GENERATIONGENIUS
ALWAYS QUESTION. ALWAYS WONDER.

LESSON PLAN

PHOTOSYNTHESIS AND CELLULAR RESPIRATION
GRADES 6-8

SUMMARY

Students engage in an activity to figure out that some organisms go through photosynthesis, others go through cellular respiration, and some go through both.

NEXT GENERATION SCIENCE STANDARDS CORRELATION

MS-LS1-6. Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

MS-LS1-7. Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

Science & Engineering Practices	Connections to Classroom Activity
Constructing Explanations and Designing Solutions	• Students investigate how sunlight is used in the process of photosynthesis, and they use the data to create an explanation. • Students watch the Generation Genius video to collect information they then use to create an explanation.
Developing and Using Models	• Students draw a model to describe the process of photosynthesis.
Scientific Knowledge Is Based on Empirical Evidence	

Disciplinary Core Ideas	Connections to Classroom Activity
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. With individual organisms, food moves through a series of chemical reactions in which it is broken down and rearranged to from new molecules, support growth, or release energy.	• Students figure out that sunlight is needed in the process of photosynthesis. • They learn that organisms like algae are not plants but also use photosynthesis. • Through the Generation Genius video, students learn about the law of conservation of mass and about how plants and animals can use stored energy.
Cross Cutting Concepts	**Connections to Classroom Activity**
Matter and Energy	• Students make a model to explain how matter is conserved within a system and how energy flows through a system.

DURATION

60 min. (2 days)

MATERIALS

- 2 test tubes with stoppers, or 4 small clear plastic containers with lids
- Elodea (other plants that will work are pathos or philodendron)
- Straws
- Aluminum foil (or brown paper bag)
- Phenol red (or other universal indicator, including red cabbage juice)
- Plant lamp (if there is no window)

ENGAGE

Hold a plant up and ask students where the mass of the plant comes from. Have students write down where they think plant matter comes from. Students should know that plant matter comes from the air (5-LS1-1); however, answers will vary. Many students will probably think that plant matter comes from soil. Use this opportunity to allow these misconceptions to surface. It is not important to correct these ideas at this time. Next, show the video "Life–Creeper Plants Climb Trees."

Have students make an individual model to explain where the plant is getting the matter it needs to grow up the side of the tree. Next, have them compare their model with at least two other students' models. When students are finished sharing, give them a few minutes to revise their model, if they choose to do so.

Have a discussion to make a class model to explain plant growth. Ask students, "What did the models you looked at have in common?" As students come to consensus on what components need to be in the model, write them on the board, and start to draw a class consensus model. Some sample student answers are as follows: plant, Sun, soil, and water. Students may also share answers that include oxygen, air, carbon dioxide, and other substances. Have a discussion about these ideas and add them to the class model, if there is consensus.

Next, focus on the process plants go through to make their matter. Say, "We know plants need certain things to grow, but how do plants use the components we have listed to grow?" Have students share their ideas about the process plants use to grow with a shoulder partner. Then have students share their ideas. Possible student ideas include the following:

- Plants use the air to grow.
- Plants use photosynthesis to make food.
- Plants get their matter from the soil.

Many students have heard the word *photosynthesis* or know that photosynthesis is how plants make food. Have a discussion to surface what students know about the process of photosynthesis. Sample student responses include the following:

- Plants take carbon dioxide from the air and make the oxygen that we breathe.
- Plants use sunlight to make food from air.
- Photosynthesis is how plants make food from the Sun.

Tell students they are moving in the right direction. Then ask, "But how do plants make food by using the Sun and air? How do we know? Is there a way we could figure out if plants really use sunlight and carbon dioxide to make what they need to grow and give us oxygen?" Have students brainstorm and then share their investigation ideas. Next, tell them they had some really great ideas and that you have an investigation they can do in the classroom that will help them gather the evidence they need to figure out if plants really use sunlight and carbon dioxide and release oxygen.

EXPLORE

Tell students they are going to investigate whether plants really use sunlight to make what they need to grow and give off oxygen as waste. Explain that there is liquid that will change color based on the amount of carbon dioxide in the water. Let the students know that the solution will be red when they get it, so they will need to add carbon dioxide until it turns yellow. Ask them how they could get carbon dioxide in the solution. (You can exhale into the solution because we release carbon dioxide as waste!)

