Name: ____________________ **Date:** ____________
Section: ________

Cell Diffusion Explorer Activity

Investigating Cell Size Limitations Through Diffusion

Phase 1: ENGAGE (5 minutes)

Getting Started: Open peebedu.com and navigate to Cell Diffusion Explorer

Read the introduction popup to understand SA/V ratio and its importance.

Essential Question: Why are cells microscopic? What prevents them from growing indefinitely larger? _______

Initial Hypothesis: Based on your knowledge of diffusion, predict which cell shape will complete diffusion fastest if all have the same volume:

- Circle (sphere-like): _______
- Tall rectangle: _______

Explain your reasoning: ____

Phase 2: EXPLORE (20 minutes)

Systematic Investigation of Cell Shape and Diffusion

Part A: Shape Comparison Drag the following shapes into the beaker (all have V=100):

- Circle
- Star
- Tall Rectangle
- Wide Rectangle

Before starting diffusion, calculate SA/V for each:

Click '`Start/Resume All`' and observe diffusion

Data Collection:

- ———

Part B: Extreme Shapes Reset and test these shapes:

- T-Shape
- Crescent
- Squiggle
- Amoeba

Pattern Recognition: Which shapes diffused fastest? ________________ What do they have in common? ________________

Part C: Mathematical Analysis Plot your data:

- X-axis: SA/V ratio
- Y-axis: Time to complete diffusion

Describe the relationship: ________________

Phase 3: EXPLAIN (10 minutes)

Connecting Structure to Function

Identify Key Patterns (List 3):

- Pattern 1: As SA/V ratio increases, diffusion time _______

- Pattern 3: Compact shapes (like circles) have _______ SA/V ratios

Cause-Effect Analysis: Complete the relationships:

- Larger SA → More membrane area → _______ exchange points

- Higher SA/V → _______ diffusion efficiency → _______ survival

Cell Size Limitations: If a spherical cell doubles its radius:

- Surface area increases by factor of: _______

- SA/V ratio changes by factor of: _______

Real Cell Adaptations: Match the cell type to its shape adaptation:

- Red blood cell • Branching projections
- Neuron • Flattened disc
- Root hair cell • Elongated extension
- Alveolar cell • Thin and flat

Phase 4: ELABORATE (10 minutes)

Applying Concepts to Biological Systems

Scenario Analysis: Muscle Cell Problem: Active muscle cells need rapid oxygen delivery.

- Why can't muscle cells just grow larger? _______

Intestinal Adaptation: Small intestine cells have microvilli (tiny projections).

- Calculate: If a cubic cell (side=10m) adds 1000 microvilli, each adding $5m^2$ surface area:

- New SA: _______ m^2

Evolutionary Trade-offs: Some organisms have giant cells (bird eggs, algae).

- What strategies might they use? _______

Phase 5: EVALUATE (5 minutes)

Assessment Questions

Pattern Application: A cell biologist observes that cancer cells are typically smaller than normal cells of the same type. Using SA/V principles, explain why this might provide a growth advantage. (3 pts)

Data Analysis: Two cells have equal volumes. Cell A takes 30 seconds to fully diffuse nutrients, Cell B takes 90 seconds. What can you conclude about their shapes? Calculate their approximate SA/V ratio difference. (3 pts)

Systems Integration: Explain how the SA/V ratio constraint connects to:

- Membrane transport (Unit 2.4)
- Cellular respiration needs (Unit 3)
- Cell communication (Unit 4)

(4 pts)

Model Evaluation: What simplifications does this 2D model make compared to real 3D cells? How might results differ? _______

Research Question: How do different organisms overcome SA/V limitations? _______

Investigate one example:

- Xenophyos (giant single-celled organism)
- Caulerpa (giant algae cell)
- Plasmodial slime molds

Explain their structural adaptations: ______________________