

**Beth Campbell
Western Michigan University
Senior, College of Education**

April, 2006

**Participant in Research Experience for Teachers (RET) Workshop
at Western Michigan University
2005-06 Academic Year**

But What *IS* Photosynthesis? Background Information

Photosynthesis overview: Photosynthesis is the process by which plants convert solar energy from the sun into useful chemical energy for food. They release molecular oxygen and remove CO₂ (carbon dioxide) from the air. Plants are photoautotrophs which means they are able to synthesize food directly from inorganic compounds using light energy, instead of eating other organisms or relying on material derived from them. The energy for photosynthesis comes from absorbed photons found in light and involves a reducing agent, in this case water. Oxygen is released as a product. All the organisms that undergo photosynthesis convert CO₂ to organic material by reducing this gas to carbohydrates. This is done through a rather complex set of reactions. The pigments that absorb the light are primarily chlorophylls and carotenoids. Chlorophylls absorb blue and red light while carotenoids absorb blue-green light, but green and yellow light are not effectively absorbed by photosynthetic pigments in plants; therefore, light of these colors is either reflected by leaves or passes through the leaves. This explains why plants are green. Chlorophyll is also unique in that it is capable of converting the active energy of light into a latent form that can be stored and used when needed. In plants that undergo photosynthesis, water is absorbed by the roots and carried to the leaves by the xylem. CO₂ is obtained from the air that enters the leaves through the stomata and diffuses to the cells containing chlorophyll.

Why is photosynthesis important?: Nearly all living things depend on the energy produced from photosynthesis for their nourishment. Animals need the plants for food as well as oxygen. Only green plants are able to change light energy into chemical energy stored in food, thus they are vital to life on Earth.

When is it best to introduce photosynthesis?: Photosynthesis is generally taught in late elementary/middle school. By the time students have reached these grades, they've developed several misconceptions about how plants work. If a basic introduction to the

process of photosynthesis was given earlier in education, I believe they would have a thorough understanding of the process by the time it is taught in more detail.

Common misconception: Students often misunderstand the basic process of photosynthesis. Rather than believing that plants make their own food internally using carbon dioxide, water, and sunlight, they think that plants take in their food from the outside environment using sources such as water and soil. They are missing the main principle of a process they've been taught in detail.

How should photosynthesis be taught?: The following lesson involves several different approaches to teaching. Students will experience aural, written, reading, and hands-on instruction. The variety of methods being used aids in the overall understanding of photosynthesis. These activities are intended for use after a basic, traditional introduction to photosynthesis has been given.

MICLIMB Standards:

Science:

- I.1.E.1- generate questions about the world based on observations
- I.4.E.6- construct charts and graphs
- II.1.E.1- develop awareness of the need for evidence in making decisions scientifically
- II.2.E.2- science concepts illustrated through creative expression
- III.1.M.2- functions, photosynthesis
- III.4.E.4- compare and contrast food, energy and environmental needs
- III.4.M.3- plants make their own food

Mathematics:

- VI.1.E.1
- VI.1.E.2
- VI.1.E.3
- III.2.E.3

Useful Web-sites:

- **Name:** ReviseWise Science
Site: http://www.bbc.co.uk/schools/revisewise/science/living/06_act.shtml
Overview: Includes activities, interactive models, a fact sheet, and test
Grade: 3-5
- **Name:** NOVA Online
Site: <http://www.pbs.org/wgbh/nova/methuselah/photosynthesis.html#>
Overview: Excellent flash interactive activities
Grade: 3-6

But What *IS* Photosynthesis?

