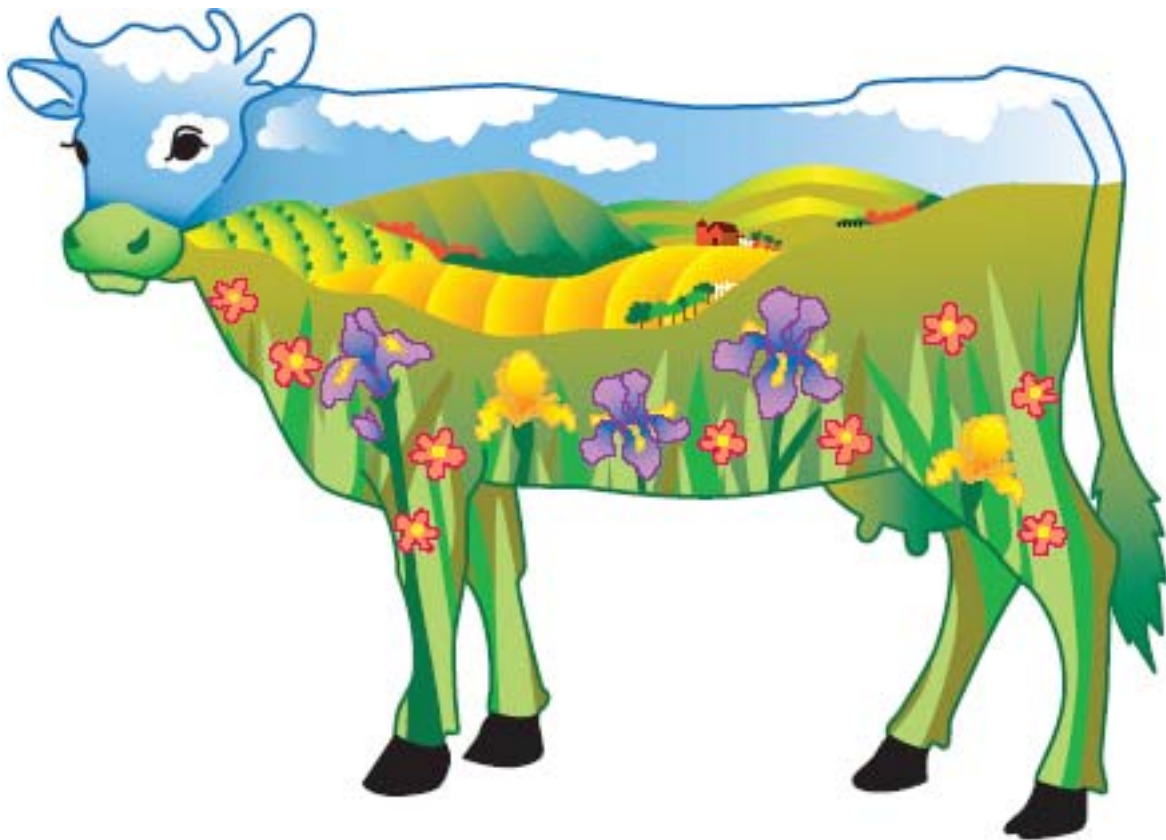


SOLE
Sciences of Life Explorations:
Through Agriculture
Grades 4 and 5



Teacher Guide
Unit: Experimenting With Seeds

UNIT PLAN

UNIT TITLE

Experimenting with Seeds

MONTH

March

GOAL

Students will become familiar with the scientific method and learn about the balance of environmental factors that plants need in order to grow strong and healthy.

OBJECTIVES

Students will:

1. Write observations of experiments in their journals, demonstrating an ability to explain data. (NYS Learning Standard 3a: Universal Foundation Skills, Elementary 1).
2. Demonstrate an ability to take turns speaking and responding to others' ideas in conversations about planting seeds. (NYS Learning Standard 4: Language for Social Interaction, Elementary 1)
3. Write and speak using language consisting of simple seed-planting vocabulary in face-to-face conversation with peers and familiar adults. (NYS Learning Standard 1: Communication Skills, Checkpoint A Modern Languages)
4. Ask "why" questions in an attempt to seek greater understanding concerning objects and events they have observed and heard about. (NYS Learning Standard 1: Analysis, Inquiry, and Design, Elementary 1)
5. Use simple measurement instruments to carry out plans for exploring phenomena through direct observation by doing experiments on seed treatments. (NYS Learning Standard 1: Analysis, Inquiry, and Design, Elementary 2)
6. Describe organized observations and measurements, recognizing simple patterns and relationships in data. (NYS Learning Standard 1: Analysis, Inquiry, and Design: Elementary 3)
7. Explain how to test a proposed solution and perform, record, and evaluate their test under teacher supervision. (NYS Learning Standard 1: Analysis, Inquiry, and Design, Elementary 1)
8. Explain that measurement is approximate, never exact. (NYS Learning Standard 3: Mathematics, Elementary 5)
9. Record predictions related to experimental probabilities. (NYS Learning Standard 3: Mathematics, Elementary 6)
10. Present results of an extended mathematics and science project that requires students to gather and process information, generate and analyze ideas, and observe common themes to realize ideas. (NYS Learning Standard 7: Interdisciplinary Problem Solving, Elementary 2)
11. Explain how agriculture provides people's basic food. (Food and Fiber Literacy Standard I: Understanding: A, 2-3)

TERMS

These terms are highlighted in bold throughout the =lesson pages.

Compacted - packed down

Conclusion - final step of the scientific method; evaluate the hypothesis and the results

Control - a subject in an experiment that isn't treated with the variable (the "normal" subject to which others are compared)

Experiment - a test that is performed in order to discover or prove something

Fertilizer - material or chemicals containing nutrients added to soil to increase its ability to support growth

First root - the new plant's root that grows before other roots grow

First shoot - the new plant's first leaves and stem

Germination - the process in which a seed begins to grow into a new plant

Hypothesis - the third step of the scientific method; a prediction or guess of what the answer to a question will be, based on what you may already know

Methods - the fourth step in the scientific method; the steps that are taken in order to test a hypothesis

Nutrient - a substance that provides nourishment for growth; plants obtain nutrients from soil

Observation - the first step in the scientific method; using your five senses to learn more about something

Oversaturated - having much more than the proper amount

Photosynthesis - the process green plants use to make their own food energy using sunlight

Question - the second step in the scientific method; wondering why something happened or what else might happen, based on your observations

Results - the fifth step in the scientific method; what happened after each step of the experiment

Scientific method - a six-step process of finding an answer to a question by performing an experiment

Seed - the part of a plant that, on its own, will grow into a new plant

Seed coat - outer covering that protects the seed

Variable - something that is being tested in an experiment, making it different from the control

Integrated Pest Management is a specialized form of environmental management wherein scientific research and real-world application work together to reduce pests such as insects, diseases or weeds.

