Mangroves
Salinity and Its Effect on Living Things

by Bill Andrake

In this episode, Jonathan explores the Mangrove swamps of Yap in the Caroline Islands of Micronesia, an island nation in the Western Pacific.

Science Lesson: Salinity and Its Effect on Living Things - Based on Webisode 24
Grade Level: 6-8
Time: 1 hour

Introduction

So why can't most plants grow in saltwater? As a rule, freshwater **organisms** cannot survive in the ocean and marine creatures cannot survive in freshwater rivers, lakes, or streams. Some marine creatures cannot handle the changes in **salinity** that happens in **estuaries**. There are a few exceptional fish such as salmon that have the ability to slowly adapt to living in the sea after beginning their life in rivers and returning from the sea to their river of origin to reproduce.

This lab activity is a demonstration of **osmosis** in plant cells and looks at how saltwater can affect the living material of a "freshwater plant" by comparing potato slices placed in both fresh and saltwater.

Science Standards

National Science Education Standards
Life Science:
- Structure and function in living systems
- Populations and ecosystems
- Diversity and adaptations of organisms
- The Cell

Ocean Literacy Principles
- ***Principle #4:*** The ocean makes Earth habitable.
- ***Principle #5:*** The ocean supports a great diversity of life and ecosystems.
- ***Principle #6:*** The ocean and humans are inextricably linked

Objectives

- Students will gain a better understanding of osmosis in living cells.
- Students will understand how salinity can affect aquatic species and how marine creatures have evolved ways for dealing with living in saline environment.

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Prior Knowledge

Students should have a basic understanding of cells and how cells use the basic processes of diffusion and osmosis for transporting nutrient, waste, and water molecules through their cell membranes in order to survive.

Helpful Vocabulary and Facts

Active Transport: Cells use energy to "actively" move or "pump" nutrient or waste molecules through their cell membranes.

Cells: The basic units of life. All living things are composed of cells.

Diffusion: The movement of molecules from an area of high concentration to an area of low concentration. In living cells nutrient and waste molecules migrate into and out of cells through their membranes with the process of diffusion.

Dehydration: Excessive water loss.

Estuary: A partially enclosed body of water formed where rivers meet the ocean.

Halophyte: A plant that lives in a saltwater environment.

Marine Organism: An ocean (or saltwater) life form.

Molecules: Particles made from more than one atom chemically bonded in a very specific way.

Organism: Any living thing.

Osmosis: The diffusion of water molecules into and out of cells. For this to happen, water molecules spread from a higher concentration to an area of lower concentration. *Water is the compound that is the most necessary for life, so its movement into and out of living material is very important.*

Passive Transport: Cells do not use any of their own energy to transport materials in and out of cells using the processes of diffusion and osmosis.

Salinity: The concentration of salt dissolved in seawater. Salinity is measured in parts per thousand (o/oo) (ppt). (Average salinity in open ocean is 35 o/oo or 3. 5 %)

Variables: In an experiment, the factor that you change between experimental groups is known as the independent variable. The dependent variable is what changes as a result of the independent variable in the experiment.

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Salinity and Its Effect on Living Things Activity

Materials:

- About 2 liters of concentrated saltwater solution made from table salt and water.
- About 2 liters of tap water at the same temperature as the saltwater solution.
  Tip: It's helpful to bottle the tap water and make up the saltwater solution the day before; having both sit at room temperature to insure that they start at the same temperature.
- Potatoes. For each lab group cut two rectangular potato slices (shape of french fries) about a half inch wide and thick, and about 2 ½ to 3 inches long.

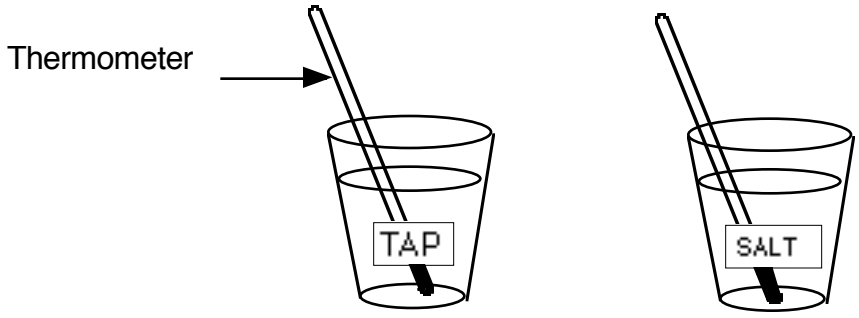
For each lab group (2- 4 students):

- Two clear plastic cups or beakers
- Thermometer
- Labels or permanent marker
- Laboratory balance, which can measure to the nearest 0.1 gram,
- Plastic (cm) ruler
- 100 ml graduated cylinder
- Paper towels

Procedure for each student lab group:

1. Label one of your cups "saltwater" and label the other "tap water". Then pour saltwater into the cup labeled "saltwater" about ¾ full and pour tap water into the other cup. Make sure the amount of water in each cup is equal.

