

Grade Level: 5

Standards: *Primary:* 5-LS1-1, 3-5-ETS1-3

Secondary: W 5.7-8

Time: 45 minutes class time plus 1-2 hours wait time

Essential Question: What is needed for plants to convert sunlight into energy and carbohydrates?

Objective: Students will conduct an experiment to collect data on photosynthesis rates under different environmental conditions.

Purpose: Students will understand that light and water are the primary components needed for a plant to create energy and materials in order to grow.

Required Materials/Resources:

- Clear cups or bowls (2-4 per student or student group)
- Natural area, place to harvest green leaves, or source of green leaves
- Water
- Potting soil
- Magnifying glasses (optional)
- Green box
- Sun Cutout
- Jar of water
- Black balloon inflated
- Sugar
- Green balloon inflated
- Fertilizer (Miracle Gro or similar)
- Fake leaves
- An apple
- Wood

Suggested Teacher Preparation:

Locate sunny spots where cups can be observed without moving them. Moving the cups drastically increases the risk of disturbing bubbles and losing data, so finding places to put them that can be observed without moving the cups will increase success. Before class, put the sugar, green balloon, leaf, apple, and wood into the green box for the closing demonstration. This lesson assumes a basic understanding of the scientific method, so if you have not taught that explicitly, incorporate teaching it into each step of the investigation.

Teacher Guidance:*Engage:*

Ask: How do plants grow? What do they need to grow? Pair share on this question and then engage in a classroom discussion. Drill down to the factors the students believe are necessary inputs (this will probably include light, air, water, and soil). Discuss the overall process of photosynthesis, plants take in carbon dioxide and, using energy from the sun, transform it into sugar, which can then be used for energy or to make materials so the plant can grow. Are all of the factors we named for plant growth equally important?

Explore:

Divide students into pairs or groups if they will not be completing the experiments individually. Tell students that they will be doing an experiment to see whether something in soil is necessary for plants to photosynthesize. Show them the basic experimental setup of a clear cup filled with water and a leaf submerged and thoroughly wetted in the cup. Let them know that plants produce oxygen as they generate sugars, so our measure of growth will be the number of oxygen bubbles we see on the leaves. They will need to make a hypothesis about how important soil is to the plant. Check off and help them adjust hypotheses if necessary and move students or groups on to experimental design. Remind them that they will need to control for everything that is not their experimental variable, soil. When checking experimental designs ensure that light level, water level, and leaf size are all controlled.

Take students outside to a native planting or other source of leaves to collect their leaves. Remind them that the leaves need to be as close to identical as possible and need to fit neatly in the cup. They also need to be green living leaves. Use only 1 tbsp of potting soil and let it settle in the water before adding the leaf. Add both leaves at the same time.

Analysis:

Have students write down how many bubbles they observe on each leaf. Put a chart at the front of the room and have each student or group enter their data on the class table. Remind students that one way we know our results are good is to do the same experiment multiple

times and compare the results. Have the students calculate an average if you have taught that or calculate an average for each column for the class.

Ask students whether their initial hypothesis was supported or rejected. Because both cups should have the same number of bubbles on average, the conclusion for the experiment should be that soil doesn't affect the rate of photosynthesis. Let students know that while making sugars is the most important thing for plant growth and soil isn't really needed for that process, soil is important because it has nutrients the plants need to make other things like proteins. This is similar to the way that we need a little bit of a lot of vitamins and minerals so that we can grow and be our healthiest.

Closing:

We're going to close with a demonstration that puts the process together. Get out green box (act out while you say). So, here is our plant. We're going to give it light (put sun in box). We're going to give it water (put water in box). And, we're going to give it some carbon dioxide (put black balloon in box). That's the part of air that we breathe out. There's usually plenty of carbon dioxide in the air. We'll let that all process (shake) and the plant produces oxygen (take out and show green balloon) that we can breathe and sugar (take out and show sugar). Now plants can use that sugar for energy just like people can and they can even store that sugar for energy later. Who has tasted maple syrup? That syrup is made from maple tree sap, which is full of sugar the tree has been storing. Energy is great and all, but plants can do even more with the sugar. They can take that sugar (put sugar back in the box) along with other nutrients from the environment (put in a tiny pinch of fertilizer) and use them to make things like leaves and fruits and even wood (take these items out of the box). Now, some animals eat the plants and other animals eat those animals, but except for thermal vents in the deep sea, all of the food and energy for all of life on Earth started with the light from the sun.

Instructions:

Gather your materials:

2 Leaves, same type of plant and same size

2 cups of water

1 TBSP potting soil

Set up your cups:

Put soil in one cup and mix it in

Put both cups in a spot where they will get the same amount of sun.

What is your hypothesis about what will happen when we put the leaves in the water?

Why is it important that the cups have the same amount of water and sun and that the leaves be the same size?

Put one leaf in each cup and make sure that it is under water and doesn't have any bubbles on it. Wait while the leaves do their thing. When the teacher tells you, carefully count the bubbles without lifting or bumping your cups.

	Number of bubbles before	Number of bubbles after
Plain cup		
Soil cup		

Was your hypothesis supported? What are your conclusions?

Evaluation:

DOK Level	Evidence
1	Student is able to complete the investigation with assistance but has difficulty drawing conclusions.
2	Student is able to conduct and describe the results of the experiment but has difficulty describing what those results means in terms of the components of photosynthesis.
3	Student is able to draw conclusions from the results of the experiment that link water, light, and air as the primary needs for photosynthesis, but recognize that soil is not directly needed for photosynthesis
4	Assessed using Expanded Learning. Student is able to expand on how minerals might have an indirect role in photosynthesis through their role in plant growth.

Differentiation:

By Product: Students can present their results in written or oral formats and can use graphics or art to convey results or analysis.

By Process: Students may work individually, in pairs, in groups, or with a facilitator.

By Content: Students may select their leaf as long as it meets the size limits.

Expanded Learning:

Use the same leaf and cup setup and different colors of transparency to see which wavelength of light is used by plants for photosynthesis.

Research and create a brief essay or set of diagrams to demonstrate the similarities and differences between leaves and lungs in how they help the organism grow and live.

Experiment with hydroponic growth systems and how adding different nutrients to the water impacts plant growth.