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**CREATURES OF LIGHT: ANSWER KEY**

**Part 1.** BIOFLUORESCENCE

**A. FLUORESCENCE IN SPINACH EXPERIMENT**

1. What color do you see? Write down your observations.

*Students should observe a red fluorescence.*

1. Why does the spinach solution fluoresce this color? Write a prediction as to why you believe that spinach fluoresces this color.

*Students should write up their own prediction. Answers may vary.*

1. Perform additional research using trusted scientific sources to determine why you observe this fluorescence in spinach.

Chlorophyll is a green pigment found in plants and algae that is critically important for photosynthesis; it is also one of the most common fluorescent molecules found in nature. Plants look green because chlorophyll reflects green light and absorbs mostly red light and some blue light. When chlorophyll is exposed to high-energy light, like ultraviolet light, electrons become excited. When the electrons release that energy, it is released as a lower-energy light; in this case, as red light.

**B. HOW BIOFLUORESCENCE WORKS**

Before watching the video clip below, answer the following questions:

1. What are some examples of fluorescent things? Name examples of fluorescence in your day-to-day life.

Highlighters, reflective construction vests, glow-in-the-dark items.

1. Identify two organisms that fluoresce.

Coral reefs, some species of fish, hawksbill turtle, swell shark, seahorses.

Watch the video clip “How Biofluorescence Works” on PBS LearningMedia at <http://bit.ly/28KlnbX> and answer the following questions:

1. How does fluorescence work? How do organisms fluoresce?

Fluorescent chemicals absorb light in a unique way. At the atomic level, the light energy excites electrons into more energetic orbits around the nucleus. When the electrons fall back to their original state, a few billionths of a second later, the excess energy is released as light (typically at a lower-energy level). Fluorescent organisms possess fluorescent proteins in their skin or other tissues.

1. What special set of conditions does biofluorescence require in order to occur?

Unlike bioluminescence, biofluorescence requires a special set of conditions to occur in nature. Biofluorescence needs light to make light. When sunlight hits Earth, it contains all the colors of the visible light spectrum. Each color is the result of a different wavelength of energy. Once light hits the ocean, water acts as a filter for longer wavelengths so that only blue light remains as the light source.

1. Biofluorescence is found all over the tree of life. Why do you think that organisms have evolved this trait?

*Answers to this question will vary. Some explanations for the evolution of biofluorescence include to signal and communicate between species, to attract mates, and to act as a camouflage.*

1. Do you think the mechanism of fluorescence in the video is the same as you observed in the spinach experiment?

Yes, fluorescence can be found all over the tree of life but can be difficult to detect since it can be washed out by visible light.

**Part 2.** BIOLUMINESCENCE

1. After cracking your glow stick, write down what you think causes it to glow.

*Students should write up their own predictions. Answers may vary.*

1. What is bioluminescence? Describe the chemical reaction that causes bioluminescence.

Bioluminescence is a light-producing chemical reaction that occurs in some organisms. Light is produced as a result of a reaction between two chemicals: luciferin and luciferase. Luciferin acts as a fuel, like gasoline, and the enzyme luciferase acts like a spark plug to fire the reaction. When the chemicals are mixed together in the presence of oxygen and other key ingredients, a reaction occurs and the excess energy is given off as light. The chemicals can differ between species, but the mechanism is always the same.

1. After watching this video, revise your hypothesis in Question 1 if need be.

*Students should revise their own hypothesis. Answers may vary.*

1. How is cracking a glow stick similar to the chemical reaction of bioluminescence? You may need to look up how a glow stick works for this explanation.

Glow sticks are composed of two compartments containing different chemicals. When the inner compartment is broken, the chemicals mix together. Similar to the mechanism of bioluminescence, the chemical reaction within a glow stick releases energy in the form of light. The inner, breakable glass vial contains hydrogen peroxide; the outer compartment contains phenyl oxalate and a dye.

1. Name examples of organisms that are capable of bioluminescence.

Jellyfish, mushrooms, snails, bacteria, fishes, insects, etc.

1. What is the evolutionary advantage of bioluminescence?

Over the past century, bioluminescence has been discovered all across the natural world. Chemicals differ between organisms, but the mechanism of fuel and spark is the same. Although theories about the exact evolutionary advantage vary across species, some theories include communication, camouflage, defense, and attracting prey or mates.

**Part 3.** Extension Questions

1. What is the difference between bioluminescence and biofluorescence? Compare the spinach experiment to the glow stick model.

Bioluminescence is a light-producing chemical reaction; biofluorescence is a process in which light is absorbed and re-emitted as lower-energy light.

1. Why do you think that bioluminescence and biofluorescence evolved separately?

*Answers to this question will vary.*

1. What is the importance of studying these traits in organisms?

*Answers to this question will vary.*

1. What are the potential applications of understanding how bioluminescence and biofluorescence work? Provide at least two examples of potential applications that are currently being researched. Provide at least one example of your own ideas.

*Answers to this question will vary. Here are some potential applications:*

* *Lamps made of small bioluminescent organisms*
* *Fluorescent tags to identify neural networks*
* *Fluorescent tags to track how viruses or cancer spread in the body*