



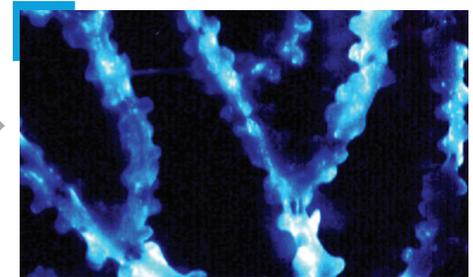
# Three Mysterious Light Effects

## Bioluminescence, Fluorescence, and Phosphorescence

Ocean organisms like certain fishes, shrimp and jellies have the ability to emit light, as do glow-in-the-dark stickers! But the glow is not all the same. Different processes create three different types of light.

### Bioluminescence is...

- Light produced by organisms through a chemical reaction and does not require light input to start the chemical reaction.
- Rare in ecosystems on land but more common in the deep ocean environment.
- Expressed in special organs of some organisms and depends on symbiotic relationships in other organisms.
- Believed to be used for a variety of reasons including attracting mates, finding food, distracting predators, camouflage, and more.
- Found in fireflies, and fungi on land and in ocean organisms such as viperfish, jellies, corals and some octopods, just to name a few.



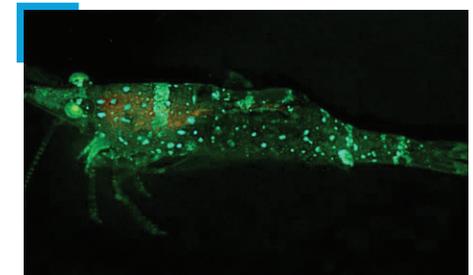
Luminescing Bamboo Coral. Image courtesy of NOAA Ocean Exploration.



Ocean twilight zone animals, like this Sloane's viperfish, rely on their photophores for a variety of important survival functions. Photo by Paul Caiger, © Woods Hole Oceanographic Institution.

### Fluorescence is...

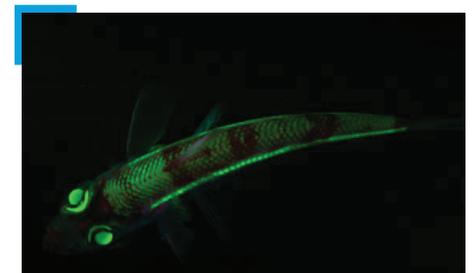
- The absorption of light at one wavelength and its re-emission at a different wavelength, or color.
- Driven by the absorption of light energy, meaning fluorescent materials emit light only as long as the atoms continue to receive external energy (i.e., sunlight).
- Typically found in marine organisms living in the upper to middle part of the ocean, where sunlight is visible.
- Usually vivid in color and concentrated in certain body parts.
- Thought to help attract prey or allow individuals of the same species to recognize each other.
- Found in several species of corals, fishes and even some species of sharks.



Unidentified sargassum shrimp bearing two colors of fluorescent patches. Image courtesy of Dr. Mikhail Matz.

### Phosphorescence is...

- Similar to fluorescence, except phosphorescent materials continue to emit light for a period of time after the external light source is removed.
- Not present in organisms.
- Man-made and used to make stickers and toys that glow in the dark. (The chemicals zinc sulfide and strontium aluminate are used in toys and stickers to make them glow for up to hours after the light source is removed.)



Note the green fluorescence of the eyes of this short-nose greeneye fish. The submersible team collected the specimen for optical studies in the ship's onboard laboratory. Image courtesy Edie Widder.

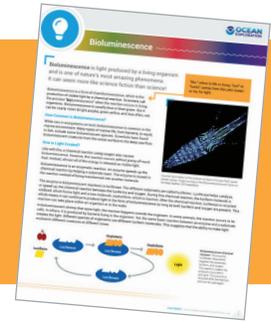
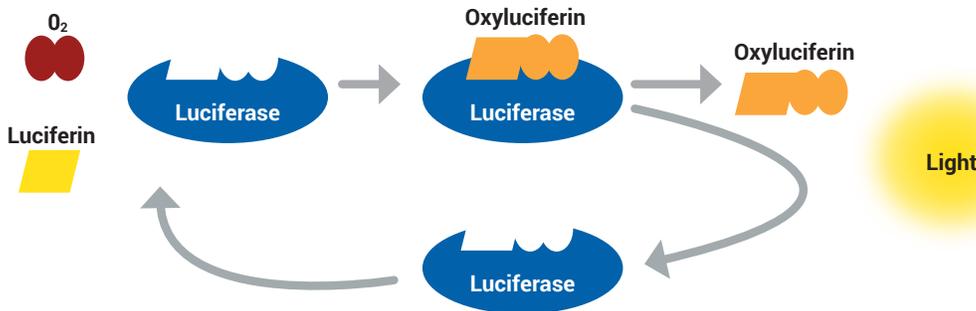


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## What Causes These Different Light Effects?

