Contributors

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Intended Audience

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<tbody>
<tr>
<td>K-4</td>
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<td>5-8</td>
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<td>9-12</td>
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Activity Characteristics

<p>| | |</p>
<table>
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<tr>
<td>Classroom Setting</td>
<td>X</td>
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<tr>
<td>Requires special equipment</td>
<td></td>
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<tr>
<td>Uses hands-on manipulatives</td>
<td>X</td>
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<tr>
<td>Requires mathematical skills</td>
<td>X</td>
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<tr>
<td>Can be performed individually</td>
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<tr>
<td>Requires group work</td>
<td>X</td>
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<tr>
<td>Requires more than one (45 min class) period</td>
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<tr>
<td>Appropriate for special needs student</td>
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Introduction

Description

Two activities are used to show students the processes of osmosis and diffusion.

Abstract

The activity will show how molecules move in a predictable manner and how these patterns drive physiological functions such as those within the lungs. Students will seal starch in a sandwich bag and place it in a beaker with a few drops of iodine. The iodine will diffuse into the bag and stain the starch. The students will then place potato cores in varying concentrations of sucrose solution. The swelling of the cores shows the process of osmosis.

Core Themes Addressed

<table>
<thead>
<tr>
<th>Core Theme</th>
<th>Addressed</th>
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<tbody>
<tr>
<td>Microbial Cell Biology</td>
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<tr>
<td>Microbial Genetics</td>
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<td>Microorganisms and Humans</td>
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<td>Microorganisms and the Environment</td>
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<td>Microbial Evolution and Diversity</td>
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<td>Other – Osmosis and Diffusion</td>
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</table>

Keywords

Osmosis, diffusion, solute, solvent, tonicity

Learning Objectives

At completion of this activity, learner will

1. Define osmosis and diffusion
2. Distinguish between hypertonic and hypotonic solutions
3. Predict which direction water will move across a semipermeable membrane, given the concentrations on either side.
4. Give examples of diffusion and osmosis in nature.

National Science Education Standards Addressed

Standard C: Life Science

- Matter, energy, and organization in living systems
Student Prior Knowledge

Diffusion refers to the movement of molecules through random motion from areas of high concentration to areas of low concentration. Osmosis is the diffusion of water molecules across a semi-permeable membrane. Both diffusion and osmosis are important in many cellular processes. For example, the diffusion of oxygen and carbon dioxide within the lungs is vital for the survival of many vertebrates. Furthermore, plants also absorb water and nutrients from the environment through the process of diffusion and osmosis.

Teacher Background Information

Students learn diffusion by filling a sandwich bag, an example of a semi-permeable membrane, with starch and placing the bag into a beaker with a few drops of iodine and observe the movement of iodine into the bag. Students learn osmosis and the concept of tonicity by placing potato cores in different concentrations of sucrose solutions.

Class Time

This activity will require a minimum of one 90 minute class period.

1. It will take students 40-45 minutes to set up the osmosis activity with the sandwich bags and record their observations
2. It will take students 40-45 minutes to set up the potato cores activity, record their observations, and graph their results.

Teacher Preparation Time

This lesson will require approximately 10 minutes of preparation time.

1. Divide supplies so that each group will have each necessary component.
Materials and Equipment (Per group)

1. One Sandwich bag
2. 15 ml of 1% starch solution
3. 250 ml beaker
4. Water
5. 4 ml Iodine solution
6. Cork borer or knife
7. 18 potato cylinders
8. Distilled water
9. Sucrose solution
10. Scale
11. Graph Paper

Methods

Activity 1

1. Obtain a sandwich bag. Place about 15 ml of 1% starch solution in the bag.
2. Tie off the end of the bag.
3. Record the color of the solution in Table 1.
4. Fill a 250 ml beaker 2/3 full with distilled water.
5. Add 4 ml iodine solution to the distilled water and record the color in Table 1.
6. Immerse the bag in the beaker of water.
7. Allow your set up to stand for 30 minutes or until you see a distinct color change in the bag or the beaker.
8. Record the final color of the solution in the bag and beaker in Table 1.

Activity 2

1. Use a cork borer to cut 18 potato cylinders 3 cm long.
2. Determine the weight of 3 potato cylinders together.
3. Record the weight of the 3 potato cylinders in Table 2 under initial mass.
4. Place 3 cylinders in each solution
   a. Distilled water, 0.2 M sucrose, 0.4 M sucrose, 0.6 M sucrose, 0.8 M sucrose, 1.0 M sucrose
5. Let stand for 15-20 minutes
6. Remove the cylinders and determine the weight of all 3 cylinders. Record the mass in Table 2 (Final Mass)
7. Determine the change of mass
8. Graph the results
9. Determine the concentration of the sucrose solution in which the mass of the potato cores does not change (Determine this value from the graph) Draw a line of best fit: The point at which this line crosses the x-axis represents the concentration of sucrose that is isotonic to the potato tissue. At this concentration there is no net gain or loss of water from the tissue.

Tips/Suggestions

1. Use the cheapest, thinnest sandwich bags you can find. These types can generally be found in dollar stores.
2. Test out the sandwich bag to make sure that they work prior to the activity. Some bags are too thick to work for this activity.
3. If a cork borer is not available, the potato cores can be prepared by cutting a potato into pieces of roughly the same size.
4. These potato cores can stay in the solutions overnight. This will produce better results.

