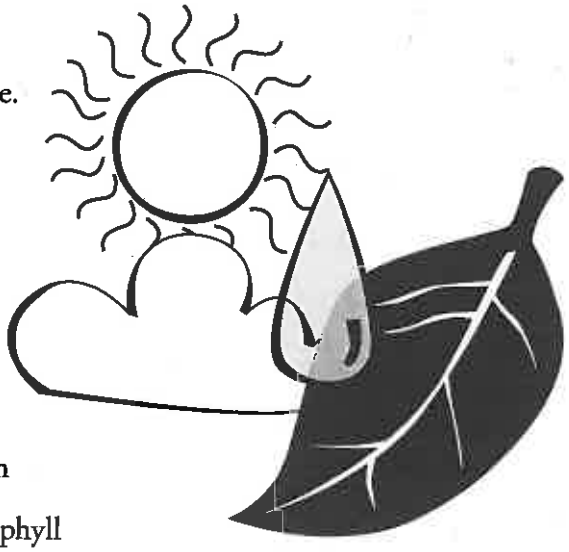
Is It Food for Plants?



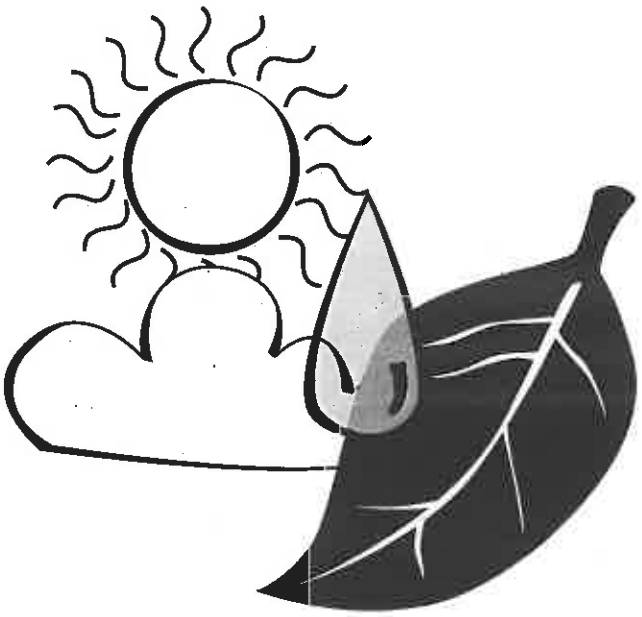
Organisms, including plants, need food to survive. Put an X next to the things you think plants use as food.

___ sunlight	___ soil
___ plant food from a garden store	___ water
___ sugar	___ leaves
___ carbon dioxide	___ oxygen
___ minerals	___ chlorophyll
___ fertilizer	___ vitamins

Explain your thinking. How did you decide if something on the list is food for plants?

Is It Food for Plants?

Teacher Notes



Purpose

The purpose of this assessment probe is to elicit students' ideas about food and plants. The probe is designed to reveal whether students use a biological concept of food to identify what plants use for food.

Related Concepts

food, photosynthesis, plants

Explanation

The best response is sugar. Sugars, such as glucose, are simple carbohydrates made and used by plants as food. Plants differ from animals in that they are able to use the energy from sunlight to transform inorganic carbon dioxide and water, which they take in from their environment, into food. This process is called photosynthesis. Part of the confusion among children and adults is due to how we define the word *food* and use the words *food* and *nutrients* interchangeably. Nutrients are substances that organisms require to carry out their life processes; they can be organic or inorganic. Not all nutrients provide energy. Examples of inorganic nutrients that do not provide energy are vitamins, minerals, and water. Examples of organic nutrients that provide energy are carbohydrates (including simple sugars), lipids (fats), and proteins. Food is a nutrient that contains energy, and it may contain inorganic

nutrients as well. Food provides energy and the building blocks for growth and tissue repair; it can be used immediately or stored for later use. For example, many plants store food in the form of starch.

All foods can be considered nutrients, but not all nutrients are considered food. To be considered food in a biological sense, the substance must contain energy that can be released during cellular respiration. Inorganic nutrients such as water and minerals are essential to metabolic processes but do not provide energy. The "plant food" commonly sold in stores is not food in a biological sense. It provides a source of inorganic nutrients that may not be present in the soil. Likewise, soil is not food but rather a source of plant nutrients such as minerals and water. Leaves are plant structures in which photosynthesis takes place and sugars are made. The leaves and other plant structures are then food for animals that eat plants. Sunlight is the form of energy used by the plant during photosynthesis, but it is not a substance and does not provide the building blocks needed to grow or repair plant structures. Chlorophyll is a substance contained in the plant's chloroplasts that is involved in photosynthesis. Fats, oils, and proteins are also foods. The only item on the list that is considered food for a plant is sugar.