- 1. Properly identify pests*
- 2. Learn the pest/host biology*
- 3. Sample the environment for pests*
- 4. Determine an action threshold*
- 5. Choose the best tactic*
- 6. Evaluate results*

SAFETY

This unit does not have any special tools with safety concerns. Follow standard classroom safety procedures.

Standards Matrix for this Lesson:

Standards:

Month	Unit	Math/Science/and Technology	English Language Arts	Social Studies	HEALTH	ARTS	Food & Fiber Literacy	CDOS	Other Languages	Interconnectedness
3	Experimenting With Seeds	1:7 e1	1:6 A				I A 2-3			
		1:7 e2	4:5 e1							
		1:7 e3								
		3:9 e5								
		3:9 e6								
		3a:2 e1								
		7:13 e2								

Standards Matrix Key:

NYS Learning Standards arranged by Standard: Category, Level

e = elementary i = intermediate

Categories:

- | | |
|---|--|
| 1 Career Development | 10 Science |
| 2 Universal Foundation Skills | 11 Technology |
| 3 Language for Information and Understanding | 12 Interconnectedness: Common Themes |
| 4 Language for Literary Response and Expression | 13 Interdisciplinary Problem Solving |
| 5 Language for Social Interaction | 14 History of the United States and NY |
| 6 Communication Skills | 15 World History |
| 7 Analysis, Inquiry, and Design | 16 Geography |
| 8 Information Systems | 17 Economics |
| 9 Mathematics | |

ADDITIONAL RESOURCES

Creepy Crawlies and the Scientific method by Sally Kneidel ISBN # 1-55591-118-8

<http://www.theideabox.com/ib.php/web=idea&idea=7541>

<http://www.sciencenetlinks.com/lessons.cfm?BenchmarkID=8&DocID=377>

<http://www.theideabox.com/ib.php?web=idea&idea=7541>

<http://www.ars.usda.gov/is/kids/fair/story.htm>

<http://www.livinghistoryfarm.org/farminginthe40s/lrScience01.html>

<http://www.dnr.state.md.us/forests/education/needs.html>

SUPPLIES AND EQUIPMENT

Empty milk cartons

Crayons or colored pencils

Paper towels

Potting soil

Trays (4 or more)

Labels

Watering can

Small plastic cups

Zippered plastic bags

Ruler

Spoons

Apple juice

Journals

Liquid dish soap

Sweetened soda

Baking soda

Seeds (Forget-me-not, kidney bean, grass)

Used coffee grounds

BACKGROUND FOR TEACHERS

In the plant growth experiments that follow, students are making use of the scientific method - observing and coming up with questions, predicting answers (hypothesizing), and setting out to prove whether their hypotheses are true through experimentation. The more involvement a student has in a project, the more it impacts him or her. Experiments inspire students to learn more about a topic.

The scientific method encourages students to question what they see, feel, hear, taste or smell. Forming a hypothesis and performing an experiment to test it promote higher levels of thinking skills and innovation.

These experiments explore the important environmental factors that plants need for growth: sun, soil, air, and water. The sun provides the warmth and energy plants need to survive. Plants make their own food through photosynthesis, using the chlorophyll contained in their leaves and the sun's light. Not enough sun will slow a plant's growth and can even kill it. Too much sun can also be a problem, if the plant and soil are drying out too quickly.

Soil provides a base for the roots to anchor themselves in and provides the plants with water and nutrients to help them grow. It is important that soil be loose and not packed down (compacted). It is harder for a plant to spread its roots in compacted soil. This limits their access to nutrients and weakens their hold in the ground.

Air is important because plants take in carbon dioxide to use during photosynthesis and give off oxygen as a by-product. Pollution in the air can block sunlight from getting to plants and harmful chemicals can also impede plant growth. The wind is useful in carrying pollen and seeds of plants to spread them around.

Water comes from the sky as precipitation and flows over or through soil into lakes, rivers, and streams. Water helps the plant move nutrients from the soil through its roots to its stems and leaves. Water keeps the plant moist and flexible, and helps it make its own food. However, a plant's roots not only need room to spread out in the soil, they also need air. If the ground is oversaturated, it has too much water and not enough air. Some plants can die if the water is not drained away soon enough.

Through these experiments, students will gain a better understanding that plants do not grow independently and discover that different factors of nature and human action influence the growth of plants. They will have a first-hand experience in learning about germination.

Germination is the process of seed growth that occurs in response to warmth and water. Dormant seeds are very dry and require the absorption of water to initiate respiration and begin to digest the food stored in the endosperm. Respiration requires oxygen, which must be sufficiently available in the soil for germination to proceed. The soil must be wet, but not so waterlogged that oxygen is inaccessible. Temperatures must be above freezing, but not excessively hot (not more than about 45 degrees Celsius or 113 degrees Fahrenheit). If conditions are right, a root emerges from the seed coat, anchoring the seed; it then grows and puts out lateral roots. The first shoot of the plant, along with the first leaves, will then emerge and appear above the soil.

QUESTIONS FOR STUDENTS

What is the scientific method?

What is an experiment?

What are the parts of a seed?

What do plants need in order to grow?

Can a seed survive if it is missing water, air, sun or soil?

What is fertilizer?

INTEREST APPROACH ACTIVITIES

DISSECTING A SEED

Materials:

Lima bean seeds
Water
Pan
Plastic knives
Magnifying glass

Procedure

1. Soak lima bean seeds in a pan of water overnight.
2. Have students examine each seed with a magnifying glass.
3. Have students split the seeds open using their fingernails or a plastic knife.
4. Re-examine the seeds, looking at the different parts:
 - A. Seed coat - protects the seed
 - B. Soft flesh - food for plant
 - C. First root
 - D. First shoot/Leaves
4. Teacher or students draw the seed on the chalkboard and label its parts.

