



## Glow big or go home

Alice Peng | Fall 2025

**Field(s) of Interest:** photochemistry, biology, physics

### **Brief Overview):**

Mentees will be learning about fluorescence and chemiluminescence in this lesson! By the end of this lesson, they should understand the basics of how a material glows and how glowing can benefit or harm animals that glow in nature. The main goal of this lesson is to bond with the mentees at your last site!

### **Agenda:**

- Introduction (5 min)
- Module 1: Stay lit (15-20 min)
- Module 2: You make my heart glow (10-15 min)
- Module 3: Let's glow crazyyy (15-20min)
- Conclusion (5 min)

### **Main Teaching Goals/Key Terms:**

- Electron
- Energy
- Excitation
- Emission
- Light
- Ground state
- Photon
- Chemiluminescence
- Fluorescence
- UV light
- Bioluminescence
- Adaptation
- Luciferin
- Luciferase

## Background for Mentors

### Module 1

- Electron
- Energy
- Excitation
- Emission
- Light
- Ground state
- Photon

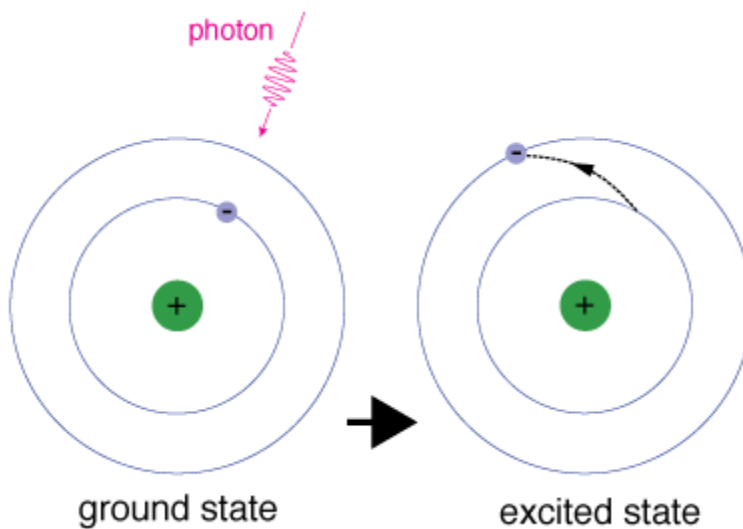
An **electron** is a tiny, negatively charged particle that moves around the nucleus of an atom.

**Energy** is the ability to cause change, and in terms of this lesson, it is what excites atoms and can be absorbed or released. There are many energy levels that electrons can move within.

**Excitation** refers to the process of an atom or molecule absorbing energy. This causes an electron to move from a lower energy level to a higher one.

Conversely, **emission** is the process of releasing energy where the electron will move from a higher energy level back to a lower energy level.

When emission occurs, **light** is produced. Light is a form of energy that travels as waves and can be seen by our eyes!



**Figure 1:** pink photon excites the blue electron from ground state to a higher energy level

The lowest energy level of an atom or molecule is called the **ground state**. This is where the electrons normally are when no extra energy is absorbed.

A **photon** is the smallest particle of light energy that is released when an excited electron falls back to a lower energy level. This is the light that we see when emission occurs.

## Background for Mentors

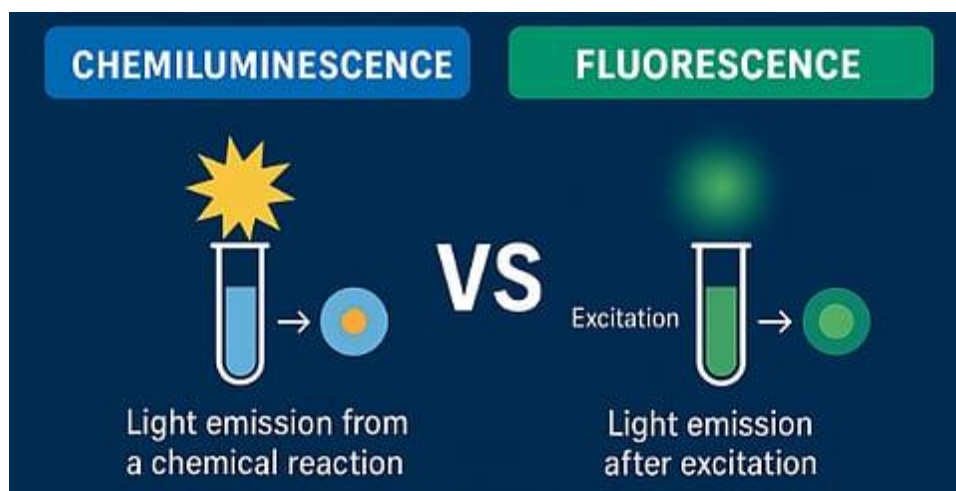
### Module 2

- Chemiluminescence
- Fluorescence
- UV light

**Chemiluminescence** is the production of light from a chemical reaction without the need for heat or electricity. This would be like a glow stick!