Glossary

- **Photosynthesis:** synthesis of chemical compounds with the aid of radiant energy and especially light; *especially* : formation of carbohydrates from carbon dioxide and a source of hydrogen (as water) in the chlorophyll-containing tissues of plants exposed to light
- **Carbon Dioxide:** a heavy colorless gas CO₂ that does not support combustion, dissolves in water to form carbonic acid, is formed especially in animal respiration and in the decay or combustion of animal and vegetable matter, is absorbed from the air by plants in photosynthesis, and is used in the carbonation of beverages
- **Oxygen:** a colorless tasteless odorless gaseous element that constitutes 21 percent of the atmosphere and is found in water, in most rocks and minerals, and in numerous organic compounds, that is capable of combining with all elements except the inert gases, that is active in physiological processes, and that is involved especially in combustion
- **Organism:** a complex structure of interdependent and subordinate elements whose relations and properties are largely determined by their function in the whole
- **Carbohydrate:** any of various neutral compounds of carbon, hydrogen, and oxygen (as sugars, starches, and celluloses) most of which are formed by green plants and which constitute a major class of animal foods
- **Pigment:** a coloring matter in animals and plants especially in a cell or tissue; *also* : any of various related colorless substances
- **Carotenoid:** any of various usually yellow to red pigments found widely in plants and animals and characterized chemically by a long aliphatic polyene chain composed of eight isoprene units
- **Chlorophyll:** the green photosynthetic pigment found chiefly in the chloroplasts of plants; a waxy green chlorophyll-containing substance extracted from green plants and used as a coloring agent or deodorant
- **Photoautotrophic:** autotrophic and utilizing energy from light
- **Xylem:** a complex tissue in the vascular system of higher plants that consists of vessels, tracheids, or both usually together with wood fibers and parenchyma cells, functions chiefly in conduction of water and dissolved minerals but also in support and food storage, and typically constitutes the woody element (as of a plant stem)
- **Stomata:** one of the minute openings in the epidermis of a plant organ (as a leaf) through which gaseous interchange takes place; *also* : the opening with its associated cellular structures
- **Cell:** a transparent sheet of celluloid on which objects are drawn or painted in the making of animated cartoons

But What *IS* Photosynthesis?

Lesson Plan

Materials: one copy of *Oh Say Can You Seed?* by Bonnie Worth, vocabulary sheet for *Oh Say Can You Seed?* (1 per student), Energy and Me CD by Billy B, lyrics for The Rock and Roll of Photosynthesis (1 per student), game supplies (see Photosynthesis Game materials), lesson plan for the Photosynthesis Game, *The Magic School Bus Gets Planted* by Joanna Cole, writing activity hand-out

Procedure:

- Introduce students to the topic of photosynthesis. Review the student's prior knowledge and quickly cover what they've previously learned. If misconceptions arise, write them on the board as questions to think about during the lesson.
- Hand out the vocabulary sheet for *Oh Say Can You Seed?* Go over any words that may confuse students.
- Read *Oh Say Can You Seed?*
- Hand out the lyrics for The Rock and Roll of Photosynthesis and read them together as a class. If there are any words that the students do not understand, review and explain them.
- Listen to the recording of The Rock and Roll of Photosynthesis. Have students follow along with their lyric hand-out.
- Introduce the Photosynthesis Game and follow the given procedure.
- Wrap-up what the students learned. Have them develop five-ten main vocabulary words that were used throughout the lesson. As homework, pass out the Writing Activity.
- If time remains in the science period, read *The Magic School Bus Gets Planted*.

But What IS Photosynthesis?

Vocabulary Guide- *Oh Say Can You Seed?*

Carbon dioxide: The gas that humans and animals breathe out, and which green plants use to make food.

Cotyledon: The first leaf or pair of leaves within the embryo. A part of the seed that stores food.

Embryo: The part of a seed that develops into a new plant, including the stem, leaves, and roots.

Fertilization: When the male (or sperm) cells contained in the pollen reach the female (or egg) cells in the ovules and cause them to grow into seeds.

Minerals: Materials that are neither animal nor vegetable. Found in rocks and soil, they help animals or plants to grow.

Nectar: The sweet liquid secreted by a flower to attract pollinators like bees, butterflies, and hummingbirds.

Ovule: The part of the plant in the ovary that contains egg cells and becomes a seed after fertilization.

Oxygen: The gas humans and animals must breathe in order to stay alive, and which green plants produce when making food.

Photosynthesis: The process by which green plants, powered by the energy of sunlight, combine carbon dioxide and water to produce sugar inside their leaves and release oxygen into the air.

Pistil: The ovule-bearing, female reproductive part of a flowering plant that includes the stigma, style, and ovary.

Pollen: The minute grains that are produced in the anthers of a flower and contain male sex cells.

Stamen: The male reproductive part of a flowering plant that includes the anthers and filaments that support the anthers.

The Rock and Roll of Photosynthesis

Well, the sun comes
streaming out of the sky
making everything grow
and keeping us alive
and our main connection
to the sun are the green leaves,
only they can make food
with sunshine energy.

