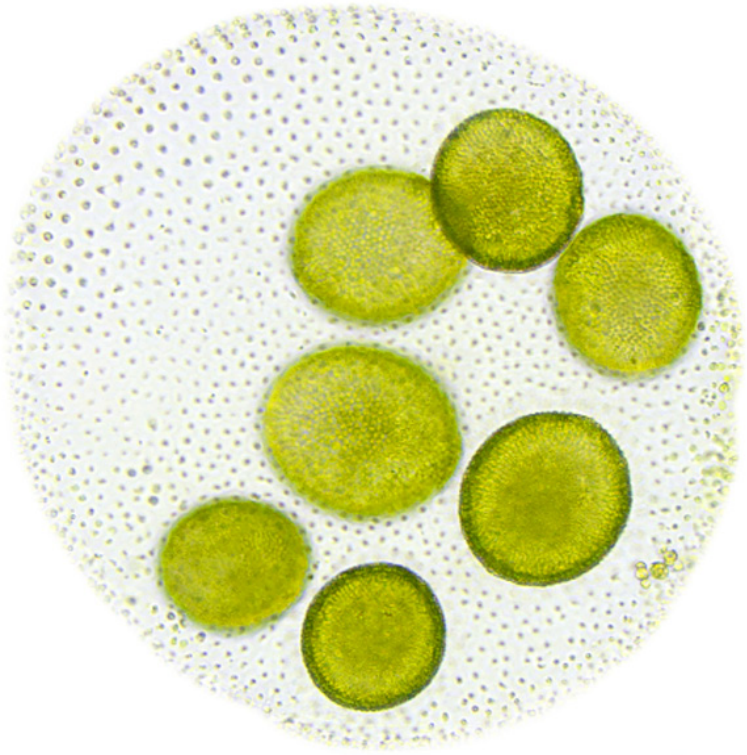
# ALGAE BLOOM AND BUST

## OVERVIEW

Climate change and increasing water temperatures, along with added nutrients from human activities, impact both aquatic ecosystems and the people who depend on them. In this experiment-based lesson, students examine one outcome: algae blooms.

GRADE LEVEL: 6–9



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# ALGAE BLOOM AND BUST

## PURPOSE

To learn about the possible effects of global climate change and human activities such as farming and waste processing, students conduct an experiment on algae and see how increases in nutrients and temperature can impact aquatic ecosystems.

## GRADE LEVEL

6–9

## BACKGROUND

Algae are simple, green aquatic plants that have no roots, leaves, or flowers. Algae and other phytoplankton are important because they form the basis for many aquatic food webs. They also produce most of the oxygen present in Earth's atmosphere. However, too many algae growing too quickly can wreak havoc on an ecosystem.

Algae make their food through photosynthesis, a process that involves capturing light energy from the sun and converting it to carbohydrates; photosynthesis requires carbon dioxide and water, and releases oxygen. When algae metabolize the carbohydrates through respiration, they get chemical energy to fuel growth, reproduction, and other life processes.

Like other green plants, algae create and metabolize food through the processes of photosynthesis and respiration.

**PHOTOSYNTHESIS**

carbon dioxide ($CO_2$) + water ($H_2O$) + light energy → food (carbohydrates) ($C_6H_{12}O_6$) + oxygen ($O_2$)

**RESPIRATION**

food (carbohydrates) ($C_6H_{12}O_6$) + oxygen ($O_2$) → chemial energy + water ($H_2O$) + carbon dioxide ($CO_2$)

The term algae bloom refers to a rapid rise of the algae population in a body of water. Algae blooms are usually caused by moderate increases in water temperature and excess nutrients—primarily phosphorus and nitrogen from crop fertilizers, animal wastes, or sewage facilities. As such, they are unintended consequences of some of the methods we use for growing food or processing waste.

The rapid increase of algae can have a drastic effect on an aquatic ecosystem. The algae cover the surface of the water, blocking sunlight from beneficial underwater plants that provide food and shelter for fish and other animals. When the algae proliferate, they start to deplete the nutrient supply and die off. This, in turn, causes a reduction of dissolved oxygen as the dead algae decompose, a process that uses oxygen. Many fish and other aquatic organisms die when the oxygen level lowers.

The Earth's climate is changing more rapidly than society has ever experienced in the past. We have strong evidence that a dramatic warming trend is largely the result of increased carbon dioxide and other greenhouse gases in the atmosphere from the burning of fossil fuels, yet another example of an unintended consequence of human activity. As global temperatures rise with climate change, more water environments are becoming susceptible to algae blooms. Warmer weather has

created longer growing seasons, and has enabled more algae to grow in northern waters previously too cold for their survival.

