

Lesson 4: Do Beans “Breathe”?



Forward for Parents and Educators:

Welcome! This is the fourth in of a series of five lessons. The series is designed for upper elementary students, but can be adapted to any child's ability level. Prior to beginning the experiment, watch the pre-lesson video. The lesson and video are accompanied by **asynchronous**, educator-led discussion. You can post in the discussion thread at any time. Frequent participation in the discussion will allow you to ask questions and check understanding of the content. During the series, students will become familiar with the scientific method within the life and physical sciences. Students will identify the scientific method as a way of knowing; understanding that science uses empirical methods that rely on logic, evidence and reasoning.

This series will address NGSS and NCSD Standards including Science and Engineering Practices, Disciplinary Core Ideas and Cross Cutting Concepts.

• INTRODUCTION:

In this lesson, you will conduct a simple experiment which will help you understand the metabolic process responsible for seed germination. **Metabolism** is the sum of all of the chemical reactions which occur in a living organism. **Germination** is the process through which an organism grows from a seed (or a spore). It is important to differentiate the seed from the plant. The plant is the organism which grows from the seed. Seeds use a different process to germinate than what plants use to grow. The seeds of plants are complex structures, but have three basic components: the seed coat, the embryo and stored food.

Cellular respiration is the process through which glucose (a sugar commonly found in your food) is converted into cellular energy through a complex pathway. Humans require oxygen to complete cellular respiration. The inputs for cellular respiration are glucose and oxygen, and the outputs are cellular energy and carbon dioxide. **Photosynthesis** is the process through which plants capture the solar energy from sunlight and build important cellular molecules such as glucose. In photosynthesis, the inputs are sunlight, carbon dioxide and water, and the outputs are a chemical readily converted to glucose and oxygen.

Our job today is to determine which process, cellular respiration or photosynthesis is responsible for seed germination.

MATERIALS:

- Viable seeds of any kind such as beans, radish sprouts or alfalfa sprouts
- Two sandwich-sized plastic baggies
- Two paper towels
- Water to keep the paper towels damp
- 15-20 seeds, divided into two equal groups
- A well-lit place in your home that gets plenty of natural sunlight, but not direct sunlight
- A dark place in your home that is approximately the same temperature as the well-lit place

SAFETY CONSIDERATIONS:

- **Don't eat the sprouts you grow in this experiment.** The sprouts we are growing in this experiment will be in a plastic bag with only moderate air flow. The humid environment may cause microorganisms, including pathogenic bacteria to grow.

PROCEDURES:

ACTIVITY 1: Observing the effect of light on seed germination

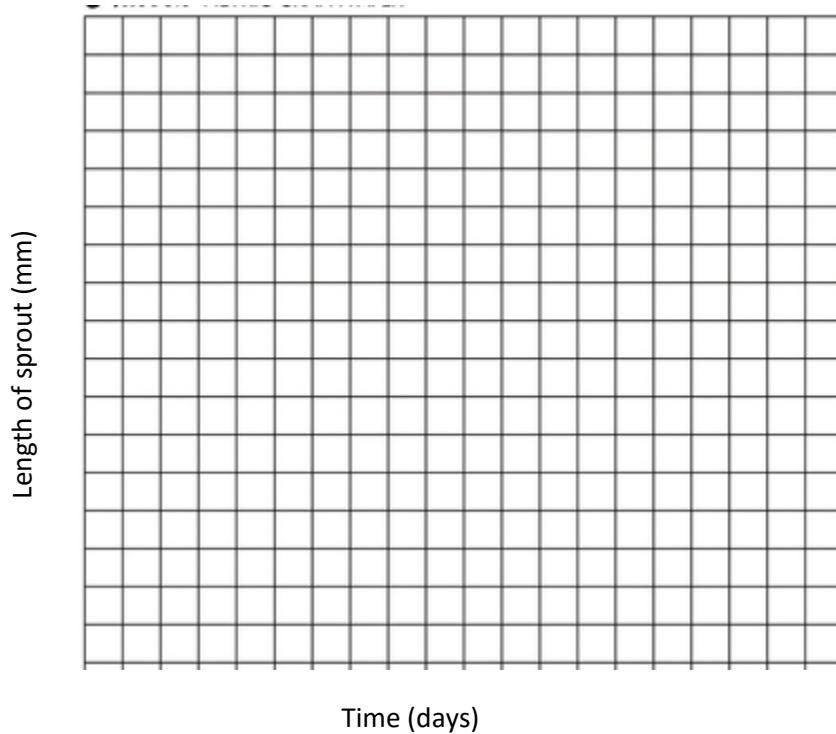
1. Place a paper towel into each baggie. Add enough water to dampen the paper towel. There should not be pools of water standing in the bag.
2. Leave the top of the bag open to allow air to flow into and out of the bags.
3. Place one bag into a well-lit area of your home that gets plenty of natural sunlight. Do not place the bag into direct sunlight.
4. Place one bag into a dark area of your home that is about the same temperature as the well-lit area.
5. Observe the seeds every day for one week. Add water as needed to keep the paper towel damp. Use a ruler to measure the length of the sprouts in mm.*

