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**Student Exploration:** **Osmosis**

**Vocabulary:** cell membrane, concentration, diffusion, dynamic equilibrium, osmosis, semipermeable membrane, solute, solvent

**Prior Knowledge Questions** (Do these BEFORE using the Gizmo.)

1. Suppose you were trapped on a desert island with no sources of fresh water. Should you drink water from the ocean? Explain why or why not.

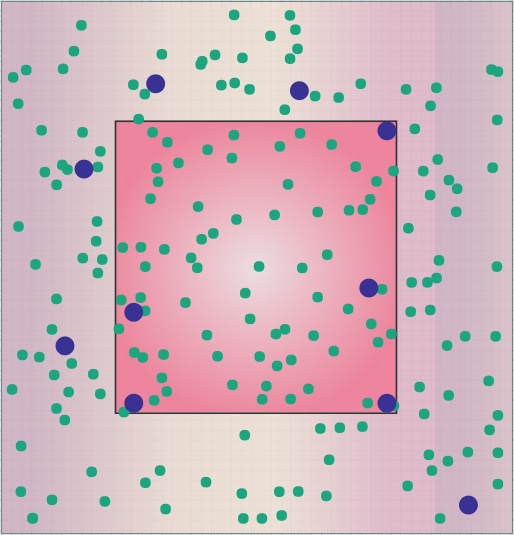
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1. What do you think would happen if you watered your houseplants with salt water?

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**Gizmo Warm-up**

A **cell membrane** is a thin “skin” that surrounds a cell. It is a **semipermeable membrane**, which means that some particles pass through the membrane easily while others cannot.

PlayThe *Osmosis* Gizmo portrays a cell (red square) in a solution of purple **solute** particles dissolved in green **solvent** particles. Press **Play** ( ) and observe.

1. Which particles can pass through the cell membrane?

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1. Which particles cannot pass through the cell membrane? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Click **Reset** (Replay), and then click **Play** again. What do you notice about the size of the cell?

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| **Activity A:**  **Observing osmosis** | Get the Gizmo ready:   * Click **Reset**. Set the **Initial cell volume** to 40%. * You will need a calculator for this activity. | 418SE2 |

**Question: How do solute concentrations affect the volume of a cell?**

1. Observe: Use the **Solute outside** slider to change the concentration of solute particles outside the cell. Click **Play**. In each case, focus on whether the cell gets bigger or smaller.
   * 1. In what situation does the cell get larger? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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* + 1. In what situation does the cell get smaller? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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1. Calculate: The **concentration** of a solute is the amount of solute particles in a given amount of solvent. To calculate percentage concentration, divide the number of solute particles by the total number of particles (solute + solvent), and then multiply by 100:

*% concentration =* (*solute ÷ total particles*) × 100

Select the DESCRIPTION tab. Click **Reset**. Set the **Solute outside** to 10 and check that the **Initial cell volume** is 40%. (Note: The cell volume is expressed as a percentage of the container size.)

* + 1. How many solute particles are found inside the cell? \_\_\_\_\_\_\_\_ Outside? \_\_\_\_\_\_\_\_
    2. How many solvent particles are found inside the cell? \_\_\_\_\_\_\_ Outside? \_\_\_\_\_\_\_\_
    3. What is the total number of particles inside the cell? \_\_\_\_\_\_\_\_ Outside? \_\_\_\_\_\_\_\_
    4. What is the % concentration of solute inside the cell? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
    5. What is the % concentration of solute outside the cell? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Observe: Click **Play**, and observe the numbers shown on the DESCRIPTION pane. How does each number change over time? Write “increases,” “decreases,” or “stays the same” (or “same”) in each space.

* Solute particles inside? \_\_\_\_\_\_\_\_\_\_\_
* Solvent particles inside? \_\_\_\_\_\_\_\_\_\_\_
* Solute concentration inside? \_\_\_\_\_\_\_\_\_
* Solute particles outside? \_\_\_\_\_\_\_\_\_\_\_
* Solvent particles outside? \_\_\_\_\_\_\_\_\_\_\_
* Solute concentration outside? \_\_\_\_\_\_\_\_\_

**(Activity A continued on next page)**

**Activity A (continued from previous page)**

1. Observe: Wait until the numbers are not changing very much. What do you notice about the solute concentrations inside and outside of the cell? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

This situation is called **dynamic equilibrium**.

1. Experiment: Click **Reset**. Check that the **Solute outside** is 10 and the **Initial cell volume** is 40%. To calculate the solvent concentration, divide the number of solvent particles by the total number of particles, and then multiply by 100. (Note: The Gizmo only displays the *solute* concentrations.)
   * 1. What is the solvent concentration inside the cell? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     2. What is the solvent concentration outside the cell? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     3. Where is there a higher solvent concentration? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     4. Click **Play**. Do most of the solvent particles move into or out of the cell? (Hint: Does the cell expand or shrink?) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Experiment: Click **Reset**, and set the **Solute outside** to 1.
   * 1. What is the solvent concentration inside the cell? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     2. What is the solvent concentration outside the cell? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     3. Where is there a higher solvent concentration? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     4. Do you think the cell will get larger or smaller? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
     5. Click **Play** to confirm your predictions. Were you correct? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
3. Summarize: You have observed examples of **osmosis**—the **diffusion** of a solvent (such as water) across a semipermeable membrane. Summarize what you have observed by filling in the blanks in the following paragraph:

*During osmosis, solvent particles move from an area of \_\_\_\_\_\_\_\_\_\_\_\_ concentration to an area of \_\_\_\_\_\_\_\_\_\_\_\_ concentration. When there is a higher concentration of solvent particles inside the cell, most solvent particles will move \_\_\_\_\_\_\_\_\_\_\_\_ the cell and the cell will \_\_\_\_\_\_\_\_\_\_\_\_. When there is a higher concentration of solvent particles outside the cell, most solvent particles will move \_\_\_\_\_\_\_\_\_\_\_\_ the cell and the cell will \_\_\_\_\_\_\_\_\_\_\_\_.*

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| **Activity B:**  **Effect of cell volume** | Get the Gizmo ready:   * Click **Reset**. * Set the **Solute outside** to 5. * Set the **Initial cell volume** to 40%. | 418SE3 |

**Question: How does changing the cell volume affect solute concentrations?**

1. Experiment: Select the BAR CHART tab, and turn on **Show numerical values**.
   1. Based on solute concentrations, do you expect the cell to swell or shrink? \_\_\_\_\_\_\_\_

* 1. Click **Play**, and observe. Was your prediction correct? \_\_\_\_\_\_\_\_

1. Observe: Click **Reset**. Move the **Initial cell volume** slider back and forth. How does the initial cell volume affect the solute concentrations inside and outside the cell?

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1. Experiment: With the **Solute outside** set to 5, predict whether the cell will swell, shrink, or stay the same with each of the following **Initial cell volume** settings. Then use the Gizmo to check each prediction.

Predictions: 20% \_\_\_\_\_\_\_\_\_\_ 50% \_\_\_\_\_\_\_\_\_\_ 60% \_\_\_\_\_\_\_\_\_\_

Actual results: 20% \_\_\_\_\_\_\_\_\_\_ 50% \_\_\_\_\_\_\_\_\_\_ 60% \_\_\_\_\_\_\_\_\_\_

1. Analyze: Why do solvent particles flow into the cell when the initial volume is below 50%?

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1. Extend your thinking: In the *Osmosis* Gizmo, the cell is placed in a very small chamber. Suppose a cell is placed in a large container of water with a very low solute concentration. What do you think would happen? Explain your answer.

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