

Diffusion across a Selectively Permeable Membrane

Adapted from "Molecular Transport Investigation" in the School District of Philadelphia Biology Core Curriculum.
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Each cell is surrounded by a **selectively permeable membrane** which regulates what gets into and out of the cell. A selectively permeable membrane allows some types of molecules to diffuse across the membrane and prevents other types of molecules from crossing the membrane.

★ What problems do you think a cell would have if it could not control what got into or out of it?

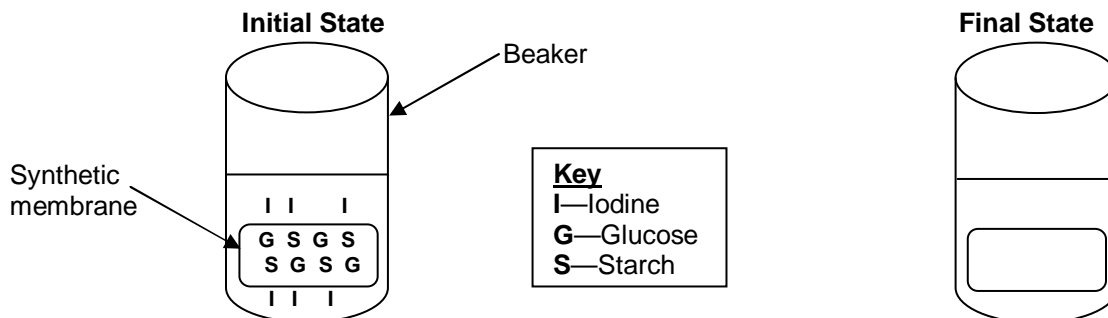
Today you will investigate the diffusion of molecules across a synthetic selectively permeable membrane that you will use to model the cell membrane. Smaller molecules can cross this synthetic selectively permeable membrane, but larger molecules cannot.

★ Which of the following four molecules do you think will be able to cross the membrane?

Molecule	Molecular Formula	Will it cross the selectively permeable membrane?	Why or why not?
Glucose	C ₆ H ₁₂ O ₆		
Starch	polysaccharide made up of many glucose molecules		
Iodine	I ₃ ⁻		
Water	H ₂ O		

To test your predictions, you will put solutions of starch and glucose in a tube of synthetic membrane and put the tube in a beaker of iodine solution. Then you will test whether some of the starch or glucose diffuses out of the tube and whether some of the iodine diffuses into the tube.

★ The Initial State diagram shows the locations of glucose, starch and iodine at the beginning of the experiment. Use your predictions about which molecules can cross the membrane to predict the locations of each type of molecule after diffusion. In the Final State diagram, write the letters for each type of molecule in the places where you think they will be found at the end of the experiment.



You will test for starch and iodine movement using color change. In solutions by themselves, iodine is brown and starch is clear. When iodine and starch are together in the same solution, the solution is blue (sometimes very dark blue).

¹ Teachers are encouraged to copy this student handout for classroom use. A Word file, which can be used to prepare a modified version if desired, and Teacher Preparation Notes are available at http://serendip.brynmawr.edu/sci_edu/waldron/.

★ Using your predictions on the previous page, write the expected color of each liquid after diffusion in the final state chart below.

Initial State	Color
Liquid in Tube	Clear
Liquid in Beaker	Brown

Final State	Expected Color
Liquid in Tube	
Liquid in Beaker	

To test whether glucose crossed the synthetic membrane to move into the solution in the beaker, you will use a glucose test strip.

Water is the main component of both the solution inside the tube and the solution in the beaker outside the tube. If water can cross the selectively permeable membrane, water could diffuse into the tube and out of the tube.

★ Decide on a method to test whether more water has moved into the tube or out of the tube or there was no change in the amount of water in the tube. Describe your method here.

Procedure:

- Obtain one 15 cm piece of dialysis tubing and two pieces of string. The tubing should be soaked in water for a minute or more.
- Fold the bottom of the piece of tubing 1 cm up and tie the folded part with a piece of string tightly to create a bag.
- To open the other end of the tube, rub the end between your fingers until the edges separate. Using a pipet, add 3 mL of glucose solution and 3 mL of starch solution to the tube.
- After the tube is filled, fold 1 cm of tubing and tie off the top of the tube with string.
- Rinse off the tube in fresh water. Be sure to rinse the string and squeeze any excess water from the string. Why is this step important?
- Add 50 mL of water to a 200 mL beaker. Make sure you don't add extra water.
- Add about 0.2 mL iodine to the water in the beaker. Be careful to avoid staining your clothes or fingers with the iodine.
- Record your observations of the colors of the solution in the tube and the solution in the beaker in the "Initial State" row in the table below. Also record the beginning value of the measure you are using to evaluate movement of water.

