EXERCISE 6

Osmosis and Diffusion

LEARNING OBJECTIVES

- Investigate the processes of diffusion and osmosis and understand their importance to living cells.
- Determine experimentally how temperature and concentration affect the rate of diffusion.
- Determine experimentally the tonicity of unknown solutions;
- Demonstrate the role of selectively permeable membranes in diffusion.

Answer these questions before you come to lab:

1. Define the following terms:

Passive transport	
Active transport	
Selectively permeable	
Osmosis	
Simple diffusion	
Equilibrium	

2. If a solution outside of a cell contains a higher concentration of a solute (e.g. glucose or sodium chloride) than the cytoplasm inside the cell, the solutions is said to be ____________________. Water will ____________ the cell.

3. If a solution outside of a cell contains a lower concentration of a solute (e.g. glucose or sodium chloride) than the cytoplasm inside the cell, the solution is said to be __________________. Water will ____________ the cell.

4. If a solution outside of a cell contains the same concentration of a solute (e.g. glucose or sodium chloride) than the cytoplasm inside the cell, the solution is said to be _________________. Water will ___________________________ the cell.

INTRODUCTION

Water is an essential requirement of all cells. For example, a plant that is not watered enough starts to wilt. In terms of osmosis and diffusion, there is not enough water **within** the cells for them to retain their shape and strength, so the plant starts to die. This is just one example of the importance of water and how water movement is necessary for the maintenance of cell structure and function.

All cells have membranes that surround them. These membranes are said to be selectively permeable, which means that the membrane allows molecules through only if they are small enough to pass through the membrane.

This exercise demonstrates the process of osmosis in which water molecules move from a high concentration of water to lower concentration of water and the effect of temperature on this process.

Exercise 1: Effect if temperature on osmosis

Procedure

1. Prepare an artificial cell by taking a small piece of the pre-wetted dialysis tubing and tying one end to make a tube. Dialysis tubing is a selectively permeable membrane, much like that of the cell. It will allow small molecules such as water through pores in its structure.

2. Place 5 ml of 60% molasses in the tube.

3. Carefully tie the other end of the tube to seal it.

4. Rinse the cell briefly under tap water to clean it and gently dry.

5. Use the electronic balance to weigh your cell (**Cell 1**). Record your results in the table below to ***3 decimal places***. (**Initial weight**).

6. Repeat steps 1-5 to make another cell with 60% molasses (**Cell 2**).

7. Get two 600ml beakers. Half fill one of them with tap water, leave one on your table and place **Cell 1** in it.

8. Half fill the other beaker with water taken from the 40°C water bath. Place this beaker into the water bath with **Cell 2** in it.
   Note the time you put the cells in the water and record the temperature of the water in each case. You will leave them for 1 hour.

What do you think will happen to your cells? Will they shrink, swell or stay the same? Explain your answer.

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This is your **hypothesis.**

Table 1. After 1 hour, remove the cells and gently blot them dry with paper towels and weigh them again. (**Final weight**).

Table 1.

	Cell 1 (60% molasses) (22°C room temp)	**Cell 2 (60% molasses) (40°C water bath)**
Initial weight (g)		
Final weight (g)		
Weight change (g) (Final-Initial weight)		

What has happened to the weights of your cells?

Why do you think this has occurred?

To check whether your hypothesis was correct, compare your results with those of the other lab groups.

Exercise 2: Effect of concentration on osmosis

What would be the result using different concentrations of molasses solution in the cells?

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Check your hypothesis by making another cell.

1. Place 5ml of 80% molasses into the cell, rinse, pat dry and weigh. (**Initial weight**).

2. Place the cell in a 600ml beaker half filled with tap water on your table.

3. After 1 hour remove the cell pat dry and weigh again. (**Final weight**).

Table 2.

	Cell 1 (60% molasses)	**Cell 3 (80% molasses)**
Initial weight (g)		
Final weight (g)		
Weight change (g) (Final-Initial weight)		

What is the difference in weight change between cell 1 and 3? ___________ g

If there were differences, what would account for those differences?

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Why was it important to leave the cells in the water for exactly the same amount of time?

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Exercise 3: Plant Cell Experiment

In this experiment you will investigate the effect of different concentrations of sucrose solution on potato cells. The solutions are 0. 1M, 0.2M, 0.4M, 0.8M and distilled water. (M means molar and is one way of expressing the concentration of a solution. 1M is the molecular weight of sucrose in 1 liter of water. The concentration increases from 0.IM to 0.8M). The solutions are labeled V, W, X, Y, and Z. We will first weigh the potato tissue, place them in the solution for some time and then weigh them again. From your results you should be able to identify each of the solutions based what happens to your potato cylinders when they are left in the solutions. The solutions may be hypotonic, hypertonic or isotonic compared to your potato cells.

What would you expect to happen to the size of the cells (and hence the weight of the cylinder) if the solution is

hypertonic
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hypotonic
____

isotonic
____

Procedure

1. Make a potato cylinder by pushing a cork borer all the way through the potato. DO NOT PUT THE BORER THROUGH A SPOT THAT ALREADY HAS A HOLE. Release the cylinder from the cork borer by pushing a pencil or similar object through the hole in the borer.

