



# The Secret Life of Plants: Searching for Evidence of Photosynthesis

Grade: 7 | Time: 2-5, 45 minute periods

## Standards:

Georgia Performance Standards in Science  
S7CS2.a, c; S7CS4.b; S7CS6.a; S7L2.a; S7CS9.b, f;  
S7L2.b. d.

Next Generation Science Standards  
LS1.C, PS3.D

Common Core Literacy Standards  
ELACC6-8RST3, ELACC6-8RST4, ELACC6-8WHST9

## Supplies:

### for recreating Priestly Experiment

1 candle

### Bring Your Own

BYO: bright sunny window or grow light;

BYO: 1 bell jar or 1 gallon glass jar (no plastic);

BYO: 1 vacuum plate or deep tray of water;

BYO: 1 small well-watered plant

BYO: candle lighter

### for Modeling Photosynthesis Reactants, Products

for each of eight groups: 1 envelope containing:

6 small pieces of black paper = carbon

18 small pieces of red paper = oxygen

12 small pieces of white paper = hydrogen

### for Observing Stomata

per group (8 groups of 4 students)

1 small jar of clear nail polish

1 piece clear tape (4 rolls total, to be shared)

2 blank microscope slides (no covers needed)

### Bring Your Own

BYO: microscope (200x – 400x preferred)

BTO: lettuce leaf or other leaf from garden

### for Leaf Chromatography to Observe Pigments

per group (8 groups of 4 students)

1 glass jar (recycled babyfood, salsa or olive jar)

1 piece filter paper

1 packet spinach seeds

### Bring your own

BYO: spinach leaves (grown in garden or purchased)

BYO: scissors (to cut filter paper into 1" wide strips)

BYO: pencil to balance across top of jar (optional)

BYO: tape to fasten filter strip to pencil (optional)

### for Calculating Rate of Photosynthesis (optional)

per group (8 groups of 4 students)

1 piece filter paper or coffee filter

1 one-hole punch (to cut leaf discs)

1 tsp baking soda (1 per class)

1 syringe (8 total)

## Garden Connection:

Plants grown in the school garden will be observed and analyzed for evidence of photosynthesis.

## Overview

Students will investigate unseen plant processes to discover evidence of photosynthesis including observations of stomata for transpiration and gas exchange, and detection of the presence of photosynthetic pigments that absorb light, using chromatography.

## Essential Questions

What happens during photosynthesis and how do we know it? What evidence of photosynthesis can I observe or detect? What are the parts of a plant's cell?

## Engage

The Priestly experiment will be re-created to demonstrate how discoveries about plant respiration and photosynthesis were made.

## Explore

Students will investigate photosynthesis in plants from the garden by: observing the stomata through which gases are exchanged; and separating and observing leaf pigments including chlorophyll a and b.

## Explain

Students will use their photosynthesis investigations and the Priestly demonstration to make sense of photosynthesis and explain, conceptually, the formula: carbon dioxide and water in the presence of sunlight produce oxygen and glucose (a sugar in which chemical energy is stored).

## Environmental Stewardship

Students will plant perennial vegetables in the school garden or trees in the schoolyard, to promote production of oxygen and sequestration of carbon dioxide.

## Evaluate

Students will demonstrate understanding of the reactants and products of photosynthesis by making a model with colored paper; and create a job resume for a leaf that reveals their understanding of the concept of photosynthesis. A rubric has been created to assess student mastery of performance expectations.

## Extend

Students may conduct further investigations on how to measure the rate of photosynthesis, how trees sequester carbon, how much oxygen a tree produces, and how water is taken up in a plant's xylem.

## Standards

### GEORGIA PERFORMANCE STANDARDS IN SCIENCE

#### **S7CS2. Students will use standard safety practices for all classroom laboratory and field investigations.**

- a. Follow correct procedures for use of scientific apparatus.
- c. Follow correct protocol for identifying and reporting safety problems and violations.

#### **S7CS4. Students will use tools and instruments for observing, measuring, and manipulating equipment and materials in scientific activities.**

- b. Use appropriate tools for measuring objects and/or substances.

