# Unit on Cell Function

Kay Holmes and Cecilia Miller, Alyeska Central School
Grade Level: Middle School

These lessons would be taught as part of a month long unit on cells, and would have been preceded by lessons about the cell theory and cell structure. The following lessons would be presented along with other lessons regarding cell function.

**Alaska Performance and Content Standards:**

Science: A9, A10, B1, B2 and D3
Math: M.A.2.1, M.A.2.4, M.A.3.4-6, M.A.5.4, M.D.1.1, and, M.D.1.1

## Lesson 1: Diffusion, Diffusion (What's your function?)

**Science Concepts:** After completing these lessons student will understand the process of diffusion and its importance to cell function. Student will understand that osmosis is a specialized form of diffusion across a selectively permeable membrane and how this too is vital to the healthy functioning of cells and living things.
**Math Concepts:** Student will understand how surface area and volume change when an object changes in size and will understand that the ratio of surface area to volume decreases with increasing size.

**Gear Up:**
Materials: Glass beaker, dark colored food coloring
Drop several drops of food coloring into a glass beaker of water. Ask students to observe what happens over the next couple of minutes and have them note changes to water and food coloring in their journals. Have students predict what will happen after 5, 10 and 20 minutes. Introduce the concept of "diffusion," define and tell students that we will be exploring how diffusion occurs in different states of matter.

**(Process Skills:** Observing, Communicating, Predicting)

**Explore: (**Materials: can of air freshener spray or perfume spray bottle)
Spread students out evenly through the classroom and have them stay stationary for the next few minutes. Explain that you will be spraying a blast of air freshener. Ask students to predict what will happen to its distribution through the room over time and have them record their prediction in their journals. Teacher will spray (up or down and not towards classroom) 2-second blast of air freshener or perfume in one corner of the room. Have someone stand at the chalkboard to record the time. Prepare students in advance that they will be noting the time (in minutes and seconds) when they smell the room deodorizer. After last student has

smelled the odor, record all the times on the board starting with those closest to odor source and ending with those furthest away.

(**Process Skills:** Predicting, Observing, Inferring, and Communicating)

**Generalize:** How is each student's distance from the odor source related to when he/she detected the odor? Why do you think this happened? Can you detect a pattern? How did what they just witness represent diffusion? How is this similar or different to what happened with the food coloring and water? How do the rates of diffusion compare in air and water? What states of matter are involved in both? What does this have to do with how cells interact with their environment? Discuss what factors might affect the rate of travel in both air and a liquid. What happens in a solid? Does diffusion occur, and if so how does the rate of diffusion compare with that of liquids or gases. How would you test this?

## Lesson 2: Osmosis

**Gear Up:** Ask students what they remember about the function of the cell membrane. Discuss how cell membranes are like a filter or gatekeeper. Ask why such a function is necessary to cell function. Introduce term "**selectively permeable.**" Allow students to guess at the definition from dissecting the word parts and then explain its meaning.

**Explore:** Break the class into groups and challenge each group to devise a way of separating out the different fractional components of a heterogeneous bucket of material.

Materials:

- One bucket partly full of water, soil, sand and various sized rocks per group of students. Tell students to imagine that this material represents different particles in a cell's environment.
- Several smaller plastic buckets or containers per group to hold the different components as they become separated.
- Variety of filtering type materials available. Have a colander, cheesecloth, dishcloth, stockings, hardware cloth, screen, etc. available to let them come up with a way to separate the different parts.

(**Process Skills**: Observing, Predicting, Inferring and Communicating)

**Generalize**: Again brainstorm what the last activity had to do with cells. Ask students what substances the human body must take in on a regular basis. (oxygen, water, nutrients). Hint: What substance makes up the bulk of the human body? Discuss why the body needs each of these substances briefly and discuss the importance of water to keeping cells alive. Define **"osmosis"** (movement of water through a cell membrane).

**Gear Up/Demonstration:**

Create a model showing how a selectively permeable membrane works. Remind them that starch is an indicator for starch (students will have learned this in a previous lesson).

Materials:

- tablespoon measuring spoon
- cornstarch
- 2c. water
- resealable plastic sandwich bag
- dropper
- iodine

Procedure: Stir 1 Tbsp. Cornstarch into 2c $H^20$ and pour into Ziploc bag. Seal bag removing most of air and rinse to remove any cornstarch on outside of bag. Place in clean cup half full of $H^20$. Add 20 drops of iodine to water in cup. Wait and observe changes in bag every 5-10 minutes.

Journal writing- Have students address following questions in their science journals.