Curricular and Instructional Considerations

Elementary Students

In the elementary grades students learn about the needs of organisms. Through a variety of instructional opportunities, students learn that animals take their food in from the environment by eating plants, animals, or both. Students wonder about the differences between plants and animals and ask questions such as "How do plants get food?" (NRC 1996, p. 128). They learn that plants need nutrients and may be introduced to the idea that plants make their own food, but the ideas related to the process of photosynthesis are not developed until middle school. Elementary students also learn about food groups and nutrients in the context of human nutrition. Identifying sugar as the food plants use exceeds grade-level expectations for elementary students. However, the probe is useful in identifying ideas that form early about food for plants, particularly the notion that plants get their food from the soil.

Middle School Students

In middle school, students are introduced to the basic process of photosynthesis. They learn that plants make sugar from carbon dioxide and water using energy from sunlight and that the sugar can be used by the plant as a source of energy and as material for growth and repair or can be stored for later use. Middle school is the time when students need to develop a scientific conception of food different from the common, everyday use of the word. Even though the basic process of photosynthesis—including the idea that sugars are plants' *only* food—has been taught, middle school students may

hold tenaciously to the misconception that plants get their food from the environment, particularly from nutrients in the soil or commercial plant food.

High School Students

In high school, students deepen their understanding by connecting their growing understanding of chemistry to the biological process of photosynthesis. The understanding that food is a source of energy is expanded to include the idea of energy from sunlight stored in the chemical bonds that form between the sugar's carbon atoms. This probe is useful at the high school level because it will often reveal that even after students have learned about photosynthesis, the idea that energy is released when chemical bonds are broken, and the biological concept of food, they may revert to their prior conceptions about where plants get their food.

Administering the Probe

This probe can be used with elementary students by removing unfamiliar words such as *chlorophyll* and substituting *air* for *carbon dioxide* and *oxygen*. For high school students the word *sugar* can be added to or substituted with *simple sugar* or *glucose*. High school teachers may also add *starch, oils,* and *protein* to the list. This probe may also be used as a card sort.

Related Ideas in *National Science Education Standards* (NRC 1996)

K–4 The Characteristics of Organisms

- Organisms have basic needs. For example, animals need air, water, and food; plants require air, water, nutrients, and light.

5–8 Populations and Ecosystems

★ For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis.

9–12 The Cell

★ Plant cells contain chloroplasts, the site of photosynthesis. Plants and many microorganisms use solar energy to combine molecules of carbon dioxide and water into complex, energy-rich organic compounds and release oxygen to the environment. This process of photosynthesis provides a vital connection between the Sun and the energy needs of living systems.

9–12 Matter, Energy, and Organization in Living Systems

★ The energy for life primarily derives from the Sun. Plants capture energy by absorbing light and using it to form strong (covalent) chemical bonds between atoms of carbon containing (organic) molecules. These molecules can be used to assemble larger molecules with biological activity (including proteins, DNA, sugars, and fats). In addition, the energy stored in bonds between the atoms (chemical energy) can be used as sources of energy for life processes.

★ Indicates a strong match between the ideas elicited by the probe and a national standard's learning goal.

Related Ideas in *Benchmarks for Science Literacy* (AAAS 1993)

K–2 Cells

- Most living things need food, water, and air.

K–2 Flow of Matter and Energy

- Plants and animals both need to take in water, and animals need to take in food. In addition, plants need light.

3–5 Flow of Matter and Energy

- Some source of "energy" is needed for all organisms to stay alive and grow.

6–8 Flow of Matter and Energy

★ Food provides molecules that serve as fuel and building material for all organisms. Plants use the energy in light to make sugars out of carbon dioxide and water. This food can be used immediately for fuel or materials, or it may be stored for later use.

