Teacher Guide: Osmosis

Learning Objectives

Students will …

- Observe the diffusion of a solvent through a semipermeable membrane.
- Describe osmosis.
- Observe that during osmosis, water will move into or out of the cell until there is an equal concentration of solute on both sides of the barrier.
- Explain why a cell will shrink when placed in a concentrated solution and expand when placed in a weak solution.
- Given the solute concentration inside and outside a cell, predict whether the cell will expand or shrink.

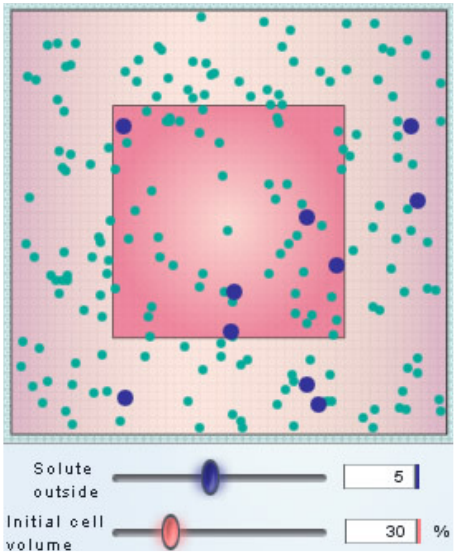
Vocabulary

cell membrane, concentration, diffusion, dynamic equilibrium, osmosis, semipermeable membrane, solute, solvent

Lesson Overview

Diffusion is the movement of particles from an area of higher concentration to an area of lower concentration. The diffusion of a solvent (such as water) across a semipermeable membrane is called osmosis.

The *Osmosis* Gizmo™ illustrates the osmosis of a solvent across a cell membrane. In the simulation, the green solvent particles can travel through the membrane, but the purple solute particles cannot. Students can control the number of solute molecules outside the cell and the initial cell volume.



The Student Exploration sheet contains two activities:

- Activity A – Students explore the effect of solute and solvent concentration on osmosis.
- Activity B – Students explore the effect of initial cell volume on osmosis.

Suggested Lesson Sequence

1. **Pre-Gizmo activity: Salty potatoes** (5 – 10 minutes)
   Cut a potato in half, and then use a spoon to scoop a depression into the round end of each half. Add a pinch of salt to one depression, and leave the other alone. After about five minutes, the salty depression will fill with water while the other depression will be dry. Osmosis pulls water from the potato cells into the salty solution.

   Ask students what is happening. Where does the water come from? Do you think a potato plant will be able to survive if watered with salt water? What would happen to a person if she drank salt water?

2. **Prior to using the Gizmo** (10 – 15 minutes)
Before students are at the computers, pass out the Student Exploration sheets and ask students to complete the Prior Knowledge Questions. Discuss student answers as a class, but do not provide correct answers at this point. Afterwards, if possible, use a projector to introduce the Gizmo and demonstrate its basic operations. Demonstrate how to take a screenshot and paste the image into a blank document.

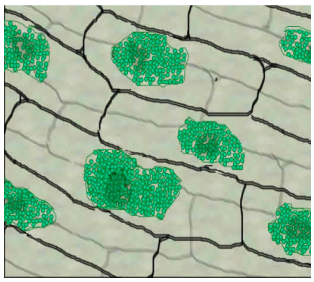
3. **Gizmo activities** (15 – 20 minutes per activity)
Assign students to computers. Students can work individually or in small groups. Ask students to work through the activities in the Student Exploration using the Gizmo. Alternatively, you can use a projector and do the Exploration as a teacher-led activity.

4. **Discussion questions** (15 – 30 minutes)
As students are working or just after they are done, discuss the following questions:

   - Which particles can pass through the semipermeable membrane shown in the Gizmo? Which particles cannot pass through?
   - What is the relationship between solute concentration and solvent concentration? [The higher the solute concentration, the lower the solvent concentration will be.]
   - What happens when the solute concentration outside the cell is increased? Why?
   - What causes the cell to stop swelling or shrinking? [The cell will keep swelling or shrinking until solute concentrations are equalized inside and outside the cell.]
   - What do you think would happen if you placed a cell in pure water?
   - What do you think would happen if you placed a one-celled freshwater organism into the ocean? What would happen if you placed a one-celled marine organism into fresh water?

