

Activity Student handout

WHO “GLOWS” THERE?!

Bioluminescent Dinoflagellates



Please read all instructions before beginning. Please handle the dinoflagellates gently!

Photos above: Hans Hillewaert, Carolina Biologicals, Aleksandra Szczepiński; below: NOAA Great Lakes Environmental Research Laboratory

Materials

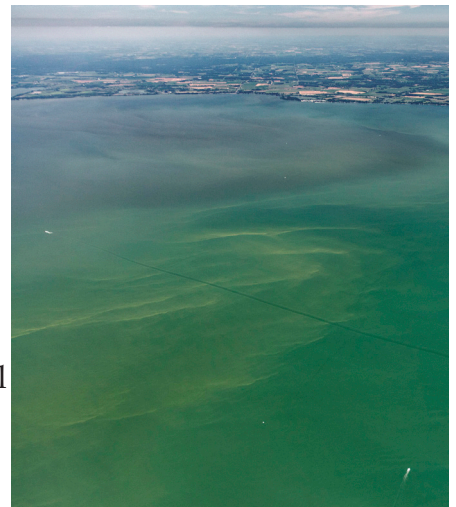
- Living dinoflagellates
Available from suppliers such as Carolina Biological Supply (www.carolina.com), PyroFarms (www.pyrofarms.com), and Sunnyside Sea Farms (www.seafarms.com). These links are provided as information, not endorsement.
- Pen or pencil
- Hand lens or home microscope
- Small, clear dish
- Spoon, baster or eyedropper
- Piece of white copy paper and/or black construction paper (optional)
- Crayons or colored pencils (optional)
- A safe, dark place (e.g., a closet, a basement, a room at night)

Background

Dinoflagellates are a type of creature that are neither plants nor animals; they are **protists**! Dinoflagellates live in the water and there are approximately 2,000 living **species** organized into about 140 **genera**. Of these 140 groups, 18 are **bioluminescent**, able to produce their own light.

Most dinoflagellates are **marine**, but some live in freshwater lakes and rivers. They exist in a variety of shapes and are very small; an individual's entire body is only a single cell.

There is strength in numbers, however, and when environmental conditions are right, dinoflagellates can reproduce rapidly. As many as 20 million individuals per liter can form large groups responsible for **harmful algal blooms**.



For more about bioluminescence and red tides, visit:

<https://latzlab.ucsd.edu/2021/10/07/the-terrifying-but-awesome-science-behind-red-tides-and-bioluminescence/>

Predict

P1. **Don't disturb your dinoflagellates!** While handling their container gently, look at your dinoflagellates. What do you see? Record your observations in the box below.

P2. **Don't swirl the container yet!** What do you think will happen when you take the container to a dark place and gently swirl the dinoflagellates? Record your predictions in the box below.

P1. What do you see?

P2. What do you think will happen?

Activity: Part 1

1a. Make sure an adult knows where you are and what you are doing. Ask them to join you!

1b. Read the instructions that came with your dinoflagellates. What time of day is best to view their bioluminescence?

1c. Gently take your container of dinoflagellates to a dark place, such as a closet or a room at night. Before you turn off the lights or close the door, find a comfortable position where you can be patient for a few minutes.

1d. **Wait a few minutes for your eyes to adjust to the darkness.** When you are ready, gently swirl the container of dinoflagellates. What do you see? Record your observations below.

1c. What happened when the dinoflagellates were swirled in the dark?

Activity: Part 2

2a. Use your spoon, baster, or eyedropper to move some of your dinoflagellates from your container to your clear dish. You might want to ask an adult for help.

2b. Use your hand lens or microscope to look at your dinoflagellates. Experiment by looking at them with the dish on top of a white piece of paper or a black piece of paper. Does the background change what you can see?

2c. What do you see? Record your observations in the box below. **With an adult's permission, email us a photo of your drawing and your mailing address, and we will send you a prize! We might use your drawing on our website! Email: bioluminescencehub@gmail.com.**

2c. What did you see when you examined the dinoflagellates with the hand lens or microscope?

Activity: Part 3

3a. Possibly with an adult's help, find an image of a **species** of **bioluminescent** dinoflagellate that is different from the one you have. Draw that **species** in the box below. Do the two species have different **morphologies**?

Hint: look for *Lingulodinium polyedrum*, *Pyrocystis fusiformis*, or *Noctiluca scintillans*, for example.

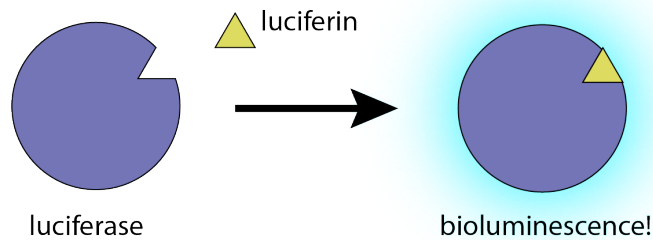
3a. Draw a bioluminescent dinoflagellate of a different species.

