

Some Background Concerning Life Science Content Standards for Fifth-Grade Teachers:

How Plants Make Food

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Introduction

The background information for teachers in this document addresses the following life science content standards¹ for fifth-grade teachers:

2. Plants and animals have structures for respiration, digestion, waste disposal, and transport of materials. As a basis for understanding this concept:

f. Students know plants use carbon dioxide (CO₂) and energy from sunlight to build molecules of sugar and release oxygen.

For additional information, see pages 70-72 in the *Science Framework for California Public Schools Kindergarten Through Grade Twelve* and visit the websites listed at the end of this document.

Biological Overview: Structure of Organisms

Life science students sometimes have difficulty remembering what level of biological structure is being discussed in each classroom activity. Therefore, Table 1 is an important reference to reduce student confusion in life sciences.

¹ As specified in *Science Framework for California Public Schools Kindergarten Through Grade Twelve*. Sacramento: California Department of Education, 2003, pp 70-72.

Table 1. Internal structure of multicellular creatures. Biologists study the bodies of plants and animals at several levels of biological organization.

Level of Biological Organization	Description	Animal Examples	Plant Examples
ORGANISM	One individual of a species	You!	Sunflower
Body Systems	Organs that work together within an animal	Circulatory system Respiratory system Digestive system Urinary system	[Not Applicable]
Organs	A part of an organism with a special function	Heart Lungs Stomach	Flower Leaf Stem Root
Tissues	Several types of cells that function together	Blood Muscle Nerve	Epidermis Xylem Phloem
Cells	Smallest independent unit of life	Red blood cell White blood cell Brain cell	Guard cell Vessel Root hair
Organelles	Structure within a cell	Mitochondria	Chloroplasts Mitochondria
Molecules	Chemical compound	Water Sugar Carbohydrate Protein Fat	Water Carbon dioxide Chlorophyll Oxygen gas Sugar
Atoms	Chemical element	Carbon atom Hydrogen atom Oxygen atom	Carbon atom Hydrogen atom Oxygen atom
Subatomic	Particles that make an atom	Electron Proton Neutron	Electron Proton Neutron

Life Science Topic: How Plants Make Food

Plants and animals have bodies composed of cells, which require food to live.

The main difference between plants and animals is that plants make their own food, and animals eat food.

This difference between plants and animals can also be seen at the biological level of the cell; most plant cells have green organelles (chloroplasts) inside them, while animal cells do not have green organelles. These green organelles allow plants to make their own food!

How Plant Cells Make Food from Water and Air

Science Framework² for California Public Schools

Grade 5: Standard Set 2. Life Sciences: 2.f. *"Students know plants use carbon dioxide (CO₂) and energy from sunlight to build molecules of sugar and release oxygen."*

*"Photosynthesis is the name of the process by which plants capture the energy of the sun and use it to initiate a chemical reaction between carbon dioxide and water that results in the production of sugar molecules and the release of oxygen molecules. The chemical process is as follows:
energy + carbon dioxide + water react to form sugar + oxygen*

*The process is expressed in the following equation:
energy + 6 CO₂ + 6 H₂O → C₆H₁₂O₆ + 6 O₂*

The sugar made during photosynthesis is just an initial compound the plant produces. All the other organic molecules are made by modification of this simple compound. For example, a significant portion of the mass of a log from a tree was once carbon dioxide gas in the air, captured by the leaves of a tree, and fixed into larger organic molecules as shown by the equation noted above. The sugar transport processes in the tree are also important in moving the products of photosynthesis down to the stem, where they could then become a part of the tree."

² As specified in *Science Framework for California Public Schools Kindergarten Through Grade Twelve*. Sacramento: California Department of Education, 2003, pp 70-72.

Background for Teachers³

In each cell of every leaf of a plant are tiny green bead-like organelles called chloroplasts (Figure 1) that contain special green molecules called chlorophyll. Chlorophyll molecules can capture the energy of light (sunlight and lamp light) and pass that energy into other molecules. Most molecules do not have this ability; but chlorophyll does!

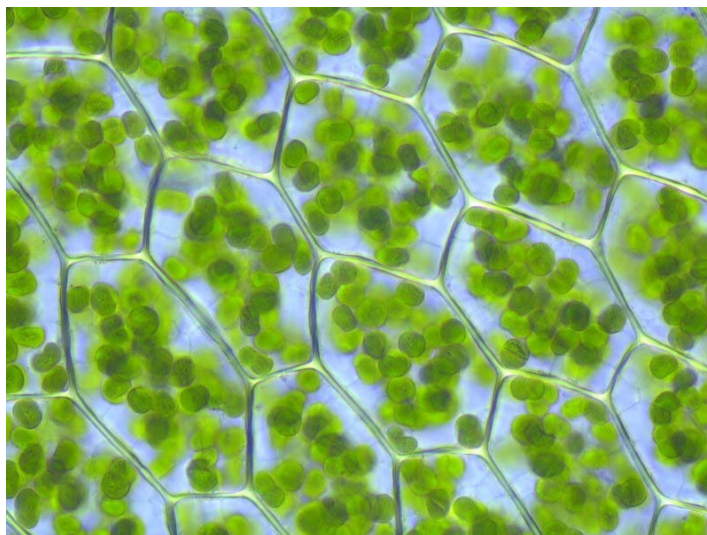


Figure 1. Microscopic photograph⁴ of plant cells containing green organelles called *chloroplasts*. Chloroplasts are green because they contain green molecules (*chlorophyll*).