#### **S7CS6. Students will communicate scientific ideas and activities clearly.**

- c. Organize scientific information using appropriate simple tables, charts, and graphs, and identify relationships they reveal.

#### **S7CS9. Students will investigate the features of the process of scientific inquiry.**

Students will apply the following to inquiry learning practices:

- b. Scientific investigations usually involve collecting evidence, reasoning, devising hypotheses, and formulating explanations to make sense of collected evidence.
- f. Scientists use technology and mathematics to enhance the process of scientific inquiry.

#### **S7L2. Students will describe the structure and function of cells, tissues, organs, and organ systems.**

- b. Relate cell structures (cell membrane, nucleus, cytoplasm, chloroplasts, mitochondria) to basic cell functions.
- d. Explain that tissues, organs, and organ systems serve the needs cells have for oxygen, food, and waste removal.

### NEXT GENERATION SCIENCE STANDARDS

#### **LS1.C: Organization for Matter and Energy Flow in Organisms**

Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)

Within individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to form new molecules, to support growth, or to release energy. (MS-LS1-7)

#### **PS3.D: Energy in Chemical Processes and Everyday Life**

The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., from sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. (secondary to MS-LS1-6)

Cellular respiration in plants and animals involve chemical reactions with oxygen that release stored energy. In these processes, complex molecules containing carbon react with oxygen to produce carbon dioxide and other materials. (secondary to MS-LS1-7)

### COMMON CORE LITERACY STANDARDS

**ELACC6-8RST3:** Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

**ELACC6-8RST4:** Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.

**ELACC6-8RST9:** Compare and contrast the information gained from experiments, simulations, video or multimedia sources with that gained from reading a text on the same topic.

## Background Information

### Photosynthesis

- Photosynthesis is the process by which plants, some bacteria and algae are able to capture and use light energy to convert carbon dioxide and water into organic molecules like glucose. Photosynthesis is fundamentally important for life on Earth as it provides the oxygen on which all other life depends and as the ultimate source of food and energy in all ecosystems.

### Priestly Experiment

- In 1771 and 1772, Priestly conducted a series of experiments using a bell jar. It was known that a candle placed in a sealed bell jar would eventually burn out and could not be relighted while still in the jar. Priestly discovered that a plant can survive indefinitely within a jar. Thus, he tried placing a plant into the jar with the burning candle. The candle went out as before and could not be relit right away. Priestly waited several days and tried again. The candle could be relit! The plant had restored the air inside the jar! Next Priestly investigated what would happen to animals. He found that a mouse placed inside a sealed jar will eventually collapse. However, a mouse can survive in a sealed jar with a plant since the plant restores the air. Priestly was the first to demonstrate that oxygen is necessary for fire and animals but that given time, plants can create oxygen, allowing fires to burn and animals to breathe.
- A few years later, Jan Ingenhousz investigated the effect of light on a plant's ability to restore air. He found that a plant left in darkness cannot restore the air for a candle. To demonstrate this, he burned up all the oxygen in a jar with a plant then left the plant in sunlight for a few days to restore the air. Then without relighting the candle, he put the plant into darkness for several more days. At the end of the dark period, he was unable to relight the candle. He concluded that a plant in darkness acts like animals, using up the oxygen that it had created. Ingenhousz had discovered that plants can photosynthesize and create oxygen but only in the light. If left in the dark, plants do not photosynthesize and thus no oxygen is produced. Moreover plants are always performing respiration, just like animals. In sunlight, the rate of photosynthesis surpasses respiration so there is an excess of oxygen being produced. But in darkness, no photosynthesis takes place but respiration continues to occur. Thus, by keeping a plant in darkness you can demonstrate that plants need oxygen and use it up, just like animals.

### Chromatography

- Paper chromatography is a process that uses filter paper and a solvent to separate and identify the different substances in a mixture. Chromatography means "to write with color." The substances in the mixture dissolve in the alcohol and wick up the paper. The heavier substances move up the paper more slowly. The lighter substances move up more quickly, so heavy and light substances get separated from one another on the paper. Plants contain chlorophyll a and b, greenish pigments, as well as carotenoids, pigments that range in color from red to orange to yellow. Leaf chromatography – using acetone (nail polish remover) or alcohol in hot water as the solvent – separates the pigments in leaves.

