Exploring Diffusion Lab

Science Objectives

- Students will explore the movement of molecules through a membrane via diffusion.
- Students will explore the effects of concentration gradient on diffusion rate.

Vocabulary

- diffusion
- concentration gradient
- molarity
- conductivity
- permeability

About the Lesson

- This activity involves students conducting 4 separate trials using 4 different molarities of a salt solution.
- As a result, students will:
  - Use a conductivity probe to help students understand diffusion rates.
  - Develop an understanding of the effect of the concentration of a solution on the rate of diffusion across a selectively permeable membrane.

TI-Nspire™ Navigator™ System

- Use Screen Capture to evaluate cooling rates obtained by the students.
- Use Live Presenter to allow students share their results and conclusions.
- Use Class Analysis for formative assessment.

Activity Materials

- TI-Nspire™ handheld
- Vernier® Conductivity Probe™
- distilled water
- 0.1 M, 0.2 M, and 0.3 M salt solutions
- 400 mL or 500 mL beaker
- 25 mL or 50 mL graduated cylinder
- funnel
- four pieces of dialysis tubing, approximately 10 cm long
- dental floss or string

TI-Nspire™ Technology Skills:

- Download a TI-Nspire document
- Open a document
- Move between pages
- Analyzing collected data
- Evaluating rates from a graph

Tech Tip:

Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

Lesson Files:

Student Activity

- Exploring Diffusion Lab.pdf
- Exploring Diffusion Lab.doc

TI-Nspire document

- Diffusion Data Collection.tns

Problem 1 – Prelab Questions

Move to page 1.2

Q1. Riding a bike down a hill is analogous to active transport.

Answer: False

Q2. Why are you going to use a conductivity probe in this lab experiment?

Answer: Salt is ionic and when it dissolves, the ions in the water conduct a current.

Q3. Which of the following shows the greatest concentration gradient?

Answer: 2% salt in a cell and 0.5% outside

Q4. The water in a stream or river flows in a manner most similar to passive transport.

Answer: True

Q5. You can place a limp piece of celery in water, and it will become crisp again. Which BEST explains this?

Answer: Osmosis

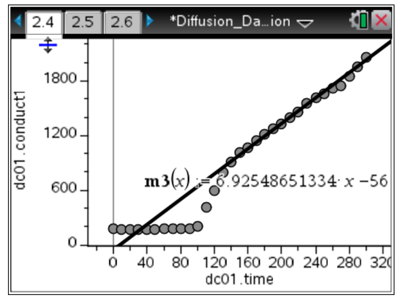
Move to pages 2.1 through 2.7.

1. To conduct the experiment and collect data, begin by pouring about 250 mL of distilled water into the beaker.
2. Tie off one end of the dialysis tube with dental floss. To tie off the dialysis tubing, twist one end of the tube, fold it over on itself, loop a knot of floss over the doubled-over tube, and tightly secure the floss.
3. Measure 15 mL of distilled water, and use a funnel to pour it into the dialysis tube.
4. Tie off the other end of the dialysis tube so you have a bag. Be careful that no liquid can leak out of the ends of the bag.
5. Plug in the conductivity probe, and set the toggle switch to the middle setting.
6. On page 2.4 set up a data collection for every 10 seconds for a total of 5 minutes.
7. Place the probe into the beaker of water, let the reading stabilize, click "start," and then place the dialysis bag into the beaker. The data should be displayed on Page 2.5.

TI-Nspire Navigator Opportunity

Screen Capture can be used here to ensure that students have obtained a reasonable data set. The graph should show that the conductivity of the solution is constant until the dialysis tubing is inserted. Once the tubing is placed in the beaker, the graph data points should slope upwards steadily. If student graphs do not have this form, you may need to assist groups to be sure that they have set up the experiment correctly.

8. When the data collection is over, use the **Movable Line** tool to draw a line of best fit through the linear portion of the data. The slope of the best-fit line is the diffusion rate.
9. Record the diffusion rate in the data table on Page 2.7 of the handheld.



Teacher Tip: They should fit the line to the linear, upward-sloping part of the data set, ignoring the initial flat readings. The units for the data are millisiemens per centimeter (mS/cm).

10. Repeat the procedure three more times for each of the three remaining salt solutions, recording data on Page 2.7.
    - The water goes in the beaker, and the salt solutions go in the dialysis tubes.
    - Use a new dialysis tube and fresh beaker water each time.

Teacher Tip: Make sure that students are starting with fresh distilled water for each trial. They should rinse their beakers and the conductivity probes after each trial.

Move to pages 3.1 through 3.6.

Q6. Which molarity gave the greatest rate of change?

Sample Answers: The greatest rate of change *should* have occurred for the 0.3 M solution.

Q7. a. Which molarity would you have EXPECTED to give the greatest rate of change?
b. Which molarity would you have EXPECTED to give the least rate of change?

a. Answer: 0.3 M **b. Answer:** 0.1 M

Q8. If you had used a 0.5 M salt solution in the tubing, how would the rate of diffusion have compared to the other rates you measured?

Answer: The diffusion rate would have been greater than that in the first trial, but less than those of the other trials.

Q9. Other than the molarity of the salt solution, what is another experimental variable that could be applied to alter the rate of diffusion?

Sample Answers: Examples of variable include the volume of water, the volume of salt solution, the surface area of the tube that is in contact with the water, and the temperature of the water and the salt solution.

Q10. Predict how your results would have been different if you had put distilled water into the dialysis tube and the salt water into the beaker.

Sample Answers: If the distilled water were in the dialysis tube, the water would diffuse out of the tubing into the sale solution. The solution would become more dilute over time, so its conductivity would decrease. The diffusion rate should be the same for a given concentration gradient, but the direction of diffusion would be opposite.

Wrap Up

Transport of materials into and out of the cell is one of the key ideas in Biology. Cells MUST be able to move things across their membranes. Passive transport allows materials to move across membranes without the cell having to expend ATP energy. Concentration gradients, in large part, determine the direction of movement of materials and the rates at which these materials move. This activity models these ideas.

Assessment

Formative assessment will consist of questions embedded in the .tns file. The questions will be graded when the .tns file is retrieved. The Slide Show can be utilized to give students immediate feedback on their assessment.