.com** and navigate to **Cell Diffusion Explorer**. Click the **Start Experimenting!** button to begin. Read the introduction popup, which describes diffusion, the surface area-to-volume (SA/V) ratio, and why cell shape matters for efficient material exchange.

Part 1 — Model Evaluation (MAPP Framework)

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

M — Mode

What type of model is the Cell Diffusion Explorer? Describe how this computational simulation represents the process of diffusion across cell membranes. In your answer, identify at least three specific simulation elements and explain what each one is designed to show about how cells exchange materials with their environment.

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A — Accuracy

(a) Identify two things this simulation represents **accurately** about diffusion and the relationship between cell shape and transport efficiency. For each, name the specific simulation feature and explain what biological concept it demonstrates.

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(b) Identify two things this simulation **oversimplifies or leaves out** about how cells actually transport materials across their membranes. Consider what you cannot observe in the simulation that would be important for a complete understanding of membrane transport.

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P — Purpose

What is the learning goal of this simulation? Explain how the Cell Diffusion Explorer is designed to help you understand how the surface area-to-volume ratio of a cell affects the rate of passive transport across its membrane. In your answer, connect at least one specific simulation feature to a biological situation in which cell shape influences how efficiently an organism exchanges materials with its environment.

P — Permanency

Could this model change with new scientific evidence? Describe one way that new discoveries might change or improve a simulation like the Cell Diffusion 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 how cell shape affects diffusion?
- 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 the mathematical concept of SA/V ratio to the biological need for efficient membrane transport?

Part 2 — Free Response Questions

Conceptual Analysis

Question 1 — Passive Transport and SA/V Ratio

*Simulation Task: Drag the **Star** shape (SA: 355.9) and the **Crescent** shape (SA: 162.1) into the beaker. Calculate the SA/V ratio for each shape (both have V = 100). Click **Start / Resume All** and observe which shape completes diffusion first. Note the difference in how quickly each shape fills with color.*

(A) (1 pt) **Describe** how the selective permeability of a cell's membrane allows a concentration gradient to form between the inside and outside of the cell.

(B) (1 pt) **Explain** why the Star shape completes diffusion faster than the Crescent shape in the simulation, using the relationship between surface area-to-volume ratio and the rate of passive transport.

(C) (1 pt) **Predict** what would happen to the diffusion rate if a cell maintained the same volume but developed membrane folds that doubled its surface area.

(D) (1 pt) **Justify** your prediction by explaining how the net movement of molecules from regions of high concentration to regions of low concentration is affected by the amount of membrane surface area available for passive transport.

Analyze Model / Visual Representation

**Question 2 — Cell Shape and Transport Efficiency**

*Simulation Task: Drag the **Circle** shape (SA: 251.4), the **Tall Rectangle** shape (SA: 200.0), and the **Amoeba** shape (SA: 251.2) into the beaker. Note that the Circle and Amoeba have nearly identical surface areas despite very different shapes. Click **Start / Resume All** and observe the diffusion rates for all three shapes.*

(A) (1 pt) **Describe** how passive transport, including facilitated diffusion, enables the movement of molecules across the plasma membrane without the direct input of metabolic energy.

(B) (1 pt) **Explain** the relationship between the surface area-to-volume ratio of a cell and its efficiency at exchanging materials with the external environment through passive transport. Use the simulation data to support your explanation.

(C) (1 pt) **Represent** how cell shape affects diffusion efficiency.

Draw your diagrams here.
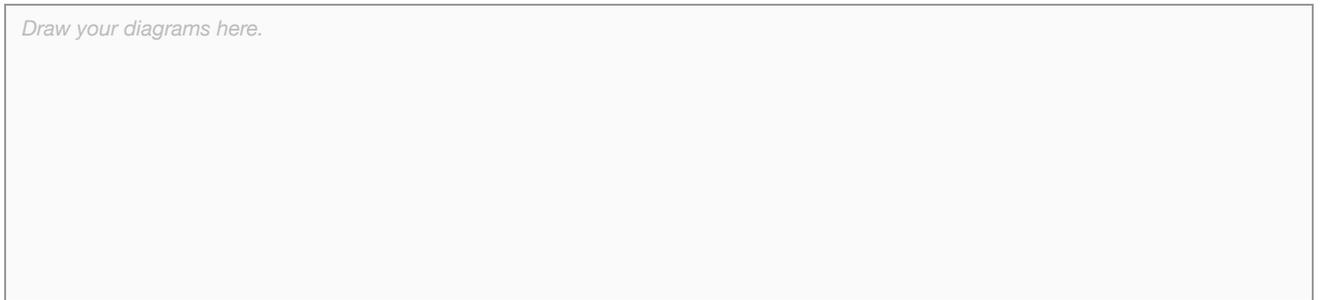
(D) (1 pt) **Explain** how the principle demonstrated in this simulation — that increased membrane surface area improves the efficiency of passive transport — applies to gas exchange in the alveoli of the mammalian respiratory system.

EK 2.5.A.2, EK 2.6.A.2