SALT SOLUTIONS AND GROW CREATURES

This toy creature grows to many times its original size when placed in water. This activity explores the effect of salt concentration on the grow creature.

Grow creatures

GRADE LEVELS

Science activity appropriate for grades 1–9
Cross-Curricular Integration intended for grades 7–9

KEY SCIENCE TOPICS

- physical change
- polymers
- solutions

STUDENT BACKGROUND

This activity is most effective as a hands-on cooperative learning activity with each group responsible for gathering data on its creature. Thus, students should be familiar with working in cooperative groups. Students should also be familiar with metric measure, making observations, and recording data.

KEY PROCESS SKILLS

• communicating	Students share information and compile class data.
• measuring	Students measure the changes in length, width, and mass of grow creatures in various salt solutions.

TIME REQUIRED

Setup	15 minutes
Performance	20 minutes (plus sitting overnight)
Cleanup	10 minutes

Materials

For "Getting Ready" only

- (optional) 1 grow creature
- (optional) container of very hot water
- masking tape and pen for labels

For "Introducing the Activity"

- tap water
- superabsorbent diaper

➤ *Different manufacturers make diapers containing superabsorbers; the diapers are identified using a variety of terms, such as ultra dry and extra dry.*

- scissors
- salt shaker
- 1 grow creature
- (optional) grow creature treated with hot water in "Getting Ready"

For the "Procedure"

Part A, per group

- distilled water
- tap water
- 35 g table salt (sodium chloride, NaCl)
- measuring cup or graduated cylinder
- set of measuring spoons
- 6 plastic containers or large-mouthed jars
- metric ruler
- (optional) balance
- 1 plastic container or large-mouthed jar

➤ *A "pop-beaker" made from a cut-off plastic 2-L soft-drink bottle works well.*

- 1 grow creature

➤ *Grow Creatures can be purchased from Terrific Science Books, Kits, & More™ (PR9907A for less than 20 or PR9907B for 21 or more); http://www.tsbkm.com.*

Part B, per group

- metric ruler
- grow creature soaked in Part A
- (optional) balance

For "Variations and Extensions"

❶ Per class

- diapers
- salt
- water
- measuring cup or graduated cylinder

❷ All materials listed for the "Procedure" plus the following:

- thermometers

❸ All materials listed for the "Procedure" plus the following:

- sugar
- rubbing alcohol

❹ Per class

- *Anacharis* sp. (also called *Elodea* sp.) (a plant available in aquarium stores)
- microscope

Safety and Disposal

No special safety or disposal procedures are required.

Getting Ready

1. (optional) Prepare a grow creature framework by pouring very hot water over the creature and allowing it to soak for approximately one hour; some of the material dissolves and the rest can be gently peeled off to reveal the small core of the dinosaur.
2. Label containers for the test liquids (See Table 1); four for the salt solutions, one for distilled water, and one for tap water.
3. Prepare four salt solutions by dissolving the indicated amount of table salt (sodium chloride) in tap water. (See Table 1.) Pour into labeled containers. (Alternatively, each group can prepare its own solution—one solution per group.)

Table 1: Salt Solution Recipes

Solution	Table Salt	Water
0.5%	2.5 grams	500 mL
	0.5 teaspoon	3 cups
1.0%	5.0 grams	500 mL
	1 teaspoon	3 cups
2.0%	10.0 grams	500 mL
	2 teaspoons	3 cups
3.5%	17.5 grams	500 mL
	3.5 teaspoons	3 cups

4. Pour the distilled water and the tap water into their labeled containers.

Introducing the Activity

Show students a diaper containing a superabsorber. Pour a cup of tap water onto the diaper, then hold the diaper up to show that the water has been absorbed. (To maximize the amount of water absorbed, rock the diaper slowly back and forth after pouring the water on it.) Have students guess how many cups of water the diaper will absorb. Several cups of water will be absorbed, depending on the size of the diaper and the mineral content of the water. Cut open the wet diaper to show the students the beads of gel that have formed. Contrast this with a dry diaper; when it is cut open, a fine powder of sodium polyacrylate is observed and can be removed from the diaper. Tell students that the polymer can absorb over 800 times its weight under certain conditions and is known as a "superabsorber." Let students speculate on the most effective conditions for absorbing water. You may wish to add salt from a salt shaker to the saturated diaper; this will cause the gel to break down and some of the water to run out of the diaper.

Next show students a grow creature. Explain how it is made from a superabsorber as well as another polymer that enables the creature to keep its shape as it absorbs water. If a grow creature was treated with hot water to expose its framework (See "Getting Ready," Step 1), show it to the students. Explain to students that they will be using the grow creature to determine the effects of salt on superabsorbers. Students may be asked to predict the results.

Procedure

Part A: Grow the Creatures

1. Set aside one grow creature as a control.
2. Divide the students into cooperative groups and assign jobs. Assign each group one of the six test liquids, and have the students in each group follow Steps 3–12.

➤ *Each group will need at least one Preparer, Measurer, and (optional) Mass Measurer to perform the following tasks:*

- *Preparer—to prepare the solution;*
- *Measurer—to measure the length, width, and thickness; and*
- *Mass Measurer (optional)—to measure the mass.*

3. Measure the length, width, and thickness of the creature. Record this information on the Data Sheet (provided).

➤ *This will generate much discussion, and a class decision must be made on the appropriate way to make the measurements so that results from different groups can be compared.*

4. (optional) Measure and record the mass.
5. Place the grow creature in the container of liquid.
6. Leave the grow creature in the container undisturbed for a period of at least 24 hours.
7. Remove the grow creature from the container.
8. Measure and record the length, width, and thickness.
9. (optional) Measure and record the mass.
10. Compare the measurements (Steps 8 and 9) with the original measurements (Steps 3 and 4).
11. (optional) Return the grow creature to the container for a longer period of time. Record measurements daily until no further change occurs.

