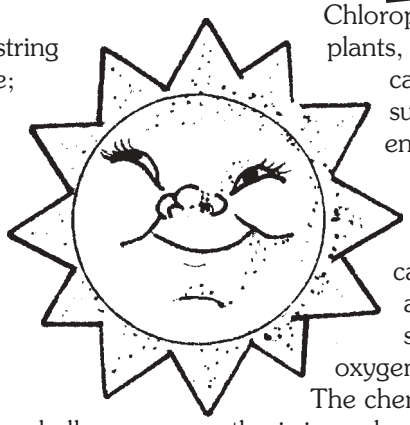
Gifts from the Sun

LEVEL: Grades 4-8
SUBJECTS: Language Arts (Drama), Science
SKILLS: Applying, collaborating, comprehending, cooperating, creating and improvising, demonstrating, describing, developing vocabulary, discussing, listening, perceiving spacial relationships, performing, role-playing, sequencing, synthesizing, understanding cause and effect, visualizing

MATERIALS

Drawing paper or tagboard; string or straight pins; scissors; tape; orange or apple slices (one slice per student); photocopies of the attached ***Photosynthesis Role Cards*** set. **Optional**: hand lens or magnifying glasses; small potted houseplant such as a Wandering Jew.



VOCABULARY

atom, carbon dioxide, chlorophyll, consumer, element, photosynthesis, producer, root, stomata, water molecule

SUPPORTING INFORMATION

The sun is only one of billions of stars in the universe. It is nearer Earth than any other star. Many ancient peoples thought the sun was a god. They worshipped the sun, made offerings to it, and built temples to honor it. Many early beliefs about the sun began when people tried to explain the movement of the sun across the sky. Sun worship or adoration of the sun still can be found among many religions throughout the world.

The energy for living things comes from the sun. Plants, algae and a few bacteria can capture the sun's energy and transform it into chemical energy for food through a biological process called photosynthesis. Before photosynthesis can begin in plants, carbon dioxide (a gas found in the atmosphere) will have entered the plant. In most plants, this occurs through tiny pores in the leaves called stomata. (One pore is called a stoma. In Greek, stoma means mouth.) Water also will have traveled through the roots and stem to the leaves, carrying dissolved minerals obtained from the soil. Leaves are the primary site of photosynthesis. Chlorophyll in the leaves of green plants, algae and some bacteria capture the energy from sunlight (called radiant energy). Organisms that contain chlorophyll look green because chlorophyll reflects green light. The carbon dioxide and the water are made into food (a simple sugar called glucose) and oxygen and water are released. The chemical equation for photosynthesis is read as follows: 6 molecules of carbon dioxide ($6CO_2$) plus 12 molecules of water ($12H_2O$) in the presence of sunlight and chlorophyll are used to produce 1 molecule of glucose ($C_6H_{12}O_6$) plus 6 molecules of water ($6H_2O$) plus 6 molecules of oxygen ($6O_2$).

$$6CO_2 + 12H_2O \xrightarrow[\text{chlorophyll}]{\text{sunlight}} C_6H_{12}O_6 + 6H_2O + 6O_2$$

Photosynthesis is a complex process. The chemical equation represents the sum of many separate, but related actions that occur. The water molecule, for example, splits into hydrogen and oxygen. The hydrogen combines with carbon dioxide to form glucose ($C_6H_{12}O_6$) and the oxygen atom combines with another oxygen atom to form an oxygen molecule (O_2). Within the glucose molecule the carbon, hydrogen and oxygen atoms are held together by chemical bonds. The radiant energy (sunlight) captured by the chlorophyll has been transformed into chemical energy. This energy is stored in the chemical bonds of the glucose molecule. Eventually, the plant expels the extra water and oxygen molecules (O_2) through the stomata in the leaves. Much of

BRIEF DESCRIPTION

Through creating and improvising, students learn the components and basic process of photosynthesis.

OBJECTIVES

The student will:
- role-play the components of photosynthesis; and
- discuss the importance of photosynthesis to plants and other living things.

ESTIMATED TEACHING TIME

One session: One and a half to two hours. (Can be taught in two sessions.)

life on Earth is dependent on this oxygen (to break down food and to breathe) produced through the photosynthetic process.

Plants can make other substances from the glucose, including other simple sugars. Long strings of sugars can be linked together to form starches. Glucose can combine with the minerals from the soil to make proteins, plant oils and fats. Plants also can convert sugar directly into cellulose.

