# Category II Summaries for Life Science Examples

## Addressing commonly held ideas

### Material A

A common misconception related to the key idea that "plants use the energy from light to make sugars from carbon dioxide and water" is that plants get their food from the soil (American Association for the Advancement of Science, 1993, p. 342).

In a middle school unit on photosynthesis, students are presented with Van Helmont's experiment (pp. **10-11**). Although this experiment addresses students' misconception that the mass gain of a growing plant comes from the soil, it does not do so explicitly. Students are not encouraged to link the experiment to their own ideas about where plants get their food. Nor are teachers given information about students' commonly held ideas about plant nutrition to facilitate such a link.

LESSON 2

# Where Does the Starch Come From?

## FOCUS

### Getting Started

Have students grow a potato in a glass of water in order to see van Helmont's experiment firsthand. (See Water—How Essential Is It? on page 11.) They should begin the experiment 2 weeks before starting this lesson. Have them weigh the potato, insert toothpicks into the potato, and then balance it on the rim of the glass with the bottom of the potato submerged in the water. After 2 weeks, they should weigh the potato a second time and explain where the extra mass came from. *(The water)*

### Main Ideas

1. Sunlight and water are necessary for photosynthesis to occur.
2. Carbon dioxide is consumed and oxygen is released during photosynthesis.
3. Photosynthesis results in the formation of a simple sugar that is later converted into starch.

## TEACHING STRATEGIES

### EXPLORATION 2

Plants that have been grown under artificial light typically do not show dramatic results for this Exploration.

In order to complete this Exploration in one class period, you may wish to have plants prepared ahead of time. Place a supply of plants in a dark place, such as a closet, for 4 days before they will be needed. Have students cut cardboard shapes to suit the sizes of the leaves for step 3. At least one plant should be prepared for step 4. A grow lamp should produce excellent results. Place the lamp as close to the leaves as possible without harming the plant (20 to 25 cm away). Leave the lamp on for 24 hours.

**WASTE DISPOSAL ALERT** Refer to page 8 for instructions on disposing of the iodine-stained materials.



LESSON 2

# Where Does the Starch Come From?

In Explorations 2, 3, and 4 you will be figuring out where the starch in plants comes from. As you do the Explorations, think about what light, water, and carbon dioxide could have to do with the starch in plants.

### EXPLORATION 2

## Light and Starch

The leaf you tested for starch in Exploration 1 was from a plant that had received plenty of light. If a plant receives no light, will it also have starch in its leaves?

### You Will Need

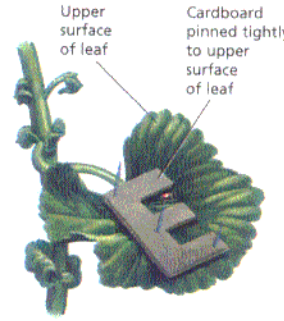
- a geranium plant (grown outdoors)
- thin cardboard
- scissors
- straight pins
- materials and equipment to test leaves for starch

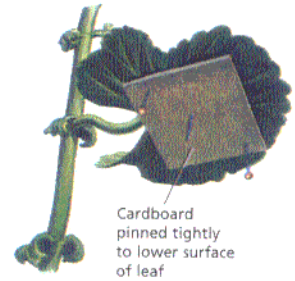
### What to Do

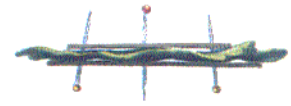
1. Put a geranium plant in a dark but warm place for 4 days. The soil should be moist but not too wet.
2. After the 4 days have passed, test some of the plant's leaves for starch, as in Exploration 1. Record your findings in your ScienceLog.
3. Now cover one leaf with cardboard, as shown in the illustrations. (Important—the leaf must still be attached to the plant!) Affix a letter or a number to the top surface of the leaf, using the method shown in the illustration.
4. Put the plant in bright light, such as under a grow lamp, for 24 hours. Then remove the cardboard pieces and test the covered and uncovered parts of the leaf for starch as you did in Part 2 of Exploration 1. Record your findings.

### Questions

1. What effect did darkness have on the amount of starch in the plant?
2. Which part of this Exploration, steps 1 and 2 or steps 3 and 4, suggests that light has an important role in determining the amount of starch in green plants? Why?
3. Could you perform steps 3 and 4 without first doing steps 1 and 2? Explain your answer.