➤ *The creatures may continue to grow for three or more days.*

12. Construct a graph from each group's data. Younger students may actually line up their grow creatures on laminated paper to construct a histogram. Older students can graph size or mass measurements versus time, maximum size or mass versus solution concentration, change of size or mass versus time, or change of size or mass versus solution concentration.

Part B: Shrink the Creatures

Challenge students to shrink the grow creatures. Make observations and record the measurements.

Variations and Extensions

1. Have students measure the amount of salt solutions of different concentration that a diaper can absorb when the solutions are poured onto the diaper (as described for water in "Introducing the Activity").
2. Challenge students to test other factors that may affect the absorbancy of superabsorbers, for example, the temperature of the water.
3. Compare the growth of creatures in aqueous solutions of electrolytes, such as sugar or alcohol.
4. Place *Anacharis* sp. (*Elodea* sp.) in 0.5% salt water under a microscope and observe. Then, place it in 3.5% salt water and observe changes.

Explanation

The following explanation is intended for the teacher's information. Modify the explanation for students as required.

Superabsorbers, found in diapers and toys (such as G.U.T.S. and grow creatures), are "water-loving" (hydrophilic) polymers. These polymers can absorb large amounts of water. Grow creatures contain two different polymers; the hydrophilic polymer that is responsible for the absorption of water and a second polymer that is "water-hating" (hydrophobic). The hydrophobic polymer forms the framework of the creature and it is the core material that remains undissolved after soaking the grow creature in hot water for 1 hour. (See "Getting Ready," Step 1.) Since the framework remains intact in water, the creature can grow without losing its original shape. The hydrophilic polymer is polyacrylamide and the hydrophobic polymer is the copolymer poly(vinylacetate:ethylene). (A copolymer is a polymer made up of two alternating monomer units; in this case the monomers are vinylacetate and ethylene.)

When the hydrophilic polymer sodium polyacrylate comes in contact with water, a gel forms that has many times the volume of the dry polymer. Sodium polyacrylate is a polymer with negatively charged carboxylate ions and positively charged sodium ions. When water is added and the polymer starts to dissolve, the negatively charged carboxylate groups orient themselves as far apart as possible. This orientation to maximize the distance between like-charged groups is partially responsible for the swelling as water molecules get trapped within the polymer matrix. Hydrolysis (reaction with water) of the carboxylate groups of the weak acid is also responsible for absorption of water and causes additional swelling. When sodium ions from sodium chloride are also present, the sodium ions are preferentially attracted to the negatively charged carboxylate groups. This decreases the amount of water attracted to the carboxylate groups, releasing water molecules that previously had been within the polymer matrix. As a result, less water is absorbed when positively charged ions from salt are present. Thus, as the concentration of sodium chloride increases, the amount of water absorbed by the hydrophilic polymer is decreased. As a result, the grow creature in 3.5% salt water has the smallest volume increase while the grow creature in distilled water has the greatest.

When the grow creature is removed from water, the water slowly evaporates, and the grow creature shrinks back to its original size.

Assessment

Have students answer the following questions:

1. Tell about the growth of your grow creature.
2. Use the class graph to compare the growth of your creature to the growth of two other creatures.
3. Why do you think the growth is different in different solutions?
4. What did you learn in this experiment that helps you understand the adaptations of aquatic plants and animals to environments with different concentrations of salt?
5. What does the word *hydrophilic* mean?

Cross-Curricular Integration

Life science:

- Discuss how living organisms are adapted for living in different saline environments. The solutions used in the experiment correspond approximately to different biological environments. For example,
  0.5% - freshwater pond or lake;
  1.0% - human body fluids (urine, blood plasma);
  2.0% - brackish water; and
  3.5% - ocean environment.

Math:

- Graph results.
- Have students complete the Math Worksheet.

References

Bonnie Bachman, Empak Co., Colorado Springs, CO, personal communication.

Chem Fax! Publication Number 755.10, Flinn Scientific Company: Batavia, IL.

Polymers: Linking Chemistry and Fun, developed by Marie Sherman, Ursuline Academy, St. Louis, MO.

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Handout Masters

Masters for the following handouts are provided:

- Data Sheet
- Math Worksheet

Copy as needed for classroom use.

Names _____ _____

_____ _____

SALT SOLUTIONS AND GROW CREATURES

Data Sheet

Name of your grow creature: _____

1. Record the initial measurements of your grow creature (before growing):

Length		Thickness	
Width		Mass	

2. Identify the solution in which you will be soaking your creature:

_____

3. What do you predict will happen to your grow creature?

_____

_____

Record your results

Soaking Time	Length	Width	Thickness	Mass

Name _____ Date _____

SALT SOLUTIONS AND GROW CREATURES

Math Worksheet

Soaking Time	Length	Width	Thickness	Mass
1				
2				
Difference between 1 and 2				
% difference between 1 and 2				
3				
Difference between 2 and 3				
% difference between 2 and 3				
4				
Difference between 3 and 4				
% difference between 3 and 4				
5				
Difference between 4 and 5				
% difference between 4 and 5				
% difference between 1 and 5				