

Name _____

Period _____

AP Biology

Date _____

LAB _____. DIFFUSION THROUGH A MEMBRANE

INTRODUCTION

The life of a cell is dependent on efficiently moving material into and out of the cell across the cell membrane. All cells need sugars and oxygen to make energy to fuel daily life. Cells also need raw materials to be able to repair themselves and to build new cells. And of course cells always need water to remain healthy. All these materials have to move into a cell to feed it.

On the other hand, cells produce waste products during their daily activities. Cells make the waste product, carbon dioxide, when they make energy. They also make the waste product ammonia when they digest proteins. Both of these waste products have to be removed or the cell will be poisoned and die.

Most of these materials move passively—costing the cell no energy—through the process of **diffusion**. **Diffusion is the movement of molecules from an area of higher concentration of those molecules to an area of lower concentration.** Another way to phrase this is that molecules move down the **concentration gradient**—a metaphorical “downhill” from high concentration to low concentration. A good metaphor for this movement of molecules is what happens if you were to open a bottle of perfume in one corner of a room. It would not be long before someone in the opposite corner of the room would smell the perfume. The molecules moved from an area of higher concentration of perfume where the open bottle was to an area of lower concentration of perfume like the opposite corner of the room. Eventually a balance, or **dynamic equilibrium**, is reached. In other words, the concentration of perfume will be approximately equal throughout the room and no **net** movement of perfume will occur from one area to the other.

However, diffusion does not entirely explain the movement of ions and molecules into and out of the cell. Sometimes a cell needs to move material against the concentration gradient. They need to move materials from areas of low concentration to areas of higher concentration. This would be the case for materials that are very valuable to the cell, like sugars, that the cell would use to make energy. That would be like swimming upstream against the current, so it requires energy. The only way for cells to do this is to use energy to pump the material “upstream” across the cell membrane. We call this process, **active transport**, because it actively uses energy to move molecules either into or out of the cell. The energy that the cell uses is in the form of ATP.

In this experiment you will measure the diffusion of small molecules through dialysis tubing, an example of a selectively permeable membrane. Small dissolved molecules (solutes) and water molecules can move freely through a selectively permeable membrane, but larger molecules will pass through more slowly, or perhaps not at all. The size of the minute pores in the dialysis tubing determines which substances can pass through the membrane. We will explore the process of diffusion through a semi-permeable membrane in this activity.

HOW TO TEST FOR STARCH	1. 4 drops <u>Lugol's Iodine (IKI)</u> 2. Solution <u>immediately</u> turns from amber to blue-black
HOW TO TEST FOR GLUCOSE	1. 4 drops <u>Benedict's solution</u> 2. Solution turns from blue to bright orange when <u>heated</u>

PROCEDURE, DAY 1

1. Cut a 30cm piece of 2.5cm dialysis tubing and soak it in water until it is soft enough to work with. Tie off one end of the tubing (like a balloon) to form a bag. This will be our model "cell." To open the other end, rub the end between your fingers until the edges separate.
2. Pour 15mL of the 15% glucose/1% starch solution in the cell using a funnel. Tie off the other end of the tubing, leaving sufficient space for expansion of the contents in the cell. In case any solution spilled on the outside, rinse off the cell under running water and set aside in a beaker for now. Record the initial color of the solution in the cell in Section 1 of **Table 1 (Experimental Observations)**.
3. Now we need to perform tests on this solution we just used. Using a pipette, place a 2mL sample of the 15% glucose/1% starch solution into a clean test tube. Test the solution for the presence of **glucose**. Record the results in Section 2 of **Table 1**.
4. Using a pipette, place another 2mL sample of the 15% glucose/1% starch solution into a clean test tube. Test the solution for the presence of **starch**. Record the results in Section 3 of **Table 1**.
5. Place 200mL of water in a 250mL beaker. Now we need to perform the same tests on this fluid. Place a 2mL sample of the water into a clean test tube and test for the presence of **glucose**. Record the results in Section 2 of **Table 1**.
6. Place a second 2mL sample of the water into a clean test tube and test for the presence of **starch**. Record the results in Section 3 of **Table 1**.
7. Add Lugol's iodine to the water in the beaker. Add only enough iodine to turn the water a medium amber color. Record this initial color of the solution in Section 1 of **Table 1**.
8. Now immerse the dialysis bag in the beaker. Cover the beaker and allow the experiment to stand undisturbed overnight.
9. **Table 2** is to be used to make **predictions** of what you expect to occur overnight in the beaker. Fill in the Day 1 Initial Observations columns (Column A) from your observations today. Then complete your predictions for each section in Column B.
10. Complete the "Day 1 Initial State" **diagram** in Figure 1.