### Teacher Preparation

- <sup>35</sup><sub>17</sub> Become familiar with background information.
- <sup>35</sup><sub>17</sub> Obtain lesson supplies and materials.
- <sup>35</sup><sub>17</sub> Arrange for computer and LED projector or smartboard, to show videos and PowerPoint presentations to the class.
- <sup>35</sup><sub>17</sub> Cut colored paper apart to represent atoms for modeling photosynthesis formula.

## LESSON PROCEDURES

### Engage: Day 1

- Read the Teacher Background Information and then tell students a little about Joseph Priestley's life. Explain that in Priestley's time, people had no understanding of oxygen and carbon dioxide as gases, nor did they understand that plants respire (exchange gases). Since plants have no noses or lungs, ask students for ideas about how respiration takes place in a plant (leaves have pores underneath called stomata that open and close to allow gases in and out)
- Recreate the Priestly experiment as a demonstration by lighting a candle on a vacuum plate or on a saucer sitting in a tray of water and placing a glass bell jar over the candle. When the flame goes out, ask students to guess why (a flame requires oxygen and the fire goes out when all the oxygen is used up). Attempt to relight the candle, which will not stay lit.
- Place a well-watered plant under the bell jar with a lit candle. Once the candle has burned out, place the bell jar on a sunny window sill or under a grow light (if using a tray of water, make sure the plant is on a pedestal so when the air inside the jar cools and more water is drawn into the jar, the plant will not be in the water). Discuss with students their predictions about what will happen inside the bell jar when it is left in a sunny window, and ask them to write their predictions in their science notebooks. Let the jar sit for one week.
- Optional: Show the first 2 min. of this TedEd video on photosynthesis: <https://youtu.be/eo5XndJaz-Y>
- Let the class know that they will be investigating plants to try to see stomata and chlorophyll, two parts of plants that are essential to photosynthesis.

### Explore: Day 1

- **Observing Stomata and Evidence of Gas Exchange in Plants**

Show students a video about how to find the stomata in plant (monocot and dicot) leaves:

(<https://www.youtube.com/watch?v=XcLhuLONQZg> – “Finding Stomata, Bozeman Science”)

Then have students actually perform the experiment using leaves from the garden and/or school grounds.

<sup>35</sup><sub>17</sub> **What you'll need for each group of 4 students:** two leaves (one monocot and one dicot), clear fingernail polish, transparent tape, two microscope slides, and one microscope.

<sup>35</sup><sub>17</sub> **Instructions:**

1. Paint a small section of the underside of each leaf with a thin layer of clear fingernail polish. Let the polish dry.
2. Place a small piece of transparent tape over the painted area of each leaf and press down firmly.
3. Peel the tape off of each leaf, and place the tape adhesive side down on each microscope slide. You should see the impression of each leaf on the tape.
4. View each slide under a microscope. Start with low power and then switch to high power to view stomata.

<sup>35</sup><sub>17</sub> Watch this video of stomata opening and closing, and to show students how to use a microscope to view stomata, if necessary: <https://www.youtube.com/watch?v=QX4Gi9wkKsA>

<sup>35</sup><sub>17</sub> Have students sketch open and closed stomata in their science notebooks.

### Explore: Day 2

- **Leaf chromatography- observing chlorophyll a and b, xanthophyll and carotene: pigments that absorb light**

(“Science Projects for Kids: Classifying Plants” by the Editors of Publications International, Ltd.)

<http://lifestyle.howstuffworks.com/crafts/other-arts-crafts/science-projects-for-kids-classifying-plants6.htm>

<sup>35</sup><sub>17</sub> **What you'll need for each group of 4 students:** coffee filter, scissors, leaves, a coin, rubbing alcohol, a jar, a pencil, tape

<sup>35</sup><sub>17</sub> **Instructions:** Leaves have a green pigment called chlorophyll that they use to capture sunlight. But did you know that leaves also have pigments of other colors to capture colors of light that chlorophyll misses? You can use chromatograph to see the many colors of pigments (light absorbers) in a leaf.

