***Note:** sections of the lesson plan template marked with * are optional, but may be useful for your planning.

Plant light blocking experiment	
Grade level	1-8
Standards (NGSS)	NGS Standards targeted to fourth grade requirements: 4-PS3-2
Learning Objectives (Goals)	(1) Explain how, through a process called photosynthesis, plants transform light energy into chemical energy in order to survive and grow. (2) Demonstrate that when part of a leaf is covered in foil, that spot bleaches because no light can reach it.
Time/duration	1h to set up experiment, 1-2 weeks for plants to bleach, ~30min – 1h to discuss results of experiment.
# students	≤32 students
Materials	Per group of 4-6 students: one large leaf plant*. Per student: one sheet of aluminum foil, 1-2 paper clips, one pair of rounded scissors, one thin black sharpie. **Collard greens have been successful in past experiments. Another option is to use plants located outside the classroom.*
***Location**	Indoor (can be adapted outdoors, depending on space availability – see optional extension activities).
***Logistics**	The potted plants need to be kept alive at least until the end of the experiment – i.e. GO-Outdoors volunteer or teacher should care for them through duration of experiment.
***Accessibility & safety awareness**	GO-Outdoors volunteers, teacher, or students can assist students with motor disabilities. Scissors should be rounded (kid-style) for safety considerations.
GO-Outdoors Missions	GO-Outdoors' mission is to increase K-12 students' exposure and access to the geosciences field through active learning strategies. Here, students will learn a fundamental concept in geobiology (that plants convert light energy into chemical energy – a form of energy accessible to the rest of the biosphere) through a highly engaging, hands-on experiment.

Lesson activities

Day 1 (60 min)

[10 min]: **Engage** students by asking questions to get them thinking about the concept of photosynthesis (plants converting light energy into chemical energy in order to grow/survive):

- What do humans need to survive? (A: food, water, oxygen)
    - Which part of this gives us energy? (A: food)
    - What is the definition of energy? (A: the ability to do work or cause change)
- What do plants need to survive? (A: air (CO_2), water, nutrients, light)
    - Do plants eat food like us, or do they make their own food? (A: they make their own food)
    - How do they make their own food? What is this process called? (A: through a process called photosynthesis, plants use energy from the sun (light energy) to convert CO_2 into sugars that they can use right away if they're hungry, or they can store the sugars for more long-term energy. Plants have special structures in their leaves which contain a green pigment called chlorophyll. Green leaves are a sign that plants are photosynthesizing and making food!)
    - Why are plants important to us? (A: plants make oxygen that humans and animals need to breathe. They also convert light energy into chemical energy – a form that is available to the rest of the biosphere)
- What would happen if we blocked the sunlight on a part of the plant leaf? (Ask the students to form a <u>hypothesis</u>, but first have a student define a hypothesis)

[5 min] Articulate instructions to students (either write instructions on whiteboard or show Powerpoint slide with instructions):

1. Using a sharpie, draw a small shape onto a piece of aluminum foil.
2. Write your initials in the shape so you can identify your shape later.
3. Cut out the shape using scissors.
4. Attach the foil shape to a plant leaf (leave the leaf intact on the plant) using the paper clip. Be gentle to avoid ripping the leaf.
5. On the associated worksheet, draw a picture of your plant leaf with the foil and write your hypothesis for what the leaf will look like after 1-2 weeks.

*For students in grades 1-3, you could pass out pre-cut shapes if necessary.

[5 min] Depending on number of students and plant availability, divide students into <u>pre-arranged groups (no more than 4-6 per plant, if possible)</u> and distribute

plants and materials. Could use ribbons tied around plants, or plant names, to assign plants to groups.

[30 min] Allow students to prepare plants and fill out worksheet. Could allocate time at the end of the 30 min block to have students share their hypotheses.

[10 min] Have students clean up their stations. Plants should either go home with the GO-Outdoors volunteer or be placed under the care of the teacher/class. Plants should be placed under direct light (sunlight or artificial 12h light: 12h dark cycle), watered frequently, and monitored for changes underneath the foil throughout the experiment (1-2 weeks).

Day 2 (60 min)
[10 min] Students divide back into the original groups. **Engage** the students by asking them to summarize what they did on day 1. Have some students share their hypotheses they wrote on their worksheet.

[20 min] Return the plants to the students for them to **explore** the results of their experiment by removing the foil and evaluating the effect. Tell them to each write/draw their observations (grades 3-5) on their worksheet.

[10 min] Using a posterboard or projected slide, provide students with some information about how plants convert sunlight to chemical energy through photosynthesis, and how this process relates to the green pigmentation of plants. This information will help students contextualize their observations from the explore phase. Then have students **explain** their observations to the class, connecting their observations to the underlying concepts you introduced.

[10 min] Have students clean up their stations.

Optional extension activities
To communicate the concept that plants intake CO_2 through stomata (small pores found on the underside of their leaves), an optional extension activity is to have the students the undersides of some leaves with Vaseline, which will starve the leaves of CO_2. Students can tie ribbons around the leaves they coat for identification.

***Instructor support**

Depending on the number of students, it might be necessary to have people help out the individual groups.

***Common misconceptions about the lesson**

***Opportunities to engage students in planning**

***Handouts** On day 1, each student will be provided with a handout (next page) where they can write and draw their hypotheses about what will happen to the plant. These will be collected at day one and given back on day 2 to each student. On day 2, the worksheet will be passed out to the students again, and they will have the chance to write whether their hypothesis turned out to be correct.

Plant light blocking activity

Name: _____

Date: _____

Day 1. Directions:

1. Draw a small shape on the aluminum foil.
2. Cut out the foil shape.
3. Attach the foil shape to your plant leaf using a paper clip. Be careful not to tear the leaf!

Draw your plant leaves with the foil:

What do you think will happen to your plant leaves? Write your **hypothesis** here:

_____

_____

_____

Day 2. Reflect on your original hypothesis from day 1.

Was your hypothesis correct (yes or no)? Record your observations below.

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Explain your observations. If your leaf bleached, what caused this to happen? Use words like **sunlight**, **chemical energy**, and **photosynthesis**. (Alternatively, if your leaf did not bleach, what might have prevented this)?

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