Oh, photosynthesis,
yes, photosynthesis
it's a process
you wouldn't want to miss-
that photosynthesis.
You know it's true,
we'd all be through
without the rock and roll
of photosynthesis.
What keeps the leaves green
and the sunlight stashed
are those chlorophyll
containers called chloroplast.
There are millions of them
moving around in each leaf
they get excited
when their leaf gets lighted
and become
the tree's food factories.

Oh, minerals and water
come up from the ground
which is where the rain falls
and the roots are found
they travel just beneath
the bark up into the leaves.
Leaves use what they need
to make food for the tree,
and the rest is vaporized
as it's released.
Now, where the vapor slips out
carbon dioxide slips in
just as the leaf releases
water's oxygen.

It makes it free for you and me.
It's a living example of harmony.
So the next time you think
everything's all wrong
go breathe among the leaves,
you're gonna know you belong.

Now, when the leaves
get sunshine and water, too.
And carbon dioxide
from you and me.
They make that sugar
people called glucose.
It becomes other sugars
in the bark and is stored
as starch.
Yes, food flowing where and
when the tree needs it most.



But What *IS* Photosynthesis? Photosynthesis Game

Purpose: The purpose of this game is to review photosynthesis in a fun and productive way. Students will understand the four main requirements for photosynthesis to occur and what the two main products are. They will use logic and probability while trying to get their plant to “grow.”

Materials: poster board, markers, 20 small post-it notes in four different colors, round stickers, glue, brad fasteners, scissors, candy, red stickers, Photosynthesis Game handout.

Procedure:

Prior to the Lesson:

- Obtain materials
- Cut five square pieces of poster board, approximately 12x12 inches each.
- Draw a circle in the center of each piece of poster board
- Divide each circle into different sections, each of which represent the four requirements for photosynthesis to occur- water, minerals, energy, and carbon dioxide. Each board does not have to contain all four elements- if you make them different it adds in the idea of probability and allows students to think logically about which boards to spin in order to get the element they need.
- Color in each of the sections with their corresponding post-it note color. The colors each represent one of the four requirements.
- Construct arrows to attach to each of the boards to use as the spinners- fasten with a brad.
- Glue the post-it notes around the boards.

During the Lesson:

- Have the students brainstorm what they believe is required for photosynthesis to occur. At this point, the class should have enough background information and prior knowledge to determine that energy, water, minerals, and carbon dioxide are needed. If they do not come up with all of the elements, discuss and review why they are each important.
- Tell the students that they are going to play a game involving the process of photosynthesis and what it produces. Pass out the Photosynthesis Game handout to each student. Read the directions together and make sure everyone is clear on what they are supposed to do.
- Have students take turns spinning the different photosynthesis boards. They are allowed one spin per turn and are to place the element they receive on the corresponding place on their worksheet. Once they obtain all four elements, they are allowed to move to the next level. Before they can start with the bigger plant, they must receive a red sticker that represents the oxygen produced by photosynthesis and a piece of candy to represent the food produced.

- For the bigger plant, they must get two of each element. This is because the plant is getting growing and is now larger. As with the smaller plant, once they receive two of each element they are to report to the teacher to receive a red oxygen sticker and a piece of candy.

Questions to Ask:

- Why do each of the boards have a different ratio of the four requirements? How did this effect which boards you used?
- What are the four requirements of photosynthesis? What does this process produce?
- What do you think would happen if there was no sunlight? Would plants be able to go through photosynthesis? If they couldn't, what would happen?

Conclusion: As a wrap-up, have the students discuss why all four elements are important and what the best and most effective way to grow a plant is. Continue with the **But What IS Photosynthesis?** lesson plan.

This lesson was adapted with permission from Daniel Patterson.