	In the tube		In the beaker		Measure to evaluate movement of water
	Color	Glucose?	Color	Glucose?	
Initial State (Before placing tube into beaker)		Yes		No	
Final State		Yes			

9. Put the tube into the beaker.
10. You will need to wait 10-20 minutes for substances to move across the selectively permeable membrane. While you're waiting, answer the Diffusion Questions on pages 4-5.
11. After 10-20 minutes use a glucose test strip to check if there is glucose in the beaker. Dip the test strip into the solution until the pad is submerged. Remove the strip, wait 30 sec, and compare the color on the test strip to the color chart.
12. In the "Final State" row in the table on page 2 record your glucose test results, your color observations, and the end value of the measure you are using to evaluate the movement of water.

Results:

1. Did starch move out of the tube? How do you know?

2. Did iodine move into the tube? How do you know?

3. Did glucose move out of the tube? How do you know?

4. Did water move into or out of the tube? How do you know?

Conclusions:

1. Use your observations to fill in this chart describing which molecules crossed the selectively permeable membrane. Circle any results that differ from your predictions on page 1.

Molecule	Molecular Formula	Did it cross the selectively permeable membrane?
Glucose	$C_6H_{12}O_6$	
Starch	polysaccharide made up of many glucose molecules	
Iodine	I_3^-	
Water	H_2O	

2. What characteristic of the molecules in your experiment appears to determine which ones can cross the selectively permeable membrane? (Include an explanation for any results that differed from your predictions.)

3. Explain how your observations support the conclusion that dialysis tubing is a selectively permeable membrane.

4. There was water on both sides of the membrane, in the tube and in the beaker. Why did water move in the direction that it did?

5. Each living cell is surrounded by a selectively permeable cell membrane which allows water to move into or out of the cell by diffusion. The diffusion of water across a selectively permeable membrane plays such an important role in biology that this process has been given a special name, **osmosis**. What will determine whether osmosis moves water into a cell or out of a cell?

6. Living cells can use energy provided by ATP to pump an ion or molecule across the cell membrane in a process called **active transport**. Active transport can move a substance from a region of lower concentration to a region of higher concentration; this is useful for a cell to maintain the correct concentration of ions and substances like glucose. What type of molecular transport was demonstrated in your investigation—diffusion or active transport? How do you know?

Diffusion Questions

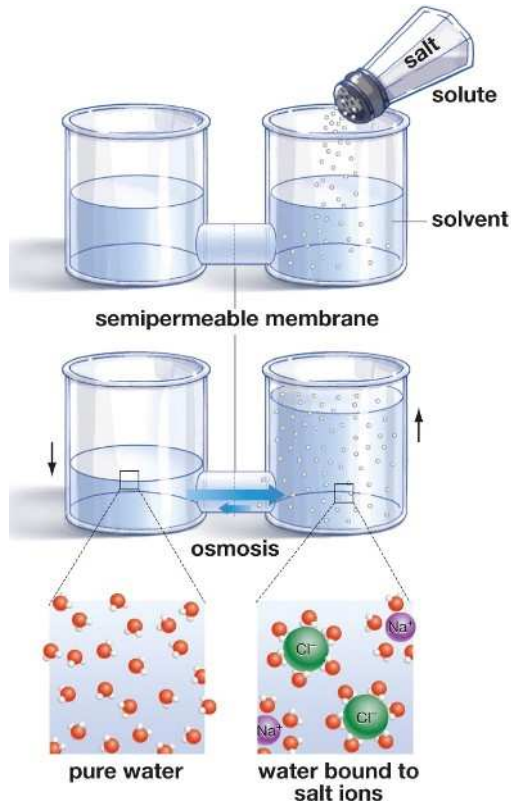
1. Any molecules that cross the selectively permeable membrane in your experiment will move by diffusion. What is diffusion?

2. Describe what will happen in the beaker shown below, and explain why. (The dark circles in the bottom figure represent some of the dye molecules and the light circles represent some of the water molecules.)

(a) Dye is dropped in.



3. Explain what is happening in the second part of the diagram shown below. Why is the beaker on the right filling up? (Note that in the beaker on the right many molecules of water are bound to the salt ions, so the concentration of free water molecules is lower in the beaker on the right. Only the free water molecules can cross the semipermeable membrane.)



4. Which way would you expect more water to diffuse in your experiment -- into the tube or out of the tube? What additional information would help you to make a more confident prediction?