PEEBEDU

Cell Diffusion Explorer (NGSS)

Unit 2: Cells

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.

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.

(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.

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 — NGSS Questions

1.

> *Simulation Task: Drag the **Star** shape (SA: 355.9) and the **Crescent** shape (SA: 162.1) into the beaker. Both have V = 100. Click **Start / Resume All** and observe which shape fills with color first.*

Describe what you observe about the rate at which each shape fills with color. Using the SA/V ratio for each shape, explain why the shape with the higher ratio completes diffusion faster than the shape with the lower ratio.

HS-LS1-3

2.

> *Simulation Task: Click **Reset Simulation**. Drag the **Circle** (SA: 251.4) and the **Amoeba** (SA: 251.2) into the beaker. Note that these two shapes have nearly identical surface areas but very different outlines. Click **Start / Resume All** and watch the diffusion progress for both.*

The Circle and Amoeba have almost the same surface area and the same volume, yet they look very different. Based on what you observe in the simulation, explain whether shape alone matters for diffusion rate when the SA/V ratio stays the same. Describe what this tells you about why SA/V ratio, rather than appearance, determines how efficiently a cell exchanges materials.

HS-LS1-3

3.

> *Simulation Task: Click **Reset Simulation**. Drag the **Tall Rectangle** (SA: 200.0) and the **Wide Rectangle** (SA: 240.0) into the beaker. Click **Start / Resume All** and observe which rectangle completes diffusion first.*

Both rectangles have V = 100, but the Wide Rectangle has a higher surface area. Explain how a cell that is flattened or spread out can take in nutrients through diffusion more efficiently than a cell that is compact. Describe how this relationship between shape and surface area helps explain why many cells that need to absorb materials quickly are thin or flat.

HS-LS1-3

4.

> *Simulation Task: Click **Reset Simulation**. Drag the **Star** (SA: 355.9), the **T-Shape** (SA: 240.0), and the **Squiggle** (SA: 213.3) into the beaker. Click **Start / Resume All** and rank the shapes from fastest to slowest diffusion.*

Explain why cells remain microscopic rather than growing to very large sizes. Use the pattern you observed in the simulation to describe how increasing a cell's size would change its SA/V ratio and reduce its ability to move materials in and out through diffusion. Connect this to why cells divide rather than continue growing.

HS-LS1-3

5.

> *Simulation Task: Click **Reset Simulation**. Drag the **Blob** (SA: 255.1) and the **Chevron** (SA: 207.2) into the beaker. Click **Start / Resume All** and observe the diffusion. Think about how the color filling inward from the membrane represents molecules entering the cell.*

The simulation shows color moving from the outside fluid into each shape, representing molecules crossing the membrane. Explain what drives this movement without any energy input from the cell. Describe how a concentration gradient forms between the environment and the inside of a cell, and explain why molecules continue to move inward until the gradient disappears.

HS-LS1-3

6.

> *Simulation Task: Click **Reset Simulation**. Drag the **Circle** (SA: 251.4) and the **Star** (SA: 355.9) into the beaker. Click **Start / Resume All** and pause partway through to observe the difference in how much color has entered each shape.*

In the box below, draw two cells with the same volume: one compact (low SA/V) and one with projections or folds (high SA/V). Use arrows crossing each membrane to show the relative rate of diffusion, with more arrows for faster diffusion. Label the membrane, the direction molecules move along the concentration gradient, and each cell's SA/V category (low or high).

Draw your diagrams here.

HS-LS1-3

7.

> *Simulation Task: Slowly drag all remaining shapes into the beaker so that many different shapes are diffusing at once. Click **Start / Resume All** and observe the full range of diffusion rates across all shapes.*

In the human body, the small intestine is lined with cells that have tiny finger-like projections called microvilli, and the lungs contain millions of small air sacs called alveoli. Using the pattern you observed in the simulation, explain how these structures increase the SA/V ratio of the tissues they belong to. Describe how this increased surface area helps the digestive and respiratory systems move nutrients and gases into and out of the body efficiently enough to keep cells alive.

HS-LS1-2