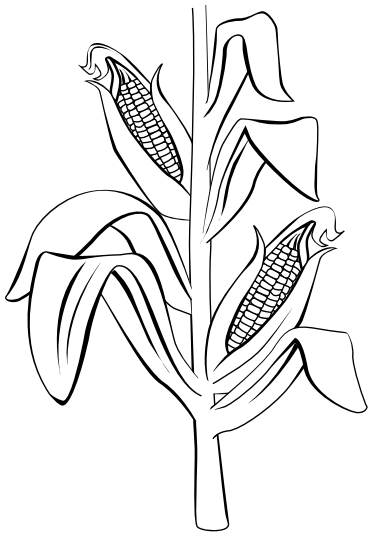
Food for Corn



Eight farmers were talking about their cornfields. They each had different ideas about the food their corn needed to grow. This is what they said:

Mrs. Farrin: "My corn plants use sunlight as their food."

Mrs. Tobias: "My corn plants use food they get from the soil."

Mr. Cullenberg: "My corn plants use sugar as their food."

Mr. King: "My corn plants use food from the fertilizer I give them."

Mrs. Joslyn: "My corn plants use carbon dioxide and water as their food."

Mr. Cody: "My corn plants use food from the chlorophyll in their leaves."

Mr. Trask: "My corn plants use food from the ears of corn they produce."

Mrs. Ahlholm: "My corn plants don't use food; instead, they make food for animals to eat."

Which farmer do you agree with the most? _____ Explain why you agree with that farmer.

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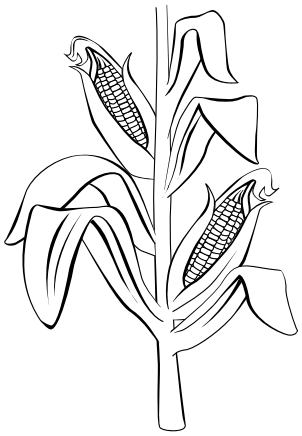
Food for Corn

Teacher Notes



Purpose

The purpose of this assessment probe is to elicit students' ideas about "plant food." The probe is designed to reveal whether students recognize that plants use the sugars they make as their food.

Related Concepts

Food, photosynthesis, plants

Explanation

The best response is Mr. Cullenberg's: "My corn plants use sugar as their food." Plants take in carbon dioxide through their leaves and water through their roots and use energy from sunlight to break apart and reassemble these molecules into a carbohydrate in the form of a simple sugar. This simple sugar (glucose) is often converted to a more complex sugar such as sucrose, starch, or cellulose. Plants can use the food (sugars) they make immediately or store it for later use. Sunlight is the source of energy for the food-making process of photosynthesis, but, by itself, it is not food (Mrs. Farrin's response). The captured energy from sunlight is transformed into chemical energy, which is stored in the chemical bonds between the atoms of carbon-containing organic molecules. Soil is the substrate in which plants grow and from which they take in water and minerals through their roots (Mrs. Tobias's response). Water and minerals are essential nutrients but they are not food. Fertilizer provides essential elements plant need such as potassium, nitrogen, magnesium, and phosphorus, but it is not food (Mr. King's response).

Carbon dioxide and water are substances plants take in to make their food, but, in their original form, they are not food (Mrs. Joslyn's response). They are broken down into atoms and molecules that are reassembled to form the sugar that becomes the food for the plant. Chlorophyll is the green pigment found within the plant cell's chloroplast that absorbs light energy for use during photosynthesis (Mr. Cody's response). Plants convert sugars they make into new structures, such as the ears of

corn that are produced when the corn is pollinated and seeds form. The sugar in the kernels of corn will provide food for the corn seedling as it germinates, but it is not the food the adult corn plant uses to grow (Mr. Trask's response). Plants not only make food but they use it too (Mrs. Ahlholm's response). Food is the material that provides energy and the building blocks for growth and repair for all organisms, including plants.

Curricular and Instructional Considerations

Elementary Students

In the elementary grades, students learn that plants need water, sunlight, nutrients, and air. They may be introduced to the idea that plants make their own food, but the ideas related to the reactants, products, and process of photosynthesis can wait until middle school. Elementary students should know that all living things, including plants, need food and that food provides energy.

Middle School Students

In middle school, students are introduced to the basic process of photosynthesis. They learn that plants make sugars from carbon dioxide that they take in through their leaves and water they take in from their roots and that the process requires energy from sunlight. They learn that plants use the sugars they make as their food in addition to making that food available to other organisms. They learn that food provides a source of energy as well as material for plant growth and repair. They learn that the food that plants make can be used immediately or stored for later use, such as in the bulb of a flowering plant. Middle school is also the time when students develop a scientific conception of *food* that differs from the common, everyday use of the word *food*.

High School Students

In high school, students deepen their understanding of photosynthesis at the molecular level by connecting their growing understanding of chemistry to the biological process of photosynthesis. They learn about the different types of carbohydrates formed by plants from simple sugars. They make connections among sunlight, food, and the energy released from the chemical bonds formed between atoms that make up the molecules of sugar.

Administering the Probe

This probe is best used at the middle and high school level. To activate their thinking, ask students if they have ever seen a corn plant or a field of corn. Where do these corn plants get the food they need to grow? For high school students, you may consider substituting the word *carbohydrates* for *sugar*.

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

- Plants and some microorganisms are producers—they make their own food.
- For ecosystems, the major source of energy is sunlight. Energy entering ecosystems as sunlight is transferred by producers into chemical energy by 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

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

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 the 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.
- The chemical bonds of food molecules contain energy. Energy is released when the bonds of food molecules are broken and new compounds with lower energy bonds are formed. Cells usually store this energy temporarily in phosphate bonds of a small, high-energy compound called ATP.