1. What did you observe about the starch solution? (it should turn purple or black)
2. What did you observe about the iodine/water solution in cup? (should not change color unless there is contamination).
3. What does the color change in the bag indicate? (Iodine was able to travel through bag)
4. What does the lack of color change in the cup indicate? (Starch was unable to travel through bag)
5. What does this demonstration tell you about the plastic bag? (It allows iodine molecules to pass through but not starch molecules which are too large)

**Process Skills:** Observing, Communicating, Inferring

**Assessment:** Have students draw a diagram depicting this demonstration including molecules involved and membrane.

Rubric Criteria (Ratings: 3-Excellent, 2-Good, 1-Poor, 0-Not Done)

- Iodine molecules drawn smaller than starch molecules
- Membrane present with openings big enough for iodine but too small for starch molecules to pass Accurate and neat labels and title provided

- Arrows showing that iodine can pass through membrane but not starch
- Accurate and clear title and labels provided

## Lesson 3: Effects of Size on Diffusion and Osmosis (or "Why are cells so small, anyway?")

**Science Concept:** Student will understand how a change in cell size affects its ability to exchange materials with its environment.
**Math Concept:** Student will understand how the ratio of surface area to volume changes with the size of a cube**.**

**Gear-Up/Assess prior knowledge:** Journal Writing-- Ask students to answer the following: Why do you think cells are so small? Reread section in text regarding cell size and discuss (ratio of surface area to volume and importance of specializing). Explain that we will be doing an experiment to illustrate this point.

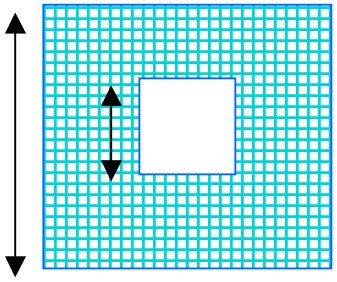
## Guided Experiment 1:

Purpose: To demonstrate how size of an object affects diffusion or its ability to absorb materials from its environment.
Materials:

- 4 packages clear gelatin or a light colored Jello prepared in small bread baking tin lined with saran wrap for easy removal (prepare so it is relatively stiff, rubbery and relatively thick, such as for Knox-blox)
- water
- knives
- graph paper (centimeter squares)
- rulers
- food coloring (a stronger concentration will work faster)
- glass beakers

Procedure: Have students form small groups and explain that they will be using cubes of gelatin to observe properties of diffusion. Have students determine rate at which food coloring penetrates the Jello. Have each group select a different size cube (e.g., 1 cm, 2 cm, 3 cm). Have each group carve up Jello to create 5 cubes of each size.

Students will immerse all of their cubes in food coloring solution. Students will remove a single cube of each size from solution every hour (or an appropriate interval dependent on concentration of solution), cut open and measure the portion that is colored versus the total diameter. Determine area of each and fill in data table.



Students will determine percentage of area colored divided by total area.

| Length of cube side | Surface area (square cm) | Volume (cubic cm) | Ratio of surface area to volume | Observations: Percent colored /total area |
|---|---|---|---|---|
| 1 cm | (1 cm X 1 cm)X6= 6 $cm^2$ | 1 cm X 1 cm X 1 cm=1 $cm^3$ | 6:1 | |
| 2 cm | | | | |
| 3 cm | | | | |
| 4cm | | | | |

**Interpret:**
Analyze classroom data and discuss with class. Ask questions such as the following:

- Was it necessary to have different lengths of soaking time?
- Do you see any patterns? What are they?
- How does ratio of surface area to volume change as the cube gets bigger?
- What happens to the time it takes for a substance to diffuse to the center of the cube as the size of that cube increases.

- What are the implications for cells getting what they need and getting rid of what they don't need as a cell increases in size?

Assessment/Journal Writing: Have students propose one hypothesis to explain why elephants have *large numbers* of small cells rather than *larger* cells.

**Apply/Assess: Experiment 2**

Based on experience gained during previous experiment, students will design experiment to test how varying shapes or concentration of solution affects diffusion. Students will write up results according to experiment report format introduced in earlier units.

(**Process skills:** Observing, Measuring, Communicating, Predicting, and Inferring)

Assessment Rubric:(rating:3-Excellent, 2-Good, 1-Needs Work, 1-Not Done)

- Experiment report has all the parts discussed earlier (purpose, hypothesis, materials, procedure, data and analysis, conclusion).
- Hypothesis is testable.
- Experiment contains a control.
- Student attempts to limit variables tested.
- Data is displayed clearly in table or graph form.
- Data is summarized either mathematically or verbally.
- Conclusion is based on data, is logical and relates back to hypothesis.
- Report is neat, legible and written in complete sentences.

**Apply/Assess:**

Students will complete "The Perfect Taters Mystery" investigation. Note: This is a copyrighted lab from Holt publishers and cannot be posted to this web site. It is a lab that has groups of students comparing the effect of salt concentration on potatoes.

Rubric criteria: (rating: 3-Excellent, 2-Good, 1-Poor, 0-Not Done)

- Question is clearly stated and can be tested by experiment
- Hypothesis follows guideline discussed earlier ("if," "then" format)
- Experiment design is well planned and contains a control
- Records/data are accurate and neatly kept
- Conclusion is logical and clearly supported by data
- Follow up letter is clearly written using complete sentences and well organized and includes recommendation

**Extension Activity:**

Have students research what makes a great French Fry. Brainstorm where they would get this information (Internet search, Survey of preferences among their peers, Interviews with fast food managers). Have small groups design an experiment to test what size and shape of potato makes the best French Fry.