FACTORS INFLUENCING SEED GERMINATION

Factor A: Depth of Planting

Materials:

2-quart milk cartons
Potting soil
Seeds (corn and radish)

Procedure

1. Punch several holes in the side of the cartons, near the base, for drainage.
2. Cut off or open up the tops of the cartons.
3. Add 2 inches of potting soil to one of the cartons.
4. On top of the 2-inch layer of soil, place 3 corn seeds and 6 radish seeds.
5. Fill the remaining portion of the carton with potting soil.
6. Fill a second carton nearly full with potting soil, to about 1 inch from the top.
7. Following the directions on the back of the seed packet for depth, plant 3 corn and 6 radish seeds.
8. Cover the seeds with approximately 3/4 inch of potting soil.
9. Place both cartons, side by side, on a classroom window sill or under grow lights.
10. Water as needed (suggested every other day) keeping the potting soil moist.
11. Make predictions about the seeds' growth.
12. Students make observations briefly as needed, recording data in journals.
13. After a couple of weeks, discuss observations in class.
14. Draw conclusions about how planting depth affected seed growth.

Factor B: Excess Water and Drainage

Materials

Same as for Factor A

Procedure

1. Punch several holes in the bottom of one of the cartons.
2. Open up or cut the tops off of both cartons.
3. Fill both cartons 4/5 full of potting soil.
4. Place 3 corn seeds and 6 radish seeds on the top of the soil in each carton.
5. Cover the seeds in both cartons with approximately 3/4 inch of potting soil.
6. Using a measuring cup, add 2 cups of water to each carton.
7. Place each carton on a paper plate and place them on a window sill or under grow lights.
8. Label each container with the date, type of seeds, and carton treatment.
9. Predict what will happen to the seeds.
10. Make observations for the next two weeks.
11. State observations in class discussion.
12. Draw conclusions about the results. How did the drainage affect growth?

Factor C: Light and Dark

Materials:

Potting soil

Styrofoam coffee cups

Shoebbox (large enough for a cup to stand upright inside)

Marigold seeds

Procedure

The following demonstration may be for the entire class or done individually, depending on the amount of classroom space and the number of participants.

1. Using a ballpoint pen or sharpened pencil, punch 3 holes in the bottom of 2 cups.
2. Fill the cups most of the way with potting soil, and plant 3 marigold seeds in each of the cups according to package directions.
3. Place one cup on a window sill or under grow lights.
4. Place the other in a dark place, such as inside a shoebox. Punch several air holes in the box.
5. Make predictions about how the seeds will grow.
6. Make observations as the days go by and record them in journals.
7. During this time, be sure to water the seeds regularly, giving each the same amount of water each time.
8. After a couple of weeks, discuss the results and make conclusions.

The class may decide to try seed treatments of their own in addition to those given here, such as the effect of seed damage or the effect of temperature on germination.

(For related activities, refer to student worksheets 2A, 2B, & 3)

SUMMARY OF CONTENT

- I. Introduction
 - A. Provides a brief overview of the lesson.
 - B. Basic questions which students should be able to answer after completing the lesson and worksheets.

- II. What do plants need to grow? (2 Pages)
 - A. Information about why sun, soil, air, and water are important for healthy plant growth.

- III. The Scientific method (3 Pages)
 - A. Outlines the six parts of the scientific method

- IV. Experiment #1 “Sun, Water, or Both?” (6 Pages)
 - A. This experiment tests the importance of sun and water to plants by following the scientific method.

- V. Experiment #2 “Bean Sprouts” (5 Pages)
 - A. This experiment tests whether seeds need soil to sprout and grow roots.

TEACHING-LEARNING ACTIVITIES

- I. Introduction
 - A. This page should be read as a group
 - B. A discussion can be started based on the essential questions.

- II. What do plants need to grow? (2 Pages)
 - A. Students can read this page as a class or individually.
 - B. After completing the reading, review of the vital information.

- III. The Scientific method (3 Pages)
 - A. Students can read as a class or individually.
 - B. Questions may be completed as a group or individually.

- IV. Experiment #1 “Sun, Water, or Both?” (6 Pages)
 - A. Students should follow the steps of the scientific method.
 - B. Test seeds with:
 - i. No sun
 - ii. No water
 - iii. No sun or water
 - iv. Both sun and water
 - A. Students should observe plants for 10 days and compare results after day 10.
 - B. Have students make conclusions about whether they answered their questions, and whether their hypothesis was correct.

- V. Experiment #2 “Bean Sprouts” (5 Pages)
 - A. Students will follow the steps of the scientific method to see whether seeds will sprout without soil.
 - B. Observe plants for 10 days and compare results
 - C. Have students make conclusions about whether they answered their questions and whether their hypothesis was correct.

SUMMARY OF CONTENT

- VI. Experiment #3 "Fertilizer" (5 Pages)
 - A. Tests what works as a fertilizer.
 - B. You may choose to tell students what their fertilizer is or have them guess.
 - C. Hypothesize about how they think different fertilizers work.

- VII. Review
 - A. Summary of main facts and lesson vocabulary.

- VIII. Test Your Knowledge
 - A. Covers the four things that plants need to grow
 - B. Asks students what experiments they like best and least.

- IX. Vocabulary

TEACHING-LEARNING ACTIVITIES

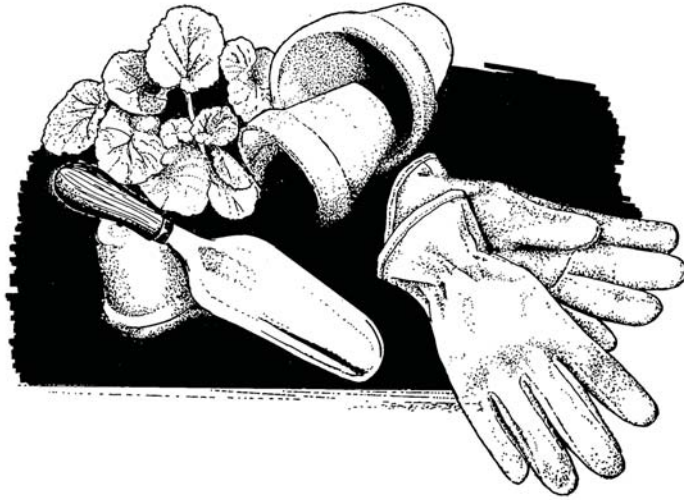
- VI. Experiment #3 "Fertilizer" (5 Pages)
 - A. Students should follow the steps of the scientific method to see what types of products work as fertilizer
 - B. Students should observe plants for 10 days and compare results.
 - C. Have students draw conclusions about whether they answered their questions and whether their hypothesis was correct.
 - D. You may choose to tell students what their fertilizer is or have them guess.
 - E. Students may hypothesize about how they think different fertilizers work.

