

NOTE: Make sure you sign up for the science lab and have the equipment, reagents, beets, and water baths prepared in advance.

TITLE OF LESSON

Biology Unit 1 Lesson 7 – Membrane Permeability Laboratory
How do things flow in and out of a cell?

TIME ESTIMATE FOR THIS LESSON

One class period

ALIGNMENT WITH STANDARDS

California – Biol CB 1a; IE 1a-g

MATERIALS

Lab 3: Membrane Permeability handout – Student Page
beets
cork borer (4 mm diameter)
ruler for measuring size of beet pieces
tubes with covers (half heat resistant)
250 ml beaker
freezer
ice (prepared before the class)
water baths with different temperatures (25°C, 37°C, 55°C, 80°C)
distilled water
spectrophotometer (460 nm)
acetone (1%, 25%, 50%)
ethanol (1%, 25%, 50%)
diluted liquid or powdered soap (1/10)

LESSON OBJECTIVES

- To change the permeability of a membrane by temperature or solvent
 - To investigate the effects of temperature and solvents on membrane permeability
 - To analyze the observed changes and relate it to the changes that must have occurred within the cell membrane
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FOCUS AND MOTIVATE STUDENTS–WARM UP ACTIVITY

- 1) Homework Check – Stamp/initial complete homework assignments. Pass back graded assignments and have students place them in the appropriate sections of their binders. Remind them they should be organizing their work by date and section.
- 2) **Agenda** – Have students copy the agenda you have posted.
- 3) Review – The teacher should very briefly review the following information. A cell is surrounded by a membrane. This membrane separates the contents of the cell (the cytoplasm and the cytoplasmic organelles) from the external environment. This plasma membrane is composed of proteins, lipids and carbohydrates and regulates the passage of substances in and out of the cell. Singer and Nicolson proposed the fluid mosaic model of the membrane in 1972. In this model the membrane is made of a double layer of lipids where its surface is interrupted with proteins. The lipids form a double layer with the hydrophobic groups in the interior and the hydrophilic groups on the exterior. The proteins exist in two forms, integral and peripheral. Integral proteins are transmembrane proteins that pass through the whole membrane. Peripheral proteins are not transmembrane proteins and stick out of one of the two hemimembranes. The proteins, lipids and carbohydrates are situated in a stable configuration with the lowest free energy.
- 4) Explain – Red beet tissue contains large amounts of betacyanin, a red pigment, located in the large internal membrane vacuoles. When the membrane is damaged, this pigment can cross the vacuole membrane and



cell (plasma membrane). In this experiment you will take pieces of beet root and test what types of environmental stress disrupts the membrane. This should give us insight into the composition of the membrane.

- 5) **Lab 3** Directions – Give each student a copy of the lab protocol, **Lab 3 Membrane Permeability** found in the student pages area of the web site. This experiment is a *modified* version of the membrane lab found at: <http://www.wmich.edu/bios/bios1502/membrane.html>. Have the students read through the lab protocol on the effects of temperature and solvents on beet root cells so they understand what they will be doing. If they have doubts about a step they should ask the teacher for clarification.
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ACTIVITIES – INDIVIDUAL AND GROUP

1. Recording Data – Have students separate into assigned groups, if they are not already seated in their groups. Half of the groups do the temperature experiment and the other half do the alcohol and acetone experiment. Divide the groups in half and assign each half their respective experiments. Everyone will need to work efficiently in order to finish on time. Have the students make three columns on a page of paper that will be stored in the lab section of their binders after the lab. Label the first column *results*, the second *observations* and the third *errors*. It is better to store this information in a safe place such as their binders since loose sheets of paper tend to get lost. This is a terrible error when working as a scientist. As the students proceed through the protocol they must record their observations, results, and errors in these columns. As a scientist it is crucial to record what happens at the moment it happens. We always say we will remember, but that isn't true. For example, if one of the water baths is too hot, it is necessary to record the actual temperature. If the time the sample is in the water bath is too short or too long, it is important to record this information. An observation could be the intensity of the pink color in the test tube after a treatment. It is necessary to record any other errors as well, since they are necessary when making conclusions about the outcome of the experiment. Give other examples, if you feel they are necessary. The teacher can write up an example of recorded results, observations and errors for the students to observe.
 2. Begin Lab 3: Membranes – Diffusion and the Effects of Temperature and Solvents. See **Lab 3 Membrane Permeability** in the student pages for the complete lab protocol. Give students the rest of the period to work on this. Remind students they must work quickly and efficiently today to finish the lab in class. The groups should take their spectrophotometry readings today. Groups that don't finish should complete the lab during lunch or after school if you can open the lab for them. If you can't, groups should take the pieces of beet root out of their samples (if they don't, the reaction will continue all night) and store them covered in a refrigerator until tomorrow and read them then. They should be taken out prior to class so the sample returns to room temperature. When the bell rings, collect all labs. *The following are probable answers to the questions posed in the handout:*
 - a. *What would happen if you didn't remove the piece of beet?* The leakage of betacyanine from the vacuole will continue since the membrane is damaged and your solution will be so dark that you won't be able to determine the absorbency during the following class.
 - b. *What do you do if you don't have a spectrophotometer?* To answer this question hold up the tubes in front of a piece of white paper and determine by eye the intensity of the color, from lightest to darkest.
 3. Lab 1 – While the students are waiting for the 15 minute incubations in the permeability experiment, they should continue the egg experiment started in lesson 6. Refer to **Lab1 Egg Experiment**. Make sure to initial their experiment results.
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HOMEWORK

- 1) **Vocabulary** – Write the target vocabulary on the board: osmosis, membrane permeability, spectrophotometry, solvent, experiment, temperature. Ask the students to write them on a sheet of paper and define them for tomorrow. They should underline the prefixes, highlight the roots and circle the suffixes as before.
- 2) Read – Read chapter 7 to 9 pp. 37-50 of *The Double Helix*. Predict 5 things you think the author will write about next. Make sure you tell why you have chosen those 5 things based on evidence from previous readings.



GROUP ROLES

Recorder – The Recorder will record all the data from the lab experiment. All students are recorders.

Facilitator – The Facilitator will keep group members focused on the experiment

Manager – The Manager is responsible for getting materials the group needs

DOCUMENTATION FOR PORTFOLIO

None