Sugar made in the leaves of plants can be used as an energy source for plant growth or it can be transferred to the roots or fruits and stored there until the plant needs energy for growth or reproduction. Some of the energy that plants (as producers) store is transferred to animals and people (as consumers) when they eat plants or other plant eaters. As plants die or lose leaves, branches, fruit, and seeds, much of a plant's stored nutrient is passed on to the soil through decomposition.

Cacti and many succulents carry on crassulacean acid metabolism (CAM) photosynthesis in the green outer cells of the stem. The stomata open during the cool night hours to allow carbon dioxide to enter the plant. The carbon dioxide is converted into organic acids within the plant. The organic acids are converted back to carbon dioxide and used in photosynthesis the following day.

Energy is not the only gift that the sun gives us. Vitamin D has been called the "sunshine vitamin" because it forms in people's skin when the body is exposed to sunlight. Vitamin D is an important vitamin that protects the body from diseases such as rickets, a deficiency disease affecting skeletal development and bone growth. Some doctors suspect that sunlight also affects people's moods. Some people suffer from depression as a result of limited sunlight, notably during the winter.

The sun also gives us the gifts of warmth, weather, seasons, time, the water cycle, navigation, and power. The temperature of any place on Earth depends on the position of the sun in the sky. Temperature greatly affects the weather of a region. Seasons change as Earth revolves around the sun. (See the FLP lesson "Seasons Through the Year.") Time, day and year results from Earth's rotation and its revolution around the sun. The uneven heating of Earth's atmosphere causes low and high pressures. Air moving from areas of high pressure to lower pressure causes wind. The sun drives the water cycle resulting in evaporation, condensation and precipitation. Today, navigators and surveyors carefully measure the position of the sun to find their location or other points on Earth. Solar energy devices use the sun to generate power.

Not to be forgotten are the authors, artists, composers, and photographers who included the beauty and warmth of the sun in their work. The Dutch painter Vincent van Gogh created landscapes with bright sunshine. And the American poet Emily Dickinson wrote about the rising and setting of the sun in a poem titled "The Sun."

Students will enjoy learning more about the chemical equation of photosynthesis and the chemical formulas of molecules, if they understand what all the capital letters and large and subscript numbers represent. There are 92 naturally occurring elements of which carbon (C), hydrogen (H), and oxygen (O) are examples. Chemists decided it was easier to use the first one or two letters of the English or Latin name for each element. When the letter for an element is used alone it represents one atom. For example, C represents one atom of carbon. Atoms can combine chemically to form a molecule such as in O_2, which is two atoms of oxygen, or O_3, ozone, which is three atoms of oxygen. The subscript number represents the number of atoms present.

Different elements or atoms can combine in chemical formulas such as H_2O, water, which indicates that each water molecule consists of two atoms of hydrogen and one atom of oxygen. (Note: When there is only a single atom of one element present it is not necessary to write 1. For example, you will not see H_2O_1.) If the chemical formula is written $2H_2O$, the large number indicates two molecules of water (H_2O). During the skit about photosynthesis the water molecules will be split. They will give their hydrogen (H_2) to the carbon dioxide (CO_2) molecules. It may be helpful to let students know the H_2 represents one molecule or two atoms of hydrogen.

GETTING STARTED

Photocopy the ***Photosynthesis Role Cards*** sheets. The number of copies of the carbon dioxide and water molecules pages will be determined by the number of students in your class. (Note: See photocopying directions on the top of each page.) Cut cards apart on the lines. Gather paper and string or pins for role signs and tape or signs for marking the stage layout. If using signs, make signs for items in Step 3.