Time	Dark (mm)	Light (mm)
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		
Day 6		
Day 7		

* If you were instructed to begin the experiment prior to receiving this handout, simply write a paragraph explaining what you observed. In science, we don't "fill in data" that we weren't able to measure. In the next activity, you'll be able to design your own experiment.

6. Graph your data. Choose a color for the beans that were drawn in the dark and a different color for the beans that were grown in the light. Plot time along the horizontal axis, and length of sprout along the vertical axis.*

Growth rate of germinating seeds placed into dark versus light environments



* If you were instructed to begin the experiment prior to receiving this handout, simply write a paragraph explaining what you observed. In science, we don't "fill in data" that we weren't able to measure. In the next activity, you'll be able to design your own experiment.

Draw Conclusions:

Use your observations to draw a conclusion. Which cellular process (cellular respiration or photosynthesis) was responsible for seed germination and sprout growth? Use your observations and data to support your conclusion. In your conclusion paragraph, explain why you were instructed to keep the temperature the same for the seeds grown in the dark, and the seeds grown in the light.

ACTIVITY 2: Design your own seed germination experiment

In the first activity, you looked at the effect of light on the rate of seed germination and sprout growth. In this activity, your job is to choose ONE thing that might affect seed germination and sprout growth. Ideas could be temperature, presence of plant food, music, etc. Since we now know that light is not needed for seed germination, keep both of your seeds in a dark place. Expose one of the bags to what you want to investigate, and treat the other one just like you did in the previous activity (this is called a control). You will be able to compare your experimental group to the control group.

1. Write a hypothesis statement for what you think will happen:

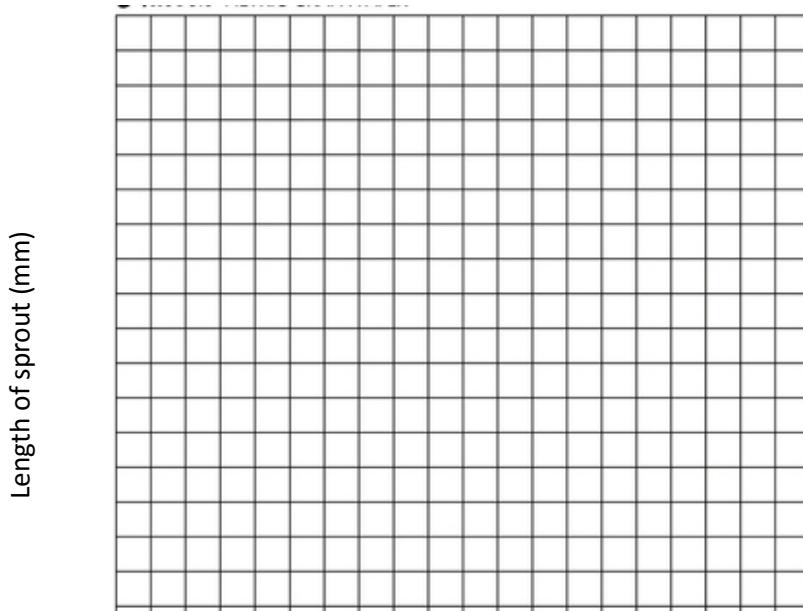
If I place seeds _____, then germination and sprout growth will _____ because _____.