When light hits a chlorophyll molecule (in a chloroplast in a cell in a leaf of a plant), the chlorophyll molecule vibrates with energy, and uses this energy to break water molecules (H_2O) apart, thereby putting the sunlight energy into “energy-packets”⁵. Every time two water molecules are broken apart, a molecule of oxygen (O_2) is released into the air.

Plants need light to make oxygen molecules from water.

Figure 2 shows bubbles of oxygen molecules being released from aquatic plants in the presence of lamplight (which simulates sunlight). When the light is turned off, the bubbles stop.

³ To deepen student understanding of photosynthesis, the following article recommends teaching concepts before teaching vocabulary words. Sullivan KJ (2008) “**Using everyday language to teach science may help students learn,**” study says. *Stanford University News* August 20, 2008. (<http://news-service.stanford.edu/news/2008/august20/teachsci-082008.html>)

⁴ From website: http://commons.wikimedia.org/wiki/File:Plagiomnium_affine_laminazellen.jpeg

⁵ The “energy-packets” are in ATP molecules (which contain the sunlight-energized hydrogen atom that was broken off the water molecule).



Figure 2. Photograph⁶ of aquatic plants: bubbles of oxygen molecules are released from the leaves in the presence of light (sunlight and/or lamplight). Plants make oxygen molecules only in the presence of light; the bubbles stop when the light is turned off.

Meanwhile, carbon dioxide molecules (CO_2) from the air enter the leaf through tiny pores (Figure 3). This movement of carbon dioxide happens both day and night.

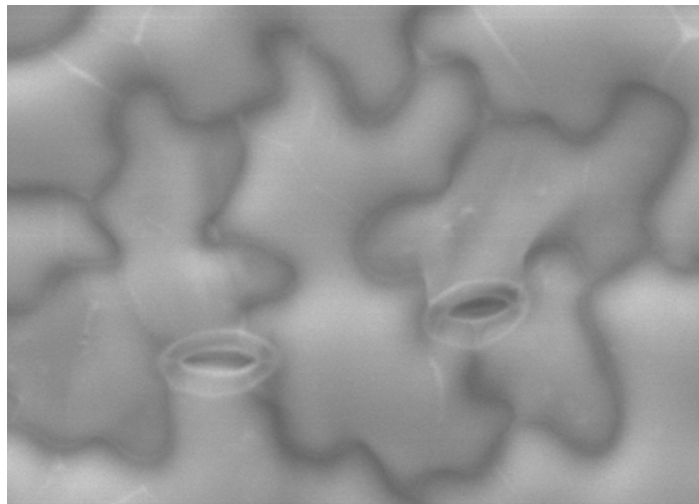


Figure 3. Close up photograph⁷ of leaf surface with specialized cells around pores. Plants have pores that take carbon dioxide molecules into the leaf. The pores (stomata) open and close by means of special cells (guard cells).

⁶Photograph from the educational website of the *Exploratorium* in San Francisco)
http://www.exploratorium.edu/xref/exhibits/oxygen_bubbles.html

Once they enter through leaf pores, the carbon dioxide molecules travel to cells inside the leaf and enter the chloroplasts of each cell. At this point, the “energy packets” (made earlier from the breaking of water) release their stored energy to link six carbon dioxide molecules together (like stringing pearls on a thread) to make a sugar molecule. This sugar molecule holds the sunlight energy that was originally captured and transferred by the chlorophyll molecules!

**The process of capturing sunlight energy
and storing this energy in sugar molecules
is called *photosynthesis*.**

The chemical reaction of photosynthesis, which takes place in the chloroplasts of plant cells, can be summarized simply in the following diagram (Figure 4) and as follows:

1. Plants take in water through their roots.
2. Sunlight energy is captured by chlorophyll molecules.
3. Oxygen is released into the air from the leaves.
4. Plants take in carbon-dioxide from the air through their leaves
5. Sugar is made (synthesized).
6. The sugar molecules synthesized in photosynthesis are the building blocks for food nutrients: carbohydrate molecules, fat molecules, and protein molecules.

