THE SCIENCE OF
Food

Do Plants Need Light?

Activity from *The Science of Food Teacher's Guide: From Ecosystems to Nutrition* and for *The Mysterious Marching Vegetables*

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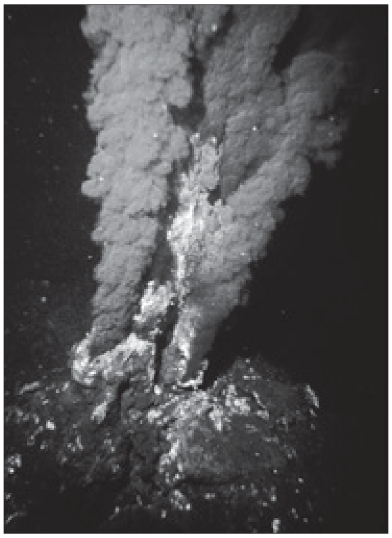
Food and Energy in Living Things

Life Science Basics



Some specialized bacteria make the molecules they need without sunlight. Bacteria that live in hot deep-sea vents obtain energy through the chemical breakdown of hydrogen sulfide in a process known as chemosynthesis. The bacteria are the primary producers in this environment.

In soil, some bacteria combine nitrogen- or iron-containing compounds with oxygen and capture the energy produced by these reactions.

Photo courtesy of NOAA.

Living things often are classified as producers or consumers, depending on how they obtain energy and nutrients. Producers typically are able to use solar energy to make the molecules they need from relatively few substances present in the air, water and soil. On land, green plants are the primary producers. In water, some plants and many varieties of algae, bacteria and other one- to many-celled organisms (Protists) are producers. All other organisms are consumers, which live directly or indirectly on food provided by producers.

Almost all producers make the molecules they need through photosynthesis. During photosynthesis, producers absorb energy from the sun and use it to combine carbon from carbon dioxide with water to make sugars and other carbohydrates. Thanks to this amazing process, light energy from the sun is converted into chemical energy stored in the bonds between atoms that hold molecules together. Plants use the energy stored in these molecules to build other compounds necessary for life. Likewise, consumers, who cannot trap energy directly from sun, must rely on molecules manufactured by plants for food.

The general sequence of who eats whom in an ecosystem is known as a food chain. Energy is passed from one organism to another at each step in the chain. Along the way, much energy is given off as heat. In fact, about 85–90% of the total usable energy is released as heat at every step in a food chain. Most organisms have more than one source of food. The relationship among all the energy flow interactions that happen in an ecosystem usually are described as a food web.

PRODUCERS AND CONSUMERS

- **HERBIVORES**, such as giraffes and caterpillars, are primary consumers. They feed on plants and other producers.
- **CARNIVORES**, such as anteaters and spiders, are secondary consumers. They feed on primary consumers. Most secondary consumers are animals, but a few are plants, like the pitcher plant.
- **OMNIVORES** eat plants and animals. Humans, pigs, dogs and cockroaches all are omnivores.
- **DECOMPOSERS** live off waste products and dead organisms. Many kinds of bacteria and fungi (molds and mushrooms) are decomposers. The decomposers themselves are important food sources for other organisms in soil, such as worms and insects. Litterfeeders, such as termites and earthworms, feed on partially broken down bits of plant and animal matter.
- **SCAVENGERS** feed on dead organisms that have been killed by another animal or that have died naturally. Vultures, flies and crows are examples of scavengers.

Do Plants Need Light?

Life Science

Only producers, such as green plants, are able to make the molecules needed for life from simple compounds in the air, soil and water. Almost all producers use energy from the sun to make food through photosynthesis. During photosynthesis, light energy is trapped and transformed into chemical energy that can be used by cells. Very few raw materials are required. Green plants need only water (H_2O) and carbon dioxide (CO_2) in the presence of light to manufacture sugar molecules and other carbohydrates, such as starch. Plants use the energy held in carbohydrates to fuel chemical reactions and to make other molecules necessary for life. Other needed materials (such as nitrogen, phosphorous or potassium) are taken in through plant roots. This activity allows students to learn about the needs of plants and the role of light in plant growth.

