Diffusion and Osmosis

(Adapted from biologycorner.com)

Introduction

Diffusion is the process by which molecules spread from areas of high concentration to areas of low concentration. This movement, down the concentration gradient, continues until molecules are evenly distributed. Osmosis is a special type of diffusion: the diffusion of water through a semipermeable membrane. The concentration of water is inversely related to the concentration of solute: more solute corresponds to less water and less solute corresponds to more water. This is important because osmotic vocabulary describes the solute and not the water. Hypertonic solutions contain a high concentration of solute and little water, relative to hypotonic solutions that have a low concentration of solute and therefore a higher concentration of water. The term “isotonic” is used when two areas have an equal concentration of solute: no net osmosis is occurring.

Exercise 1: Diffusion through a gel

One factor that can affect the rate of diffusion is the size of the molecule. Larger molecules tend to move more slowly than smaller molecules. In this experiment, students will compare the diffusion rates of two dyes traveling through agar.

Materials
- Pre-punched agar plates
- Potassium permanganate
- Janus green
- Ruler

Procedure
1. Using the dropper, drop a single drop of potassium permanganate into one of the wells on the plate.
2. Repeat with Janus green.
3. Allow the plates to sit undisturbed for 30 minutes.
4. Which dye do you think will have the faster diffusion rate? _____________________
5. After 30 minutes, measure the radius of the dye front from the middle of the well and record your results.
6. Calculate the diffusion rate (mm/hr) by dividing the dye front radius by 0.5.

<table>
<thead>
<tr>
<th>Potassium permanganate</th>
<th>Janus Green</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molecular weight</td>
<td>158g/mole</td>
</tr>
<tr>
<td>Radius (mm)</td>
<td></td>
</tr>
<tr>
<td>Diffusion rate</td>
<td></td>
</tr>
</tbody>
</table>
**Questions:**

1. Did your outcome match your expectation? Provide an explanation for your results.

2. What are other factors that can affect the rate of diffusion?

**Exercise 2: Observation of Osmosis in a plant cell**

Plants have cell walls that can prevent lysis if too much water flows into the cell. Plant cytoplasm tends to be hypertonic to the outside environment, which results in an inflow of water and a high amount of pressure (turgor pressure) inside the cell. When a plant is placed into a hypertonic environment, the water will leave the cell. This causes the cell to shrink and detaches the plasma membrane from the cell wall (plasmolysis). Turgor pressure can hold plants upright, while plasmolysis can cause plants to wilt.

**Procedure**

Observe the two *Elodea* leaves under the microscope. One slide is a leaf in isotonic solution: you should be able to identify the chloroplasts and an empty space in the middle of the cells which is the vacuole. The next leaf has been soaked in a salt water solution; compare the cells to the first slide.

**Questions:**

1. What is the difference between a hypertonic solution and a hypotonic solution?

2. What will happen to plant cells that are placed in a hypertonic solution?

3. What will happen to animal cells placed in hypotonic solution? Why should this be different from plant cells?

4. Why are dehydrated patients given saline intravenously instead of water?
**Exercise 3: Osmosis Across a Membrane**

Observe the movement of water across a semipermeable membrane.

**Materials**
- Dialysis bags (4 per group)
- Dental floss
- 15% sucrose solution
- 30% sucrose solution
- Triple beam balance
- Beakers (4 per bench)
- Graduated cylinder
- Stir rods

**Procedure**
1. Obtain 4 strips of dialysis tubing and tie a knot in one end of each using the dental floss.
2. Pour approximately 10ml of each solution into separate bags (see table below).
3. Remove most of the air from the bag (but leave a little bit of space) and tie the bag.
4. Blot the bags to remove any sugar that may have spilled; check the bags for leaks.
5. **Record the weight of each baggie in the data table.**
6. Place a bag in each beaker (be sure to keep track of which bag is in which beaker!). Fill the beakers with enough of the appropriate solution to cover your bags (refer to the above table).
7. **Predict what you think will happen during the experiment.**
8. Record weight every 10 minutes in data table.
9. After 30 minutes, remove the bags from solution and record the final weight.

<table>
<thead>
<tr>
<th></th>
<th>Tube 1</th>
<th>Tube 2</th>
<th>Tube 3</th>
<th>Tube 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inside bag</td>
<td>water</td>
<td>15% sucrose</td>
<td>30% sucrose</td>
<td>water</td>
</tr>
<tr>
<td>Inside beaker</td>
<td>water</td>
<td>water</td>
<td>water</td>
<td>15% sucrose</td>
</tr>
<tr>
<td>Tonicity of bag?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Predicted outcome?</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Data</strong></th>
<th>Tube 1</th>
<th>Tube 2</th>
<th>Tube 3</th>
<th>Tube 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight at 0 min</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Weight at 10 min</td>
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<tr>
<td>Weight at 20 min</td>
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<tr>
<td>Weight at 30 min</td>
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</tbody>
</table>
Questions:
1. Did you results match your predictions? Propose an explanation for why your results (either overall or an individual bag) may have differed from what you were expecting.

2. Based on what you have observed, are the dialysis bags permeable to sucrose?