- VII. Review
 - A. Provided for student reference

- VIII. Test Your Knowledge
 - A. Student should complete this page individually
 - B. This sheet can be used as a review or as a quiz grade

- IX. Vocabulary
 - A. Provided for student reference

Student Lesson: Experimenting with Seeds Introduction



Do you ever wonder why grass grows, flowers bloom, and fruits blossom and ripen? It is because they are getting the right things they need to help them grow! In the wilderness, plants have to get everything directly from the Earth. In a garden, people help the plants get what they need.

Sunlight, healthy soil, clean air, and clean water all work together to help a seed become a strong, healthy plant. What would happen if a plant didn't get enough water, air, sun, or nutrients from the soil? Would the plant still grow? Or would it die?

The word "science" comes from the Latin word "*sciens*" meaning "to know." But science isn't just facts in a book that you have to learn and memorize. It's a process of discovery, a way to learn how things work by drawing conclusions from what you learn and observe.

Scientists have not learned all there is to know about life on Earth and how the universe works. People are finding out new things every day by using science. It can be a lot of fun! In this lesson you will have the chance to perform experiments on plant seeds, and to be a real scientist!

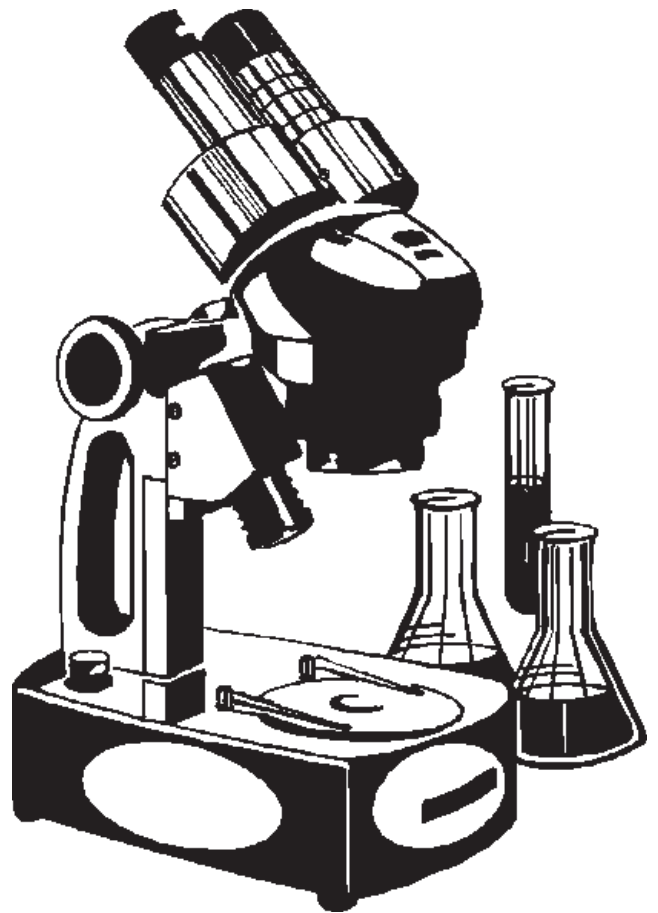
What do plants need in order to grow?

What is an experiment?

What is the scientific method?

Can seeds survive if they are missing water, air, sun, or soil?

What does fertilizer do?



Student Lesson: Experimenting with Seeds

What do plants need to grow?

Sun

The sun provides warmth and energy for plants to survive. Plants use the sun's energy to make their own food energy in their leaves. Not enough sun will slow down a plant's growth and can even kill it. Too much sun can also be a problem, if the plant and soil dry out too quickly.



Soil

Soil provides a base for the roots to hold on to as a plant grows bigger. It also provides plants with water and the nutrients they need to be healthy. Nutrients in the soil help plants grow strong. In turn, some plants become healthy food for us.

It is important for soil to be healthy and not packed down (compacted). If the soil in a field is compacted, farmers plow to loosen it before they plant their seeds.

Think of compacted soil as a snowball. When snow falls, it is fluffy. To make a snowball, you have to pack it tightly with your hands. It becomes heavier and the snowflakes move closer together. That is what compacted soil is like. Or, have you ever tried to walk through a room that's so full of people you can't get in between them? That's what roots have to do in compacted soil.

Compacted soil makes it harder for roots to spread out. This limits their access to water and nutrients and weakens the plant's hold in the ground. The more room roots have, the more soil the plant can hold in place so it doesn't wash away during a rain storm, or erode.

Student Lesson: Experimenting with Seeds

What do plants need to grow?

Air

Plants take in carbon dioxide from the air to use in the process of photosynthesis (making their own food energy) and give off oxygen which we use. Pollution in the air, from machines, fires, and other sources, can block sunlight from plants. Harmful chemicals in pollution can be bad for plant growth too. The wind carries pollen and seeds of plants to help spread them around. This is the plant's way of reproducing.



Water

It comes from the sky as precipitation and it flows over or through soil into lakes, rivers, and streams. Water is very important to plant growth. Water helps the plant move nutrients from the soil up through its stems and leaves. Water keeps the plant moist and flexible, and helps the plant make its own food.

When growing your own plants, pay attention to how often it rains and how long the ground takes to soak up the water. If it hasn't rained in a while and the soil feels dry, you may need to water your plants. You can do this with a hose, a sprinkler, or a watering can.

However, don't over-water your plants, either. A plant's roots not only need room to spread out in the soil, they also need air! If the ground is oversaturated, it has too much water and not enough air. Some plants can die if the water is not drained away soon enough.

Student Lesson: Experimenting with Seeds

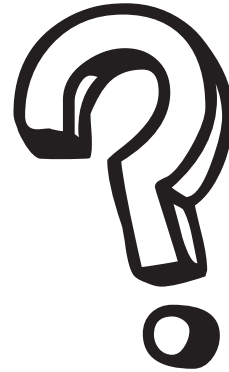
The Scientific Method

The scientific method is the process of finding the answer to a question by performing an experiment. There are six steps to follow when using the scientific method and they are: observation, question, hypothesis, methods, results, and conclusion. Billy is going to use the scientific method to learn about dogs.