PROCEDURE, DAY 2

1. It is now the second day. Record the final **color** of the solution in the cell and the final **color** of the solution in the beaker in Section 1 of **Table 1**.
2. Observe the colors of the solution in the cell and in the beaker as a test for **starch** and record the results for starch in Section 3 of **Table 1**.
3. Take a sample of the liquid in the beaker and test for the presence of **glucose**. Record the results in Section 2 of **Table 1**.
4. Take a sample of the liquid in the cell and test for the presence of **glucose**. Record the results in Section 2 of **Table 1**.
5. Compare your predictions to your actual data. Any surprises? If so, discuss with the class.
6. Complete the “Day 2 Final State” **diagram** in Figure 1.
7. Complete the **Summary Questions**.

TABLE 1. EXPERIMENTAL OBSERVATIONS

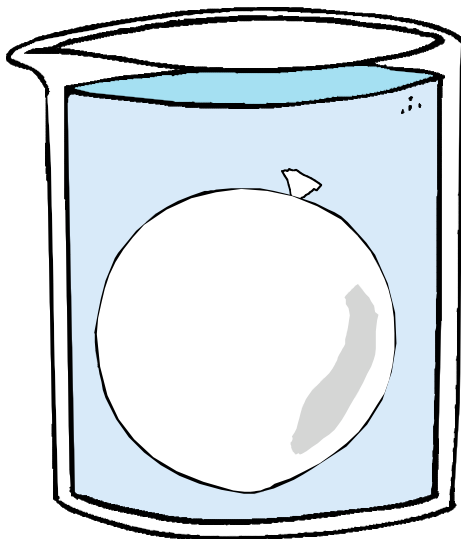
	Initial contents	1		2		3	
		Color of Solutions		Presence of Glucose		Presence of Starch	
		A Day 1 (Initial)	B Day 2 (Final)	A Day 1 (Initial)	B Day 2 (Final)	A Day 1 (Initial)	B Day 2 (Final)
Cell	15% glucose 1% starch						
Beaker	H ₂ O & IKI						

TABLE 2. PREDICTIONS

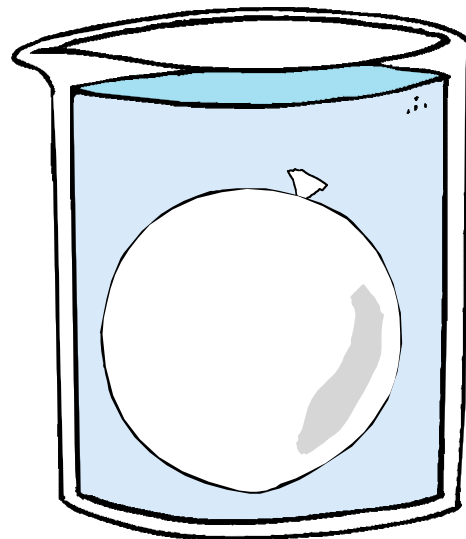
	Initial contents	4		5		6	
		Color of Solutions		Presence of Glucose		Presence of Starch	
		A Day 1 (Initial) from Table 1	B Day 2 (Final)	A Day 1 (Initial) from Table 1	B Day 2 (Final)	A Day 1 (Initial) from Table 1	B Day 2 (Final)
Cell	15% glucose 1% starch						
Beaker	H ₂ O & IKI						

FIGURE 1.

Label the diagrams below to identify the **contents of the bag and the beaker** in the Day 1 Initial State and in the Day 2 Final State of the experiment. In the Final State diagram, draw **arrows** to indicate the **movement of molecules** during the experiment.



DAY 1: INITIAL STATE



DAY 2: FINAL STATE

SUMMARY QUESTIONS

1. Which substance(s) are entering the dialysis bag and which are leaving the bag? What experimental evidence supports your answer?

2. Explain the results you obtained by discussing concentration differences and membrane pore size.

3. Although we didn't measure it, what other molecule can we assume also moved across the membrane? _____

4. In assessing the movement of glucose, starch and iodine across the membrane in this experiment, you generated qualitative data. Quantitative data use numbers to measure observed changes. How could this experiment be modified so that quantitative data could be collected to show that water diffused into the dialysis bag.

5. Based on your observations, compare the size of each of the following molecules (glucose molecules, water molecules, IKI molecules, starch molecules) to the size of the pores in the dialysis membrane (greater than, less than):

The size of glucose molecules are _____ the membrane pore size.

The size of water molecules are _____ the membrane pore size.

The size of IKI molecules are _____ the membrane pore size.

The size of starch molecules are _____ the membrane pore size.

6. What results would you expect if the experiment was set up incorrectly: the water and IKI solution was placed inside the dialysis bag and the starch and glucose solution was placed in the beaker.

7. In many animals, glucose, rather than starch, is transported by the blood through the body to all cells. In the digestive system, starches are digested by amylase to yield glucose. Based on the findings of this lab, explain why the digestion of starch to glucose is necessary.

8. Summarize the process of diffusion.