**Fluorescence** is the emission of visible light by a substance that has absorbed energy (usually from ultraviolet light). The light appears only while the material is being excited and stops when the energy source is removed. An example would be highlighters! For lab nerds like me, BFP and GFP fall into this category.

**Ultraviolet (UV) light** is a type of electromagnetic radiation with a shorter wavelength and higher energy than visible light; it is invisible to the human eye but can cause some materials to fluoresce. The sun produces UV light



**Figure 1:** comparison of chemiluminescence to fluorescence

## Background for Mentors

### Module 3

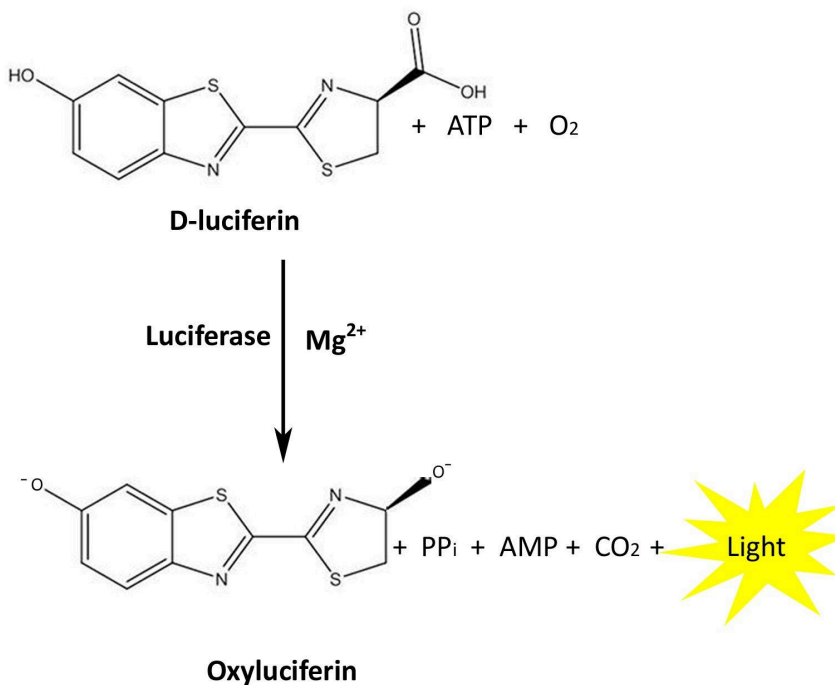
- Bioluminescence
- Adaptation
- Luciferin
- Luciferase

**Bioluminescence** is a type of chemiluminescence that occurs inside living organisms to produce light through a chemical reaction inside their bodies. Fireflies and lots of deep sea creatures have this ability.

An **adaptation** is a trait or behavior that helps an organism survive and reproduce in its environment. Bioluminescence is an adaptation that helps some animals attract mates, lure prey, or hide from predators.

**Luciferin** is the light-producing chemical in bioluminescent organisms. When it reacts with oxygen, it gives off light.

**Luciferase** is the enzyme that speeds up the reaction between luciferin and oxygen, causing the light to be produced. Fun fact: there are actually biological assays where you can link the luciferase gene to a promoter to detect promoter strength or gene activity based on level of fluorescence