DO NOT MIX SALTWATER WITH TAP WATER.



2. Using the thermometer **measure the temperature** of the water in each cup and **record** these readings in the data table. THE TEMPERATURE SHOULD BE THE SAME.

Salinity and Its Effect on Living Things Activity (continued)

3. Put one of your potato slices **on a PAPER TOWEL** labeled "tap water"

Place the other potato slice **on another PAPER TOWEL** labeled "saltwater"

DON'T MIX THEM UP!!!

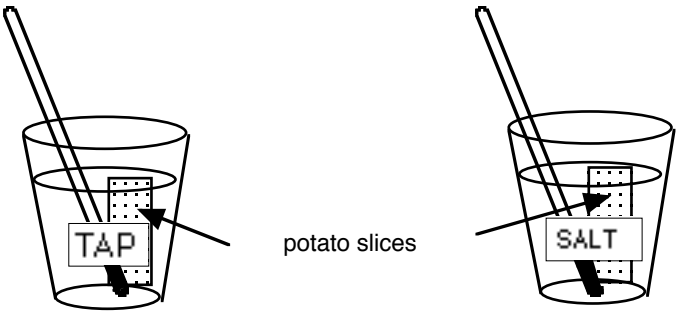
4. Determine the MASS of each potato section and record your mass to the nearest tenth of a gram (0.1 g) in the data table under **"before"**.

DO NOT MIX UP THE POTATO SLICES !!!

5. Next using the graduated cylinder with water at a starting volume of about 50 ml, measure the displaced **volume** of each potato slice to the nearest **ml**. Write the volume of each potato slice in the data table under **"before."**

6. Then with a cm ruler, measure the length of your potato slice along the longest edge to the nearest 0.1 cm. Record this in the chart under "before" as well.

7. Place each potato slice in their assigned cups of water for **20 - 30 minutes**.



8. At the end of the 20 - 30 minutes remove the potato slices and return them to their labeled paper towels, **AND DON'T MIX THEM UP !!!** Pat them dry.

9. Measure the **mass, volume, and length** of each as before record this in data table under **"after".**

10. Calculate the **difference** in the mass, volume, and length of the potato slices **before** being put in water and **after**. Record this in the data table and decide whether this was a loss or a gain for each.

11. Try bending and twisting each slice with your hands. Compare how each slice responds and record these observations as well.

Data Table and Observations

TEMPERATURE : Saltwater _____ ° C Tap Water _____ ° C

MASS OF POTATO SECTIONS (g)

	before	after	difference	loss or gain?
TAP WATER	_____ g	_____ g	_____ g	_____
SALTWATER	_____ g	_____ g	_____ g	_____

VOLUME OF POTATO SECTIONS (ml)

	before	after	difference	loss or gain?
TAP WATER	_____ ml	_____ ml	_____ ml	_____
SALTWATER	_____ ml	_____ ml	_____ ml	_____

MAX. LENGTH OF POTATO SECTIONS (cm)

	before	after	difference	loss or gain?
TAP WATER	_____ cm	_____ cm	_____ cm	_____
SALTWATER	_____ cm	_____ cm	_____ cm	_____

RESPONSE TO BENDING THE TWO POTATO SLICES.

_____

_____

_____

_____

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Follow-up Questions

1. What was the ***independent variable*** in this experiment? _____

2. For this to be a valid experiment, why was it important to make sure that the temperature of saltwater was the same as the that of the tap water?

_____

_____

_____

3. If 1,000 g of seawater has 30 g of dissolved salt then what is the concentration of salt?

_____ parts per thousand or _____ percent

What would be the **concentration of water** in this seawater?

_____ parts per thousand or _____ percent

4. What is **osmosis** ? _____

_____

_____

5. Which has a **higher concentration** of SALT, the living tissue of the potato or saltwater ?

_____

Which has a **higher concentration** of WATER, the living tissue of the potato or saltwater ?

_____

Summarize your experiment findings.

1) Do you feel that the potato tissue survived in saltwater? Yes _____ No _____

2) From your knowledge of osmosis, what do you feel was the cause for this? _____

(a) salt poisoning (b) dehydration (water loss) (c) overhydration

What is the evidence for your answer: *(refer to your data and observations)*

_____

_____

_____

Scientific Reasoning: *Osmosis is the diffusion of _____ molecules in or out of cells from a higher concentration to a _____concentration.*

*The cells of the potato in **saltwater** lost water because there was a _____ concentration of water inside the cells than there was outside the potato, so _____ diffused out of the potato causing it to lose mass and shrink.*

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Going Further

1. If a saltwater organism were placed in **freshwater** it would not survive. What do you think may cause death in this case?

_____

_____

2. What is an estuary?_____

_____

3. Does salinity in an estuary increase or decrease in the following situations:

After heavy rains ? _____

When snow melts and rivers enter the ocean with a lot of runoff ? _____

After many hot summer days without rain ? _____

4. If a marine plant or animal is sensitive to changes in salinity would it be more likely to live in an estuary or the ocean? _____

Explain your answer completely.

