Name: _____ Date: _____

# 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.

   _____

   _____

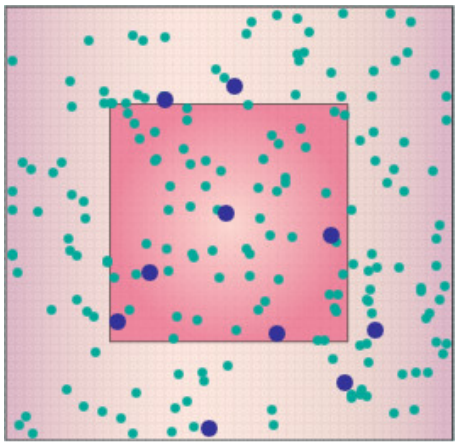
2. What do you think would happen if you watered your houseplants with salt water?

   _____

   _____

**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.



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

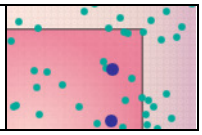
1. Which particles can pass through the cell membrane?

   _____

2. Which particles cannot pass through the cell membrane? _____

3. Click **Reset** ( ), and then click **Play** again. What do you notice about the size of the cell?

   _____

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

   A. In what situation does the cell get larger? _____

   _____

   B. In what situation does the cell get smaller? _____

   _____

2. 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:

   $$\%\ concentration = (solute \div total\ particles) \times 100$$

   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.)

   A. How many solute particles are found inside the cell? _____ Outside? _____

   B. How many solvent particles are found inside the cell? _____ Outside? _____

   C. What is the total number of particles inside the cell? _____ Outside? _____

   D. What is the % concentration of solute inside the cell? _____

   E. What is the % concentration of solute outside the cell? _____

3. 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? _____
   - Solute particles outside? _____
   - Solvent particles inside? _____
   - Solvent particles outside? _____
   - Solute concentration inside? _____
   - Solute concentration outside? _____

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

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

4. 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**.

5. 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.)

   A. What is the solvent concentration inside the cell? _____

   B. What is the solvent concentration outside the cell? _____

   C. Where is there a higher solvent concentration? _____

   D. Click **Play**. Do most of the solvent particles move into or out of the cell? (Hint: Does the cell expand or shrink?) _____

6. Experiment: Click **Reset**, and set the **Solute outside** to 1.

   A. What is the solvent concentration inside the cell? _____

   B. What is the solvent concentration outside the cell? _____

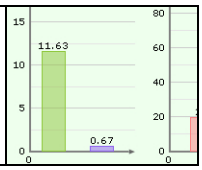
   C. Where is there a higher solvent concentration? _____

   D. Do you think the cell will get larger or smaller? _____

   E. Click **Play** to confirm your predictions. Were you correct? _____

7. 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 _____.*

| **Activity B:**<br><br>**Effect of cell volume** | Get the Gizmo ready:<br>• Click **Reset**.<br>• Set the **Solute outside** to 5.<br>• Set the **Initial cell volume** to 40%. |  |
|---|---|---|

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

1. Experiment: Select the BAR CHART tab, and turn on **Show numerical values**.

   A. Based on solute concentrations, do you expect the cell to swell or shrink? _____

   B. Click **Play**, and observe. Was your prediction correct? _____

2. 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?

   _____

   _____

   _____

3. 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% _____ |

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

   _____

   _____

5. 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.

   _____

   _____

   _____