1. Observation is using any of your five senses (sight, touch, taste, listen, and smell) to learn more about something.

When observing Grandpa's dog, Billy can use his sight to see how the dog wags its tail. He can pet the dog to feel his fur. He can smell the dog and listen to the dog's bark. However, Billy probably wouldn't want to try tasting the dog. Would you?

2. Question is the step where you think of questions based on your observations. You might wonder why something happened, or what else could happen.



Billy thinks of questions he would like to ask about the dog.

- Does it come when a stranger calls its name?
- Does it prefer to chew on bones or squeaky toys?
- Does the dog prefer being outside or inside during the day?

3. Hypothesis is a prediction or guess of what the answer is to a question. You can predict what will happen or will not happen based on what you already know.

Billy wants to know if the dog comes when a stranger calls its name. Billy knows that when people train their dogs, they usually teach the dog to come to them when they call its name. Billy's hypothesis is that the dog will only come when its name is called by its owner.



Student Lesson: Experimenting with Seeds

The Scientific Method

4. Methods is the step where you test your hypothesis so see if you are correct or not. To test your hypothesis, you must perform an experiment. An experiment will have a control and a variable.

A control is the normal conditions under which the observation happened. The control in Billy's experiment is having Grandpa (the dog's owner) calling its name. He named the dog, and lives with it every day.

A variable has the same conditions as the control with one difference. The variable in Billy's experiment is Billy calling the dog's name. Billy has not met the dog before and the dog does not recognize him as its owner.



To test his hypothesis, Billy hides in the house while Grandpa is outside with the dog.

Grandpa calls the dog's name. Billy writes down what happened. In the next step, Grandpa hides inside the house. Billy walks across the yard, away from the dog. Billy calls the dog's name. He writes down what happened.



6. Results are what happened after each step of the experiment.

Billy's results showed that the dog came when Grandpa called its name. The dog also came when Billy called its name.

6. Conclusion is the step where you talk about your hypothesis (whether your prediction was right or not) and why you got the results you did.

Billy guessed in his hypothesis that the dog would only come when the owners called its name. His results showed that the dog will come when its owners or strangers call its name. Billy explains that the dog must be very friendly since it came to him when he, a stranger, called its name.

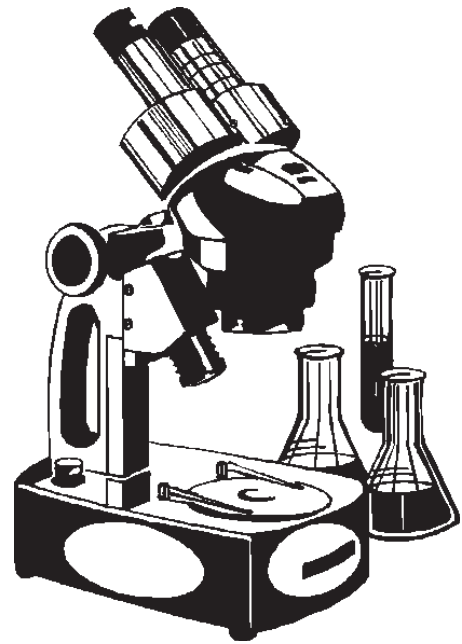


name _____

Student Lesson: Experimenting with Seeds The Scientific Method

1. List the steps of the scientific method in order:

- 1) _____
- 2) _____
- 3) _____
- 4) _____
- 5) _____
- 6) _____



2. What is a hypothesis?

3. In which step do you perform an experiment to test your hypothesis?

4. In this lesson, you will be performing experiments on the seeds of plants. You have already learned what plants need to grow.

Write down a question you have about how plants grow:

name _____

Student Lesson: Experimenting with Seeds

Experiment #1: "Sun, Water, or Both?"

Observation:

Outside the sun shines during the day and water falls from rain clouds. Plants seem to be growing all of the time. But the sun doesn't shine at night and clouds don't always rain.

Question:

If seeds can grow, whether or not the sun is shining or clouds are raining, do they even need sun and water to grow?

Write your hypothesis (educated guess)

The methods (experiment) used to test your hypothesis:

Materials:

4 clear plastic cups

Potting soil

Spoon

Flower seeds

Paper towels


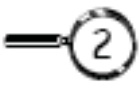

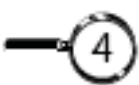
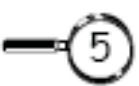
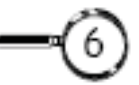
Ruler

Crayon/pencil

Labels

Masking tape

Procedure:

	Use your spoon to scoop potting soil into your plastic cups until each cup is 3/4 full.
	Plant 3 to 4 seeds in each cup.
	Label each cup with your name. Then, label the first cup "no sun," the second cup "no water," and the third cup "no sun or water." These cups will be the variables.
	Label the fourth cup "sun and water". This cup will be the control.
	Set each cup on its assigned tray: all "no water" cups on the "no water" tray, etc.
	Over the next two weeks, look at your cups each day. Water the "no sun" and the "sun and water" cups. Write down your observations and draw a picture of what you see.

name _____

Student Lesson: Experimenting with Seeds
Experiment #1: "Sun, Water, or Both?"

Draw and write what's happening in your cup each day.

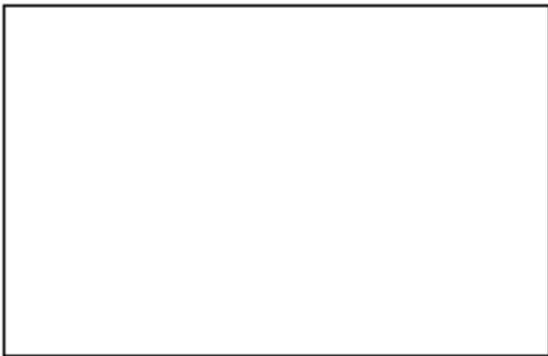
DAY 1



DAY 2



DAY 3



name _____

Student Lesson: Experimenting with Seeds
Experiment #1: "Sun, Water, or Both?"

DAY 4



DAY 5



DAY 6



DAY 7



name _____

Student Lesson: Experimenting with Seeds Experiment #1: "Sun, Water, or Both?"

DAY 8

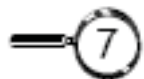


DAY 9



DAY 10





After you make your last observations on Day 10, collect all four of your cups and pick up a couple of paper towels.



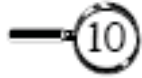
Using a spoon, carefully scoop the plants out of the first cup and set them on the paper towel. Draw what you see on the next page.