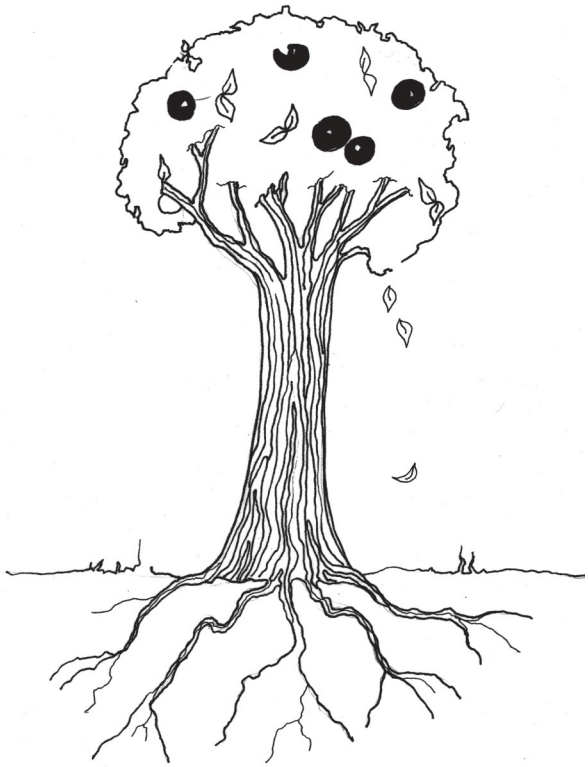
PROCEDURE

Note: Depending on your grade level you may want to share the Supporting Information about photosynthesis before conducting this lesson. Most general science or biology text books also can be used.

1. Ask students to guess what is the life form that can produce its own food. *(A plant.)* Tell students that they are going to create a skit demonstrating how green plants produce their food in a process that is called photosynthesis. (Fungi and algae can also be included as answers, but the lesson deals with plants.)

2. Explain that each student will be assigned a role. Since there is no written script, the various types of characters will decide among themselves what they will look like, where they will stand (see drawing in Step 3), how they will behave, and how they will interact with other characters. The information on their ***Photosynthesis Role Card*** will help them to decide their actions.

3. Draw the following sketch of a tree in a visible place or mark on the floor with tape or signs. Students need to know the arrangement so they will know where they will stand and where they will move during the skit.



4. Assign roles and distribute the cut-apart role cards. There will be:

   - one to three chlorophylls
   - four stomata
   - one sun
   - two roots
   - up to six carbon dioxides (CO_2)
   - the rest water molecules (H_20).

   Have students meet with others in their group. Students read their role card, decide how they will act out their role, and make their role sign. Each role card includes information to help students understand where they need to stand (diagram of the tree in Step 3) and with whom they need to interact. Encourage students to be creative in deciding how to act out their role, what symbols to make, and in the making or gathering of props.

   If necessary, visit with each group to make certain they understand their role, where they will stand, and with whom they need to interact. (The chlorophyll stands in the leaves, the primary site of photosynthesis. The chlorophyll interacts with sunlight, carbon dioxide and water. The stomata also stand in the leaves. Stomata work in pairs to create an opening so carbon dioxide can enter and water and oxygen can exit. The carbon dioxide stands outside the outline of the tree. Carbon dioxide moves through the stomata of a leaf. Inside

the leaf, carbon dioxide interacts with the water molecule. The water molecules stand in the roots of the tree and work their way up through the stem and into the leaves. Water and carbon dioxide interact. The water molecule splits apart and gives hydrogen to the carbon dioxide. The carbon dioxide becomes sugar and the oxygen from the water molecule exits the leaf through the stomata. The sun can stand anywhere and shine on the plant. The roots are in the soil.)

You may want to conduct the skit the next day to give students time to gather or create props, make role signs, and practice acting their roles.

Optional session break

5. When students are ready to demonstrate the process of photosynthesis, have them take their starting places. Have each group explain its role to the class. If necessary, walk the students through the skit one time.

6. Begin the skit. After the role-playing has started, you enter the group as an animal. Go to the center of the area where the fruit is. Pretend to eat a piece of fruit (or eat a slice of real fruit from a bowl of fruit slices) that the students are "photosynthesizing" around.

7. After the skit, serve the snack of orange or apple slices to students. Emphasize that these are examples of food produced by plants that we eat.

   Discuss the significance of photosynthesis for plants. Point out that plants cannot obtain food from any other sources. Plants store some food for use when photosynthesis cannot occur (e.g., at night, in winter for plants that lose their leaves, in spring for plants that go dormant, during germination of seeds underground).

8. Discuss some ways in which animals and people depend on plants and thus on the process of photosynthesis. Explain that animals and people eat plants or other plant eaters (animals) for food and that we all breathe the oxygen given off by plants.

9. Summarize the lesson by having students discuss questions in small groups or with the class. Ask:

   - How would you portray your role differently now that you have seen the whole process? What would you change? Why?
   - What would happen if one part of the process was unavailable? No water (H_2O)? No sunlight? No carbon dioxide (CO_2)? No roots?

   - What is at least one thing you learned that you will share with others?
   - How will you look or think about plants differently knowing they are capable of producing their food?
   - What would your life be like if you could produce your food?
   - How do you depend on plants? How do others depend on plants?
   - How will understanding the process of photosynthesis help you understand other biological (scientific) processes?