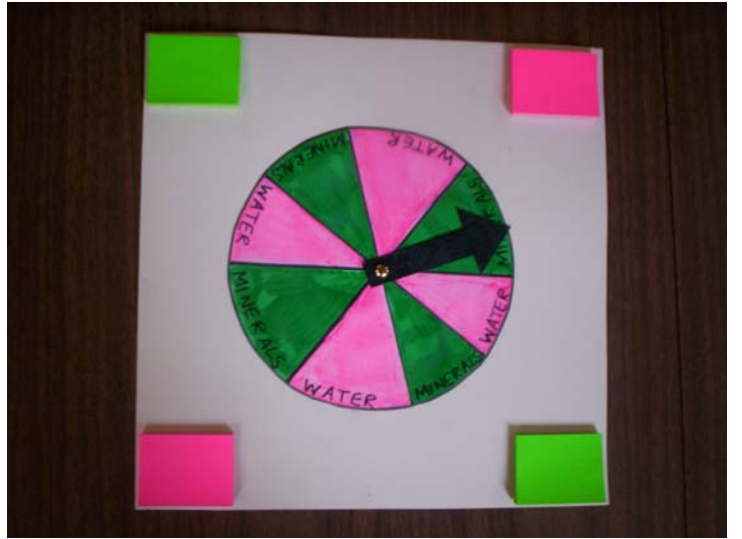
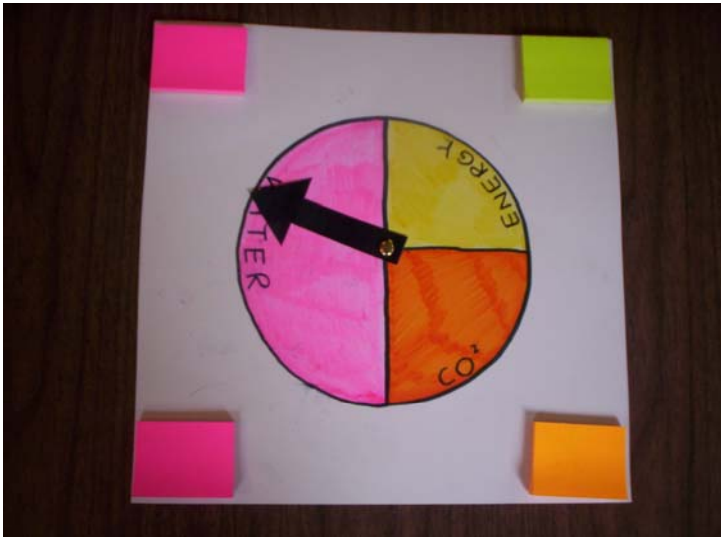
But What *IS* Photosynthesis? Photosynthesis Game