Answers to Student Handouts

1. Which substance(s) entered the bag and which one(s) left the bag? What experimental evidence supports your answer? Water and the Iodine solution entered the bag, water and glucose left the bag. The Iodine solution change changed the starch in the bag from clear to dark blue.

2. What results would you expect if the experiment started with iodine solution inside the bag and starch and water outside? Why? The iodine solution will diffuse out of the bag turn the starch to a dark blue color because the bag is only permeable to water and iodine solution but not to starch.

3. Briefly describe how plant roots absorb water from the soil. Use the terms you learned from this activity (e.g., hypertonic, hypotonic, isotonic, solute etc). The solutes present in plant roots creates a hypertonic environment compared to the soil, which causes water to diffuse from the soil into the roots.
Introduction

Today you will be completing two different activities on osmosis and diffusion. In the first exercise you will measure diffusion of small molecules through a sandwich bag, which will serve as an example of a semi-permeable membrane. The movement of a solute through a semi-permeable membrane is called **diffusion**. The size of the tiny pores in the sandwich bag determines which substance can pass through the membrane.

In the second experiment you will use potato cells to investigate the relationship between solute concentration and the movement of water through a semi-permeable membrane by the process of osmosis. When two solutions have the same concentration of solutes, they are said to be **isotonic** to each other. If the two solutions are separated by a semi-permeable membrane, water will move between the two solutions, but there will be **no net change** in the amount of water in either solution. If two solutions differ in the concentration of solutes that each has, the one with more solute is **hypertonic** to the one with the less solute. The solution that has less solute is **hypotonic** to the one with more solute.

Student Background Knowledge

Diffusion refers to the movement of molecules through random motion from areas of high concentration to areas of low concentration. Osmosis is the diffusion of water molecules across a semi-permeable membrane. Both diffusion and osmosis are important in many cellular processes. For example, the diffusion of oxygen and carbon dioxide within the lungs is vital for the survival of many vertebrates. Furthermore, plants also absorb water and nutrients from the environment through the process of diffusion and osmosis.

Vocabulary

**Diffusion**: The spread of particles through random motion from regions of higher concentration to regions of lower concentration.

**Osmosis**: The movement of water through a semi-permeable membrane into a region of higher solute concentration, aiming to equalize the solute concentrations on the two sides.

**Tonicity**: A measure of the osmotic pressure of two solutions separated by a semi-permeable membrane.
Materials Checklist

<table>
<thead>
<tr>
<th>Item</th>
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<tbody>
<tr>
<td>Sandwich bag</td>
</tr>
<tr>
<td>15 ml of 1% starch solution</td>
</tr>
<tr>
<td>250 ml beaker</td>
</tr>
<tr>
<td>Water</td>
</tr>
<tr>
<td>4 ml Iodine solution</td>
</tr>
<tr>
<td>Cork borer</td>
</tr>
<tr>
<td>18 potato cylinders</td>
</tr>
<tr>
<td>Distilled water</td>
</tr>
<tr>
<td>Sucrose solution</td>
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<tr>
<td>Scale</td>
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</tbody>
</table>

Procedure

Activity 1

1. Obtain a sandwich bag. Place about 15 ml of 1% starch solution in the bag.
2. Tie off the end of the bag.
3. Record the color of the solution in Table 1.
4. Fill a 250 ml beaker 2/3 full with distilled water.
5. Add 4 ml iodine solution to the distilled water and record the color in Table 1.
6. Immerse the bag in the beaker of water.
7. Allow your set up to stand for 30 minutes or until you see a distinct color change in the bag or the beaker.
8. Record the final color of the solution in the bag and beaker in Table 1.

Activity 2

1. Use a cork borer to cut 18 potato cylinders 3 cm long.
2. Determine the weight of 3 potato cylinders together.
3. Record the weight of the 3 potato cylinders in Table 2 under initial mass
4. Place 3 cylinders in each solution
   a. Distilled water, 0.2 M sucrose, 0.4 M sucrose, 0.6 M sucrose, 0.8 M sucrose, 1.0 M sucrose
5. Let stand for 15-20 minutes
6. Remove the cylinders and determine the weight of all 3 cylinders. Record the mass in Table 2 (Final Mass)
7. Determine the change of mass
Results

Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Initial Contents</th>
<th>Initial Solution Color</th>
<th>Final Solution Color</th>
</tr>
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<tbody>
<tr>
<td>Bag</td>
<td>1% starch solution</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beaker</td>
<td>H₂O + iodine</td>
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</table>

Table 2.

<table>
<thead>
<tr>
<th>Solution</th>
<th>Initial Weight</th>
<th>Final Weight</th>
<th>Change in Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distilled water</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>0.2 M sucrose</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>0.4 M sucrose</td>
<td></td>
<td></td>
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<tr>
<td>0.6 M sucrose</td>
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<td>0.8 M sucrose</td>
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<tr>
<td>1.0 M sucrose</td>
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Graph the results from Table 2.

- Determine the concentration of the sucrose solution in which the mass of the potato cores does not change (Determine this value from the graph) Draw a line of best fit: The point at which this line crosses the x-axis represents the concentration of sucrose that is isotonic to the potato tissue. At this concentration there is no net gain or loss of water from the tissue.
1. Which substance(s) entered the bag and which one(s) left the bag? What experimental evidence supports your answer?

2. What results would you expect if the experiment started with iodine solution inside the bag and starch and water outside? Why?

3. Briefly describe how plant roots absorb water from the soil. Use the terms you learned from this activity (e.g., hypertonic, hypotonic, isotonic, solute etc).