Grade Level: 3-5
Time Estimate: 1 day

BIOLUMINESCENCE / INSTRUCTOR INFO

Summary

This lesson includes vocabulary, content, and creative activities to help students learn about bioluminescence. Students will define bioluminescence, learn what types of organisms use bioluminescence, and learn how this adaptation helps organisms survive and thrive in their environments.

Part 1. What is Bioluminescence?
Part 2. The Purpose of Bioluminescence
Part 3. Scientific Applications
Activity 1. Glowing Fish Art

Goals & Objectives

The students will:
- Define bioluminescence;
- Learn about the different colors that bioluminescent light can be expressed in;
- learn what types of organisms use bioluminescence;
- Learn how this adaptation helps organisms survive and thrive in their environments;
- Learn the scientific applications of bioluminescence.

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// STANDARDS

This lesson aligns with the following TEKS:
Grade 3 Science: 1A, 3A, 3D, 4B, 6A, 9A, 9B, 10A
Grade 4 Science: 1A, 3A, 3D, 4B, 6A, 9A, 9B, 10A
Grade 5 Science: 1A, 3A, 3D, 4B, 6A, 9A, 9B, 10A

This lesson aligns with the following Next Generation Science Standards:

From Molecules to Organisms: Structures and Processes – 4-LS1-1

Science and Engineering Practice
Engaging in Argument from Evidence
• Engaging in argument from evidence in 3–5 builds on K–2 experiences and progresses to critiquing the scientific explanations or solutions proposed by peers by citing relevant evidence about the natural and designed world(s). (4-LS1-1)

Disciplinary Core Ideas
LS1.A: Structure and Function
• Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1)

Crosscutting Concepts
Systems and System Models
• A system can be described in terms of its components and their interactions. (4-LS1-1)

STEM
This lesson plan aims to assist teachers in implementing a STEM-based program into their classroom while inspiring the next generation of explorers, scientists, and stewards of the ocean. Based on real science and the Global Shark Tracker™, this lesson is intended to promote environmental awareness and to prepare students for STEM careers.

Helpful Tips

1. The content in this lesson is related to OCEARCH and the Global Shark Tracker. Spend a few minutes getting familiar with the website and the tracker if you have not done so already. The Global Shark Tracker is also available as an app for iPhone and Android.
2. This lesson plan is designed to be adaptable to suit your specific needs. Use the entire lesson plan or just parts of it. This material can be expanded to be an entire unit or condensed for just one day in the classroom.
3. Vocabulary words will be underlined as they appear in the lesson plan. A complete list of vocabulary words is included as well.
4. Answers to questions and prompts for discussions will appear in italics.
5. Optional activities and content (side notes) will appear in a box. Use these to enhance your lesson and adapt it to suit your needs!
6. Have questions for OCEARCH Expedition Leader, Chris Fischer? Email info@OCEARCH.org to schedule a Skype session and let your students/child talk directly to Chris and the OCEARCH crew!
7. Email all questions about this lesson to info@OCEARCH.org.

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BIOLUMINESCENCE / VOCABULARY

Adaptation - A characteristic that an organism has that helps them survive in their environment.

Bacteria - A single-celled organism.

Barbel - A piece of tissue that grows from the mouth or snout of a fish; looks like a whisker.

Bioluminescence - The ability of an organism to produce its own light through chemical reactions.

Chemical Reaction - A chemical change that occurs when two or more substances combine to form a new substance.

Habitat - The natural home of a plant, animal, or organism.

Luciferin – A molecule that reacts with something to produce light.

Molecule - The smallest unit of an element.

Organism - A single plant, animal, or single-celled life form.

Predator - An animal that hunts other animals for food.

Prey - An animal that is hunted and eaten.

Wavelength - The distance between two crests of a wave.

BIOLUMINESCENCE / PRE-LESSON ASSESSMENT

Use the following true/false and multiple-choice questions as an introduction/warm-up to the lesson topics. You can do this in a verbal or written format, as a game, individually, or as a whole class! A handout is provided if you wish to hand the questions out in a quiz format.

The questions do not need to be graded. They are intended to give the students an idea of what they will be learning and to see what they already know.

1. Bioluminescence is the ability of an organism to produce _____?

- **a.** Gas
- **b.** Food
- **c.** Light
- **d.** Oxygen

Answer: c

2. True or False

Bioluminescence is mostly produced by organisms that live in partial or total darkness.

Answer: True

3. True or False

Only animals can produce bioluminescent reactions.

Answer: False

4. Which of the following can produce a bioluminescent reaction?

- **a.** Dog
- **b.** Jellyfish
- **c.** Lightbulb
- **d.** Platypus

Answer: b

5. Bioluminescence can be used to:

- ***a.*** Find a mate
- **b.** Communicate
- **c.** Lure food
- **d.** All of the above

Answer: d

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Name: _____

Date: _____

Bioluminescence

Select the correct answer(s) to each of the following questions.

1) Bioluminescence is the ability of an organism to produce _____?

a. Gas

b. Food

c. Light

d. Oxygen

2) True or False

Bioluminescence is mostly produced by organisms that live in partial or total darkness

3) True or False

Only animals can produce bioluminescent reactions.