2. Fill in the table, and use it to collect your data

Time	Control (mm)	(mm)
Day 1		
Day 2		
Day 3		
Day 4		
Day 5		
Day 6		
Day 7		

3. Graph your data. Choose a color for the beans that were drawn in the dark and a different color for the beans that were grown in the light. Plot time along the horizontal axis, and length of sprout along the vertical axis.

Growth rate of germinating seeds _____



Draw Conclusions:

Use your observations to draw a conclusion. Do your results support your hypothesis. Use the data you collected to construct sentences that support your claim. Explain how your control helps support your conclusion. Was your test fair? Construct an argument to explain why your test was fair. If the test was not fair, write a sentence to explain how it may have affected your results.

Activity 3: Make Beans and Rice

The following recipes have been provided by [The Centi\\$ible Nutrition Program](#).

Beans & Rice

Makes 4 servings | Protein • Grains

Ingredients

- 1 teaspoon canola oil
- 1 medium onion, chopped
- 2 garlic cloves, chopped (1 teaspoon minced or ½ teaspoon powder)
- 2 cups beans, cooked or 1 15-ounce can, drained (red, black, and white beans work well)
- 1 15-ounce can stewed tomatoes
- ¼ teaspoon black pepper
- ½-1 Tablespoon Mexican seasoning or CNP Mexican Seasoning
- 3 cups cooked brown rice

Directions

1. Wash hands in warm, soapy water.
2. Heat oil in pan or electric skillet. Add onions and garlic and cook until lightly browned, about 5 minutes.
3. Add beans, tomatoes, pepper, and Mexican seasoning. Cook over low heat and simmer for 30 minutes.
4. Serve beans over rice.



CNP Mexican Seasoning

Ingredients

- 2 Tablespoons chili powder
- 2 Tablespoons paprika
- 1 Tablespoon garlic powder
- 2 teaspoons ground cumin
- 1 teaspoon oregano
- 1 teaspoon cayenne pepper or crushed red pepper flakes
- ½ teaspoon salt (optional)

Directions

1. Combine all spices in a jar or plastic bag and mix well.
2. Keep in a cool, dry place for up to 6 months.

Nutrition Facts

4 servings per container	Serving size	1 Cup (412g)
Calories	320	% Daily Value*
Total Fat 3g	4%	
Saturated Fat 0g	0%	
Trans Fat 0g		
Cholesterol 0mg	0%	
Sodium 600mg	26%	
Total Carbohydrate 64g	23%	
Dietary Fiber 11g	40%	
Total Sugars 8g		
Includes 0g Added Sugars	0%	
Protein 12g		
Vitamin D 0mcg	0%	
Calcium 100mg	8%	
Iron 4mg	25%	
Potassium 730mg	15%	

* The % Daily Values (DV) tells you how much a nutrient in a serving contributes to a daily diet. 2000 calories a day is used for general nutrition advice.

Recipe from the Cent\$ible Nutrition Program. Learn how to save money, cook quick and healthy meals, and stretch your food dollar by contacting your local CNP educator.



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Science and Engineering Practice	NCSD Grade Level Standards	Cross-Cutting Concepts
<ul style="list-style-type: none"> Asking questions and defining problems Planning and carrying out investigations Analyzing and interpreting data Engaging in argument from evidence Obtaining, evaluating and communicating information 	<p>K.2.2 Use observations to describe patterns of what plants and animals need to survive</p> <p>2.3.1- Plan and conduct an investigation to determine if plants need sunlight and water to grow.</p> <p><i>Clarification statement: Students will need to understand the difference between a seed and a plant. The seed does not need sunlight to germinate, however a plant requires sunlight to grow.</i></p> <p>3.3.2- Describe a cause and effect relationship between a specific casual environment factor and its effect on a given variation in a trait.</p> <p>5.2.2- Support an argument that plants get the materials they need for growth primarily from air and water</p>	<p>2. Cause and Effect</p> <p>6. Structure and Function</p>

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