Light Stick Chemiluminescence

Supplies:

- 3 light sticks
- 3 clear plastic cups (9 oz.)
- water
- microwave
- ice

Instructions:

For this experiment, you will find out how temperature affects the chemical reaction that occurs in light sticks. The chemiluminescence depends on the mixing of the hydrogen peroxide with the catalyst chemical inside the light stick. *Catalysts* speed up and help chemical reactions!

You will observe how the light sticks react when placed in three different temperatures of water.

1. Fill the first cup with ice-cold water.
2. Fill the second cup with room temperature water.
3. Fill the third cup with hot water.

   ****Ask an adult to help you heat up the water in the microwave and pour it into the third cup.****
4. *Do not break the light sticks, yet.* Place one stick into each cup.
5. Allow the sticks to sit in the water for 3 minutes. This will allow the chemicals inside the light sticks to adjust to the temperature of the water.
6. Turn off the lights.
7. Bend the sticks to break the capsules inside.
8. Place the light sticks back into their designated cups.
9. Let them sit in the water, and watch the light sticks.
10. Notice how quickly or slowly the color changes.
11. Compare the brightness of each light stick.
    - Which cup holds the brightest stick?
    - Which light stick is the dimmest?
    - How quickly did the light sticks glow?

- How long do the light sticks keep their glow?
- Why do you think the temperature of the water affects the light?

The Science Behind It:

Light produced by a chemical reaction is called **chemiluminescence**. Bioluminescence is just one form of *chemiluminescence.* Have you ever used a glow or light stick at night? These little colorful toys glow in the dark because of a chemical reaction.

To create this reaction, you must bend the light stick, breaking a delicate glass capsule inside that contains hydrogen peroxide. The light stick contains another chemical plus colored dye. When you bend the light stick and break the capsule, the hydrogen peroxide mixes with the second chemical causing a reaction. This chemical reaction releases a type of energy that causes a colorful luminescent glow!

Chemiluminescence is also referred to as "cold light" because the glow does not give off any heat. When heat produces light, it is called *incandescence, or "hot light"*. A fire's glow is an example of incandescent light, where light is produced from the heat.

The light in our light sticks is from a chemical reaction. In our experiment, the cup that contained the hot water had the brightest light stick because the heat caused the chemicals to react at a faster rate, as the molecules were colliding faster. Since the reaction happened more quickly, the light did not last as long as the other two light sticks. The coldest water had the slowest reaction. Although the color was the dimmest, this light lasted the longest. Note that if you were to shake the light stick really hard after breaking the glass tube, this would speed up the mixing, making the chemical reaction faster and the stick glow brighter, sooner.

The light produced by the chemical reaction, which occurred inside these sticks, is called *chemiluminescence*. It is a form of "cold light." This is how bioluminescence occurs in nature. Two chemicals mix together and produce light energy without requiring heat.

Real World Relevance: Chemiluminescence

Emergency workers and the military use larger, more intense, glow sticks for search and rescue. Deep-sea divers also use light sticks when exploring the ocean. Chemiluminescence is also essential for forensics, the scientific detective work around crime scenes. Forensic scientists spray a chemical called *luminol* on surfaces at the scene, one that may look clean to the eye. Luminol and the iron in blood cause a chemical reaction making it glow. The detectives can easily find places with small traces of blood that can't be detected with our eyes using chemiluminescence.

Fireflies

When the Sun sets on a cool Summer evening, tiny lights begin to flash like little fireworks. These little sparks are fireflies, a magical work of nature! These tiny insects signal beautiful and colorful displays of light. This type of natural light is called **bioluminescence**. *"Bio"* means "life" and "*lumin"* means, "light."

Bioluminescence is not magic; it is caused by a chemical reaction. A chemical called ***luciferin*** and an enzyme called ***luciferis*** is inside the abdomen of the firefly's body. When the firefly mixes these elements with oxygen, a chemical reaction occurs inside the firefly's *lantern* (a part of the abdomen). This reaction causes extra energy to emit from the organism in the form of light. This light is *bioluminescence*.

Firefly Fun Facts

* There are over 2,000 different species of fireflies.
* Male fireflies emit a pattern of flashing lights to attract a mate.
* The *synchronous firefly* emits bioluminescent light in patterns as a group. These fireflies actually synchronize! This species lives in and around the Great Smokey Mountains. This light phenomenon occurs only 2 weeks from mid-May to mid-June each year.
* Some species of female fireflies mimic the flashing patterns of other species to lure male fireflies. The female then eats the male!
* Predators stay away from fireflies because they do not taste good! Fireflies produce bitter chemicals so other insects do not want to eat them.

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* Light produced by fireflies is extremely efficient. Almost 100% of the energy in the chemical reaction is emitted as pure light. In comparison, an incandescent lightbulb only emits 10% of light. The rest of the energy is lost as heat.
* Fireflies on the West Coast of the United States are not bioluminescent. California, for example, has fireflies. But they do not light up!
* Fireflies are actually winged beetles (not flies)! Fireflies are a family of insects called *Lampyridae.* This name comes from the Greek word *lampein, which means "to shine."* (Think of a lamp!)
* Firefly bioluminescence displays an array of colors. Different species may shine green, yellow, white or even bluish light!