Bioluminescence
By Beth Frede

Art by Halyna Povkhanych depicting Pandora from the movie *Avatar*.
https://www.saatchiart.com

Have you ever wondered how some creatures can produce light with their own bodies? Have you ever PONDERED (considered or contemplated) what it is that allows them to glow and shine in the dark? Today, we're diving into the fascinating world of BIOLUMINESCENCE, the BIOCHEMICAL EMISSION (meaning release or emanation) of light by living organisms. If you've ever seen the movie AVATAR about the fictional (made up), glowing world of PANDORA, you have a good idea of how magical bioluminescence can be. But the WHIMSICAL (meaning playful or fanciful) glow of bioluminescence is real and has multiple purposes for the organisms that EMPLOY (use) it.

SPELL: EMPLOY MAGICAL CONSIDERED
The subject of today's lesson is? BIOLUMINESCENCE
Bioluminescence is the _____ emission of light by living organisms.
BIOCHEMICAL

The word that means considered or contemplated is what? PONDERED
The fictional world in the movie Avatar is called _____. PANDORA
_____ means fanciful or playful. WHIMSICAL
The word emission means what? RELEASE, EMANATION
What's one fact about bioluminescence? IT IS REAL; IT HAS MULTIPLE PURPOSES, BIOCHEMICAL EMISSION /RELEASE OF LIGHT BY LIVING ORGANISMS

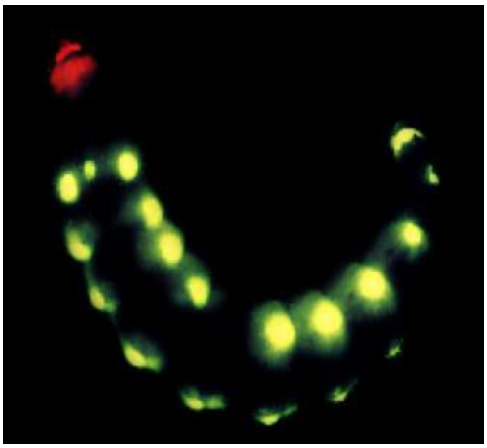
Not all living things can put on a light show, but many MARINE organisms (organisms of the sea) can, such as certain types of fish, jellyfish, and even some tiny PLANKTON. Fireflies and some FUNGI on land can also glow. So how do they do it? For many, it's like a mini CHEMISTRY experiment happening inside their bodies. These creatures have special MOLECULES (which are little ATOMS bonded together) called "LUCIFERIN" and "LUCIFERASE" that react with each other and with oxygen to create light.

SPELL: BONDED OXYGEN EXPERIMENT
The word referring to organisms of the sea is? MARINE
The word that means little atoms bonded together is? MOLECULES
Bioluminescence is like a mini _____ experiment happening in the organism's body. CHEMISTRY
Give an example of some marine organisms that are bioluminescent. CERTAIN FISH, SOME PLANKTON, JELLYFISH
Bioluminescence is created by special molecules called _____ that react together with oxygen. LUCIFERIN, LUCIFERASE
What chemical element does the symbol O stand for? OXYGEN
When you hear the word "chemistry", what word or image comes to mind?

Speaking of light, let's talk about the different colors that bioluminescent creatures can EXHIBIT (display). Most shine blue or green, while others appear more yellow. Some creatures even glow red or pink, like the MAUVE STINGER JELLYFISH shown in the picture on the left, below. Okay, so maybe you knew bioluminescent creatures could be colorful. But did you also know there are some RARE (infrequent) cases of organisms that can glow more than one color at once? An example of this is the

RAILROAD WORM, which has a red glowing head and a green glowing body. Different versions of luciferase cause differences in color.

The mauve stinger jellyfish
https://www.projectnoah.org/spottings/510545669?fbclid=IwAR0Oa1QBSGNJFETdK-zyswq7g6whBPFtregikqhQqO6OfTBiM7NG63B8sqM



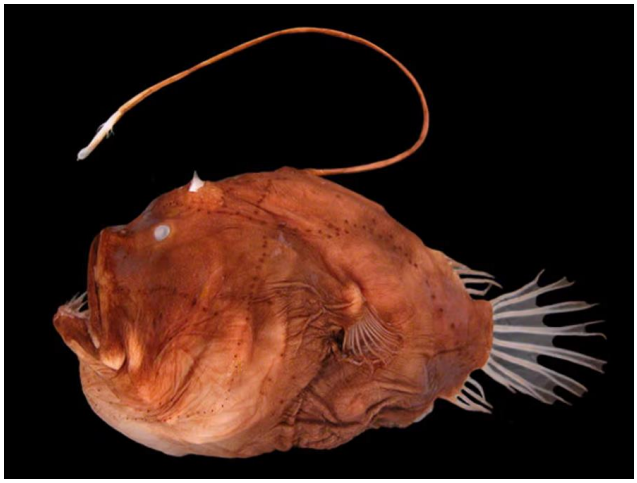
The two-colored Railroad worm
https://www.aeroconf.org/cms/content_attachments/44/download

