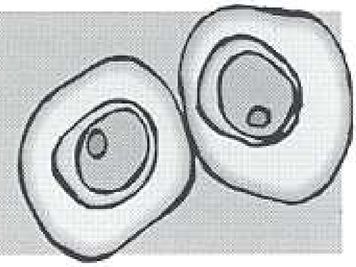
Name ______________________________ Period _____ Date ______________

Laboratory Activity #5 — Student Laboratory Packet

Diffusion Through a Membrane

A Laboratory Activity for the Living Environment



Part 1—Diffusion Through a Membrane

Molecules are constantly moving. They move in straight lines unless they are deflected by other molecules or obstacles in their environment. *Diffusion* is the process by which the collisions between molecules cause them to continually spread apart from each other. Their overall movement can therefore be described as movement from an area of greater concentration to an area of lower concentration. Diffusion continues until the molecules are equally distributed, that is, their concentration is equal throughout the area that contains them. At this point, the molecules continue to move and collide, but their concentration remains the same throughout the area of containment.

When certain molecules encounter artificial membranes with pores, they may be able to pass through. If the molecules are small enough to pass through the pores, their movements eventually will cause the concentration of these molecules inside and outside of the membrane to equalize.

Living cells are surrounded by a membrane that acts as a selective barrier between the contents of the cell and its environment. The membrane is selectively permeable; it allows some molecules and other particles to enter and exit while blocking others. Even small molecules that could ordinarily pass through may be blocked. The permeability of the membrane can change depending on changes in the internal or external environment of the cell.

As a part of this activity, you will build a model cell using an artificial membrane. Remember that this membrane is only a model. Unlike a cell membrane, it will always have the same permeability to dissolved substances. Small molecules and water will be able to pass through easily while larger molecules will not.

Objectives

By the end of this activity, you should be able to:

- demonstrate how to test for simple sugars and starch using chemical indicators
- explain diffusion through a membrane
- describe the permeability of a model membrane for glucose, starch, and Starch Indicator Solution

Important Note: Record all of your data and answers on these laboratory sheets. You will need to keep them for review before the Regents Examination. You will also need to transfer your answers to a separate Student Answer Packet, which your teacher will use in grading your work. The school will retain that packet as evidence of your completion of the laboratory requirement for the Living Environment Regents Examination.

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Materials

- dialysis tubing or plastic bags
- string or unwaxed dental floss
- Glucose Indicator Solution
- test tube rack
- concentrated glucose solution
- funnel
- tap water
- 7 test tubes
- starch solution
- paper towels
- droppers or pipettes
- safety goggles (1 pair per student)
- Starch Indicator Solution
- 250 mL beaker
- hot water bath (for class or several groups)
- test tube holder

Safety

- Avoid all direct contact with laboratory chemicals. The Glucose Indicator Solution is corrosive, and the Starch Indicator Solution will stain.
- Do not eat or drink in the laboratory.
- Wash your hands and work area when the laboratory is completed.
- Be careful when using the hot water bath to avoid burns.
- Wear goggles whenever someone in your laboratory is using glassware or chemicals.

Procedures: *Make a "Cell"*

The directions below are for making a "cell" with dialysis tubing. If you are using plastic bags, follow the directions your teacher provides.

1. Take a 20 cm length of dialysis tubing and soak it in warm tap water for a few minutes. You should then be able to pull the ends apart gently, forming it into a tube. Rubbing the ends of the tubing between your fingers under water is sometimes helpful when attempting to open the tube.
2. Seal one end of the tube by folding the end over and tying it closed with a piece of string or dental floss. The goal is to make that end completely leak-proof.
3. Pour glucose solution into the tube until it is about 1/4 full. Next, add enough starch solution to fill the tube about halfway. You can use a funnel to make this easier.
4. Tie off the top of the tube in the same way you tied off the bottom. The tube should not leak from either end. Gently mix the contents of the tube by turning it upside down and back again. Check for leaks.
5. Rinse off the "cell" you've just made by holding it under running water.
6. Place the "cell" in a beaker and add water until the "cell" is just covered.
7. Add Starch Indicator Solution (containing iodine) to the water in the beaker. Add enough to make the water an amber color.
8. Label the "Initial State" part of the diagram found on page 4. Indicate the contents and color of the beaker and cell.
9. Based on your knowledge of diffusion, predict what will happen to the substances inside and outside of the "cell." Record your prediction here:

10. Set the beaker aside while performing the chemical tests described in the next section of this investigation. Leave it undisturbed for at least 20 minutes.