4) Which of the following can produce a bioluminescent reaction?

a. Dog

b. Jellyfish

c. Lightbulb

d. Platypus

5) Bioluminescence can be used to:

a. Find a mate

b. Communicate

c. Lure food

d. All of the above

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BIOLUMINESCENCE / LESSON PLAN

PART 1. WHAT IS BIOLUMINESCENCE? **15-20 mins.**

Introduction

Bioluminescence is the ability of an organism to produce its own light using chemical reactions! One of the most well-known organisms that can do this is the firefly. Have you ever seen the twinkling lights of fireflies on a warm summer night? If so, have you ever wondered how or why they light up? There many other organisms besides fireflies that have the ability to produce bioluminescent light. According to NOAA, scientists estimate that bioluminescence exists in 90% of the animals living in the open ocean in waters below 500 m (1,640 ft). That's a lot of animals!

Before continuing, look at online photo galleries or videos of bioluminescent animals with the students. What do all of these animals have in common? Where do they live? What characteristics do they have?

How it Works

Bioluminescence is the result of a chemical reaction within the organism's body. A chemical reaction is a chemical change that occurs when two or more substances combine to form a new substance. Bioluminescent organisms have a special molecule in their body called luciferin (substance #1), which reacts with oxygen (substance #2) to produce light. Many organisms also produce the catalyst luciferase, which helps to speed up the reaction.

Firefly light tends to be yellow or white, but bioluminescence comes in many different colors. The color of the light is determined by the light's wavelengths. When light reaches our eyes, our brain processes the color of the light based on the light's wavelength. Bioluminescent light can be yellow, green, blue, red, etc. But more about that later!

We now have a general idea of how bioluminescence occurs, but why do so many animals have this amazing ability? What do they use it for?

PART 2. THE PURPOSE OF BIOLUMINESCENCE **10 mins.**

Bioluminescence is an adaptation that helps organisms survive and thrive in their environments. Ask the students how? What could bioluminescence be used for in the deep ocean?

Hunting

Some organisms use their bioluminescent light as a hunting tactic. Their light attracts prey towards their mouths while they sit and wait. This reduces the amount of energy that they must exert to capture and eat their prey. One animal that does this is the sea anglerfish. This fish has a bioluminescent barbel that dangles in front of its mouth. When a prey animal gets close enough, the sea anglerfish ambushes it and snaps its jaws shut!

Protection

Bioluminescent light can also be used as a self-defense mechanism for protection from predators. Some organisms use a short, bright flash of light to startle and distract any nearby predators. This can also confuse the predator as to where the prey actually is. The deep-sea squid can detach its bioluminescent arms (don't worry, they grow back!), which distract its predators so it can make an easy get away!

Communication

Bioluminescent light is also used to communicate. What types of things would animals in the deep sea need to communicate to their fellow species? They can signal the location of food or warn each other of a nearby predator. Some species even use bioluminescence to attract a mate. Female syllid fireworms attract males with their light while swimming around in circles. There are many types of fish, such as flashlight fish and anglerfish, who even use their light to tell the difference between males and females.

PART 3. SCIENTIFIC APPLICATIONS **5-10 mins.**

Now that we know what animals use bioluminescence for, how can humans apply this knowledge to scientific purposes? How can bioluminescence help humans? There are a variety of ways that humans make use of bioluminescence in genetics, dentistry practices, warfare, and medical practices:

- Scientists use bioluminescence as an imaging tool to observe biological processes in living organisms. This method of imaging is non-invasive meaning that it is not harmful to the organism. By doing this, scientists are able to study different diseases and treatments for them.
- Doctors use this same imaging tool to locate tumors and detect different diseases such as Alzheimer's and cancer.
- Scientists at GE have invented a tool called the BioScan that detects water contamination quicker and more accurately than traditional methods. Being able to immediately detect bacteria contamination in water can save lives!

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BIOLUMINESCENCE
ACTIVITY 1. GLOWING FISH ART

INTRODUCTION

Bioluminescence is the ability of an organism to produce its own light using chemical reactions! During this activity, students will get to make their own bioluminescent ocean animal to show all their friends and family!

MATERIALS

- Tonic water
- Food coloring
- Plastic cups
- White cardstock (recommended), construction paper, or craft paper
- Pencils
- Markers, crayons or colored pencils
- Small paint brushes
- Black light

INSTRUCTIONS

Prep: Mix the tonic water and food coloring in the plastic cups; one color per cup.
1. Give each student a piece of white paper and a pencil.
2. Ask students to describe bioluminescence. How does it occur? What does it look like? What types of animals are bioluminescent?
3. Ask students to use their pencil to draw their own bioluminescent animal. It can be real or imaginary, scary or cute. Students can draw more than one animal (a school for example) and even the surrounding environment.
4. Students should use their markers, crayons, or colored pencils to color in their picture, with the exception of the parts that are bioluminescent. Anything that lights up should be left white.
5. Pass out the cups of "bioluminescent paint". One of each color per table or small group.
6. Now instruct the students to use this special paint to color in the bioluminescent parts of their picture.
7. Allow the paintings to dry.
8. Turn of the lights and use a black light to view the students' gallery of bioluminescent creatures. If time allows, have the students introduce their animal to the class. What is it called? What does it use its bioluminescence for?

TIPS

Have towels or paper towels handy in case of any spills!