SPELL: VERSIONS ALREADY DIFFERENCES
Most bioluminescent creatures shine ____ or green. BLUE
Some glow red or pink, like the ___ ___ jellyfish. MAUVE STINGER
The word that means infrequent is? RARE
What's an example of an organism that glows more than one color? RAILROAD WORM
There are rare cases of organisms doing what? GLOWING MORE THAN ONE COLOR, etc.
What color does the railroad worm glow? RED, GREEN
VAKT: In the pictures above, trace your finger along the outline of the jellyfish, and touch each glowing dot on the railroad worm.

Not all bioluminescent creatures glow the same way. That is, some don't technically produce their own glow, while others do. The ones that *don't* are more like HOSTS for other bioluminescent organisms. The ANGLERFISH, for example, has a kind of BULB on its head that lights up thanks to bioluminescent BACTERIA that live there. Scientists think that the fish provide the bacteria with NUTRIENTS it needs, while the bacteria provide the glow that the anglerfish needs to lure its PREY. You might say the anglerfish and the glowing bacteria are SYMBIOTIC, meaning they work

together to help each other. Each gives something the other creature needs, and gets something it needs in return.

SPELL: BULB TECHNICALLY HOSTS
Some bioluminescent creatures don't technically ____ their own glow.
PRODUCE
The ____ has a kind of bulb on its head that lights up to lure its prey.
ANGLERFISH
The anglerfish's bulb lights up due to the bioluminescent ____ that live there.
BACTERIA
What does "symbiotic" mean? IT IS WHEN TWO ORGANISMS WORK TOGETHER TO HELP EACH OTHER, etc.
What's something else that uses a bulb? LAMP, FLASHLIGHT, etc.



Anglerfish with glowing bulb. BioMed Central (CC BY 2.0) From https://newatlas.com/anglerfish-glow-bacteria-genome-sequenced/55546/

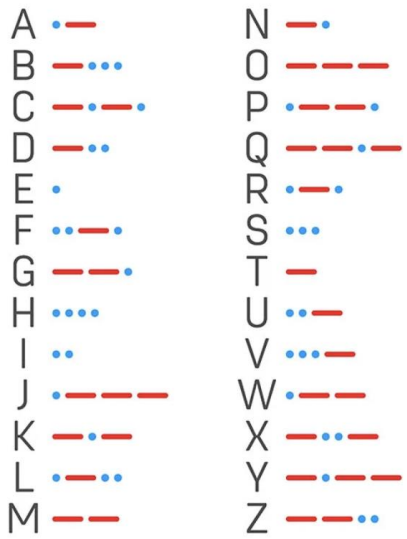
Now that we know *how* these organisms glow, let's learn about *why*. Actually, bioluminescence serves different purposes. Some creatures use their light to attract PREY, like the deep-sea anglerfish we mentioned, that dangles its glowing LURE to catch a tasty meal. Others use their glow to confuse or WARN would-be predators to stay away. There's a name for this, actually… it's called APOSEMATISM. Both FIREFLIES and MILLIPEDES use aposematism to trick predators into thinking they're dangerous or poisonous, so they'll be left alone. It's pretty clever how these little creatures are able to protect themselves without the BENEFIT (advantage) of strength or size!

SPELL: LURE ADVANTAGE THEMSELVES
One purpose for bioluminescence is for creatures to attract ____. PREY
Bioluminescence is sometimes used to confuse or warn would-be ____ to stay away. PREDATORS
Using bioluminescence to confuse or warn their predators is called what? APOSEMATISM
The word that means “advantage” is? BENEFIT
Thanks to aposematism, millipedes and fireflies can protect themselves without needing ____ or size. STRENGTH
What number does “milli” refer to? 1000
What number does “Cent” refer to, like in the word “centennial”? 100
What do some creatures use their light to do? ATTRACT / LURE PREY, CONFUSE / WARN PREDATORS
A creature that uses aposematism are ___. FIREFLIES, MILLIPEDES
Fireflies and millipedes trick their predators into thinking they’re what? DANGEROUS, POISONOUS
Who’s someone you think is resilient?

