Diffusion Using Dialysis Tubing

Introduction

How do membranes around cells regulate the internal composition of the cell? Can any molecule pass through the membrane or only certain molecules. What determines the direction of molecular movement? Use dialysis tubing to teach students the fundamental concepts of diffusion.

Concepts

- Diffusion
- Concentration gradient
- Semipermeable membrane

Background

Diffusion is one of the key processes involved in the movement of materials throughout living systems. *Diffusion* is the tendency for molecules of any substance to spread out into the available space. Diffusion can be effectively demonstrated by observing the action of a drop of dye in a glass of water. The H_2O molecules that make up water are in constant motion. If a drop of blue food dye is added to the glass, the dye begins to slowly diffuse throughout the water. The individual dye molecules disperse and collide with the moving water molecules and eventually become evenly distributed throughout the glass. The solution in the glass appears as a uniform light blue. The movement of *individual* molecules is indeed random. The *net* movement of the dye molecules is directional in a sense that they move from a region where they are highly concentrated to a region where they are less concentrated. Diffusion is said to occur down a concentration gradient. When the dye has become evenly distributed, and the dye and water are at equilibrium, the net movement of the dye appears to have stopped. It is important to understand that the random movement of individual dye and water molecules continues even when equilibrium is reached.

Cells are enclosed within membranes that regulate the movement of materials into and out of the cell. Some molecules are small enough to move freely in and out of the cell through the membrane. However, not all molecules can diffuse through freely. Therefore, cell membranes are *selectively permeable* or *semipermeable*. A simplified analogy is that of a porous membrane in which some molecules are small enough to fit through the pores while others are too large.

Dialysis is the separation of smaller molecules from larger molecules in solution by selective diffusion through a semipermeable membrane. Dialysis tubing will be used in this laboratory to simulate a cell membrane. It is made of selectively permeable cellulose tubing perforated with microscopic pores. The pores are small enough for the tubing to be used to model the behavior of the cell membrane with respect to the sizes of molecules that can or cannot diffuse through it.

Materials

- Silver nitrate solution, $AgNO_3$, 0.1 M, 9–10 drops
- Sodium chloride solution, NaCl, 1 M, 25 mL
- Water, distilled or deionized
- Beaker, 250-mL
- Dialysis tubing, 6″ piece
- Graduated cylinder, 25-mL
- Pipet, Beral-type
- String, 4″ piece, 2
- Test tube rack
- Test tubes, 3

Safety Precautions

Silver nitrate solution is corrosive and can cause burns; avoid all contact with eyes and skin. Salt solutions are irritating to eyes and skin. Wear chemical splash goggles, chemical-resistant gloves and a chemical-resistant apron. Wash hands thoroughly with soap and water before leaving the laboratory. Follow all laboratory safety guidelines. Please review current Material Safety Data Sheets for additional safety, handling and disposal information.

Preparation

Cut the dialysis tubing into 6″ pieces and place in water to soak for 15 minutes prior to use. Extra dialysis tubing is recommended to accommodate the occasional rip of dialysis tubing.

Publication No. 10936
061616

Procedure

1. Obtain a 6″ length of pre-soaked dialysis tubing. The tubing is soaked in order to soften it for handling and to open the hollow tube. Twist the tubing between your thumb and index finger to make sure the tubing can be opened. Keep the tubing moist throughout the experiment.
2. Close one end of the tube by tying a tight knot with a short piece of string about 1 cm from the end of the tubing. Be sure it is tied very tight with a secure knot so nothing can leak from the tube.
3. Carefully pour 20 mL of salt solution into the dialysis tubing bag using a 25-mL graduated cylinder. *Note:* Using a 10-mL graduated cylinder twice may be easier for some students to work with as the dialysis tubing is small.
4. Use a second short piece of string to close the open end of the dialysis tubing. Tie the knot tight to prevent leakage.
5. Rinse the dialysis tube bag thoroughly under running water so that there is no salt solution on the outside of the dialysis bag.
6. Place approximately 200 mL of salt-free water into a clean 250-mL beaker. Place the dialysis bag into the beaker of water as shown in Figure 1.
7. Allow the beaker to sit undisturbed for 10–15 minutes. Complete step 8 while waiting.

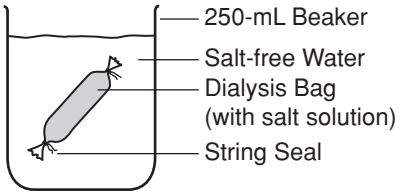

Figure 1.

8. Label two test tubes in a test tube rack and prepare them as described below. Use a Beral-type pipet to add the silver nitrate solution. Observe the test tubes before and after the drops of test solution are added and record the results.

   #1 5 mL of water + 3 drops of silver nitrate

   #2 5 mL of salt solution + 3 drops of silver nitrate solution

9. After 10–15 minutes, use a clean test tube to test the water in the beaker outside the dialysis tube as described below. Record the test results.

   #3 5 mL of beaker water + 3 drops of silver nitrate solution

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory wastes. Silver nitrate solution should be disposed of according to Flinn Suggested Disposal Method #11. All other solutions may be disposed of according to Flinn Suggested Disposal Method #26b.

Discussion

The results of this activity show that the salt did diffuse through the dialysis tube into the water in the beaker. This is confirmed by the presence of white precipitate when silver nitrate is added to a sample of beaker water.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Constancy, change, and measurement
Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standard C: Life Science, structure and function in living systems
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter
Content Standard C: Life Science, the cell, matter, energy, and organization in living systems, behavior of organisms

Tips

- Try additional solutions which contain solutes of different molecular weights to demonstrate not all molecules will diffuse through the dialysis tubing.
- Dialysis tubing clamps, available from Flinn Scientific (Catalog Nos. AP4349 and FB1232) may be used instead of string to seal each end of the dialysis tubing.
- Lab kits which also study diffusion using dialysis tubing are available from Flinn Scientific and are listed below.

FB0435	Dialysis Fundamentals
FB1870	Introduction to Osmosis and Diffusion
AP4514	Diffusion through Membranes

Materials for *Diffusion Using Dialysis Tubing* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP4352	Dialysis Tubing, 3 meters
S0305	Silver Nitrate Solution, 0.1 M, 100 mL
S0347	Sodium Chloride Solution, 1 M, 500 mL
AP4349	Dialysis Tubing Clamp
FB1232	Disposable Dialysis Tubing Clamps

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.