In addition to suffocating aquatic habitats, some species of marine algae produce dangerous toxins that can be deadly to both aquatic and land life, including humans. Called "harmful algal blooms" (formerly known as "red tides"), these dangerous phenomena are occurring earlier and more frequently with climate change. Rising temperatures and increasing levels of $CO_2$ in the atmosphere—combined with increased nutrients—are impacting the growth and relative abundance of harmful algal bloom species.

## MATERIALS

- Algae sample (see Preparation)
- Four one-gallon glass jars or aquaria with covers
- Bottled or distilled water
- Four eyedroppers
- One bottle of liquid plant food
- Two identical aquarium heaters or other sources of heat (see Preparation)
- Thermometer
- Tape or grease pen for labeling jars
- Magnifying lenses
- Microscope (with at least 10x power) and slides
- Dissolved oxygen test kit (optional)
- "Algae Observation" student page
- "Story of an Algae Bloom" student page

## PREPARATION

- Four to eight days before doing the lesson, prepare the algae culture:
    - Obtain algae from a freshwater pond or lake, or from a scientific supply house (see Resources). You will need one dropperful of algae for each of the four jars.
    - Fill four jars with equal amounts of bottled or distilled water. (Tap water may contain chlorine or other substances that would affect the experiment.)
    - Place a dropperful of algae in each of the four jars. Let the algae culture incubate four to eight days. This time period will let the algae adjust to the jar environment and ensure approximately equal growth in each jar.
- Obtain two submersible aquarium heaters, set to the same temperature. For this experiment, the ideal water temperature is 25–28˚C (75–82˚F).

  (As an alternative, you can place the water containers on heating pads wrapped in plastic bags and set on "low." Test the temperature with a jar of water placed on the heating pad. If the water gets above 28˚C [82˚F], enclose a book in a plastic bag to create a spacer between the jar and the heating pad. Experiment with one or more spacers until the water temperature remains constant at the desired level for 12 to 24 hours.)
- Make copies of the student pages.

## LESSON INTRODUCTION

Ask students to jot down a list of factors that plants need to survive and thrive (such as water, sunlight, nutrients, carbon dioxide, ability to reproduce, etc.). After students have had a few minutes to write, ask them to share factors from their lists.

Remind students of the relationship between global climate change and an overabundance of carbon dioxide and other greenhouse gases in the atmosphere. Ask, "What effect might rising temperatures have on plants? What effect would it have on other organisms?" Ask them to think about what might happen if there was an overabundance of any of the other factors.

## CONDUCTING THE LESSON

1 Explain to students that they will conduct an experiment with algae to examine the effect of an increase in two factors: temperature and nutrients. Ask, "What are algae? Why might they be important for aquatic ecosystems?"

2 Set up the four jars so that all have equal amounts of bottled water and algae, and are exposed to the same light intensity. Label the four jars, and prepare them as follows:

- Jar A: water and algae only.
- Jar B: water, algae, and liquid plant food (add the amount recommended on the label).
- Jar C: water and algae, with a heat source.
- Jar D: water, algae, and plant food (the same amount as Jar B), with a heat source.

3 Distribute the "Algae Observations" student page. Ask students to predict algae growth by rank ordering the jars, with a "1" for the jar they think will have the most algae growth in 1–2 weeks, and a "4" for the jar they think will have the least.

4 Every day or two for the next 1–2 weeks, direct students to observe the jars and rank order the amount of algae they see, recording their results on the "Algae Observations" student page. Take a drop from each culture, place it on a microscope slide, and have students count and record the number of algae per drop that they see. (Optional) Use the test kit to determine the level of dissolved oxygen in each jar.

5 After observing the jars for 1–2 weeks, have students answer the questions on the "Algae Observations" student page.

6 Divide the class into pairs for reading "The Story of Algae Bloom" student page, and answering the questions that follow the story.

**NOTE:** Be sure to properly dispose of algae cultures. Do not pour them down the drain without treating them first in one of the following ways:

1 Adding bleach to the culture in the ratio of 2 ½ tablespoons to one gallon of culture, and leaving it to sit overnight before pouring it down the drain with running water.

2 Bringing the culture to a boil in a microwave-safe container in a microwave oven. While this will cause an unpleasant smell, it will not contaminate your microwave for future food use.