⁷ Photograph from <http://upload.wikimedia.org/wikipedia/commons/9/90/Arabidopsis-epiderm-stomata2.jpg>

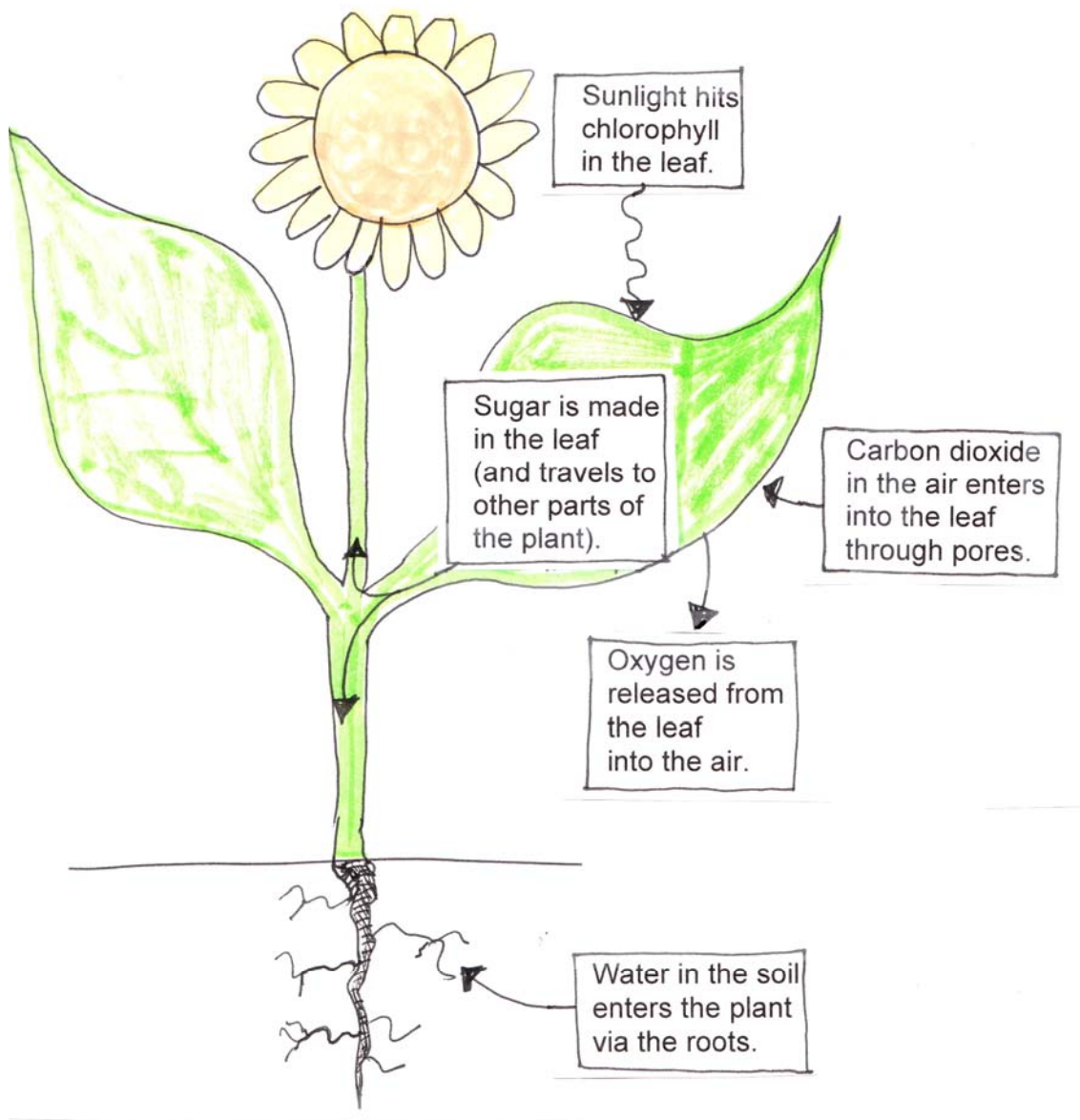


Figure 4. Simplified summary of photosynthesis. Water molecules and carbon dioxide molecules enter the plant; sunlight strikes the chlorophyll molecules inside the plant; oxygen molecules are released; sugar molecules are made and stored.

Websites

Photosynthesis

Biology 4 Kids Educational Site

This website contains simple descriptions and diagrams of photosynthesis.

http://www.biology4kids.com/files/plants_photosynthesis.html

This page explains the process of photosynthesis in plant cells.

http://www.biology4kids.com/files/cell_chloroplast.html

This page describes chloroplasts and their role in photosynthesis.

Kidpede Educational Site of History and Science

This website contains biology information for middle school students.

<http://www.historyforkids.org/scienceforkids/biology/cells/photosynthesis.htm>

This page describes photosynthesis.

You Tube Home Video by Children

This website contains some videos that are related to biology.

<http://www.youtube.com/watch?v=ihxVt3DJaF0>

This link is a very funny (and accurate) educational home video that teaches about photosynthesis. It is a play on "Bill Nye the Science Guy."