Chemical Testing

Table One — Chemical Test Procedures

When Testing a Sample with	Follow This Procedure:
Starch Indicator Solution	• place 10 drops of the substance to be tested in a clean test tube • add 10 drops of Starch Indicator Solution • carefully mix the contents of the tube • observe any color change • record results
Glucose Indicator Solution	• place 10 drops of the substance to be tested in a clean test tube • add 10 drops of Glucose Indicator Solution • heat in a hot water bath for 2 minutes • observe any color change • record results

Procedure

- Obtain 6 clean test tubes and use them when testing samples of distilled water, starch, and glucose with each of the two indicator solutions. Follow the procedures described in Table One.
- Record your results in Table Two below. Enter the color observed in the test tube after each test is completed.

Table Two — Chemical Test Results

Indicator Solution Used	Material Tested		
	Distilled Water	Starch	Glucose
Blue-colored Glucose Indicator Solution			
Amber-colored Starch Indicator Solution			

What test would you need to perform to prove that it is the *combination* of glucose and the Glucose Indicator Solution that changes color when heated and not just the glucose or the Glucose Indicator Solution alone? Support your answer with an explanation.

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Model Cell Observations

- Carefully examine the "cell" and beaker you put aside earlier.
- Record any changes, including color changes, you observe in the "cell" and in the beaker.

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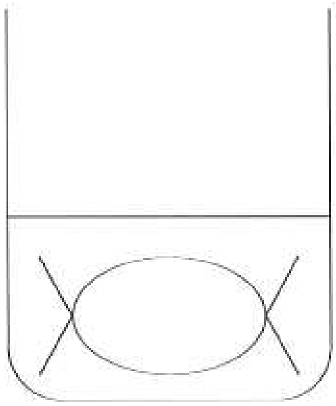
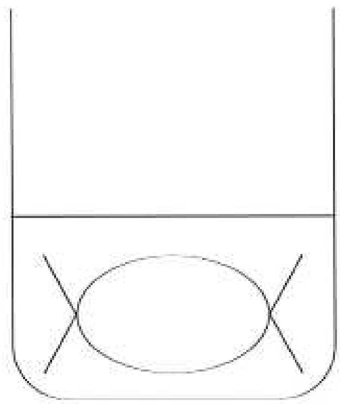
- Use a pipette to transfer 10 drops of the solution in the beaker (outside the "cell") to a clean test tube. Test it with Glucose Indicator Solution. Did a color change occur? ______ Is this test result positive or negative? ______

- Label the contents and note the colors present in both the beaker and the cell of the "Final State" diagram below.



Initial State



Final State

- Clean up according to the directions given by your teacher.

Questions:

1. What is the best explanation for the color change that occurred inside the "cell"?

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2. Did any starch diffuse out of the "cell"? _______ Explain how you can tell.

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3. Did any glucose diffuse out of the "cell"? ________ Explain how you can tell.

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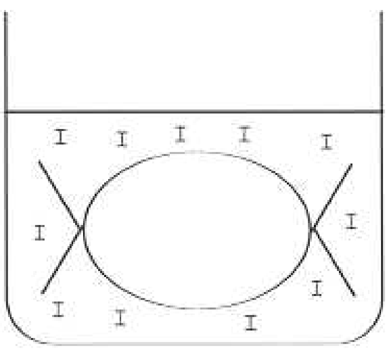
4. Which substance(s) diffused through the membrane?

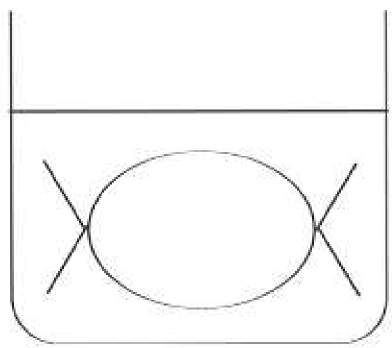
5. Which substance(s) did not diffuse through the membrane?

6. Explain why some substances were able to pass through the membrane while others were not able to.

7. In the "Initial State" diagram below, Starch Indicator Solution is indicated with the letter "I" because it contains iodine. Using the letters "S" for starch and "G" for glucose, indicate the areas where each of these molecules are located in both diagrams. Be sure you indicate the location of iodine molecules in the "Final State" diagram too.



Initial State



Final State

Part 2—Diffusion of Water Across a Membrane (Osmosis)

Osmosis is a special type of diffusion. Specifically, it is the diffusion of water across a membrane. Osmosis is a very important process because it enables cells to maintain the proper water balance. Generally water will diffuse across a membrane, resulting in equal concentrations of water on both sides. If the cytoplasm of a cell is 95% water, the remaining 5% is dissolved materials (solute). If the liquid that surrounds the cell has the same concentration of water as the cytoplasm, no net diffusion occurs in either direction. In other words, equal numbers of water molecules move into and out of the cell. If the liquid outside the cell has a higher concentration of water (less solute) than the cytoplasm, water will diffuse into the cell. If the liquid outside the cell has a lower concentration of water (more solute) than the cytoplasm, water will diffuse out of the cell. In this activity, you will place living cells in different solutions and observe the results.