2. Using a razor blade, cut both ends of the potato cylinder so that no potato peel is present.

3. Make 4 more cylinders in the same way.

4. Use the electronic balance to weigh each cylinder (label them V-Z) and record the weight in the table below. This is the initial (or starting) weight of the cylinders.

Record ***your*** potato cylinder results here.

Table 3.

	Cylinder in (solution V)	**Cylinder in (solution W)**	**Cylinder in (solution X)**	**Cylinder in (solution Y)**	**Cylinder in (solution Z)**
Initial weight (g)					
Final weight (g)					
Final-initial weight (g) + or -					

5. Place each cylinder in a different test tube and pour in enough of each of the solutions provided to ensure the cylinders are fully covered. Match the cylinders with the solutions V, W, X, Y, and Z as shown in the table below.

6. Let the cylinder sit undisturbed for at least 90 minutes.

7. After 90 minutes, blot the potato cylinders GENTLY on a paper towel and record the weights in the table above.

8. Calculate the weight change of your cylinders, indicating if the weight increased (+) or decreased (-).

9. Now compare your results with the class results by writing the weight change for each cylinder on the board.

10. Record the average of the class results in the table below.

Record the ***Class Results*** here.

Table 4.

	V	W	X	Y	Z
Average weight change (g) (+ or -)					

Exercise 4: To demonstrate selective permeability.

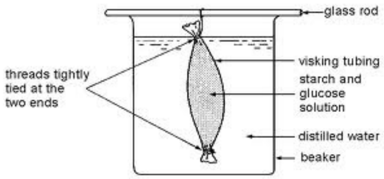
A selectively permeable membrane will allow some molecules to pass through and not others. This may be based on the size of the molecules. Dialysis tubing is a selectively permeable membrane.

Glucose and starch are both carbohydrates. What type of carbohydrate is

Glucose? ______________________________

Starch? _______________________________

Procedure



Apparatus to show dialysis

1. Prepare an artificial cell as you did before in **Exercise 1**.

2. Fill the cell to about 5ml with the glucose /starch mixture.

3. Rinse the cell well and place in a beaker of distilled water and leave for 45 minutes.

4. After 45 minutes, get a clean test tube and measure out 2 ml of the water in which the cell was sitting and place into the tube.

5. Add 2 ml of Benedict's solution.

   Benedict's solution is used to test for ___________________________________

6. Place the tube in the boiling water bath for about 5 minutes and observe any color change.

7. Place a drop of iodine in a well of the depression plate. Add a drop of the water taken from around the cell.

Iodine tests for __________________________

8. Record your results in the table below.

Table 5.

Liquid from beaker tested with	**Color**	**Substance present**
Benedict's solution		
Iodine solution		

Which substance was present in the water? ___________________________________

Which substance was not present in the water? ________________________________

Explain why this substance was present while the other was absent from the water.

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IMPORTANT NOTE: Dispose of Benedict's solution and Lugol's Iodine in the appropriate waste jar.

Exercise 5: Observing Plasmolysis.

Procedure

1. Take a leaf of ***Elodea*** and place it on a slide with a drop of water and put on a cover slip.

2. Using the 40X objective, observe the cells under the microscope and draw 4 of the cells that you see.

3. Make a new slide with a fresh leaf but use a drop of solution A.

4. Draw 4 cells from this slide.

What difference do you observe between the cells in the 2 slides?

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Describe what you observe happening in the cells in solution A.

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What kind of solution is solution A compared to the cytoplasm of the cells? Explain your answer.

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Review Questions

1. Explain ***fully*** why all the cells placed in water gained weight.

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2. Copy your results for cells 1 and 2 (Table 1) in the table below.

	Cell 1 (60% molasses) (22°C room temp)	**Cell 2 (60% molasses) (40°C water bath)**
Initial weight (g)		
Final weight (g)		
Weight change (g) (Final-Initial weight)		

Explain why the cell placed in 40°C gained more weight in the time.

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3. Copy your results for cells 1 and 3 (Table 2) in the table below.

	Cell 1 (60% molasses)	**Cell 3 (80% molasses)**
Initial weight (g)		
Final weight (g)		
Weight change (g) (Final-Initial weight)		

a. What is meant by the term 'concentration gradient'?

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b. Explain why the cell with 80% molasses gained more weight in the time.

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4. In the table below, copy the weight change in your potato cylinders (Table 3).

	Cylinder 1 (solution V)	**Cylinder 2 (solution W)**	**Cylinder 3 (solution X)**	**Cylinder 4 (solution Y)**	**Cylinder 5 (solution Z)**
Initial weight (g)					
Final weight (g)					
Final-initial weight (g) (+ or -)					

Keeping in mind that the solutions may be either, hypotonic, isotonic or hypertonic to the potato cells, explain the weight change in each of your cylinders.

In which of the solutions did the potato cylinders gain weight?

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Explain why they gained weight.

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In which of the solutions did they lose weight?

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Explain why they lost weight.

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What would you say about a solution in which the cylinder neither gained nor lost weight?
Explain your answer.

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5. Record the results of the average weight change in potato cylinders placed in the 5 different sucrose solutions, in the table below. (Class results Table 4).

The concentrations of the five solutions used were: 0.1M, 0.2M, 0.4M, 0.8M, distilled water.

	V	W	X	Y	Z
Average weight change (g) (+ or -)					

Which solution was water? Explain why you think so.

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Which solution is 0.8M sucrose? Explain why you think so.

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