**Figure 1:** luciferin pathway

## Introduction

<b>Concepts to Introduce</b> <ul style="list-style-type: none"><li>• Atom - like the tiniest piece of lego that builds everything in life</li><li>• Visible light range- this is the range of wavelengths that our human eye can see<ul style="list-style-type: none"><li>◦ There are many other ranges that we can't see but still exist</li></ul></li></ul>	<b>Questions to Pique Interest</b> <ul style="list-style-type: none"><li>• What makes a glow stick glow?</li><li>• Why do glow sticks fade over time?</li><li>• Why do some animals glow?</li><li>• What are some animals that do glow?</li></ul>
<b>Scientists, Current and Past Events</b> <ul style="list-style-type: none"><li>• Fluorescence is being used in head and neck surgery to improve precision by lighting up the nerves<ul style="list-style-type: none"><li>◦ <a href="#">Link to article</a></li></ul></li><li>• 2008 Nobel Prize in Chemistry was awarded to Osamu Shimomura, Martin Chalfie, and Roger Y. Tsien for their discovery and development of the green fluorescent protein (GFP) that is widely used across the world in laboratory research</li></ul>	<b>Careers and Applications</b> <ul style="list-style-type: none"><li>• Fluorescence is used in a lot of diagnostics imaging and research assays</li><li>• Fluorescence powders are used to enhance latent fingerprints in forensics</li><li>• UV light can reveal invisible evidence like bloody fluids in forensics</li></ul>

## Module 1: Stay lit

Mentees will be playing hot potato to demonstrate how having the hot potato will excite them the same way a photon excites an electron. **Class activity (can even be outside)**

<b>Teaching Goals</b> <ol style="list-style-type: none"><li>1. <b>Electron</b>- negatively charged particle</li><li>2. <b>Energy</b>- excites atoms and can be absorbed or released</li><li>3. <b>Excitation</b>- process of an atom or molecule absorbing energy</li><li>4. <b>Emission</b>- process of releasing energy</li><li>5. <b>Light</b>- form of energy that travels as waves</li><li>6. <b>Ground state</b>- lowest energy level of an atom</li><li>7. <b>Photon</b>- smallest particle of light energy</li></ol>	<b>Materials</b> <ul style="list-style-type: none"><li>• Ping pong ball ( like 5 per site)</li></ul>
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### Different Methods for Teaching

1. **Excitation** - Electrons start out at the lowest level → like a person standing on the ground. When they jump onto an object like a chair or a box, they are at a higher energy level
2. **Emission**- People cannot stay balanced on higher objects forever and will eventually need to step back down to a lower object/back onto the floor
3. **Ground state** - The lowest energy level, which is the floor
4. **Photon** - It is the smallest unit of light, like a grain of sand on the beach; more grains of sand will create a bigger beach just like more photons will create a brighter light

### Procedure

1. Mentees will represent the electrons
2. The floor is “ground state”
3. Ping pong ball represents a photon
4. Mentors will randomly toss the ping pong ball to a mentee
5. Mentees who receive ping pong ball will jump up to represent excitation to a higher energy level
6. When mentees land back on the ground state, this represents emission
7. They will then toss the ping pong ball to another mentee, and the process repeats
8. Mentors can choose to have as many ping pong balls circulating in this activity as they would like/can handle



**Figure 1:** mentees tossing ball to each other

### Classroom Notes

Pass the ping pong ball instead of tossing if mentees are inclined to throw it at each other.

## Module 2: You Make My Heart Glow

Mentors will be doing a demo of tonic water, highlighters, and glow sticks in the dark to show how chemiluminescence differs from fluorescence. **Small group demo**

<b>Teaching Goals</b> <ol style="list-style-type: none"> <li>1. <b>Chemiluminescence</b>- production of light from a chemical reaction without the need for heat or electricity</li> <li>2. <b>Fluorescence</b>- emission of visible light by a substance that has absorbed energy</li> <li>3. <b>UV light</b>- type of electromagnetic radiation with a shorter wavelength and higher energy than visible light</li> </ol>	<b>Materials</b> <ul style="list-style-type: none"> <li>• Black light (5 per site)</li> <li>• 2 glow sticks wrist circles per mentee</li> <li>• 1 paper per mentee</li> <li>• 10 highlighters per site</li> <li>• 5 Tonic water per site</li> </ul>
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### Different Methods for Teaching

1. **Chemiluminescence vs. Fluorescence** - have mentees predict what will happen when the lights are turned off, which items will glow and which will not? Why?

### Procedure

1. **Keep the tonic water sealed in its bottle!!**
2. Have mentees draw some marks on a piece of paper with the highlighter/invisible ink pen
3. Crack the glowsticks
4. Turn off lights/close the blinds!
5. Observe how only glowsticks are glowing since they are chemiluminescent
  - a. The chemical reaction that occurred inside glowstick allows it to glow without outside sources
6. Now turn on UV light
7. Tonic water and highlighter glow now too
  - a. This makes them fluorescent since tonic water and highlighters absorb the UV light photons and get excited



Figure 1: tonic water



Figure 2: highlighter



Figure 3: glowsticks

### Classroom Notes


Don't have to turn off lights if your site can't do that.