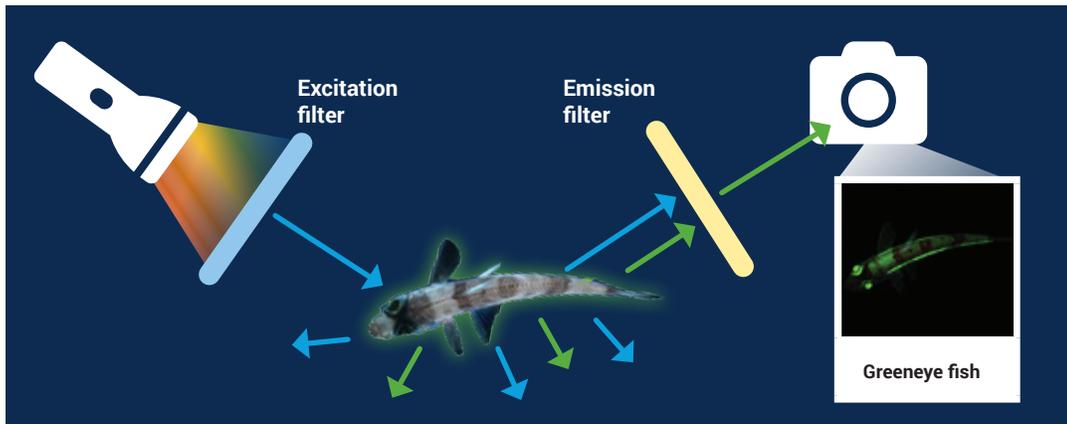
Two different processes create these three different types of glowing light.

- A **chemical reaction** between molecules causes bioluminescence. Thus, it is a form of **chemiluminescence**. The production of light in bioluminescent organisms results from the conversion of chemical energy to light energy. [Learn more about this process.](#)



**Bioluminescence chemical reaction:** The enzyme, luciferase, helps bond together the substrate, luciferin, and oxygen. The reaction creates the products oxyluciferin and light. The enzyme is recycled after the reaction, and can be used again.

- An **external light source** (like the sun or a flashlight) provides the energy that causes fluorescence and phosphorescence. The glowing effect occurs when atoms on a surface (e.g., zinc sulfide) **absorb light energy** then emit some of that energy as a *different color* of light.



**Fluorescent organisms** have special fluorescent proteins that absorb light at one wavelength, and re-emit light at a longer wavelength with less energy. Special equipment is needed to observe fluorescence. An excitation filter is used to filter all wavelengths of light that do not excite the fluorescent proteins. An emission filter is then used to filter out any of the excess light that is reflected by the organism's skin, so the fluorescence can be seen. Under normal light conditions, fluorescence is often undetectable because the low intensity, low energy light is masked by the light source and reflected light.

It makes sense that bioluminescence, which does not depend on light energy, is commonly found in the dark deep ocean. Some organisms in the deep ocean are also fluorescent. But why do we find fluorescence in the absence of light? It could be that fluorescence provides a benefit to animals not related to its light properties. Scientists still don't know all the answers about how light is used in the deep ocean or how organisms originally evolved to have these specialized light effects. Continued data collection during ocean exploration of deep-sea environments can help solve these questions!

## ADDITIONAL RESOURCES

Light It Up Activity Demo: <https://oceantoday.noaa.gov/fullmoon-light-it-up/>

How Do Living Organisms Produce Light?: <https://oceanexplorer.noaa.gov/facts/living-light.html>

The Allure of Fluorescence in the Ocean [MBARI]: <https://www.youtube.com/watch?v=whbeFXFZqiU>

Luminescing Bamboo Coral (image): <https://oceanexplorer.noaa.gov/explorations/09bioluminescence/logs/slideshow/slideshow.html>  
Sloane's viperfish (image): <https://www.whoi.edu/news-insights/content/fish-with-flashlights/>  
Fluorescent shrimp (image): [https://oceanexplorer.noaa.gov/explorations/05deepscope/logs/aug22/media/fluorescent\\_shrimp.html](https://oceanexplorer.noaa.gov/explorations/05deepscope/logs/aug22/media/fluorescent_shrimp.html)  
Greeneye fish (image): [https://oceanexplorer.noaa.gov/explorations/04deepscope/logs/aug16/media/greeneye\\_fluor.html](https://oceanexplorer.noaa.gov/explorations/04deepscope/logs/aug16/media/greeneye_fluor.html)  
Bioluminescence factsheet (pdf): <https://oceanexplorer.noaa.gov/materials/bioluminescence-fact-sheet.pdf>