Side view



## LESSON 2 ORGANIZER

**Time Required** 3 class periods

**Theme Connection** Energy

**Process Skills** observing, analyzing, inferring, predicting

**New Term**
**Photosynthesis**—the process by which green plants make food

**Materials** (per student group)
**Exploration 2:** geranium plant (grown outdoors); 10 cm × 10 cm piece of thin cardboard; scissors; 4 or 5 straight pins; grow lamp; materials to test for starch from Part 2 of Exploration 1 on page 7 (additional teacher materials: 25 mL of 0.1 M sodium thiosulfate solution; a few sheets of old newspaper; 250 mL of water; 600 mL beaker; see Advance Preparation on page 1D.)
**Testing for Carbon Dioxide:** 2 small jars with lids; 2 small candles; a few matches; about 200 mL of limewater; safety goggles (additional teacher materials for preparing limewater: 4 mL of calcium hydroxide; 200 mL of water per class; see Advance Preparation on page 1D.)
**Exploration 3:** 2 leaves; 2 test tubes; 2 large jars with lids; about 20 mL of 4% sodium hydroxide solution; 1 g of

*continued*

## Water—How Essential Is It?

When you started this chapter, you may have thought that plants get their food only from the soil. If you did, you are in good company. That's what the great philosopher Aristotle thought too! But a Belgian scientist of the seventeenth century, Jan Baptist van Helmont, questioned this belief and decided to look into the matter further. He decided to find out what role water had in plant growth.

What happens when a plant is deprived of water? You have probably seen what happens when you or somebody else forgets to water a houseplant. Plants that don't get enough water wilt. If they continue to be deprived of water, they eventually die.

Van Helmont performed an experiment that convinced him that water was so important that it was completely responsible for the great change in mass that occurs in growing plants. In other words, he concluded that water was completely responsible for growth in plants.

What do you think? Before you decide, let van Helmont tell you about his experiment, translated from his own words. Don't let the odd wording and spelling throw you. People spelled and spoke quite differently in van Helmont's day. (The masses have been changed to metric units.)

***Journal***

*I have learned from this handicraft operation that all vegetables do immediately and materially proceed out of the element of water only. For I took an earthen vessel in which I put ninety kilograms of earth that had been dried in a furnace, which I moystened with rainwater, and I implanted therein the trunk, or stem, of a Willow tree, weighing two kilograms and about two-hundred and fifty grams. At length, five years being finished, the tree sprung from thence did weigh seventy-six kilograms. But I moystened the earth vessel with rain-water, or distilled water (always when there was need) . . . and lest the dust should be co-mingled with the earth, I covered the lip or mouth of the vessel with an iron plate covered with tin, and easily passable with many holes. I computed not the leaves that fell off, in the four autumnes. At length, I again dried the earth of the vessel, and there were found the same ninety kilograms, wanting a few grams. Therefore almost seventy-four kilograms of wood, bark, and roots arose out of water only.*

***Jan Baptist van Helmont***

The corn plant on the left is healthy because it received adequate rainfall. The corn on the right is stunted because it did not receive enough water.



### ORGANIZER, *continued*

baking soda (sodium bicarbonate); 19 mL of water; wax pencil; lamp with 100 W bulb; materials to test for starch from Part 2 of Exploration 1 on page 7 (additional teacher materials: 1 g of sodium hydroxide and 24 mL of water for preparing sodium hydroxide solution; 50 mL of vinegar; a few strips of pH paper; 25 mL of 0.1 M sodium thiosulfate solution; a few sheets of old newspaper; 250 mL of water; 600 mL beaker; see Advance Preparation on page 1D.) **Exploration 4:** lamp with 100 W bulb; 2 test tubes; wooden splint; a few matches; 50 g of baking soda (sodium bicarbonate); 950 mL of water; 2 clear plastic containers or 600 mL beakers; 2 clear funnels; elodea sprig; safety goggles

**Teaching Resources**

Exploration Worksheets, pp. 6, 8, and 9
Transparency Worksheet, p. 11
Transparency 1

★ **An Exploration Worksheet is available to accompany Exploration 2 on page 10 (Teaching Resources, page 6).**

## Answers to *Questions, page 10*

1. The leaves from a plant left in the dark have little or no starch compared with leaves from a plant that has been in bright light.
2. Both parts suggest that green plants need light to produce starch. In each case the plants (or parts of the plants) that did not receive light had less starch. However, steps 1 and 2 could not be considered without comparing the results with those from Exploration 1.
3. Steps 3 and 4 could have been done without first doing steps 1 and 2. However, steps 1 and 2 reduce the amount of starch in the plant's leaves so that the production of starch in the uncovered parts of the leaves is more apparent.

## Water—How Essential Is It?

Before students begin reading, have them discuss what happens when a plant is deprived of water. *(It wilts and eventually dies.)* Help them to conclude that water is essential for healthy growth.

Have students silently read about van Helmont's experiment, or call on a volunteer to read it aloud. Monitor students' understanding of the material by having them discuss and complete the pictorial summary on page 12.

Point out to students that before the 1600s, scientists thought that plants obtained their food directly from the soil. This theory was first proposed by the Greek philosopher Aristotle (384–322 B.C.). This food was believed to have been absorbed directly by the roots and utilized by the plants without much change. Van Helmont was the first to provide experimental evidence that conflicted with this theory.

## Primary Source

*Description of change:* excerpted from early writings by Jan Baptist van Helmont
*Rationale:* excerpted to focus on the importance of water to plant growth