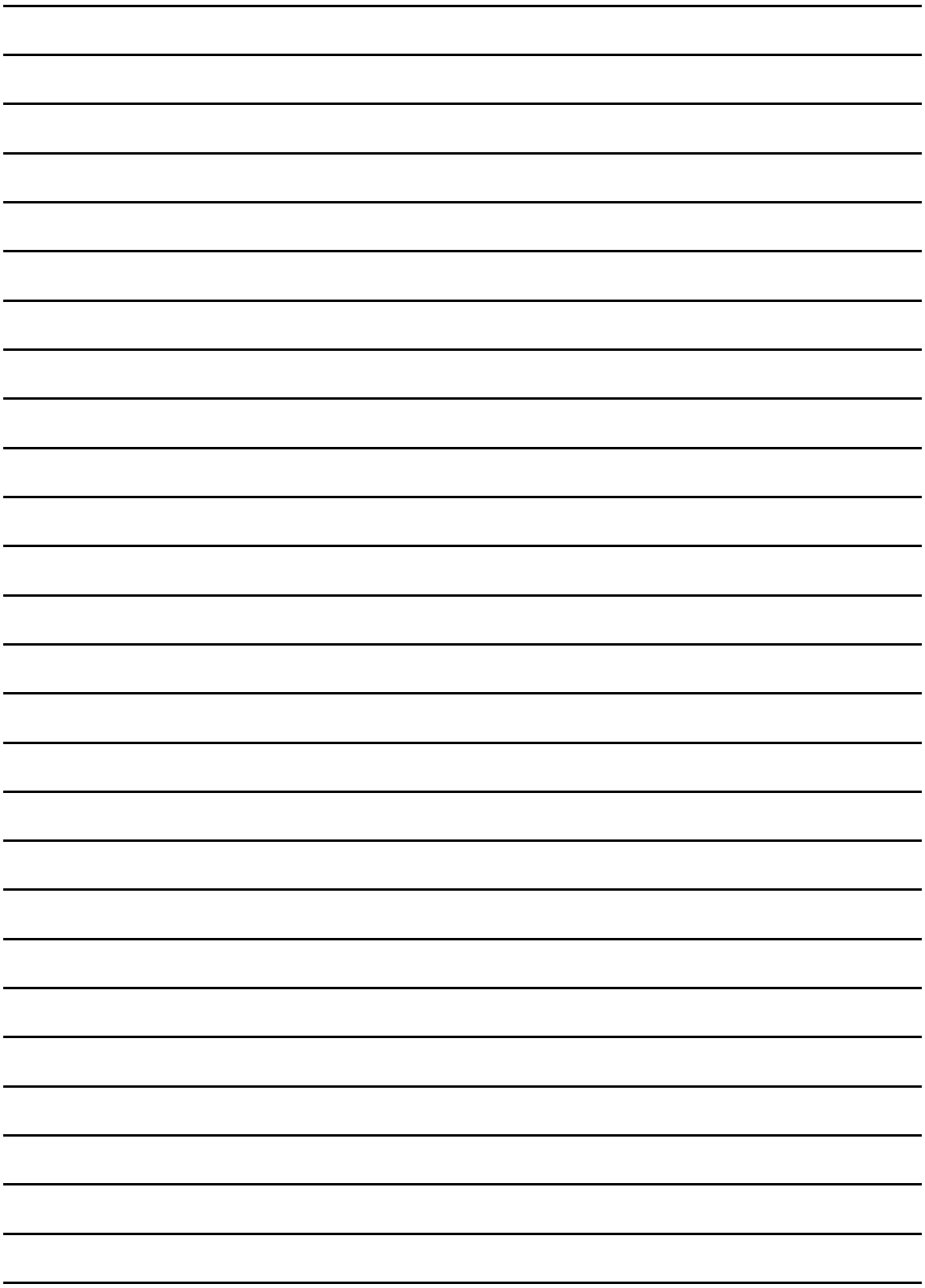
Name: _____

Directions: Your friend Miranda is trusting you to take care of her plant while she is on vacation. You want her to come back and find a beautiful flower waiting for her. In order for the plant to grow well, you know that photosynthesis needs to occur. It is your job to make sure the plant receives the four main elements required for a plant to undergo photosynthesis- water, carbon dioxide, minerals, and energy.

- There are five boards around the classroom that have the four different requirements for photosynthesis.
- You get one spin per turn at the board you choose. Take a post-it note for whatever color you land on. Each post-it note and color represents one of the four parts of photosynthesis.
- Return to your seat and place the sticky note on the appropriate place around your plant.
- Continue spinning the boards until you receive all of the elements- water, carbon dioxide, minerals, and energy. You must obtain all four requirements for the smaller plant before you can move on to the larger plant.
- Photosynthesis produces oxygen for us to breathe and food for the plant to grow. Once you have all of the four parts, report to the teacher to receive your oxygen and food.
- Repeat the process again so that your plant can grow even bigger! This time, you must get two post-it notes for each of the four elements. This is because your plant is growing! Once you have two of each requirement, report to the teacher to receive your oxygen and food.
- Congratulations! You have successfully taken care of your friend's plant for her!

Hint: Each of the spinner boards has a different ratio of the four parts of photosynthesis. If you need more energy, find the board that has more energy sections.





But What *IS* Photosynthesis? Conclusions

I implemented this lesson in Lori Howell's fifth grade classroom at Pine Street Elementary in Wayland, Michigan. While I would have preferred to work with an earlier grade, I believe that these children still benefited from the instruction. I was worried that the texts I had chosen were too young for them, but they were attentive and interested through both *Oh Say Can You Seed?* and *The Magic School Bus Gets Planted*. Lori Howell had done an excellent job of introducing and teaching plants to her kids and they were already quite knowledgeable about photosynthesis. We had an active discussion about the function and process, during, and after the main lesson occurred. The class was very excited to play the Photosynthesis Game and completed the activity in approximately 25 minutes. The writing activity that the class completed as homework served to evaluate their understanding and the effectiveness of the lesson. My original plan included doing a demonstration with the elodea water plant. Unfortunately, the experiment did not work and I was unable to do that part of the lesson. It was my hope that the class would be able to see the actual process of photosynthesis, but the game was created to supplement that part of the lesson. Judging by the questions I asked, my goal was achieved.