Unit Links

The Mysterious Marching Vegetables
Story, p. 8–10;
Science box, p. 10

Explorations
Let's Talk About the Food We Eat, p. 2–3

Growing plants in the classroom can be a simple and rewarding process for students. Elaborate equipment is not necessary for growing plants indoors. If you do not have a window with bright light, place plants under a fluorescent lamp. Allow only about five inches from the tops of the pots or growing plants to the light source. Inexpensive fluorescent lamps appropriate for growing plants often are sold in hardware stores as "shop lights."

SETUP

Soak enough bean seeds overnight in a container of water to give at least 12 soaked seeds to each group of students (4 seeds for observation). Each group also will need at least 4 dry bean seeds.

Moisten the soil before use. Place the soil in a plastic bag or container and add water until it is damp. Let the moistened soil in the unsealed bag sit for at least 1/2 hour before using.

As an alternative to peat pots, use disposable plastic or foam cups (punch one or more drainage holes in the bottom of each cup). Once students have planted their seeds, set the pots on plastic or foil trays near a light source.

SAFETY

Have students wash hands before and after the activity. Clean work areas with disinfectant.

PROCEDURE

Session 1: Observing dry seeds

1. Give each student a dry bean and a magnifier. Have students use their magnifiers to observe the bean seeds. Each student

CONCEPTS

- Plants require light, water, air and soil to grow.
- Light is necessary for the production of new plant material.

OVERVIEW

Students learn about plant growth and development by conducting an experiment that demonstrates the importance of light to plants.

SCIENCE, HEALTH & MATH SKILLS

- Observing
- Recording observations
- Measuring in centimeters
- Comparing measurements
- Graphing measurements
- Interpreting results
- Drawing conclusions

TIME

Preparation: 10 minutes per session

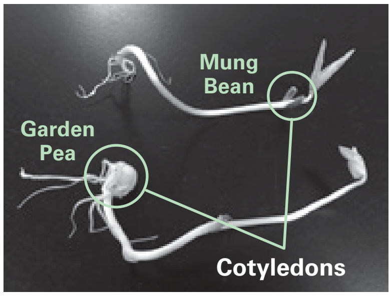
Class: 30 minutes for each session; 10–20 minutes each day for 1–2 weeks;

MATERIALS

Each group will need:

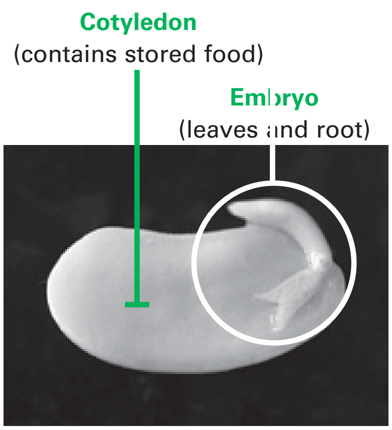
- 12 soaked bean seeds
- 4 dry bean seeds
- 4 hand lenses (magnifiers)
- 4 peat pots (3-in. size), or disposable cups
- 4 pieces of string or yarn (each approx. 6-in. in length)
- 4 sheets of paper towels or paper plates
- 2 cups of moistened soil
- Dispensing bottle (2-oz size), or dropper
- Metric ruler
- Copies of student sheets

COTYLEDONS



As shown by the Mung bean seedling (above), the cotyledons have expanded, thrown off the seed shell, and now are located just beneath the seedling's first true leaves. The green pea seedling's cotyledons remained encased in its seed coat to act as an underground storage organ.

Photo © Annkatrin Rose, Ph.D.



Bean seed embryo without its seed coat.

Photo © Rhonda Clark.

> **ETIOLATION**
>
> Plants growing in dark conditions sometimes will develop tall spindly stems. This process, called etiolation, is a result of plants using their energy to grow upward in search of light.

should draw a seed on his or her "Seeds and Seedlings" sheet. Make sure that each student is able to observe the seed coat and the dark indentation on one side of the seed, corresponding to where the new plant will emerge.

Session 2: Observing and planting soaked seeds

1. Before proceeding with planting, give each student a soaked seed (on a paper towel) for observation. The students should compare the soaked seed to a dry seed. Ask, *How is the soaked seed similar to the dry seed? How is it different?* Have students remove the "skin" (seed coat) and spread apart the pieces of the tiny plant inside. They will be able to identify the cotyledons (seed leaves), other tiny leaves and the beginnings of what will become the plant root.
2. Have Materials Managers pick up 4 pots and 8 soaked seeds from a central location in the classroom. Direct the members of each group to pick a name for their group and to write it on the pots. They should number their pots: 1, 2, 3 and 4.
3. Have groups fill their pots about 3/4 full of soil.
4. Direct the students to make two indentations (about 1/2 cm deep) in the surface of the soil and to place one seed in each hole. Have them cover the seeds lightly with soil. Each group will have four pots, with two seeds in each pot.
5. Have students place the pots on trays near a bright, sunny window or under a fluorescent light.

