

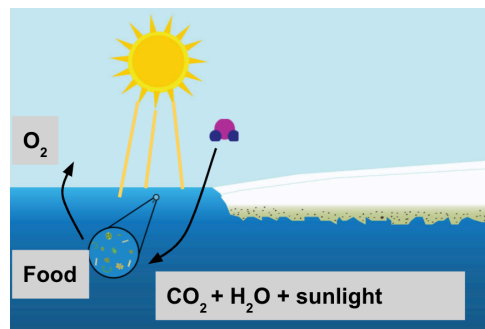


Photosynthesis Investigation - Teacher Guide

(Lesson 3 of 8 - back to [overview](#))

Setting the Stage

Arctic algae make up the base of the Arctic food web, creating and providing energy for all other organisms by converting dissolved carbon dioxide into food/energy via photosynthesis. The process of photosynthesis can only take place in the presence of sunlight. The decline in sea ice has allowed more solar energy to reach the Arctic Ocean, which may lead to an increase in ocean algae productivity (increasing ocean algae populations).



Lesson Overview

In this 2-day lesson, students will conduct a photosynthesis investigation and analyze satellite imagery to explain how declining sea ice has changed the amount of sunlight reaching the Arctic.

Day 1

- *Part 1 – Sea Ice and Arctic Algae (15 minutes)*
Students identify and explain patterns in NASA satellite images that show changes in sea ice and chlorophyll concentrations in the Arctic.
- *Part 2 – Photosynthesis Investigation - Day 1 (45 minutes)*
Students set up a lab investigation to determine whether sunlight is necessary for photosynthesis.

Day 2

- *Part 3 – Photosynthesis Investigation - Day 2 (30 minutes)*
Students analyze results from the investigation.
- *Part 4 – Post-Lab Questions (15 minutes)*
Students investigate how the availability and absorption of solar energy in the Arctic has changed over time.
- *Part 5 - Update Summary Table (10 minutes)*
Students reflect on what they learned from the lesson and how it relates to the unit driving question.

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Instructional Overview	
Grade Level	Middle/High School
Instructional Time	60 minutes (<i>total time needed</i>)
Unit Driving Question	How might the decline in sea ice affect Arctic organisms large and small?
Lesson Driving Questions	- Can plants do photosynthesis (produce food/energy) without light? - Has the decline in sea ice impacted the amount of sunlight reaching the Arctic?
Building Toward	Middle School: MS-LS2-3 High School: HS-LS2-4 , HS-LS2-5
Three Dimensions	Science and Engineering Practices: - Planning and Carrying Out Investigations - Analyzing and Interpreting Data Disciplinary Core Ideas: <i>Middle School:</i> - LS1.C: Organization for Matter and Energy Flow in Organisms - LS2.B: Ecosystem Dynamics, Functioning, and Resilience <i>High School:</i> - LS1.C: Organization for Matter and Energy Flow in Organisms - LS2.B: Ecosystem Dynamics, Functioning, and Resilience Crosscutting Concepts: - Cause and Effect - Stability and Change
What Students Will Do	- Carry out an investigation to determine if light affects the ability of plants (algae) to do photosynthesis. - Analyze and interpret satellite imagery to explain how and why declining sea ice has changed the amount of sunlight absorbed by the Arctic.
Materials	Slide Deck Student Worksheet (1 per student) Answer Key NASA Earth Observatory - The Arctic is Absorbing More Sunlight <i>Photosynthesis Investigation materials needed for each group</i> - Safety goggles - Straw (1 per group) - Plant x2 (spirogyra or elodea) 4 test tubes 4 stoppers/caps - Test tube rack - Aluminum foil



	☐ Light source ☐ Tape ☐ Marker Optional homework assignment: ☐ “Arctic Sea Ice Algae” - Reading (1 per student) ☐ “Arctic Sea ice Algae” - Student Worksheet (1 per student)
Material Preparation	☐ Cue and test web links ☐ Print student worksheets ☐ Review speaker notes in the slide deck ☐ Review Answer Key ☐ Display summary table and initial ideas public record
Vocabulary	<u>Photosynthesis</u> - process by which plants (including algae) produce food/energy <u>Chlorophyll</u> - green pigment plants use to absorb sunlight <u>Primary productivity</u> - the rate at which plants convert carbon dioxide into food/energy.