1. Cut a strip one inch wide from a coffee filter. Cut one end of the strip to a point.
2. Place a leaf on the paper 1 in above the bottom. Roll the edge of a coin over the leaf, pressing green into paper.
3. Let the paper dry, and repeat the process with three different leaves.
4. Pour a 1/2-inch layer of rubbing alcohol into the bottom of a jar.

5. Tape your paper strip to the middle of a pencil and hang it so that the very tip of the strip touches the alcohol. (The colored strip of leaf “juices” should not touch the alcohol -- you may have to adjust the length of the strip.)
  6. Optional: Lay a piece of foil or paper over the top of the jar to keep the alcohol from evaporating.
  7. Watch carefully as the alcohol moves up the filter paper, carrying the pigments along with it. In 10 to 20 minutes the colors should be separated -- do not allow them to run to the top of the paper.
- How many colors do you see? Could you see these colors in the leaf itself? The finished filter paper is called a chromatograph. Let it dry and use your chromatograph for a special bookmark.

- ALTERNATIVE process for seeing colors in leaves using paper chromatography (with nail polish remover instead of alcohol):
  - » **What you'll need:** *Various types of leaves, small cups, coffee filters cut into strips, nail polish remover, and coin*
  - » **Safety Note:** *Nail polish remover is flammable; do not use near heat. It also is harmful if ingested.*
  - » **Instructions:**
    - (1) Tear each leaf into small pieces. Put the pieces of each leaf into a cup. Each leaf should get its own cup.
    - (2) Pour enough nail polish remover into the cups to just cover the pieces of leaves
    - (3) Label each coffee filter with the original color of the leaf. Stand a strip of coffee filter into each cup. Wait for 10 minutes as the liquid travels up the paper.
    - (4) Take filter paper from the cup and let it dry. Compare the results for all your leaves. How do pigments differ?
      - Plant pigments play an important role in capturing light for photosynthesis. These pigments give leaves their colors. Chlorophyll pigment makes leaves green and allows the plant to capture energy from the sun for photosynthesis. Anthocyanins make leaves red. Carotenoids make leaves yellow.
      - In the fall, trees prepare for winter by shutting down photosynthesis. As this happens, the chlorophyll disappears from the leaves. As this happens, the green color fades and we begin to see yellow and orange – colors that have been there all along, but were hidden by the green pigment. Sugars trapped inside the leaves react with light and other chemicals to reveal new colors.

### Engagement Part 2 (several days after initial Priestly experiment)

Bring the bell jar and the plant back out from the first part of the Priestly experiment. Have students make observations about the plant. Attempt to light the candle (it should light). Ask students why the candle that has been in an air tight container will now light when it wouldn't before. (Students may cite the infusion of air when the bell jar is opened . As an alternative, set up two bell jars and place a candle only in one, and a candle with a plant in the other. Ask students how Priestly made sense of this experiment and what he concluded about plants. Read from the Teacher Background Information on this experiment. Show this Scholastic StudyJams video about photosynthesis to debrief the investigations: <http://studyjams.scholastic.com/studyjams/jams/science/plants/photosynthesis.htm> and show this Bill Nye video to debrief the Priestly experiment: <https://www.youtube.com/watch?v=pdgkuT12e14> .

### Explain from Evidence

Students should be able to explain photosynthesis conceptually as the process of converting light energy into chemical energy which can be used or stored in a plant, and explain the formula for photosynthesis in words as: water + carbon dioxide => in the presence of sunlight => glucose and oxygen. Plant respiration is the opposite process: glucose (sugar) and oxygen break down into carbon dioxide and water. Students will be able to explain findings from the Priestly experiment.

### Environmental Stewardship

Students will plant perennial vegetables in the school garden or trees in the schoolyard, to promote production of oxygen and sequestration of carbon dioxide.

### Evaluate

Working in groups of 4, students will use the pieces of colored paper that represent various molecules to display their knowledge of the reaction of photosynthesis. Each envelope should only have enough molecules to create half of the reaction at a time so the students can see that nothing is created or destroyed, only rearranged (Law of Conservation of Matter). Ask students to imagine they are leaves applying for a job in a photosynthesis company. Students should create their “resume,” explaining their job qualifications and describing how they will get the job done. Descriptions should include key vocabulary such as stomata, water, carbon dioxide, light, energy, chlorophyll and chloroplast. A rubric is provided to assess student mastery of performance expectations.