_____

_____

5. Of what advantage(s) is it to mangroves to have the ability to live in harsh saltwater environments.

_____

_____

_____

6. USING YOUR IMAGINATION… come up with an adaptation in cells, body part, organ, or strategy that a marine creature might use to keep from dehydrating in saltwater. Describe how it would work.

_____

_____

_____

_____

_____

_____

Other Activities:

- Research ways that other "halophytes" adapt to living in saline conditions.
- Find information about halophytes such as marsh grasses that are the foundation for salt marsh ecosystems.
- What adaptations do marine animals possess for living in saltwater? freshwater ?

Sample Data and Observations Collected from a Trial

TEMPERATURE : Saltwater 21 ° C Tap Water 21 ° C

MASS OF POTATO SECTIONS (g)

	before	after	difference	loss or gain?
TAP WATER	7.8 g	8.0 g	+ 0. 2 g	Gain
SALTWATER	7.2 g	6.3 g	- 0. 9 g	Loss

VOLUME OF POTATO SECTIONS (ml)

	before	after	difference	loss or gain?
TAP WATER	6 ml	6 ml	0 ml	neither
SALTWATER	6 ml	5 ml	-1 ml	loss

MAX. LENGTH OF POTATO SECTIONS (cm)

	before	after	difference	loss or gain?
TAP WATER	5.5 cm	5.7 cm	+0.2 cm	gain
SALTWATER	5.6 cm	5. 4 cm	- 0.2 cm	loss

RESPONSE TO BENDING THE TWO POTATO SLICES.

The potato after being in saltwater is like rubber. It bends and twists. The potato slice in freshwater feels stiff and doesn't bend.

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Answer Guide: Salinity and Its Effect on Living Things

1. What was the ***independent variable*** in this experiment? *Salinity*
2. For this to be a valid experiment, why was it important to make sure that the temperature of saltwater was the same as the that of the tap water?

If the temperature were different we would have introduced another variable into the experiment and we would not know what was responsible for any changes that we saw to the potato slices.

3. If 1000 g of seawater has 30 g of dissolved salt then what is the concentration of salt?

30 parts per thousand or *3.0* percent

What would be the **concentration of water** in this seawater?

___970_____ parts per thousand or ___97_____ percent

4. What is **osmosis** ? *the diffusion of water molecules into and out of cells from a higher concentration to an area of water to a lower concentration of water.*

5. Which has a **higher concentration** of SALT, the living tissue of the potato or saltwater? *saltwater*
Which has a **higher concentration** of WATER, the living tissue of the potato or saltwater? *potato*

Summarize your experiment findings.

1) Do you feel that the potato tissue survived in saltwater? *No*

2) From your knowledge of osmosis, what do you feel was the cause for this? *B*

(a) salt poisoning (b) dehydration (water loss) (c) overhydration

What is the evidence for your answer: *(refer to your data and observations)*

The potato that was placed in saltwater lost mass and size.

Scientific Reasoning: *Osmosis is the diffusion of* ____water_____ *molecules in or out of cells from a higher concentration to a* __lower___ *concentration.*

The cells of the potato in ***saltwater*** *lost water because there was a* _higher__ *concentration of water inside the cells than there was outside the potato, so* _water molecules__ *diffused out of the potato causing it to lose mass and shrink.*

Answer Guide: Salinity and Its Effect on Living Things (continued)

Going Further:

1. If a saltwater organism were placed in **freshwater** it would not survive. What do you think may cause death in this case?

Overhydration instead of dehydration. Water enters cells from a higher concentration outside to a lower concentration inside the cells of the creature. The cells swell and are damaged.

2. What is an estuary? *A semi-enclosed body of water formed where rivers meet the sea*

3. Does salinity in an estuary increase or decrease in the following situations:

After heavy rains ? _____*decrease*_____

When snow melts and rivers enter the ocean with a lot of runoff ? _____*decrease*_____

After many hot summer days without rain ? _*increase due to evaporation*_

4. If a marine plant or animal is sensitive to changes in salinity would it be more likely to live in an estuary or the ocean? _____*Ocean*_____

Explain your answer completely.

The ocean is large and its salinity does not fluctuate as easily as an estuary. Any creature sensitive to salinity changes would not want to live in an estuary, where salinity is always changing especially with freshwater input from rivers.

5. Of what advantage(s) is it to mangroves to have the ability to live in harsh saltwater environments.

With this ability, mangroves can dominate this region without any competition from other plant species.

6. USING YOUR IMAGINATION… come up with an adaptation in cells, body part, organ, or strategy that a marine creature might use, to keep from dehydrating in saltwater. Describe how it would work .

Students may come up with any number of ideas here. Perhaps special filters to exclude salt from cells or "pumps" to take in water. Special organs that store water, etc.

Often students come up with imaginary adaptations which are versions of actual adaptations used by the cells of marine creatures to allow them to survive saline environments.