   Over the next several days . . .
   - Once the seeds sprout, have students "mark" one of the two plants within each pot by loosely tying a piece of string around its base. *If a plant dies, students should continue to measure the remaining plant.*
   - Have students measure both plants in each pot every day or every other day and record the length of the stems in cm on their "Seeds and Seedlings" sheets.
   - Let students water the plants every day or two with a squirt bottle. The soil should be moist but not wet.

Session 3: Light experiment

1. When most of the seedlings are approximately 10 cm tall, explain to the students that they will now investigate the effect of light on the growth of the bean plants. Ask, *What do you think will happen if we give some of the plants less light?*
2. Have each group move pots 3 and 4 to a new location that you have selected (in the back of the classroom or in a dark corner away from the windows or light source). Ask, *Do you think that the plants in the new place will have as much light as the others? Why or why not? What do you think will happen to the plants receiving less light?* Have students discuss possible outcomes and make predictions.

3. Students should continue to measure the plants for another 3–5 days and record their measurements on their “Just Growing Up” student sheets.

Session 4: Looking at data

1. After making their final observations, have students complete the remaining questions on the “Just Growing Up” sheet.
2. Discuss students’ results in class. They should be able to conclude that the difference in available light led to any observed differences between the two groups of plants. Ask, *Were the plants all about the same size before you moved pots 3 and 4 out of the bright light? Are all the plants still the same size? Why do you think that is so? Are there any differences other than size?* Help students to conclude that the differences in growth (the plants with less light will have grown less or will have developed tall, narrow stems) and in color (the plants with less light will be lighter green) were caused by the differences in the availability of light. *What is the only thing that was different about the two sets of pots?* (Only the amount of light changed; all other aspects of the experiment—water, soil, seedlings, pots, planting method—were unchanged for both groups.)
3. Ask, *Where do you think the plants in pots 1 and 2 got the materials and energy to produce more stems and leaves? What were the plants in pots 3 and 4 missing? What do you think would happen if we put the plants in pots 3 and 4 back in the light?*

VARIATIONS

- Have students rinse away the soil and compare the final masses in gm of the plants in pots 1–2 vs. pots 3–4.
- Conduct the same activity with corn seeds (a monocot), and compare the results.
- Help students “see” chlorophyll, the pigments essential for converting light energy into chemical energy (food molecules), by placing a handful of crushed fresh leaves (any kind) into a clear container filled up to about 2 cm with rubbing alcohol. Stir the mixture briefly and insert the tip of a strip of coffee filter paper into the alcohol. The pigments will travel up the paper strip and form a green band that will be visible after about 1/2 hour. This method of separating chemicals in solution is known as paper chromatography. **Safety Note.** Make certain the area is well ventilated and have students wear protective eyewear. Do not use alcohol near an open flame.

QUESTIONS FOR STUDENTS TO THINK ABOUT

How might you change this experiment to observe the effects of different amounts of water on plant growth, or of the addition of fertilizers to plants? Which parts of the experiment would you change? Which parts of the experiment would you leave the same?

DICOT OR MONOCOT?

Flowering plants are divided into two groups, based partially on the structure of their seeds. Plants with two cotyledons in the seed are called dicotyledonous plants or “dicots.” Beans, roses, daisies and oaks all are examples of dicots. Monocotyledonous plants or “monocots” have seedlings with one initial leaf. Grasses, sedges, lilies and orchids all are monocots.

PHOTOSYNTHETIC ORGANISMS

In addition to plants, green algae, blue-green algae (relatives of bacteria) and other single and multi-celled protists carry out photosynthesis. Scientists have found evidence of photosynthetic organisms in rocks more than 3.4 billion years old!

CHLOROPLASTS

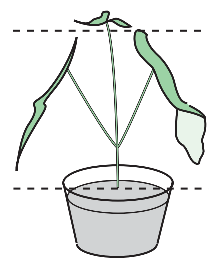
Within plant cells, photosynthesis takes place in specialized structures known as chloroplasts. Scientists believe that chloroplasts originated as free-living photosynthetic bacteria that became introduced into the cells of other organisms. A square millimeter of leaf may contain as many as 500,000 chloroplasts!