## Extend

- **(“How to Find the Rate of Photosynthesis” by Dyna Whiting, eHow Contributor)**

[http://www.ehow.com/how\\_10051836\\_test-rate-photosynthesis.html](http://www.ehow.com/how_10051836_test-rate-photosynthesis.html)

» **What you'll need:** *leaves from a plant, a single hole puncher, a syringe, baking soda and water solution, and a stopwatch.*

» **Instructions:**

- (1) Cut little circles from the leaves using a paper punch. The experiment will be done using these leaf disks. Be sure to prepare an abundant amount for sample selection and multiple experiment results.
- (2) Place the leaf disks inside the syringe and fill the syringe with the baking soda and water solution. Remove any leaf disks that float and keep only the ones that sink to the bottom of the syringe. Empty the syringe and refill it once again with the baking soda solution.
- (3) With your stopwatch, measure the amount of time needed for the leaf disk to go from a resting position to the moment it begins floating from the bottom of the syringe. This will occur when the leaf begins generating oxygen as a byproduct of photosynthesis.
- (4) The amount of time recorded can provide you with a rough estimate of tested leaf's rate of photosynthesis. Repeat the experiment a few more times and average the results for a more accurate test result.
- (5) Use leaves from various plants and repeat the experiment to compare the rates among different plants.

- **(“Exploring the Rate of Photosynthesis” from Biology Corner)**

[http://biologycorner.com/worksheets/photosynthesis\\_rate.html](http://biologycorner.com/worksheets/photosynthesis_rate.html)

» **What you'll need:** *test tube, Elodea cuttings, sodium bicarbonate (baking soda), beaker with water, and a lamp.*

» **Instructions:**

- (1) There are various set-ups that can be used to measure the rate of photosynthesis. Each relies on counting the oxygen produced during the reaction. To improve results, add a pinch of baking soda to the water in the test tube. Cut elodea stems at an angle and use your fingers to crush the end of the stem. The water in the beaker is meant to absorb the heat from the light. If you do not see bubbles right away, re-cut and crush the stems, experiment with moving the light closer to the apparatus or remove the heat sink if using CFL bulbs. Your goal is to find a way to consistently measure the rate of photosynthesis using any of the designs above. Practice measuring the rate of photosynthesis to get a baseline for you plant.

- Calculating oxygen emitted from trees:

- **(“How to Calculate O<sub>2</sub> from Emitted Trees” by Don Patton, eHow Contributor)**

[http://www.ehow.com/how\\_5798812\\_calculate-o2-emitted-trees.html](http://www.ehow.com/how_5798812_calculate-o2-emitted-trees.html)

» **What you'll need:** *pencil and paper, tape measure, a calculator, and a tree.*

» **Instructions:**

- (1) Measure the overall height of the tree in feet. If the tree is too tall to measure directly, visualize a right triangle formed by the tree and the ground. Estimate the spot on the ground where a line from the top of the tree to the ground would form a 45-degree angle. Measure along the ground from the base of the tree to that point.
- (2) Measure the height of the tree's lowest branch in feet.
- (3) Subtract the lowest branch height from the total height of the tree. This is the height of leaf producing region.
- (4) Determine the average radius of the tree in feet by measuring the distance from the trunk to the outer edge of the leaves. If possible, take several measurements at different heights and average them.
- (5) Find the square of the average radius and multiply it by Pi (a value of 3 will do). Multiply this result by the height of the leaf region to find the volume of the leaf region in cubic feet.
- (6) Select an easily accessible section of the tree and use the tape measure to establish a one cubic foot section.
- (7) Count the leaves in the one cubic foot section.
- (8) Multiply the number of leaves in the one cubic foot section by the total leaf region volume of the tree. The result is an estimate of the number of leaves on the tree.
- (9) Multiply the number of leaves by the oxygen production rate of 5 mL/hour. The result is the amount of oxygen the tree produces per hour.
- (10) For the total average daily oxygen production, multiply by 12 hours of sunlight per day. For the average yearly production multiply again by 365 days per year.