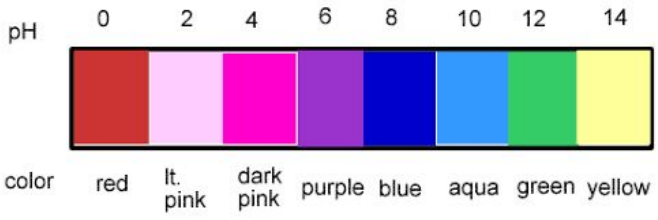
Conducting the Investigation

This investigation will allow students to collect observational data to figure out if plants give us carbon dioxide and release oxygen as waste. Have students work in small groups.

Give each group of students two test tubes or plastic containers, phenol red (enough to fill each container at least halfway), straws, two small leaves (or part of one leaf, depending on the size of the test tube or container), and a plant lamp (if there is no window for sunlight).

First, have students blow into the phenol red until the solution is yellow. (This step could also be done by the teacher before the investigation to save time. It can also be done by adding baking soda to the solution instead of having students blow in it.) Then pour half of the solution into each of the containers. Add a leaf to each of the containers. Have students collect initial qualitative data. This should include a picture of the setup, color of the liquid, type of leaf, leaf color, coverage, and placement. Then, wrap one container with foil or place it in a brown paper bag. Next, place both containers in a sunny window or under the plant lamp.

Have students return to their seats and make a prediction about their investigation results. Before they write their predictions, display the phenol red indicator chart.



Remind students that the solution was red when they started, then changed to yellow as they blew on it. Prompt them to think about what might happen to the color of the solution if the leaves really do use the carbon dioxide and then release the oxygen.

Tell students this process will take some time, and they will need to let their investigations sit for at least 24 hours (over a weekend yields better results).

End of Day 1

EXPLAIN

Have students gather their test tubes to collect their data. Students need to record the changes they see in the tubes, focusing on the color of the water and any other things they see in the water (including bubbles). Have students analyze their data using the indicator chart. Ask them what patterns they notice in the data.

Next, have student groups work together to draw some conclusions from their investigation and compare the results with their initial predictions to determine if their data supported or refuted their prediction. Have each group share their results, then have a whole-class discussion to figure out what they are seeing. Results could include the following:

- Changes in color in both tubes—from yellow to red or purplish
- Uncovered tubes having more change in color than covered tubes
- Bubbles in the tubes
- Leaf looking the same

Prompt students to think about why covering the test tube may have resulted in a different color. Students should conclude that it was because of the Sun. If students don't bring up the idea that sunlight is needed for photosynthesis, prompt them to think about what they know about what plants need in order to grow.

At this point, students may wonder why the leaves in the dark even made the solution change at all. If this comes up, have students brainstorm ideas about why color change still happens, even when there is no sunlight.

ELABORATE

Tell students it sounds like they need some more information about what is going on with the plant leaves, so you have a video that will give them some more information.

WATCH THE GENERATION GENIUS PHOTOSYNTHESIS AND CELLULAR RESPIRATION VIDEO AS A GROUP

After the video ask, "What information from the video can help us answer more of our questions about why the solution changed color in the dark?" Have students share their answers to this question, and then have them discuss the other information they learned from the video.

Lastly, circle back to the original lesson question, and have students revise their original models or create new ones to explain where plants get the matter they need for growth. Models should now include the following:

- Sunlight is needed for plants to grow.
- Plants go through a process called photosynthesis to make the matter they need.
- Plants take in carbon dioxide and water. These reactants change during a chemical reaction to make sugar, and

plants release oxygen as waste.

- Plants can also store energy to be used later when there is no sunlight or when it doesn't have any leaves.
- When plants use their stored energy, they go through a process called *cellular respiration.*

EVALUATE

There are multiple ways to assess your students' understanding of this topic. The Exit Ticket is an opportunity for students to use the science ideas they built in the lesson in a new context. Alternatively, you can use the Kahoot! quiz (which provides downloadable scores at the end of the game) and/or the paper quiz. All these resources are located right below the video in the assessment section.

EXTENSION

Have students engage in the plant activity, but have different groups test different variables (e.g., using a stem instead of a leaf, using different amounts or types of light, changing the temperature, and trying other water conditions [salt verses fresh]). You can also do this investigation using probes, instead of an indicator, if those are available in your building.