Name ____________________ Date ____________________

Cell Membranes And Permeability

11

Do all chemical substances pass in and out of a cell membrane with equal ease? Do chemical substances move from areas of high concentration to areas of low concentration as they pass in and out of a cell? What determines what substances can diffuse into a cell? These questions may seem difficult to answer. Sometimes scientists use models to help answer difficult questions. Part of this investigation will use a model of a living cell which will allow you to observe changes that are controlled by the cell membrane.

The cell membrane determines what substances can diffuse into a cell. This characteristic of a cell membrane is called permeability. Many cells are semipermeable. Some substances can pass through the cell membrane, but others cannot. A certain substance, potassium permanganate, can pass through a cell membrane. However, its diffusion into a cell is influenced by its concentration and the time allowed for diffusion.

In this investigation, you will
(a) use a plastic bag model for a living cell membrane.
(b) determine if the plastic "membrane" is permeable to starch and iodine.
(c) determine the effect of time and concentration on the diffusion of potassium permanganate into potato cubes.

Materials

plastic lunch bag
rubber bands or twist ties
test tube rack
100-mL beaker
test tubes—2
graduated cylinder
glass marking pencil (wax)
starch solution
iodine solution
potato
razor blade (single-edge)
small beakers—4
clock or watch with second hand
5% potassium permanganate solution
1% potassium permanganate solution
0.1% potassium permanganate solution
tweezers
metric ruler
water

Procedure

Part A. A Cell Membrane Model

• Fill a plastic lunch bag with 40 mL of starch solution. Seal the top of the bag by twisting the bag and attaching a rubber band or twist tie. The plastic bag filled with starch solution (Figure 1-A) represents a cell.

• Note and record in Table 1 the exact color of the starch inside the plastic bag cell. Use the "Before" column to record your observation.

• Fill a beaker with 20 mL of water. Add 20 mL of iodine solution to the water. **CAUTION:** *If iodine spillage occurs, rinse with water and call your teacher immediately.* The water and iodine solution represent the environment into which you will place your plastic bag cell. Use Figure 1-B as a guide.

• Pour some of the water-iodine solution from the beaker into a test tube. Fill the test tube about ¼ full. Mark this tube "before." Use Figure 1-C as a guide.