10. To increase students' understanding of photosynthesis, have them repeat the skit.

EVALUATION OPTIONS

1. Have students draw a diagram showing how the process of photosynthesis happens. Then have them write a paragraph explaining components of the process and the importance of photosynthesis to other living things.

2. Evaluate the students' participation in their group, in the skit, and during the discussion of the process of photosynthesis.

3. Have each group act out the process of photosynthesis. Make sure all students understand what each group did in the original skit.

4. Students complete one or both of the following.

   - My role in photosynthesis was _____ and I am important to photosynthesis because …
   - I would like to be a plant because …

EXTENSIONS AND VARIATIONS

1. Perform the skit again having students switch their roles. Discuss the differences and similarities. Have students perform the skit for another class.

2. Have students observe plants in an outdoor setting or a common houseplant, such as the Wandering Jew, to notice which parts of the plants are green. Give students a hand lens and have them look closely at both sides of a leaf. Note the stomata. Students can observe the roots of the houseplant by carefully removing the plant from its pot.

3. Have students trace the foods that they had for lunch back to plants. (Example: beef comes from cattle that ate corn and/or grass; bun is made with flour from wheat and eggs from chickens that ate corn, and so on. See the FLP lesson "Lunchtime Favorites.")

4. Have students write poems or songs about why photosynthesis is important to people and other animals or to the environment. Have them explain how they depend on photosynthesis for survival. Perform the poems or songs for other classes.

5. Take a trip to the library and have students explore sun mythology. For example, the Greek believed the sun god Helios drove a chariot across the sky. The Eskimos believed the sun traveled in a boat beyond the northern horizon at night and was responsible for the northern lights (aurora borealis). The Inca believed the sun was the most important of a group of sky gods.

6. Compare Earth to other planets. Have students research similarities and differences in temperature, atmospheric conditions (e.g., gases present or absent in the atmosphere), plants, and other organisms (e.g., bacteria). Based on their research, have students design plants on planets that are hotter or colder than Earth. Have them consider how photosynthesis might work on those planets.

7. Have students make an arrangement of leaves and draw and paint them on paper. The leaves may be alive, dead, look as if they are falling to the ground, and so on.

ADDITIONAL RESOURCES

Ayers, Patricia. *A Kids Guide to How Flowers Grow*. Powerkids Press. 2000. ISBN: 0823954625.

Ayers, Patricia. *A Kids Guide to How Fruits Grow*. Powerkids Press. 2000. ISBN: 0823954668.

Ayers, Patricia. *A Kids Guide to How Herbs Grow*. Rosen Publishing Group. 2000. ISBN: 0823954641.

Ayers, Patricia. *A Kids Guide to How Plants Grow*. Rosen Publishing Group. 2000. ISBN: 0823954633.

Ayers, Patricia. *A Kids Guide to How Trees Grow*. Powerkids Press. 2000. ISBN: 0823954633.

Ayers, Patricia. *A Kids Guide to How Vegetables Grow*. Rosen Publishing Group. 2000. ISBN: 082395465X.

Burchardt, Ann. *Apples: Early-Reader Science Foods*. Bridgestone Books. 1996. ISBN: 1560654481.

Burchardt, Ann. *Corn: Early-Reader Science Foods*. Bridgestone Books. 1996. ISBN: 1560654503.

Burchardt, Ann and Chuck Kostichka. *Potatoes: Early-Reader Science Foods*. Bridgestone Books. 1996. ISBN: 1560654511.

Burns, Diane. *Cranberries: Fruit of the Bogs*. Carorhoda Books. 1995. ISBN: 0876149646.

Gibbons, Gail. *From Seed to Plant*. Holiday House. 1993. ISBN: 0823410250.

Johnson, Sylvia. *Apple Trees: A Lerner Natural Science Book*. Lerner Publications Company. 1989. ISBN: 0822514796.

Kalman, Bobbie. *Hooray For Orchards!* Crabtree Publishing. 1997. ISBN:0865056676.

Kalman, Bobbie. *What Is a Plant?: The Science of Living Things*. Crabtree Publishing. 2000. ISBN: 0865059594.

Landau, Elaine. *Bananas: True Book*. Children's Press. 2000. ISBN: 0516267590.

Landau, Elaine. *Corn: True Book- Food & Nutrition*. Children's Press. 1999. ISBN: 0516210254.

Legg, Gerald. *From Seed to Sunflower (Lifecycles)*. Franklin Watts, Inc. 1998. ISBN: 0531153347.

Llewellyn, Claire. *Milk: What's For Lunch?* Children's Press. 1998. ISBN: 0516208403.