Bioluminescence

How do dinoflagellates make their own light?

Bioluminescence is light produced by a chemical reaction inside a living thing. Dinoflagellates aren't the only creatures capable of creating their own light; some **species** of fish, mushrooms, beetles, jellyfish, sea stars, squid, worms, and many other types of creatures have this ability.

The precise **chemical reaction** is slightly different among **species**, but most **bioluminescent** reactions include two key pieces: a **luciferase** and a **luciferin**. A **luciferase** is an **enzyme**, a type of **protein** that breaks other molecules into smaller pieces. A **luciferin** is a small molecule that fits into a specific opening in the **luciferase** and is broken down during the reaction. When the **luciferase** breaks down the **luciferin**, light is produced!



Glossary

bioluminescence - light produced by a chemical reaction within a living thing

chemical reaction - two or more substances interact to become a new substance

enzyme - a type of protein that breaks other molecules into smaller pieces

genera - plural of genus; a group of related species

harmful algal bloom (formerly, "red tide") - in the right conditions, dinoflagellates can form large clusters or "blooms"; when these clusters are toxic to animals such as clams and fish, they are called "harmful."

luciferase - the type of enzyme (a protein) used in a bioluminescent reaction

luciferin - the small molecule broken down during a bioluminescent reaction

marine - relating to the ocean or sea water; living in the ocean

morphology - the way a creature is built; its shape and form, its body parts

protein - a chain of pieces (like a candy necklace) of a living thing too small to see that fold and lock into grooves. Proteins can be part of chemical reactions that start, stop, or change body functions, or build body parts (skin, hair, muscle).

protist - a creature that is only one cell and is neither plant, animal, bacteria, nor fungus

species - a specific type of creature that is different from all other types of creatures

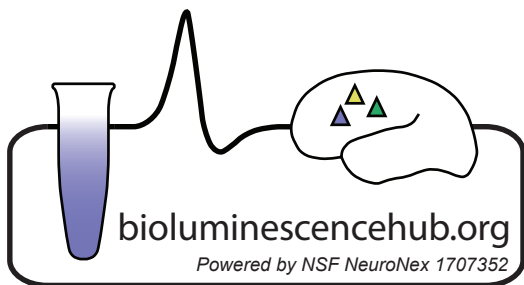
Learn More

To learn more, visit the following (non-affiliate) websites:

- The Bioluminescence Web Page: <https://biolum.eemb.ucsb.edu/>
- The Latz Laboratory: <https://latzlab.ucsd.edu/>
- National Geographic Encyclopedia:
<https://www.nationalgeographic.org/encyclopedia/bioluminescence/>
- Tree of Life Web Project, Dinoflagellates: <http://tolweb.org/Dinoflagellates/2445>

Enjoy this activity? Want to learn more? Let us know!

Email us at bioluminescencehub@gmail.com and follow us on Twitter and Instagram @BiolumHub.



Activity Teacher/Parent Guide

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Learning Objectives

At the end of this activity, students should know...

- Bioluminescence is light created by a chemical reaction within or by a living thing.
- Dinoflagellates are a group of one-celled creature that is neither plant, animal, nor fungus.
- Dinoflagellates have diverse morphologies; most species are marine.
- Many, many dinoflagellates in a group cause algal blooms and, when gently disturbed, light up their surrounding water.

Tips

Part 1:

- Avoid disturbing the dinoflagellates before you are ready. Each time they are swirled, some of their luciferin substrate is used up and must be regenerated over time. If you have many students, order several jars of dinoflagellates.
- Note the diurnal cycle of your dinoflagellates. Most are reverse-cycled when they arrive (i.e., they are kept under lights at night and in the dark during the day) so they are ready for use during typical classroom sessions. Dinoflagellate bioluminescence is much brighter when they have been cycled to think it is nighttime.
- Choose a location that is as dark as possible, and wait until your eyes adjust to the darkness before gently swirling your dinoflagellates. A classroom might not be dark enough. If a dark space is not available, you might try observing the dinoflagellates while under a dark sheet.

Part 2:

- If possible, examine your dinoflagellates with a microscope. Dinoflagellates are very small.
- **Email us a photo of your students' drawings and your mailing address, and we will send you a prize! We might use your drawings on our website!**
Email: bioluminescencehub@gmail.com.

Questions?

Enjoy this activity? Want to learn more? Let us know!

Email us at bioluminescencehub@gmail.com and follow us on Twitter and Instagram @BiolumHub.