Can You Tolerate It? [MS]

Adapted from American Museum of Natural History and Goulburn Valley Water

Grades: 9-12
Time: 45 minutes to 1 hour

Goals: To demonstrate how osmosis works in plant cells and to understand how this relates to salt marsh plants and plant succession from maritime forest to marsh edge.

Objectives:
Students will be able to: understand and define osmosis in plant cells; demonstrate an osmotic reaction in plant cells; and explain how osmosis regulates plant succession within a salt marsh community.

Materials:

One large eggplant
Cutting knife
Shallow trays
Table salt
200ml beakers
Straws
Teaspoon measuring spoons
Water

Procedures:

1. Pre-Activity (introduction): Explore the different types of osmotic solutions, including hypertonic and hypotonic, and how they relate to salinity regulation in plants. Describe a salt marsh community and the succession of plant species from a maritime forest to the salt marsh edge (you will review this after the experiments are completed). Differentiate between a freshwater marsh and salt water marsh and what influences their salinity concentrations. Introduce the experiment and have the students begin to make predictions about how the eggplant will react to salt.

2. Activity: Pre-slice the eggplant for each pair of students, while you give them time to find a partner for the experiments. Pass out the eggplant slices, shallow trays and table salt. Ask the students to pour a generous amount of salt over the inside layer of the eggplant and make observations as the salt is absorbed into the cells of the vegetable. For best results, have the students wait approximately 15 minutes; they can move on to the second experiment while they wait.

Pass out four beakers of water, teaspoon measuring spoons, straws, and salt to each pair of students. Instruct them to create four different saline solutions – 1 teaspoon, 5 teaspoons, 15 teaspoons, and 25 teaspoons – and mix well. Explain that each solution represents a concentration that can be measured using an electrical conductivity (EC) scale based on tolerance to salinity. Give examples of EC tolerance for low, moderate, high, and very high and then have the students predict which marsh plants would have each tolerance level. Next, using their straws, have the students taste the solutions, so they understand the concentration level more clearly.

3. Post-Activity (review): Begin a discussion of the first experiment. What happened to the eggplant as the salt was absorbed into its cells? What type of osmotic reaction did it represent and how many of the students were correct in their hypotheses? If this reaction were to occur in a salt marsh community, where would it happen and what plants might react this way? Next, relate the taste test to tidal fluctuations and salt water intrusion. How do the students believe plants would react to the changes in salinity based on the EC tolerance levels?

Key Words:

Osmosis	Diffusion	Solute
Semi-permeable membrane	Dehydration	Saturation
Hypertonic	Hypotonic	Isotonic
Electronic conductivity	Salinity	

Background Information:

Adapted from Smithsonian at Fort Pierce

In a salt marsh ecosystem, salt plays an important role in the delineation of plant species, based on their tolerance levels. An organism that exhibits high tolerance to salt is called a halophyte and is usually located close to the water's edge. These species would include salt marsh grasses such as cordgrass. The less tolerant species, such as cedars, will be found more upland and as far away from the water's edge as possible. Most of these halophyte species will experience some type of tidal flooding during extreme high tides on lunar cycles or during storm surges.

Most angiosperms, flowering plants, are not halophytes, so as the salinity (amount of salt in water) increases, their diversity decreases, until you reach the water's edge, where there will usually be only one or two species present. Some plants, such as the saltwort, have the ability to increase their succulence by retaining water and excreting salt. If you ever tasted saltwort, it would in fact be salty and some people have chosen to use it as a natural flavoring for salads.

Inside halophytic plants, their cells exhibit a form of osmosis when they deal with tidal influxes of salt. By definition, osmosis is the ability of water to move across a semi-permeable membrane, such as the outside of a cell, from an area of low solute to an area of high solute. Salt water will draw any fluids inside their cells out, causing them to shrivel, wilt, and eventually die. This is especially true in areas that have flooded over and the salt water has never receded. You will see evidence of dead trees that took in too much salt water into their roots.

Experimentally, we can measure salinity in several ways. One way is to use a probe to digitally determine the ratio of salt to water in part per million. In the experiment provided, it uses electrical conductivity, or EC. Electrical conductivity will measure inorganic materials including calcium, bicarbonate, and other ions dissolved in water. These materials are rated on a scale of how tolerant they are to salinity.