- Measuring carbon dioxide uptake in trees:  
**(“How Do I Calculate Carbon Sequestration?” by Shari Caudill, eHow Contributor)**  
[http://www.ehow.com/how\\_8701126\\_measure-co2-uptake-trees.html](http://www.ehow.com/how_8701126_measure-co2-uptake-trees.html)
  - » **What you’ll need:** *tape measure, tree, and facts about an individual tree.*
  - » **Instructions:**
    - (1) Determine the weight of a living tree—its green weight, as it is called. Each species has a different computation formula, however, the following equations provide a rough estimate. If the tree has a diameter of less than 11 inches, the formula is  $W = 0.25D^2H$ . With more than an 11-inch diameter, use  $W = 0.15D^2H$ . The  $W$  represents the above-ground weight of the tree in pounds. The  $D$  is the diameter in inches, and  $H$  represents the height in feet. A tree’s diameter decreases as you climb. According to the National Computational Science Leadership Program (NCSLP), foresters stand next to a tree and measure it at chest height.
    - (2) Measure the tree chosen for your calculations. For example, let’s say the tree is 10 inches in diameter and 15 feet tall. The diameter squared is 100. Multiply that figure by 0.25 for 250. Then multiply 250 by 15. The above-ground weight of the tree is 375 pounds.
    - (3) Multiply the above-ground weight of the tree by 120 percent or 1.2 to estimate the weight of the root system, according to computations cited by NCSLP. The total for our example tree is 450 pounds.
    - (4) Determine the dry weight, or the weight of a cut tree, by multiplying the green weight by 72.5 percent or .725. According to an article by the University of Nebraska Lincoln Extension, the average tree is about 27.5 percent moisture and 72.5 percent dry matter. Hence the 72.5 estimate. The actual percentage of dry to moist depends on the tree’s species and the region in which it is located. If you are able to determine the exact species, you can find the proper dry weight percentage and substitute it in place of the 72.5 percent. Using this estimate though for our example, our tree is 326 pounds in dry weight.
    - (5) Estimate the carbon content at 50 percent of the tree’s total dry weight. With our example tree, 50 percent of 326 pounds would mean 163 pounds of CO<sub>2</sub>. An article published by the U.S. Department of Agriculture, estimates that CO<sub>2</sub> comprises about 52.1 percent of a softwood tree’s dry weight and about 49.1 percent of a hardwood’s dry weight. There are always slight regional variations.
    - (6) Multiply the content of the tree’s CO<sub>2</sub> by 3.6663 to determine the weight of the carbon stored by the tree. Our example tree’s carbon weighs around 597 pounds.
    - (7) Divide the estimated weight of the tree’s stored carbon by the age of the tree to reach the annual sequestration total. If you are unaware of the tree’s age, estimate it. The example tree is estimated at 10 years old, so it is sequestering about 59 pounds of CO<sub>2</sub> annually
- Coloring flowers to show how water is taken up in the plant’s xylem:  
**(“Coloring Flowers” by Rose Marimore)**  
<http://www.madsci.org/experiments/archive/887562625.Bi.html>
  - » **What you’ll need:** *White flowers (Queen Anne’s Lace or white carnations work best), water-soluble food coloring (blue and red work best), a container, and a knife to split the flower’s stem if you want to experiment further.*
  - » **Safety Note:** *Be careful with the knife if you cut the stem.*
  - » **Instructions:**
    - (1) Add food coloring and water to container in which you’ll place the white flowers. Put flowers in container.
    - (2) Wait 6-12 hours, and observe. For a better idea of what goes on, check back every few hours to note the level of the food coloring in the plant. Depending on the length of the stem, the white petals should ultimately turn the color of the dye added to the water.
    - (3) If you want to experiment further, split the stem into two, or into thirds, and place each section in a container with different food coloring (white flowers in blue/red/yellow produces an interesting effect). Observe results.

The leaves and some petals of plants contain many small pores, called stomata. Water evaporates through these pores. As it does, the plant draws water through its stem, and ultimately from its roots via the soil (or from the water in the vase). This process of water loss from the plant is called transpiration. Water movement through the plant occurs in xylem, hollow cells stacked end to end to form tubes. In leaves and thin stems, the xylem occurs in vascular bundles that also contain phloem, which transports organic compounds throughout the plant. In leaves, vascular bundles are termed veins. Blue or red dye is very good for outlining the xylem in the plant as it draws the water and dye up the stem. You can see it quite clearly if you cut the stem and look at it in cross-section.