Use a ruler to measure the height of each plant, from the top of the sprout to the tip of the roots. The seeds may still be attached. Write your measurement next to your bean drawings on the next page.

name _____

Student Lesson: Experimenting with Seeds
Experiment #1: "Sun, Water, or Both?"

 Repeat steps 8 and 9 with each of your other three cups.

Cup Labeled: _____

Cup Labeled: _____

Cup Labeled: _____

Cup Labeled: _____

Student Lesson: Experimenting with Seeds Experiment #1: "Bean Sprouts"

Observation:

The roots of plants seem to always be in the soil.

Question:

Do seeds need soil to sprout and grow roots?

Write your hypothesis (educated guess):

The methods (experiment) used to test your hypothesis/guess:

Materials:

1 zippered plastic bag

Paper towels

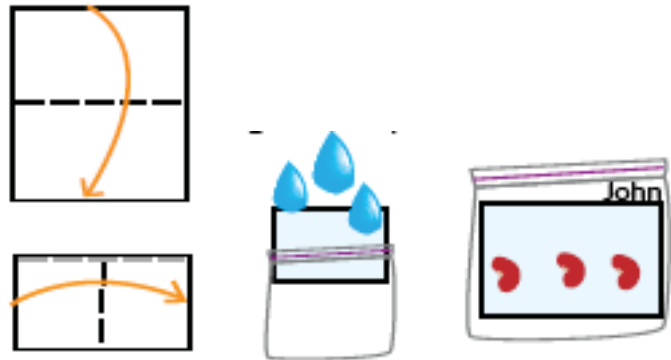
Water

1 plastic cup

Potting soil

Spoon

6 to 8 beans (seeds of the bean plant)



Procedure:

	Fold a damp sheet of paper towel so it fits inside the bag. Put 3 to 4 beans inside. This is the variable (no soil).
	Close the bag and write your name on it with a permanent marker. Your teacher may help you with this.
	Set your bag on a window sill where it can receive sunlight during the day. Each day, open the bag to give the seeds fresh air and redampen the paper towel if it is getting too dry.
	Use your spoon to fill your cup 3/4 full of potting soil. Plant 3 to 4 beans in the soil. This is the control.
	Label your cup with your name and set it where it can receive sunlight during the day. Remember to keep the soil moist - not too wet or dry.
	Over the next two weeks, draw your observations of the beans in the bag. Write down your observations of the beans in the cup. Use the following pages.

name _____

Student Lesson: Experimenting with Seeds
Experiment #1: "Bean Sprouts"

Draw your observations of the bag, and write your observations of the cup.

Beans in Bag

Beans in Cup

DAY 1



DAY 2



DAY 3




name _____

Student Lesson: Experimenting with Seeds
Experiment #1: "Bean Sprouts"

Beans in Bag

Beans in Cup

DAY 4



DAY 5



DAY 6



DAY 7



name _____

Student Lesson: Experimenting with Seeds
Experiment #1: "Bean Sprouts"

Beans in Bag

Beans in Cup

DAY 8



DAY 9



DAY 10





After you make your last observations on Day 10, collect your bag and cup. Get a sheet of paper towel and use your spoon to scoop the seedlings out of the cup.



Compare what you see in the bag with what you scooped out of the cup.

Student Lesson: Experimenting with Seeds

Experiment #3: "Fertilizer"

Observation:

Garden and agriculture supply stores sell fertilizers. Gardeners and farmers use fertilizers to help their plants grow better and faster by giving them extra nutrients.

Question:

If I don't want to spend money on pre-made fertilizer, what can I use around my house to fertilize my plants? We suggest you try making a fertilizer solution out of each of these items: sugar-sweetened soda, apple juice, dish soap, baking soda, and leftover coffee grounds. You can also use a purchased indoor plant fertilizer.





Write your hypothesis (educated guess):

The methods (experiment) used to test your hypothesis/guess:

Materials:

Large Styrofoam cups
 Grass seeds
 Potting soil
 Spoons
 Permanent marker
 Water or fertilizer solution
 Ruler

Procedure:

 1	Divide into groups. Some groups will water their cups with different types of fertilizer and water solutions. Some will water their cups with just water (they will be the control).
 2	Fill your cup 3/4 full with potting soil. Plant your seeds in the soil. Write your name on the side of the cup.
 3	Lightly water your seeds. Make sure you label your cup with the type of solution you are using. Your teacher may choose to label them with the name of fertilizer or just use a letter like A, B, C, D or E.
 4	Write down your observations each day for the next ten school days. After the grass plants sprout, measure and record their heights.

name _____

Student Lesson: Experimenting with Seeds
Experiment #3: "Fertilizer"

Record your observations here.

My fertilizer solution is: plain water OR _____

Day 1 _____

Day 2 _____

Day 3 _____

Day 4 _____

Day 5 _____

name _____

Student Lesson: Experimenting with Seeds
Experiment #3: "Fertilizer"

Day 6 _____

Day 7 _____

Day 8 _____

Day 9 _____

Day 10 _____

name _____

Student Lesson: Experimenting with Seeds

Experiment #3: "Fertilizer"

Results:

What happened in this experiment?

Is it obvious which produced the tallest plants? _____

Each group should determine the average height of their plant. Your teacher will advise you how to measure the plants, so that everyone uses the same method.

Add the height of each plant in your group together, then divide that answer by the number of plants. Write the name or letter of each solution and the average height.

Solution: _____ Height: _____	Solution: _____ Height: _____
Solution: _____ Height: _____	Solution: _____ Height: _____
Solution: _____ Height: _____	Solution: _____ Height: _____
Solution: _____ Height: _____	Solution: _____ Height: _____
Solution: _____ Height: _____	Solution: _____ Height: _____

Which fertilizer solution produced the tallest plants? _____

What was that fertilizer solution made of? _____

name _____

Student Lesson: Experimenting with Seeds

Experiment #3: "Fertilizer"

1. Would you use your fertilizer again? _____
2. Compared to the control, what fertilizers worked best? _____

3. What groups, if any, did worse than the control group? _____

Conclusion:

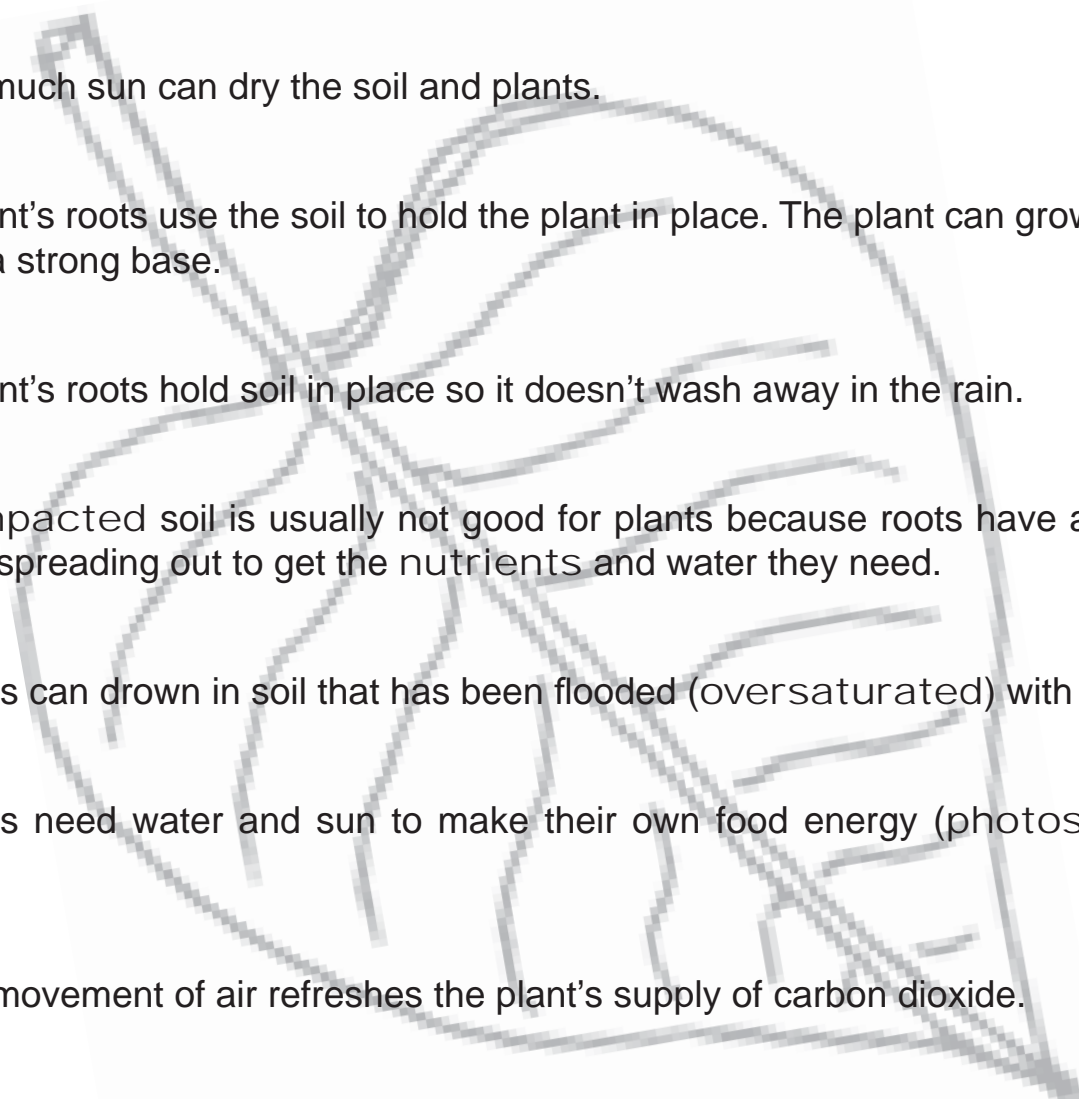
1. Do your results answer the question at the beginning of the experiment? _____

1. Read your hypothesis over again. Was it correct? Partly correct? _____

More to think about:

- Did all the plants get the same amount of water and sunlight?
- Did any of the plants get too much or too little?
- Can having too much water or sun, or not enough water or sun, cause plants to grow poorly?
- Did you see any plants change appearance due to too little, or too much, sun or water?
- Were the changes quick or slow?

Student Lesson: Experimenting with Seeds?
Review: What Do Plants Need, to Grow?

- 
- The sun provides warmth and energy for plants.
 - Too much sun can dry the soil and plants.
 - A plant's roots use the soil to hold the plant in place. The plant can grow tall if it has a strong base.
 - A plant's roots hold soil in place so it doesn't wash away in the rain.
 - Compacted soil is usually not good for plants because roots have a harder time spreading out to get the nutrients and water they need.
 - Plants can drown in soil that has been flooded (oversaturated) with water.
 - Plants need water and sun to make their own food energy (photosynthesis).
 - The movement of air refreshes the plant's supply of carbon dioxide.
 - Air can transport pollen and seeds from plants so that new plants can grow somewhere else.

name _____

Student Lesson: Experimenting with Seeds

Test Your Knowledge

1. What would happen to a plant without water? How about a plant without light?

2. What can you do to help a plant if the soil is dry?

3. Can a plant have too much water? Explain.

4. Why is compacted soil bad for growing plants?

5. Why is polluted air not good for growing plants?

6. Which experiment did you like best? Why?

7. Which experiment did you like the least? Why?

Student Lesson: Experimenting with Seeds

Vocabulary

Compacted - packed down

Conclusion - final step of the scientific method; evaluate the hypothesis and the results

Control - a subject in an experiment that isn't treated with the variable (the "normal" subject to which others are compared)

Experiment - a test that is performed in order to discover or prove something

Fertilizer - material or chemicals containing nutrients added to soil to increase its ability to support growth

First root - the new plant's root that grows before other roots grow

First shoot - the new plant's first leaves and stem

Germination - the process in which a seed begins to grow into a new plant

Hypothesis - the third step of the scientific method; a prediction or guess of what the answer to a question will be, based on what you may already know

Method - the fourth step in the scientific method; the steps that are taken in order to test a hypothesis

Nutrient - a substance that provides nourishment for growth; plants obtain nutrients from soil

Observation - the first step in the scientific method; using your five senses to learn more about something

Oversaturated - having much more than the proper amount

Photosynthesis - the process green plants use to make their own food energy using sunlight

Question - the second step in the scientific method; wondering why something happened or what else might happen, based on your observations

Results - the fifth step in the scientific method; what happened after each step of the experiment

Scientific method - a six-step process of finding an answer to a question by performing an experiment

Seed - the part of a plant that, on its own, will grow into a new plant

Seed coat - outer covering that protects the seed

Variable - something that is being tested in an experiment, making it different from the control

Integrated Pest Management is a specialized form of environmental management wherein scientific research and real-world application work together to reduce pests such as insects, diseases or weeds.