Objectives

By the end of this activity, you should be able to:

- predict what would happen if cells are placed in solutions having different concentrations
- explain how the diffusion of water plays a role in several real-world situations
- prepare wet-mount slides and use appropriate staining techniques
- make observations of biological processes

Materials

- red onion
- cover slips
- water
- dropper/pipette
- glass microscope slides
- distilled water
- colored pencils (red)
- salt solution
- if the salt solution is not provided:
  - triple-beam or electronic balance
  - 10 mL graduated cylinder
  - salt
  - beaker

Safety

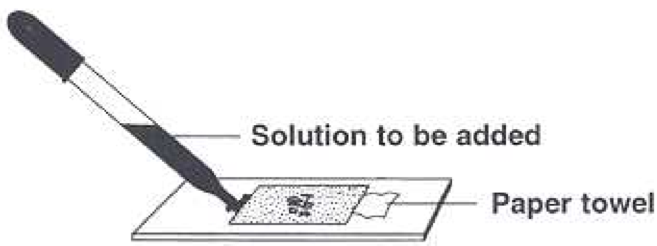
- Do not eat or drink in the laboratory.
- Wash your hands and work area when the laboratory is completed.
- Handle slides and cover slips with care.

Procedures

1. If the salt solution is not provided by your teacher, use a balance to measure 1 gram of salt. Measure 10 mL of distilled water with a graduated cylinder. Add both the salt and the water to a 250 mL beaker and mix. This will be your prepared salt solution.
2. Your teacher will provide a small, curved section of an onion for you to use. Break the section in the middle and gently peel off the reddish outer membrane.
3. Position the membrane in a drop of water on a slide. Be careful not to allow the membrane to fold over on itself.
4. Add a cover slip and observe the cells using the low power of a microscope. Choose the magnification that will allow you to see individual cells and their contents. If you do not see any cells with red coloration, search on the slide for cells that do have it. You may need to make another slide.
5. Have your teacher observe your slide with the microscope to be sure you have a good preparation.

6. Based on your observations, draw and color a typical red onion cell mounted in water. Label the cell wall, cell membrane, and cytoplasm.

7. Next, without disturbing the slide, add salt solution. You can do this by placing a small piece of paper towel against one edge of the cover slip and adding several drops of the salt solution to the other side. (See diagram below.) The paper towel will soak up the liquid already on the slide and draw the salt solution through. Remove the paper towel before it soaks up too much liquid and dries out the slide.



8. Observe the cells for several minutes. You should see a change in the cells from your previous observation. If not, add more salt solution. Describe the changes you observed in the red onion cells.

9. Have your teacher check your slide with the microscope to be sure you are able to observe the effects of salt on cells.

10. Based on your observations, draw and color a typical red onion cell mounted in salt solution. Label the cell wall, cell membrane, and cytoplasm.

11. Describe what happens to the water content of the red onion cells when they are placed in a salt solution.

12. Replace the salt solution with distilled water. Use the same technique you used in Step 7, but use distilled water instead of salt solution. It may require 20 or more drops to wash all the salt away.

13. Observe the cells for several minutes. Describe the changes that occurred in the red onion cells.

14. Have your teacher check your slide with the microscope to be sure the effects of distilled water are visible.

15. Based on your observations, draw and color a typical red onion cell mounted in distilled water.

Analysis Questions

1. During Part 1 of this laboratory activity, one group of students followed the directions incorrectly. They poured the Starch Indicator Solution into the "cell" and filled the beaker with starch and glucose solution. State how their results would differ from those obtained by students in their class who followed the directions correctly.

2. Some state roads are salted heavily in the winter, creating an environmental problem. Based on observations you made in this laboratory activity, explain how organisms could be harmed by high levels of salt from roadways.

3. When a person in the hospital is given fluid intravenously (an I.V.), the fluid is typically a saline (salt) solution with about the same water concentration as human body tissues. Explain how the use of distilled water in place of this saline solution would be expected to upset the patient's homeostasis. Your answer should refer to the process of diffusion.

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4. Many fresh-water one-celled organisms have structures called *contractile vacuoles*. These structures collect and pump out excess water that accumulates in the cell. Name the process that causes water to flow into these organisms. ____________________ Explain why contractile vacuoles would be of little value to one-celled organisms living in the ocean (salt water).

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5. Popcorn sold at most movie theaters is very salty, causing people to become thirsty and buy soft drinks. Describe in scientific terms why the salty popcorn causes this thirst. You should mention changes in specific body cells in your answer.

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6. In many animals, glucose, rather than starch, is transported by the blood through the body to all the cells. Starches in many foods are digested to yield glucose. Based on what you learned in this laboratory activity, explain why the digestion of starch to glucose is necessary.

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