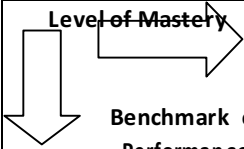



# The Secret Life of Plants: Searching for Evidence of Photosynthesis

Grade: 7 | Time: (3-5) 50 minute periods

Name: \_\_\_\_\_

Date: \_\_\_\_\_

School: \_\_\_\_\_

<p>Level of Mastery</p>  <p>Benchmark or Performance Measure</p>	 <p><b>EMERGING</b> Not yet proficient <b>1 point</b></p>	 <p><b>COMPETENT</b> Partially proficient <b>4 points</b></p>	 <p><b>PROFICIENT</b> Mastered task <b>5 points</b></p>	<p><b>TOTAL POINTS</b></p>
<p><b>Photosynthesis Modeling</b></p>	<p>Student has trouble providing a description of photosynthesis. Has considerable trouble explaining how the reaction takes place. Student has trouble with arranging the molecules to create <math>6\text{CO}_2</math>, <math>6\text{H}_2\text{O}</math>, <math>\text{C}_6\text{H}_{12}\text{O}_6</math> and <math>6\text{O}_2</math>.</p>	<p>Student is able to describe the process of photosynthesis. Knows that the process involves <math>\text{CO}_2</math>, <math>\text{H}_2\text{O}</math>, glucose and <math>\text{O}_2</math> but has trouble explaining how. Student is able to arrange the molecules to create most of the compounds of <math>6\text{CO}_2</math>, <math>6\text{H}_2\text{O}</math>, <math>\text{C}_6\text{H}_{12}\text{O}_6</math> and <math>6\text{O}_2</math>.</p>	<p>Student is able to provide a clear, concise, and accurate description of the process of photosynthesis. Clearly articulates how <math>\text{CO}_2</math> and <math>\text{H}_2\text{O}</math> become glucose and <math>\text{O}_2</math>. Student is able to arrange the molecules to create <math>6\text{CO}_2</math>, <math>6\text{H}_2\text{O}</math>, <math>\text{C}_6\text{H}_{12}\text{O}_6</math> and <math>6\text{O}_2</math>.</p>	
<p><b>Photosynthesis Job Resume</b></p>	<p>Much of the needed vocabulary is lacking. A heading, objective, skills, and/or experience are missing from the resume.</p>	<p>Student is able to adequately describe their job qualifications and methods for performing photosynthetic duties using the correct vocabulary. Student may be missing one of the following: a heading, objective, skills, and experience are covered in detail.</p>	<p>Student is able to thoroughly describe their job qualifications and methods for performing photosynthetic duties using the correct vocabulary. A heading, objective, skills, and experience are covered in detail. Extra information given to enhance resume.</p>	
<p><b>Explaining the Priestly Experiment Demonstration</b></p>	<p>Student has trouble with providing an explanation of how the Priestly experiment relates to photosynthesis.</p>	<p>Student is able to provide a clear, explanation of the Priestly experiment and how it relates to photosynthesis.</p>	<p>Student is able to provide a clear, description of the Priestly experiment and how it relates to photosynthesis and can further explain what would happen to a mouse in the bell jar, with and without a plant.</p>	
<p><b>Lab Experiment: Separating Pigments with Leaf Chromatography</b></p>	<p>Student's filter paper did not separate any pigments</p>	<p>Student's filter paper separated pigments, which are labeled.</p>	<p>Student's filter paper separated pigments which are labeled and from which student can identify chlorophyll a.</p>	
<p><b>Lab Experiments: Viewing Stomata</b></p>	<p>Student performs experiment but has not sketched open and closed stomata in science notebook.</p>	<p>Student performs experiment and has sketched open and closed stomata in science notebook.</p>	<p>Student performs experiment and has sketched open and closed stomata for both a monocot leaf (parallel veins like a blade of grass or corn) and dicot leaf (branching veins) in science notebook.</p>	