Related Research

- Much of the research on students' ideas about food for plants was conducted in the 1980s and still applies to students' ideas today. Universally the most persistent notion is that plants take their food from the environment, particularly the soil. Students also believe that plants have multiple sources of food (Driver et al. 1994).
- Children appear to consider food as anything useful taken into an organism's body, including water, minerals, and, in the case of plants, carbon dioxide or even sunlight. Typically, students do not consider starch as food for plants. Their reasoning is that starch is something plants make, not something they eat (Driver et al. 1994).
- Students often give a nonfunctional explanation about why plants and animals need food. They say it is needed to keep them alive, rather than describing the role of food in metabolism (Driver et al. 1994).
- In a study by Wandersee (1983) that surveyed 1,405 students ages 10–19 about the product of photosynthesis, most students selected proteins, relating them to food for growth, rather than energy. Some students in this study also mentioned plants getting vitamins from the soil.
- In a study by Tamir (1989), some students thought sunlight, associated with energy, was the food for plants. Many students also considered minerals taken in from the soil as food or believed that minerals had a direct role in photosynthesis.
- The everyday reference to fertilizers as "plant food" may promote the idea of fertilizer as being the food for plants (Driver et al. 1994).
- The idea that plants take their food in from the environment, rather than making it internally, is a common misconception that is highly resistant to change. Even when taught how plants make food by photosynthesis, students still hold on to the notion that food is taken in from the outside (AAAS 1993).

★ Indicates a strong match between the ideas elicited by the probe and a national standard's learning goal.

- Some children consider chlorophyll to be a food substance (Driver et al. 1994).

Suggestions for Instruction and Assessment

- Take the time to elicit students' definitions of the word *food*; many students use this word in a way that is not consistent with its biological meaning (AAAS 1993). Have students identify the difference between the everyday use of the word and the scientific use. Contrasting the two uses and providing examples may help them see the difference and begin to use the scientific definition.
- Understanding that the food plants make is very different from other nutrients such as water and minerals may be a prerequisite for understanding the idea that plants make their food rather than acquire it from the environment (Roth, Smith, and Anderson 1983).
- Many researchers note the conceptual demands of the topic of plant nutrition and point out that to understand the abstract and complex concept of photosynthesis, students need to possess the prerequisite concepts of living things, gas, food, and energy. Before introducing a chemical equation for photosynthesis, first help students understand that "an element, carbon (which is solid in its pure form), is present in carbon dioxide (which is a colorless gas in the air) and that this gas is converted by a green plant into sugar (a solid, but in solution) when hydrogen (a gas) from water (a liquid) is added using light energy, which is consequently converted to chemical energy" (Driver et al. 1994, p. 30).
- High school students can often define photosynthesis and provide the equation, but questions that ask them to apply a basic understanding are often not asked of students. Use questions that encourage students to use the concept of photosynthesis to explain food, growth, and energy-related plant ideas.
- Show a container of plant food and a container of vitamins for humans. Build an analogy between the two to show that their purpose is to provide essential inorganic nutrients, not food energy.

Related NSTA Science Store Publications and Journal Articles

American Association for the Advancement of Science (AAAS). 1993. *Benchmarks for science literacy.* New York: Oxford University Press.

Driver, R., A. Squires, P. Rushworth, and V. Wood-Robinson. 1994. *Making sense of secondary science: Research into children's ideas.* London: RoutledgeFalmer.

George, R. 2003. How do plants make their own food? *Science & Children* (Feb.): 17.

Keeley, P. 2005. *Science curriculum topic study: Bridging the gap between standards and practice.* Thousand Oaks, CA: Corwin Press.

National Research Council (NRC). 1996. *National science education standards.* Washington, DC: National Academy Press.

Wali Abdi, S. 2006. Correcting student miscon-

ceptions. *Science Scope* 29 (4): 39.

Weinburgh, M. 2004. Teaching photosynthesis: More than a lecture but less than a lab. *Science Scope* 27 (9): 15–17.

Related Curriculum Topic Study Guides

(Keeley 2005)

"Food and Nutrition"

"Photosynthesis and Respiration"

References

American Association for the Advancement of Science (AAAS). 1993. *Benchmarks for science literacy.* New York: Oxford University Press.

Driver, R., A. Squires, P. Rushworth, and V. Wood-Robinson. 1994. *Making sense of secondary science: Research into children's ideas.* London: RoutledgeFalmer.

Keeley, P. 2005. *Science curriculum topic study: Bridging the gap between standards and practice.* Thousand Oaks, CA: Corwin Press.

National Research Council (NRC). 1996. *National science education standards.* Washington, DC: National Academy Press.

Roth, K., E. Smith, and C. Anderson. 1983. *Students' conceptions of photosynthesis and food for plants.* East Lansing, MI: Michigan State University, Institute for Research on Teaching.

Tamir, P. 1989. Some issues related to the justifications to multiple choice answers. *Journal of Biological Education* 11 (1): 48–56.

Wandersee, J. 1983. Students' misconceptions about photosynthesis: A cross-age study. In *Proceedings of the international seminar: Misconceptions in science and mathematics,* eds. H. Helm and J. Novak, 441–446. Ithaca, NY: Cornell University.