4-H Virtual Forest User's Guide

Photosynthesis

Concept

This module will illustrate the process of photosynthesis. Specifically, students will explore how light energy, water, and carbon dioxide are converted into sugars and oxygen. Students will learn about the fate of these "by-products" in the environment, and complete an interactive learning activity to demonstrate that they have learned the photosynthetic process.

This module supports the following Science SOLs:

Living Systems and Processes

4.2 a) the survival of plants and animals depends on photosynthesis

2.5 a) plants and animals are interdependent with their living and nonliving surroundings

Earth Resources

4.8 d) forests, soil, and land

LS.4 The student will investigate and understand that there are chemical processes of energy transfer which are important for life. Key ideas include:

a) photosynthesis is the foundation of virtually all food webs; and
b) photosynthesis and cellular respiration support life processes.

Module Description

Begin. Plants and animals have several things in common. For example, both plants and animals are composed mostly of water and protein, contain cells and tissues, consume and store energy, and reproduce. However, plants and animals are also different in many ways. One major difference is that most plants can manufacture their own food. Animals can't!

The module opens with an image of three or more trees, standing side by side, with the sun radiating light. Sidebar text introduces the concept of photosynthesis. The text reads as follows:

> “Did you know that trees and plants can make their own food, but animals can’t? Trees and plants make food and help produce the oxygen we breathe through an interesting process called photosynthesis.”

Photosynthesis means “putting together with light.” During photosynthesis, trees and plants use energy from the sun to change carbon dioxide and water into sugars and oxygen.

Throughout the module, the user advances to the next frame by clicking the forward arrow with the mouse. Users can also return to the previous frame by clicking the back arrow.

Chloroplasts. Photosynthesis takes place in structures called “chloroplasts”. Chloroplasts are found mainly in the plant’s leaves, and contain green pigments called “chlorophyll.” Chlorophyll traps and stores energy from sunlight, and it gives leaves their green color.

This frame illustrates the cross section and structure of a leaf. Sidebar text describes chloroplasts and chlorophyll, and introduces some interesting trivia.

> “The leaves contain the structures that make photosynthesis work. These structures are called chloroplasts. A leaf has about 500,000 chloroplasts per square millimeter! Each chloroplast contains green pigments called chlorophyll.”

Clicking the arrow labeled “Detail” causes a chloroplast to expand and show the structure’s internal detail.

Sunlight, Air, and Water. This frame illustrates how sunlight, water, and air enter the leaf. While chlorophyll is capturing sunlight, tree roots are absorbing water and nutrients. The water and nutrients are carried up the tree in the xylem and enter the leaves through veins. Something else is also happening: carbon dioxide is entering the leaves through openings called stomata!

Clicking each arrow surrounding the leaf—labeled 1, 2, and 3—results in animation that shows sunlight (1), air (2), and water (3) entering the leaf.

Chlorophyll. Once the water and carbon dioxide reach the leaves they come into contact with the chloroplasts. The *chloroplasts* take energy absorbed by the *chlorophyll* and use it to change carbon dioxide and water into sugar and oxygen. It may be helpful to think of chloroplasts as chemical factories powered by the sun. This frame illustrates the photosynthetic reaction occurring in the chloroplast, accompanied by the sound of a factory.

Inside the Leaf. This frame returns us to the leaf cross section to show how the photosynthetic products are dispersed. Oxygen is released to the atmosphere through the stomata. The sugars exit the leaves through the veins.

Xylem and Phloem. This frame illustrates how phloem carries sugars throughout the tree. It also shows water moving up through the xylem to the leaves. Sidebar text refers to this process, and also introduces the fact that half of the sugars produced during photosynthesis are used to fuel the tree's growth, and scientific estimates show that photosynthesis produces an estimated 176 billion tons of sugars each year.

Energy Storage. Fortunately for us, trees produce more food than they need. Leftover sugars are stored in the cells of roots and fruits. We obtain this energy by eating products such as apples, bananas, and oranges. Animation in this frame illustrates some of the edible fruits, vegetables, and roots that come from trees and plants.

Fall Colors. Students and adults alike often have questions regarding why leaves change color and drop to the ground in the fall. This frame attempts to answer these questions.

As summer turns into fall, the days become shorter and the temperature gets colder. Trees respond to this decrease in sunlight by producing less chlorophyll. Other pigments begin to show through, and the leaves change color from green to yellow, orange, red, or brown. Eventually, trees stop producing chlorophyll entirely. Without chlorophyll, photosynthesis stops, and the leaves fall to the ground.

Animation to the right illustrates leaves from four common Virginia tree species, and the colors that those species typically turn in the fall. Rolling the mouse over this image results in a pop-up window that explains how features called "carotenoids" and "anthocyanins" contribute to a leaf's coloration. The summary line at the bottom of the screen introduces the concept that conifers continue photosynthesis during the winter months, but at a slower rate.

Decomposition. It is important to introduce the process of decomposition. When trees fall to the ground and begin to rot, or decompose, they take in oxygen and give off carbon dioxide. Many people mistakenly feel that, if we continue to harvest timber, then we will run out of oxygen. This is untrue, for reasons addressed in more detail in the "Timberrr!" module.

Conclusion. In conclusion, although most of the Earth's atmospheric oxygen comes from plant-like organisms in the ocean and geologic processes, photosynthesis is still a very important process that helps support life on earth. Photosynthesis produces oxygen, food, and wood. These are things that animals, including people, need to live.

At this point the user can engage in an interactive learning activity by clicking to "create your own photosynthesis!" Click the mouse within the orange circle to begin.

Learning Activity - Create your own photosynthesis!

An interactive learning activity entitled "Create Photosynthesis" enables student to reinforce what they learned in the module by "creating" a photosynthetic reaction. Using

the mouse, users click and drag each ingredient to the appropriate leaf. Clues accompanying each leaf help steer the user in the right direction. An incorrect match results in a buzzer, and the ingredient returns to its position at the bottom of the screen automatically. Correct matches are accompanied by a sound, a brief statement about that feature, and the ingredient remains attached to the leaf. The matches are as follows:

- Provides light energy – sun
- Enters through the roots – water
- Absorbed through stomata – carbon dioxide

Once all three matches are made, the text “Congratulations! You created photosynthesis!” appears at the top of the screen. The reaction is show at the bottom of the screen, and students are given the opportunity to “Play Again” or return to the main module.

References

Campbell, N.A. 1990. *Biology*. (2nd ed). The Benjamin Cummings Publishing Company, Inc. Redwood City, CA. 1165 p.