Seeds and Seedlings

Use this sheet to record your plant observations.

Draw a picture of a dry bean seed.	Draw a picture of a bean seed after soaking.	Draw a picture of the insides of the soaked bean seed.

1. Plant two bean seeds in each of four pots. Label the pots with the numbers 1, 2, 3 and 4.
2. Once the plants are growing, tie a string loosely around the base of one plant in each pot. Measure the length of the stems of both plants in each pot every day or every other day using a ruler. Record your measurements in mm below.



Measure stems from the soil to the bottom of the tallest leaf.

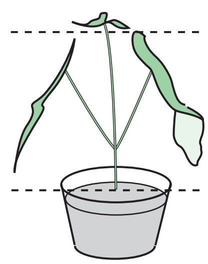
Date	Pot 1		Pot 2		Pot 3		Pot 4	
	Marked Plant	Unmarked Plant	Marked Plant	Unmarked Plant	Marked Plant	Unmarked Plant	Marked Plant	Unmarked Plant

Semillas y Plantitas

Escribe tus observaciones sobre las plantas en esta hoja.

Dibuja una semilla seca.	Dibuja una semilla remojada.	Dibuja el interior de la semilla remojada.

1. Siembra dos semillas en cada una de las cuatro macetas.
2. Cuando ya están creciendo las plantas, amarra un hilo en la base de una de las dos plantas en cada maceta. Escribe tus medidas en mm en los espacios a continuación.



Mide el tallo desde el suelo hasta la base de la hoja más alta.

Fecha	Maceta 1		Maceta 2		Maceta 3		Maceta 4	
	Planta Marcada	Planta sin Marcar	Planta Marcada	Planta sin Marcar	Planta Marcada	Planta sin Marcar	Planta Marcada	Planta sin Marcar

Write your prediction. What will happen if some bean plants receive more light than other bean plants?

Move Pots 3 and 4 to an area with less light. Continue to observe and measure the plants in each of the four pots. Record your measurements in mm below.

	SAME LIGHT				**LESS LIGHT**			
Date	**Pot 1**		**Pot 2**		**Pot 3**		**Pot 4**	
	Marked Plant	Unmarked Plant	Marked Plant	Unmarked Plant	Marked Plant	Unmarked Plant	Marked Plant	Unmarked Plant

Answer the questions below at the end of the experiment.

1. Describe the final appearance of the plants in Pots 1 and 2.

2. What was the average height of the plants in Pots 1 and 2? ____________ **mm**

3. Describe the final appearance of the plants in Pots 3 and 4.

4. What was the average height of the plants in Pots 3 and 4? ____________ **mm**

5. On a separate sheet of paper, make a bar graph of the final heights of the plants in all four pots.

6. What differences, if any, did you observe between the plants that got more light and the plants that got less light? How might you explain the observed differences?

Simplemente Están Creciendo

Escribe tu predicción. ¿Qué pasará si algunas plantas reciben más luz que las otras?

Mueve las macetas 3 y 4 a un área con menos luz. Continúa haciendo tus observaciones y medidas de las plantas en las cuatro macetas. Escribe tus medidas en mm en los espacios a continuación.

	LUZ				MENOS LUZ			
Fecha	**Maceta 1**		**Maceta 2**		**Maceta 3**		**Maceta 4**	
	Planta Marcada	Planta sin Marcar	Planta Marcada	Planta sin Marcar	Planta Marcada	Planta sin Marcar	Planta Marcada	Planta sin Marcar

Responde a las siguientes preguntas cuando termines el experimento.

1. Describe la apariencia final de las plantas en las macetas 1 y 2.

2. ¿Cuál fue la altura promedia de las plantas en las macetas 1 y 2? ____________ **mm**

3. Describe la apariencia final de las plantas en las macetas 3 y 4.

4. ¿Cuál fue la altura promedia de las plantas en las macetas 3 y 4? ____________ **mm**

5. En otra hoja, haz una gráfica de las alturas finales de las plantas en las cuatro macetas.

6. ¿Cuáles diferencias observaste entre las plantas que recibieron más y menos luz? ¿Cómo puedes explicar las diferencias que observaste?