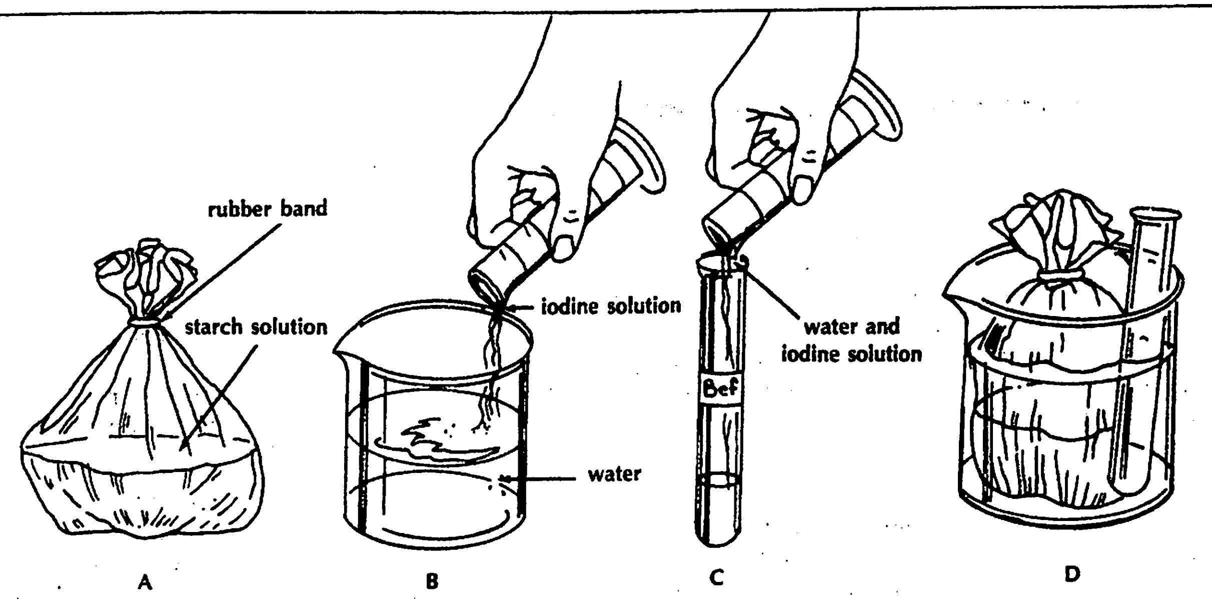

FIGURE 1

- Place the plastic bag and test tube into the beaker of iodine solution. Use Figure 1-D as a guide.
- Put your name on the beaker with a glass marking pencil. Allow the "cell" to stand overnight.
- The next day, remove the plastic bag and test tube and put them aside.
- Pour some of the remaining iodine-water solution from the beaker into a new test tube. Fill the test tube about ¼ full. Mark this tube "after."
- Decide which tube, before or after, contains the darker and lighter of the two solutions. Record which solution is darker and which is lighter in Table 1.
- Using the "After" column, record in Table 1 the color of the starch inside the cell.

TABLE 1. COLOR CHANGES

	BEFORE	AFTER (NEXT DAY)
Color of starch inside bag (cell)		
Color of iodine outside bag (cell)		

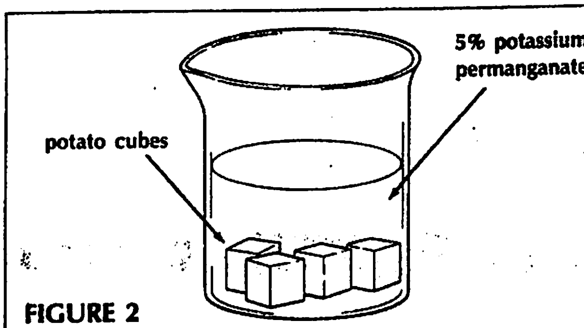

FIGURE 2

Part B. Influence of Time on Diffusion

- With a razor blade, cut five cubes from a potato. Each cube should measure 1 cm on each side.
- Place four of the five cubes into a small beaker half filled with 5% potassium permanganate solution (Figure 2). Note the exact time the cubes are added to the solution.

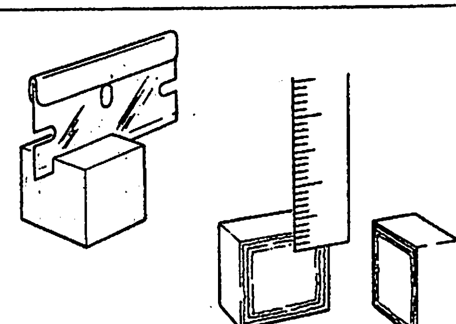
FIGURE 3

TABLE 2. POTATO CUBES IN SOLUTION FOR DIFFERENT LENGTHS OF TIME		
CUBE	TIME IN SOLUTION (MIN)	DISTANCE OF DIFFUSION (MM)
1	0	
2	10	
3	20	
4	30	
5	40	

• With tweezers, remove one cube from the solution every ten minutes.

• Slice each cube open with a razor blade (Figure 3). **CAUTION:** *Slice away from fingers to avoid cuts.* Carefully dry the razor blade before slicing each cube. Measure the distance in millimeters that the solution has diffused into each potato cube. Distances that you measure may not be very large.

• Record the distance and total time in the solution for each cube in Table 2.

• Slice open the cube that was not added to the solution. This cube will be your "control." Consider it as the zero minutes cube (Cube 1) in the table.

Part C. Influence of the Chemical Concentration on Diffusion

• Pour equal amounts of the following liquids into separate beakers:

5% potassium permanganate solution
1% potassium permanganate solution
0.1% potassium permanganate solution

Label each beaker as to the strength of liquid being used—5%, 1%, or 0.1%. Record the concentrations in Table 3.