Part 1 - Where Do Algae Get Their Energy? (15 minutes)

Refer to Part 1 slides included in the [slide deck](#). See presenter notes for additional information.

1. Students “turn and talk” to their partner about the following prompt, “Algae don’t have mouths like you and me, so how do these plants of the Arctic produce/make their own food?” and then share their ideas with the class.
2. Use prompt and the subsequent class discussion to review the process of photosynthesis.
3. Consider utilizing the following prompts as a way to segue into “Part 2 - Photosynthesis Investigation.”
 - a. Can plants do photosynthesis in water?
 - b. Can plants do photosynthesis without sunlight?

Part 2 - Photosynthesis Investigation (Day 1) (45 minutes)

Refer to Part 2 slides included in the [slide deck](#). See presenter notes for additional information.

1. Gather and set up materials (see instructional overview table for materials list)

Optional: Prepare a BTB solution beforehand that can be distributed to each group (100 mL of solution per group).



Optional: Watch the videos below to learn more about the photosynthesis investigation.

- [BTB Solution Introduction](#)
- [Photosynthesis and Elodea](#)

2. Review the student worksheet as a whole class (background, materials, and **procedure**)
 - a. Model the procedure with students as needed

Note: The more algae (spirogyra, elodea, or other aquatic plant) students use the more obvious the color change will be.

3. After reviewing/modeling procedure and distributing materials, students set up the photosynthesis investigation and answer day 1 questions on their student worksheets.
4. Review day 1 questions as a whole class (see [Answer Key](#) as needed)

Part 3 - Photosynthesis Investigation (Day 2) (30 minutes)

Refer to Part 3 slides included in the [slide deck](#). See presenter notes for additional information.

1. Students “turn and talk” with a partner(s) to address prompts intended to get students to reflect on day 1 activities.
2. Students observe changes and reflect on the investigation to answer day 2 questions on their student worksheets.
 - a. Emphasize that the plants fixed carbon dioxide to make food via photosynthesis. This is important because in future lessons students will analyze a dataset that shows how this fixed carbon gets passed to higher trophic levels.

Note: Use the “Take home points” slide (slide #14) to really highlight the flow of carbon between the atmosphere (exhale) → hydrosphere (evidence is solution color change) → biosphere (plant via photosynthesis). In addition, reinforce that light is required for photosynthesis and segue into Part 4 where students analyze data visualizations to determine how declining sea ice is impacting the amount of solar energy reaching the Arctic.

Part 4 - Post-Lab Questions (10 minutes)

Refer to Part 4 slides included in the [slide deck](#). See presenter notes for additional information.

1. Students make predictions about how the decline in sea ice may be impacting the amount of sunlight reaching the Arctic Ocean.
2. Tell students that scientists have been using satellites to investigate how declining sea ice might be impacting the amount of sunlight reaching the Arctic Ocean (and thereby the ability of algae to do photosynthesis).
3. Introduce satellite measurements (figures) showing changes in sea ice and absorbed radiation in the Arctic over the period from 2000-2014.



- a. Challenge students to think about what the different colors represent in each figure.
4. Students visit [this "NASA Earth Observatory" webpage](#) to identify and explain patterns in sea ice and absorbed radiation datasets.
 - a. Encourage students to click the "View Both Images" icon.
5. Review student answers as a whole class.

Note: Use the "Take home points" slide (slide #21) to bring the entire lesson together:

- Algae need sunlight to do photosynthesis
- Loss of sea ice increases the amount of sunlight reaching/absorbed by the Arctic Ocean
- What does this mean for Arctic algae? We'll explore this question in the next lesson...

Part 5 - Update Summary Table (10 minutes)

Refer to Part 6 slides included in the [slide deck](#). See presenter notes for additional information.

1. Students work in groups to reflect on their learning and how it relates back to the unit driving question, "how might the decline in sea ice affect Arctic organisms large and small?"
2. Facilitate a discussion in which students come to a consensus about what they learned and how it helps them understand the unit driving question. Ideas/concepts agreed upon by the class should be included in the whole class summary table (see [Answer Key](#) as needed).
 - a. Students record new summary table entries onto their own summary tables.

Optional homework assignment: Students read and [answer questions](#) about the "[Arctic sea ice algae](#)" article.

Notes: Use the last sentence of the reading, "So even though there are more ice algae early on, is there more total ice algae for the whole season?" to start the next class (lesson 4).