5. **Follow-up activities** (variable)
Osmosis can be observed in a variety of experiments and demonstrations.

   - Place *Elodea* leaves on two microscope slides. Add a drop of distilled water to one, and a drop of salt water to the other. After about 5 minutes, observe each leaf under a microscope. Students will see that cells in the saltwater solution have undergone *plasmolysis*, a process in which the cell membrane pulls back from the cell wall.



***Elodea* plasmolyzed**

   - To demonstrate osmosis on a large scale, place a raw egg in vinegar and let it sit overnight to dissolve the shell. Place the egg in distilled water one day and find its mass and circumference. Then, place the egg in corn syrup, let it sit overnight, and measure it again. The egg in corn syrup will shrink due to osmosis.
   - Place grapes in containers of distilled water, grape juice, and corn syrup. Let them sit overnight. Measure the mass of each grape the next day. Like the egg, the grapes in corn syrup will be smallest because of water loss from osmosis.

See the **Selected Web Resources** on the next page for detailed instructions.

Scientific Background

Molecules in a liquid are in constant motion. When substances are added to a liquid, the molecules will naturally spread out from areas of higher concentration to areas of lower concentration. This occurs until the concentrations of each substance are even throughout the liquid. This process is called *diffusion*.

Cells are enclosed by a *semipermeable membrane*. The cell membrane is permeable to *solvents* such as water, but less permeable or impermeable to various *solutes* such as salt and sugar. In these cases, diffusion will occur until solute concentrations are equal on both sides of the semipermeable cell membrane, but this can only occur by the movement of solvent molecules across the cell membrane.

For example, suppose a cell is placed in a highly concentrated salt solution, also called a *hypertonic solution*. In this case, the concentration of water molecules is much higher inside the cell than outside. Water molecules leave the cell by osmosis until the concentration of water molecules inside the cell is equal to the concentration of water molecules outside the cell. The cell will shrink and shrivel as water leaves the cell.

When a cell is placed in a *hypotonic solution* with a low concentration of salt molecules, the concentration of water molecules is higher outside the cell than inside. Water molecules move into the cell until concentrations are equalized, and the cell swells and may even burst!

Biology Connection: Osmoregulation

Living in salt water or fresh water presents unique challenges to organisms. The process of controlling the flux of water into and out of an organism is called *osmoregulation*.

Marine animals must excrete excess salt from their bodies to maintain *isotonic* conditions inside their bodies. Fish and marine mammals are able to produce urine with a much higher salt concentration than urine produced by human kidneys. Some saltmarsh plants have special glands that excrete salt, or the plants store salt in their fleshy leaves.

In fresh water, organisms must find ways to excrete excess water. Protists such as paramecia have a *contractile vacuole* that collects water and then pumps it out. Freshwater fish excrete water in urine but also are able to actively pump salts into their bodies via cells in their gills.

Selected Web Resources

Diffusion and osmosis: http://hyperphysics.phy-astr.gsu.edu/hbase/Kinetic/diffus.html
Potato demonstration: http://www.biotopics.co.uk/life/osmsis.html
Elodea lab: http://www.sciencenetlinks.com/pdfs/plasmolysis_actsheet.pdf
Egg lab: http://staff.tuhsd.k12.az.us/gfoster/standard/labosmosis.htm
Grape lab: http://faculty.hra.org/~mschin/Osmosis%20Lab.pdf
Diffusion and osmosis labs: http://www.und.nodak.edu/dept/jcarmich/101lab/lab4/lab4.html
Osmoregulation in fish: http://www2.hawaii.edu/~delbeek/delb11.html
Why we can't drink salt water: http://www.straightdope.com/columns/read/2131/what-would-happen-to-you-if-you-drank-seawater

Related Gizmos:
Diffusion: http://www.explorelearning.com/gizmo/id?417
Paramecium Homeostasis: http://www.explorelearning.com/gizmo/id?520