• Cut three potato cubes each measuring about 1 cm on a side.

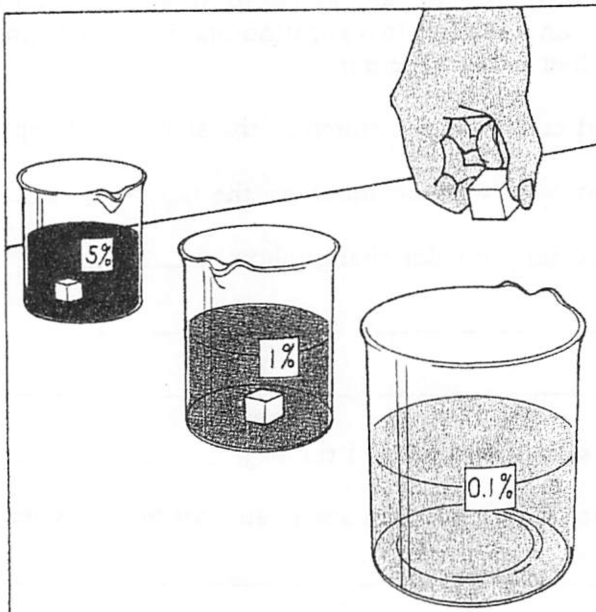

FIGURE 4

• Place one potato cube into each beaker (Figure 4). Note the exact time the cubes are added to the solutions.

• After 40 minutes, use tweezers to remove each potato cube from its solution.

• Slice each cube in half with a razor blade. Carefully dry the blade before slicing each cube.

• Measure the distance in millimeters that the potassium permanganate solution has diffused into each cube.

• Record the distances in Table 3.

TABLE 3. POTATO CUBES IN SOLUTIONS OF DIFFERENT CONCENTRATIONS		
CUBE	CONCENTRATION OF CHEMICAL	DISTANCE OF DIFFUSION
1		
2		
3		

Analysis

1. In Part A, the plastic bag represents what part of an actual cell? ____________
2. Recall from an earlier investigation that iodine solution plus starch (or polysaccharide) forms a blue color when mixed together.

   (a) What color was the starch at the start of the experiment? ____________

   (b) What color was the starch on the next day? ____________

   (c) What did the color change show? ____________

   ____

   ____

3. (a) Did starch move out of the bag? ____________

   (b) What evidence do you see to support your answer? ____________

   ____

   ____

4. (a) Was iodine on the outside lighter in color before or after the experiment? ____________

   (b) If iodine moved into the bag, would its color on the outside become lighter? ____________
5. A membrane is permeable to a substance if that substance can move through the membrane. It is impermeable if that substance cannot move through the membrane.
   (a) Using your experimental results, explain if the bag is impermeable or permeable to iodine.

   ____

   ____

   (b) Using your experimental results, explain if the bag is impermeable or permeable to starch.

   ____

   ____
6. Diffusion results in the movement of chemicals through a permeable cell membrane from areas of high amount or concentration toward areas of low amount or concentration.
   (a) At the start, was iodine in high or low concentration outside of the bag? ____________

   (b) At the start, was iodine in high or low concentration inside the bag? ____________

   (c) Did iodine move by diffusion? ____________
7. Some scientists believe that membranes contain very small pores. Pore size may determine why some chemicals can or cannot pass through a cell membrane. How might the size of the membrane pore compare to the size of

   (a) the iodine molecules? ____________

   (b) the starch molecules? ____________
8. On a separate sheet of paper, write a paragraph which summarizes Part B of this investigation. Include (a) the purpose of Part B, (b) your investigation findings, and (c) how the length of time in the solution influences the amount of diffusion. Use specific values from Table 2 to support your statements.
9. On a separate sheet of paper, write a paragraph which summarizes Part C. Include (a) the purpose of Part C, (b) your investigation findings, and (c) how the concentration of a solution influences the amount of diffusion. Use specific values from Table 3 to support your statements.