Fireflies also use their flashes of light to COMMUNICATE with each other. These tiny insects, also known as LIGHTNING BUGS, have their own special light LANGUAGE which they use to find mates. Males and females signal each other with specific PATTERNS of flashes. Although two fireflies might look exactly the same to the untrained eye, you’ll know they’re different SPECIES if their flash patterns are different. It’s almost like their own secret MORSE CODE.

SPELL: SECRET PATTERNS SPECIFIC
Fireflies use flashes of light to __ with each other. COMMUNICATE
Fireflies are also known as ___ bugs. LIGHTNING
Fireflies use their own special light ___ to find mates. LANGUAGE
___ signal each other with specific patterns of flashes. MALES and/or FEMALES, FIREFLIES, LIGHTNING BUGS

VAKT: Morse code is a system of dots and dashes that was used to transmit messages by radio before voices could be transmitted. “Write” your first and last initials in morse by tapping your finger on the table for each dot and sliding your finger on the table for each dash.



https://scoutlife.org/hobbies-projects/funstuff/575/morse-code-translator/

Hold onto your hat because bioluminescence gets even cooler! Deep beneath the ocean's surface, there's a seemingly magical world filled with an ABUNDANCE (very large quantity) of glowing creatures that look like they're from another planet. According to NOAA, the NATIONAL OCEANIC and ATMOSPHERIC ADMINISTRATION, scientists estimate that bioluminescence exists in 90 percent of the animals living in the open ocean, in waters below 500 meters, or 1,640 feet, deep.

SPELL: OCEAN ESTIMATE BENEATH
The word that means “very large quantity” is? ABUNDANCE
NOAA stands for the National Oceanic and Atmospheric _____.
ADMINISTRATION
Scientists estimate bioluminescence exists in what percent of the animals living in the deep, open ocean? 90 PERCENT
Bioluminescence exists in 90 percent of the animals living in the open ocean in waters below how many meters? 500
500 meters equal how many feet? 1,640

What is an antonym for abundance? SCARCITY, INADEQUACY, DEFICIENCY, INSUFFICIENCY
VAKT: Check out this photo gallery of bioluminescent undersea creatures: https://ocean.si.edu/ocean-life/fish/bioluminescent-animals-photo-gallery

Now picture a beach at night, and as the waves crash onto the shore, they sparkle and glow. That's bioluminescence in the form of tiny plankton which are also known as DINOFLAGELLATES. You'd probably see this in a warm-water LAGOON. (A lagoon is a stretch of salt water that's separated from the sea by a coral reef or sand bank), but plankton live in all sorts of AQUATIC (water) environments. Some plankton EMIT (give off) light when day turns to DUSK (sundown) and their bodies sense that it's time to glow. Others glow when they're disturbed, like by waves or a passing boat moving through the water. These plankton light up, creating a beautiful and mysterious SPARKLING effect. By the way, the luciferase in plankton is actually related to CHLOROPHYLL, the green chemical found in plants.

SPELL: SPARKLING MYSTERIOUS RELATED
Tiny plankton are also known as what? DINOFLAGELLATES
Dinoflagellates are usually found in warm-water ____. LAGOONS
The word that means "give off" is? EMIT
Another word for dusk is? SUNDOWN
Some plankton glow when they're ____ by waves or a passing boat. DISTURBED
The luciferase in plankton is related to what chemical that's found in plants? CHLOROPHYLL
A lagoon is a stretch of salt water separated from the sea by what? CORAL REEF OR SAND BANK
Some plankton glow when they're disturbed by ___. WAVES, PASSING BOATS
What's something else that sparkles that isn't bioluminescent? STARS, DIAMONDS, etc.

Guess what? Bioluminescence isn't just fun to watch – it's also helpful to humans. Scientists have HARNESSED the power of bioluminescence to develop tools for medical RESEARCH. They use the light-producing molecules to track and study CELLS, GENES, and DISEASES. This helps

researchers learn more about how our bodies work and find new ways to treat illnesses. Humans have also used bioluminescence for safety. For example, ancient people relied on glowing FUNGI to NAVIGATE (or find their way) safely through dense, dark jungles. Believe it or not, there are over 80 species of bioluminescent MUSHROOMS! And in the 1800s, coal miners used jars of fireflies to light their way when regular lamps or flames were too dangerous because they might've sparked an EXPLOSION.