## DISCUSSION AND WRAP-UP

Lead a discussion about students' findings:

- Which treatment exhibited the most algae growth?
- What factors cause an algae bloom?
- Can you think of another situation in which "too much of a good thing" has a negative effect on people or the environment?
- How might an algae bloom such as the one described in "The Story of an Algae Bloom" be prevented?
- What might be the effect of global climate change and the resulting worldwide increases in water temperature?

## RESOURCES

For live algae cultures and dissolved oxygen test kits:

- eNasco. www.enasco.com.
- Carolina Biological Supply. www.carolina.com.
- Ward's Natural Science. www.wardsci.com.

## SOURCES

This activity was adapted from:
Carolie Sly, Leslie Comnes, and Sandra Brislain. "Algae Bloom and Bust." *In Water Wisdom: Curriculum for Grades Four through Eight*. Alameda, CA: Alameda County Office of Education, 1990).

The Background section includes information about the effects of climate change on algae from:
"Climate Change and Harmful Algal Blooms." National Oceanic and Atmospheric Administration. Retrieved from http://www.cop.noaa.gov/stressors/extremeevents/hab/current/CC_habs.aspx

"Harmful Algae Take Advantage of Global Warming: More Algal Blooms Expected." April 7, 2008. Science Daily. Retrieved from http://www.sciencedaily.com/releases/2008/04/080403140928.htm

Name_____

# ALGAE OBSERVATION

Predict the growth of algae in 1–2 weeks by placing a "1" next to the jar you think will have the most algae, and a "4" next to the one you think will have the least.

Jar A _____ Jar B _____ Jar C _____ Jar D _____

Each day of observation, rank the amount of algae in each jar (as in your prediction above) and record other observations.

| | DATE | | DATE | | DATE | | DATE | | DATE | |
|---|---|---|---|---|---|---|---|---|---|---|
| | RANKING | BSERVATIONS | RANKING | OBSERVATIONS | RANKING | OBSERVATIONS | RANKING | OBSERVATIONS | RANKING | OBSERVATIONS |
| JAR A | | | | | | | | | | |
| JAR B | | | | | | | | | | |
| JAR C | | | | | | | | | | |
| JAR D | | | | | | | | | | |

Name_____

**QUESTIONS:**

1 At the end of the observation period, which jar had the most algae? _____

2 Was your original prediction correct? If not, what might have caused this result?

_____

3 Did the rankings for each jar stay the same over time? _____

4 How did plant food affect the growth of algae? Compare the amount of algae in jars B and D to the control (jar A).

_____

_____

5 How did temperature affect algae growth? Compare jars C and D to the control (jar A).

_____

_____

6 Which had more effect: plant food or temperature? Compare jar B to jar C.

_____

_____

Name_____

# THE STORY OF AN ALGAE BLOOM

A small lake sits in a farming area. When it rains, water runs off the surrounding farmland, carrying traces of fertilizer and manure into the lake. Due to climate change, the lake water is about 5 degrees (˚F) warmer than it was 50 years ago.

One summer, the warm water and nutrients cause an algae "bloom," the rapid growth of algae. The lake's water appears green as the algae nearly cover its entire surface. When the algae die, they sink to the lake bottom, where they are decomposed by bacteria. This process of decomposition requires oxygen, and causes the level of oxygen in the water to drop.

1 Draw a picture of the place described in the story.

Name_____

2 What are possible consequences of a sudden increase in algae on fish and other organisms living in the lake? How might these organisms be affected when the algae die?

_____

_____

_____

3 What are possible consequences of a lack of oxygen on other plants and animals living in and around the lake?

_____

_____

_____

4 Write a statement describing how people's activities appear to impact the lake and the organisms living in it.

_____

_____

_____

5 If you lived near the lake and an algae bloom began, what might you do? To whom would you go for help? How might this problem be prevented in the future?

_____

_____

_____

_____

_____

_____

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## ABOUT THE CENTER FOR ECOLITERACY

The Center for Ecoliteracy is an internationally recognized leader in systems change innovations in education for sustainable living. Since 1995, the Center has engaged with thousands of educators from across the United States and six continents. The Center offers publications, seminars, academic program audits, coaching for teaching and learning, in-depth curriculum development, keynote presentations, and technical assistance. Books authored or coauthored by the Center for Ecoliteracy include *Ecoliterate: How Educators Are Cultivating Emotional, Social, and Ecological Intelligence* (Jossey-Bass, 2012); *Smart by Nature: Schooling for Sustainability* (Watershed Media, 2009); and *Ecological Literacy: Educating Our Children for a Sustainable World* (Sierra Club Books, 2005).

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## PHOTOS

**Cover** Algae: istockphoto 000018937146, NNehring