Diffusion and Osmosis

During your first year of residency at Mountainside Hospital, you are treating a group of patients that exhibit signs of dehydration. You have to be sure to take note of all the solutes included in the IV for your mentor to review.

1. Why wouldn't you administer an IV of pure water to your patients?
2. What are the functions of the salts in the solution?
3. Before administering treatment, how would you calculate the best concentration of solutes to give your patient in order to maximize recuperation?

Today, you are going to design models of living cells using Dialysis tubing. Dialysis tubing acts much like a cell membrane in that it is selectively permeable to some solutes and water. Using the tubing, you will determine the rate of diffusion using different solutions.

Exercise A:

Introduction:

In this exercise you will measure diffusion of small molecules through dialysis tubing, an example of a semi permeable membrane. The movement of a solute through a semi permeable membrane is called **dialysis**. The size of the minute pores in the dialysis tubing determines which substance can pass through the membrane. A solution of glucose and starch will be placed inside a bag of dialysis tubing. Distilled water will be placed in a beaker, outside the dialysis bag. After 30 minutes have passed, the solution inside the dialysis tubing and the solution in the beaker will be tested for glucose and starch. The presence of reducing sugars like glucose, fructose, and sucrose will be tested with **Benedict's Solution.** The presence of starch will be tested with **Lugol's** solution (iodine-potassium-iodide).

Materials:

- Distilled or tap water
- Benedict's Solution
- Potassium Iodide
- 1 M glucose
- 20 cm-long dialysis tubing

Procedure

1. Obtain a 30 -cm piece of 2.5-cm dialysis tubing that has been soaking in water. Tie off one end of the tubing to form a bag. To open the other end of the bag, rub the end between your fingers until the edges separate.

2. Place 15 mL of the 15% glucose/ 1% starch solution in the bag. Tie off the other end of the bag, leaving sufficient space for the expansion of the bag's contents. Record the color of the solution in **Table 1.1**.
3. Test the 15% glucose / 1% starch solution in the bag for the presence of glucose. Your teacher may have you do a Benedict's test. Record the results in **Table1.1.**
4. Fill a 250 mL beaker or cup 2/3 full with distilled water. Add approximately 4 mL of Lugol's solution to the distilled water and record the color in **Table 1.1**. Test the solution for glucose and record the results in **Table 1.1.**
5. Immerse the bag in the beaker of solution.
6. Allow your set up to stand for approximately 30 minutes or you see a distinct color change in the bag or the beaker. Record the final color of the solution in the bag, and of the solution in the beaker, in **Table 1.1.**
7. Test the liquid in the beaker and in the bag for the presence of glucose. Record the results in **Table 1.1**.

Table 1.1

	Initial Contents	**Solution Color**		**Presence of Glucose**	
		Initial	**Final**	**Initial**	**Final**
Bag	**15% Glucose & 1% Starch**				
Beaker	**H_2O & IKI**				

Analysis:

1. Which substances (s) are leaving the bag? Which are entering the bag? What supports your answers?
2. Explain your results.
3. How would you adjust this experiment to include quantifiable data?
4. Based on your findings, rank the following molecules by relative size (smallest to largest): Water, Glucose Molecules, IKI Molecules, Membrane pores, Starch molecules.

Exercise B

Osmosis:

In this experiment you will use dialysis tubing 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 **hypertonic** to the one with the less solute. The solution that has less solute is **hypotonic** to the one with more solute. These words can only be used to compare solutions.

Pre-Lab Questions:

1. How can you use weight measurements to determine the direction and rate of diffusion? What type of control would be used for this method?
2. If given any tools you wanted, besides weights, how would you discover the rates and direction of diffusion of sucrose, sodium chloride, glucose, and egg protein?
3. If a substance will not diffuse, will it affect the rate of diffusion of the other molecules?

Materials:

- Dialysis Tubing
- Distilled Water
- 0.2 M sucrose
- 0.4 M sucrose
- 0.6 M sucrose
- 0.8 M sucrose
- M sucrose
- Beakers

Exercise B Procedure:

1. Obtain 6 strips of presoaked dialysis tubing.
2. Tie a knot in one end of each piece of tubing to form 6 bags. Add about 15-25mL of each of the following solutions to each of your tubes.
    a. Distilled Water
    b. 0.2 M sucrose
    c. 0.4 M sucrose
    d. 0.6 M sucrose
    e. 0.8 M sucrose
    f. 1.0 M sucrose
3. Rinse and record weight of each bag.
4. Place each bag into a beaker to find the molarity of the solution in the dialysis bags.
5. Now fill each beaker with 2/3 of water or enough to completely submerge the bag.
6. After 30 minutes, remove bags from water and determine their mass.

Contents in Dialysis Bag	Initial Mass	Final Mass	Mass Difference	Percent Change in Mass
Distilled Water				
0.2M Sucrose				
0.4M Sucrose				
0.6M Sucrose				
0.8M Sucrose				
1.0M Sucrose				

1. Create a table that appropriately compares the class data for Percent change. Calculate the average percent change for each solution and include the data on your table.
2. Graph BOTH your individual results and your class data.
3. What is the relationship between the change in mass and the molarity of the sucrose inside the Dialysis bag? Explain.
4. What would happen to the mass of the bags if all bags were placed in 0.4M Sucrose rather than Distilled water?
5. Why would you bother calculating the percent change rather than just comparing changes in mass?

Exercise C:

Materials:

- Potato
- Cork Borer
- Scale
- Distilled Water
- 0.2 M sucrose
- 0.4 M sucrose
- 0.6 M sucrose
- 0.8 M sucrose
- M sucrose
- Beakers

This exercise will be a group effort. Each team of students will be required to test only one solution, and share their results with the class.

1. Obtain 100mL of your assigned solution.
2. Slice a potato into 4 discs without skin, and use a cork borer to do so.
3. Measure and record the mass of the 4 discs.
4. Put all 4 discs into the designated solution and let sit overnight.

5. The next day, remove discs. Measure and record their total mass.
6. Calculate percentage change from initial to final and graph data. Calculate the percent change in the weights. (final – initial)/initial X 100

Contents in Dialysis Bag	Initial Mass	Final Mass	Mass Difference	Percent Change in Mass
Distilled Water				
0.2M Sucrose				
0.4M Sucrose				
0.6M Sucrose				
0.8M Sucrose				
1.0M Sucrose				

1. Create a table that appropriately compares the class data for Percent change. Calculate the average percent change for each solution and include the data on your table.
2. Graph BOTH your individual results and your class data on the graph provided.
3. Calculate the molar concentration of sucrose in the potato core.

*Save all of your class data for tomorrow's analysis.

4. If a potato core is allowed to dehydrate by sitting in the open air, would the water potential of the potato cells decrease or increase and WHY?

5. If a plant cell has a lower water potential than its surrounding environment and if pressure is equal to zero, is the cell hypertonic, isotonic or hypotonic with re4spect to its environment? Will the cell gain water or lose water. EXPLAIN your answers.

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