Related Ideas in *Benchmarks for Science Literacy* (AAAS 2009)

K–2 Flow of Matter and Energy in Ecosystems

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

K–2 Cells

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

3–5 Flow of Matter and Energy in Ecosystems

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

6–8 Flow of Matter and Energy in Ecosystems

- Food provides molecules that serve as fuel and building material for all organisms.
- ★ Plants use the energy from light to make sugars from carbon dioxide and water.
- Plants can use the food they make immediately or store it for later use.

9–12 Flow of Matter and Energy in Ecosystems

- The chemical elements that make up the molecules of living things pass through food webs and are combined and recombined in different ways. At each link in a food web, some energy is stored in newly made structures, but much is dissipated into the environment. Continual input of energy from sunlight keeps the process going.

Related Research

- Universally, the most persistent notion people of all ages have about where plants get their food 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 (Driver et al. 1994).
- 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.

★ 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). For plants, chlorophyll is not food; it only serves as food for animals that consume it and break it down.
- Food is colloquially understood to be anything an organism takes in for nourishment; therefore, students believe that anything absorbed from the soil is food. This is an instance where everyday meaning and scientific meaning clash and create confusion. Garden fertilizers labeled "plant food" reinforce this erroneous idea that fertilizer is food for plants (Allen 2010).
- The common misconception that plants get their food from the environment rather than manufacturing it internally, and that food for plants is taken in from the outside, is particularly resistant to change, even after instruction (Anderson, Sheldon, and Dubay 1990).
- Some students who know that plants make their own food think they do so for the benefit of animals that eat plants. They do not recognize that plants use the food they make (Driver et al. 1994).

Suggestions for Instruction and Assessment

- Combine this probe with "Is It Food for Plants?" in *Uncovering Student Ideas in Science, Vol. 2: 25 More Formative Assessment Probes* (Keeley, Eberle, and Tugel 2007).
- Combine this probe with probe #9 in this book, "Apple Tree," to determine whether students recognize both the plant structure in which food is made and what plants use their food for.
- 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 2009). For example, many students think of food as something that is taken in through the mouth. Have students identify the difference between the everyday use of the word *food* and the scientific use of the word. Contrasting the two uses and providing examples may help students recognize the difference and know when the word is used in a biological context.
- Beginning in elementary grades, students need to recognize that all organisms need and use food. This includes plants as well as animals.
- Understanding that the food plants make is very different from nutrients they take in may be a prerequisite for understanding the idea that plants make their food rather than acquire it from their environment (Roth, Smith, and Anderson 1983).
- High school students can often define *photosynthesis,* provide the equation, name the cell organelle involved, and identify glucose as the food that is made. However, students are rarely asked basic questions that call on them to apply this understanding. Develop questions that use the concept of photosynthesis to explain food, growth, repair, and energy-related plant ideas.
- Provide examples that help students recognize that plants use the sugars they make, such as the maple sap flowing in a tree in the spring or the stored starch in a bulb.
- With high school students, trace disaccharides (sucrose) and polysaccharides (starch, cellulose) in plants back to the simple sugar produced during photosynthesis. Use the analogy of a plant as a kind of food factory, manufacturing its own glucose from raw materials, using it as fuel, converting it to cellulose to build plant structures, or storing it for later use in the form of starch.
- It might be worth pointing out that some common plants do partition part of their sugars to serve as food for animals. Apples, cherries, and some other fleshy fruits evolved specifically to attract animals that

will eat the fruit. The seeds within these fruits can survive passing through the animal's digestive tract and are deposited with feces to grow new plants in new areas. The primary dispersal mechanism of species of plants with fleshy fruits is consumption by animals. Some more astute students might raise this question. Some plants even fine-tune their fruits to ensure only the correct species eat them. The capsaicins that make chili peppers hot are meant to deter mammals (whose guts destroy the seeds) from eating the fruits. Birds cannot sense the chemicals, so they eat them and distribute the seeds.

- The Phenomena and Representations for the Instruction of Science in Middle Schools (PRISMS) website, a collection in the National Science Digital Library (NSDL) funded by the National Science Foundation, provides examples of reviewed web-based phenomena and representations related to the topic of photosynthesis at *http://prisms.mmsa.org*.

Related NSTA Science Store Publications, NSTA Journal Articles, NSTA SciGuides, NSTA SciPacks, and NSTA Science Objects

American Association for the Advancement of Science (AAAS). 2001. *Atlas of science literacy.* Vol. 1. (See "Flow of Matter in Ecosystems" map, pp. 76–77, and "Flow of Energy in Ecosystems" map, pp. 78–79.) Washington, DC: AAAS.

George, R. 2003. How do plants make their own food? *Science and Children* 40 (5): 17.

Koba, S., with A. Tweed. 2009. *Hard-to-teach biology concepts: A framework to deepen student understanding.* (See Chapter 4, "Photosynthesis and Respiration," pp. 119–141.) Arlington, VA: NSTA Press.

Mundry, S., P. Keeley, and C. Landel. 2009. *A leader's guide to science curriculum topic study.* (See Module B6, Photosynthesis and Respiration Facilitation Guide, pp. 144–149.) Thousand Oaks, CA: Corwin Press.

Related Curriculum Topic Study Guides (in Keeley 2005)
"Food and Nutrition"
"Photosynthesis and Respiration"

References

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Anderson, C., T. Sheldon, and J. Dubay. 1990. The effects of instruction on college non-majors' conceptions of respiration and photosynthesis. *Journal of Research in Science Teaching* 27: 761–776.

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 and Arlington, VA: NSTA Press.

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