From https://www.foxweather.com/earth-space/glowing-review-exploring-the-beauty-of-bioluminescence

SPELL: HARNESSED SAFETY MOLECULES

Scientists have harnessed the power of bioluminescence to develop tools for medical _____. RESEARCH

Humans have used bioluminescence to find their way through dense, dark _____. JUNGLES

In the 1800s, coal _____ used jars of fireflies to light their way when regular lamps or flames were too dangerous. MINERS

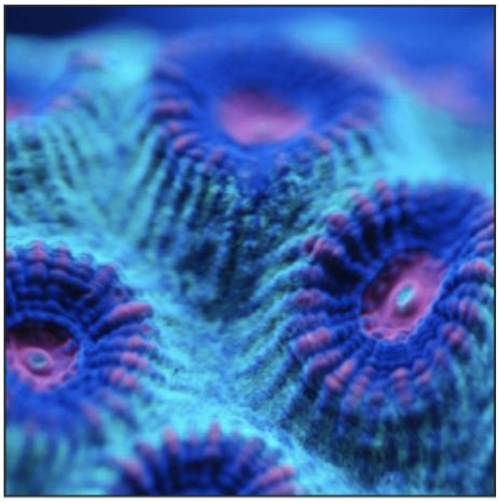
Miners used fireflies instead of lamps so they wouldn't spark a what? EXPLOSION

There are over how many species of bioluminescent mushrooms? 80

Scientists use the light-producing molecules to study what? CELLS, GENES, DISEASES

Name an edible type of mushroom. BUTTON, SHIITAKE, PORCINI, PORTOBELLO, etc.

As amazing as bioluminescence is, not everything that glows in the dark is bioluminescent. Some things, like glow-in-the-dark toys or stickers for example, are actually FLUORESCENT. When something is fluorescent, it stores light ENERGY which it then releases slowly. This is different from the bioluminescent organisms we've been talking about, which create light through chemicals that mix together and cause a REACTION. So next time you see a firefly or hear about glowing waves, you'll know the fascinating chemistry behind these enchanting lights!



Fluorescent Pineapple Coral. Photo from https://www.qualitymarine.com/news/fluorescence-bioluminescence-and-phosphorescence/

SPELL: ENCHANTING CHEMISTRY RELEASES

Some things that glow in the dark aren't bioluminescent, they're actually _____. FLUORESCENT

When something is fluorescent, it stores light ____ which it then releases slowly. ENERGY

Bioluminescent organisms create light through chemicals that mix together and cause a _____. REACTION

Name a fluorescent item? GLOW IN THE DARK STICKERS AND/OR TOYS

If you could be bioluminescent, what color or colors would you glow?

Creative Writing: You are a scientist who studies bioluminescent creatures, and you find a new creature that has never been discovered before. What did you find, where did you find it, and what does it look like? What special features does it have? How does it use its bioluminescence? What will you name it?

Beth Frede is an S2C Practitioner based in New Hampshire where she lives with her husband and dog. She loves painting, puttering in the kitchen, and learning about new things while writing lessons.

This lesson was adapted from text generated by ChatGPT.

Additional resources:

- https://ocean.si.edu/ocean-life/fish/bioluminescence
- https://scitechdaily.com/the-role-of-bioluminescence-in-nature/ https://www.aeroconf.org/cms/content_attachments/44/download
- https://education.nationalgeographic.org/resource/bioluminescence/
- https://ocean.si.edu/ocean-life/fish/bioluminescent-animals-photo-gallery
- https://newatlas.com/anglerfish-glow-bacteria-genome-sequenced/55546/
- https://i.pinimg.com/originals/bf/f9/92/bff992eb2368ebc6d45ea9cd53e86c6b.jpg
- https://www.bbc.com/future/article/20220407-the-living-lights-that-could-reduce-energy-use
- https://www.qualitymarine.com/news/fluorescence-bioluminescence-and-phosphorescence/
- https://www.foxweather.com/earth-space/glowing-review-exploring-the-beauty-of-bioluminescence
- https://www.imedpub.com/abstract/how-is-bioluminescence-employed-by-humans--in-nature-38640.html
- https://www.differencebetween.com/what-is-the-difference-between-bioluminescence-and-fluorescence/
- https://www.projectnoah.org/spottings/510545669?fbclid=IwAR0Oa1QBSGNJFETdK-zyswg7g6whBPFtregikqhQgO6OfTBiM7NG63B8sqM
- https://scoutlife.org/hobbies-projects/funstuff/575/morse-code-translator/
- https://www.saatchiart.com/art/Painting-Avatar-Pandora-forest-at-night-Glow-in-the-dark-Pandora-forest-painting-100-Handmade-Ready-to-ship/916384/4810243/view