Llewellyn, Claire. *Potatoes: What's For Lunch?* Children's Press. 1998. ISBN: 0516262238.

National Gardening Association. 180 Flynn Ave. Ste 3, Burlington, VT 05401. (802) 863-1308.

Peters, Celeste. *Peppers, Popcorn, and Pizza*. Raintree Steck Vaughn. 2000. ISBN: 0739801368.

Robson, Pam. *Banana: What's For Lunch?* Children's Press. 1998. ISBN: 0516262173.

Royston, Angela. *Life Cycle of the Bean*. Heineman Library. 1998. ISBN: 1575726122.

Saunders-Smith, Gail. *Beans: Plants Growing and Changing*. Pebble Books. 1997. ISBN: 1560654872.

Wisconsin Fast Plants Program, Department of Plant Pathology, 1630 Linden Drive, University of Wisconsin, Madison, WI 53076. (608) 263-5645. Free Newsletter.

EDUCATOR'S NOTES

 Conceptual Framework Reference: I.C.1., I.C.2., III.A.2.

PHOTOSYNTHESIS ROLE CARDS

(Cut cards apart.)

(Make one copy of this sheet.)

Directions: Read the paragraph below. Decide how your group will act its role. What props will you gather or create? Where do you need to be when the skit begins? Will you move? Where? How will you behave? How will your group interact with the other characters?

Chlorophyll

Your sign will say "chlorophyll." You are the green substance in leaves and other portions of plants. Without you, photosynthesis cannot occur. When light strikes the leaf in your presence, carbon dioxide (CO_2) and water (H_2O) interact to yield oxygen and sugar. (Be prepared to interact with water molecules and carbon dioxide.)

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Stomata

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Carbon Dioxide: Your sign needs to say "carbon dioxide" (CO_2) on one side and "sugar" on the other side. Decide where you will go as sugar.

Your chemical name is carbon dioxide (CO_2). You are a gas in the atmosphere (air). You enter the leaf through tiny openings called stomata. Inside the leaf, you combine with hydrogen (H_2) from water molecules (H_2O) and are transformed into sugar. (Turn your sign over from [CO_2] to sugar.) Sugar can occur anywhere in a plant, but mostly it occurs in fruits. Sugar molecules can join into long chains to become starch, which is plentiful in seeds and some roots.

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Roots

Your sign will say "roots." You are important to take in water molecules (H_2O) needed by the leaf from the soil. Starch (long chains of sugar molecules) also can be stored in you.

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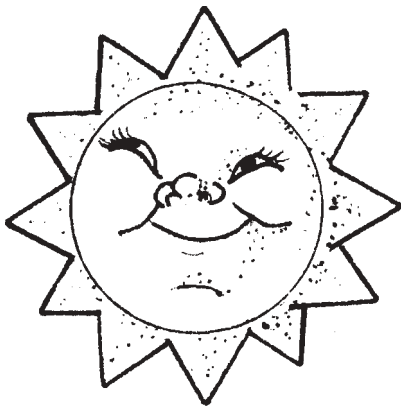
Sun

Your sign will say "sun." You are the source of light or radiant energy that the leaf captures. Radiant energy is then tranformed into chemical energy and stored in the bonds of the sugar. Plan to use a prop that demonstrates your light and heat.



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(Make several copies of this sheet depending on your class size.)

Directions: Read the paragraph below. Decide how your group will act its role. What props will you gather or create? Where do you need to be when the skit begins? Will you move? Where? How will you behave? How will your group interact with the other characters?

Water Molecules: Your sign will say "H_20" and needs to be big enough to cut or tear the (H_2) and (O) apart.

Your chemical name is water molecule (H_20). You are absorbed by the plant roots from the soil. Then you move to the leaf. Many of you just exit as water vapor through tiny holes in the leaves called stomata. Some of you participate in photosynthesis by breaking apart. Your hydrogen (H_2) combines with carbon dioxide (CO_2). Your oxygen atom (O) joins another oxygen atom to form an oxygen molecule (O_2) and exits from the leaves as a gas. (Be prepared to tear your H_20 sign apart, handing the H_2 to carbon dioxide [CO_2], and then joining another oxygen atom.)

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A root, a stem, a leaf, some means of capturing

sunlight and air and making food—in sum, a plant.

The green substance of this earth, the chlorophyll,

is all summed up in the plants.

Without them, we perish,

all of us who are flesh and blood.

Hal Borland, Our Natural World, 1969