- 1. Properly identify pests*
- 2. Learn the pest/host biology*
- 3. Sample the environment for pests*
- 4. Determine an action threshold*
- 5. Choose the best tactic*
- 6. Evaluate results*

Teacher Information for Student Worksheets

Student Worksheet 1

Introduction

This introductory page may be read as a class, providing an opportunity to initiate a group discussion around the essential questions.

Student Worksheet 2A-2B

Soil and Sun

Some information about soil, sun, water and air will be review for students.

Student Worksheets 3A-3C

The Scientific Method

The teacher or capable students can read this aloud and discuss as a group.

Encourage students to consider the difference between a question that warrants only observation and a question that warrants an experiment to answer it. For example, if a student asks “How often does the dog eat in one day?” they would simply observe a dog for one day and note how many times it eats. If the student asks “Does the dog prefer dry or canned food?” the student would set up an experiment to find out. After reading about and discussing the scientific method as a group, students may be asked to complete the questions together or individually.

Answers:

1. Observation, Question, Hypothesis, Methods, Results, Conclusion
2. A hypothesis is the third step of the scientific method; a prediction or guess of what the answer to a question will be, based on what you may already know.
3. The experiment is part of step four: methods.
4. Answers will vary

Student Worksheet 4A

Experiment #1: “Sun, Water, or Both?”

All three experiments are formatted to follow the scientific method, reinforcing the steps. Hand out materials and guide students through each step. Have at least 4 labeled trays ready for students to place their cups on. Make sure you organize the plants in groups of “no sun,” “no water,” “no sun or water,” and “sun and water.” Students should wash their hands after step 5. Students can volunteer ideas of where each tray will be kept in to keep plants out of sunlight. The “no sun” tray should be placed in a closet or covered with a cardboard box. If using a cardboard box, pole a few air holes. You may wish to hang a “do not water” sign next to the “no water” tray as a reminder.

After the two-week observation period, students should study their seeds on a paper towel. Have students measure their seeds from one end of the whole seed/plant to the other end (root tips to tip of stem). Note: The tiny seedlings may break once handled, and must be removed very carefully from the cup. It might help to remove plants with a spoon under the roots, or even inside a bucket of water

Student Worksheet 4B-D

Experiment #1: "Sun, Water, or Both?"

Students should use the boxes on the left of their page to draw what they see, and the lines on the right to write their observations. Complete sentences are not needed: short notes like "nothing growing yet" or "one small sprout" are acceptable.

Student Worksheet 4E

Experiment #1 "Sun, Water, or Both?"

Students draw their final observations of what the seeds from each cup look like. Remind students to label which box describes which cup. The measurement should be next to its corresponding drawing. Have students clean up their mess and wash their hands. Students may wish to keep a plant that was doing well; you can help them re-pot it so they can take it home.

Student Worksheet 4F

Experiment #1: "Sun, Water, or Both?"

The questions help to organize the students' results so it is easier for them to grasp what the experiment proved. Students's conclusions should discuss what their original hypothesis was and how the results proved it correct or incorrect. Remind students that they did not fail just because their hypothesis was incorrect; they simply discovered something new they did not know before.

Student Worksheet 5A

Experiment #2: "Bean Sprouts"

Hand out materials to students and guide them through each step. You should label their bags and cups with permanent marker.

Student Worksheet 5B-D

Experiment #2 "Bean Sprouts"

Students should record observations by drawing the beans in bags (in the boxes) and writing observations of the beans in cups (on the lines).

Student Worksheet 5E

Experiment #2: "Bean Sprouts"

Reinforce the steps of the scientific method by asking students what their original observations were, and what question they answered by doing the experiment. Ask them to restate their hypothesis, and why the methods were chosen. What was the control? What were the variables? What was their conclusion, and how did it compare with their hypothesis?

Student Worksheet 6A

Experiment #3: "Fertilizer"

This experiment is designed as a group activity. It requires that you mix the fertilizer solutions ahead of time. One group will receive plain water to act as the control group. The other groups gets 5mL of their assigned fertilizer (sugar-sweetened soda, apple juice, liquid dish soap, baking soda, or leftover coffee grounds) mixed with 450mL of water. You may choose to use a commercially-prepared indoor plant fertilizer as one of the variables. Groups will share their container of water or fertilizer solution. Students should write what fertilizer their group is testing on the blank space in their materials list. You may choose to tell your students what their fertilizer is, or use only a letter. They can guess what is in the solution by color, sight or smell. Students may also hypothesize about how different solutions may work.

Student Worksheet 6B-D

Experiment #3: "Fertilizer"

Students will write down their daily observations of their own cup. Students should lightly water their plants each day with their solution. Remind them that if the cups have no drainage holes, they can easily overwater their plants. It can be difficult and messy to remove excess water. If your class has access to medicine droppers this may be an easier way to water. Students can use the name of the fertilizer solution or the code letter you have given them. If students have used a code, reveal what the solution contained at the end of the experiment.

Student Worksheet 6E

Experiment #3: "Fertilizer"

The questions help to organize the students' results so it is easier for them to grasp what the experiment proved. Students's conclusions should discuss what their original hypothesis was and how the results proved it correct or incorrect. Call on each group to offer their results. Determine which fertilizer worked best and which one was least effective. Remind students that they did not fail if their hypothesis was incorrect, they simply discovered something new they did not know before.

Student Worksheet 7

Review

Students may read this page individually or as a class.

Student Worksheet 8

Test Your Knowledge

Students should complete this page individually, It may be counted as a test or quiz grade. Questions 6 and 7 could be used as feedback for future lessons.

Answers:

1. The plant would dry up. Or, It would not be able to move nutrients from the ground to its leaves. Without light, it would stop growing. Or, it would not be able to make food.
2. Water it with a watering can, a sprinkler, or a water hose.
3. Yes; too much water can oversaturate the soil, leaving little or no room for roots to get air.
4. It is harder for plants to spread their roots out to get the nutrition, water, and air they need.
5. Pollution can block sunlight from reaching the plants. Or, chemicals in pollution can harm them.
6. Answers wil vary.
7. Answers wil vary.

Student Worksheet 9

Vocabulary

Provided for student reference