## Module 3: Let's glow crazyyy




Bioluminescence is observed in nature and animals use them for different reasons. Mentees will be playing glowtag to understand how glowing can be a benefit and a disadvantage to have in nature. **Class activity**

<p><b>Teaching Goals</b></p> <ol style="list-style-type: none"> <li>1. <b>Bioluminescence</b>- type of chemiluminescence that occurs inside living organisms</li> <li>2. <b>Adaptation</b>- trait or behavior that helps an organism survive and reproduce in its environment</li> <li>3. <b>Luciferin</b>- light-producing chemical</li> <li>4. <b>Luciferase</b>- enzyme that speeds up the reaction between luciferin and oxygen</li> </ol>	<p><b>Materials</b></p> <ul style="list-style-type: none"> <li>• Glowsticks from module 2</li> </ul> <p><b>OR</b> (per mentee)</p> <ul style="list-style-type: none"> <li>• 1 cupcake liner</li> <li>• 5 lue dots</li> <li>• 4 UV streamers</li> <li>• 1 string</li> <li>• 2 googly eyes</li> </ul>
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<p><b>Different Methods for Teaching</b></p> <ol style="list-style-type: none"> <li>1. <b>Bioluminescence</b>: where in nature is bioluminescence observed? What are the pros and cons?             <ol style="list-style-type: none"> <li>a. Pros: fireflies glow to attract mates and warn other predators that they taste bad and to not eat them</li> <li>b. Cons: visible to predators, requires a lot of energy to produce</li> </ol> </li> <li>2. <b>Luciferin</b> - the ingredients of a recipe that you are cooking and has the potential to be a dish</li> <li>3. <b>Luciferase</b> - the chef that actually prepares and cooks the ingredients into a full/final dish (light)</li> <li>4. <b>Adaptation Examples</b> - camouflage, webbed feet (duck), insulation (penguins), long necks (giraffe)</li> </ol>
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<p><b>Procedure</b></p> <p>Option 1: Glow tag</p> <ol style="list-style-type: none"> <li>1. Have mentees wear the glowstick on wrist or somewhere visible on their body</li> <li>2. Play tag (better outside and away from tripping hazards) → this really only works for sites at dusk unless sites want to turn off classroom lights but lowkey dangerous</li> <li>3. Reinforce how the glowsticks help mentees see each other better in the dark which is like mate attraction but also poses as a danger</li> </ol>	 <p><b>Figure 1:</b> mentees playing tag</p>
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<p>from predators</p> <p>Option 2: Q&amp;A with the kids where they can ask the mentors anything</p> <p>Option 3: Have a glow party and celebrate the last site!!</p>	<p>Examples of questions for Q&amp;A that I've received:</p> <ul style="list-style-type: none"> <li>• What is your dream career and why?</li> <li>• How old are you? (LOL)</li> <li>• Is middle school scary?</li> <li>• What is your fav Taylor Swift song?</li> <li>• What do you learn in college?</li> <li>• Do you have a boyfriend? (LOL again)</li> </ul> <p><b>Figure 2:</b> <i>examples</i></p>  <p><b>Figure 3:</b> <i>glow party!</i></p>
<p><b>Procedure</b></p> <p>Option 4:</p> <ol style="list-style-type: none"> <li>1. Put 4 glue dots on the inside of the cupcake liner</li> <li>2. Fold a streamer in half</li> <li>3. Stick the middle of that streamer on each glue dot (repeat x 4)</li> <li>4. Put a glue dot in the middle of the outside of the cupcake liner</li> <li>5. Stick a string on that glue dot so that the string holds up the jellyfish</li> <li>6. Put googly eyes on</li> <li>7. Shine UV light on streamers to see your jellyfish glow!</li> <li>8. Take pictures!!</li> </ol> <p><b>THIS IS ONLY FOR SL: Valeria, Kayla, Meisen, Sandra, August, Nathan, Lilly, Lucas</b></p> <p><b>*All other sites are doing one of the first 3 options</b></p>	 <p><b>Figure 1:</b> <i>4 streamers on bottom of cupcake liner</i></p>  <p><b>Figure 2:</b> <i>final jellyfish!</i></p>

### Classroom Notes

Only mentors get flashlights only, don't let mentees grab flashlights to prevent them from shining UV light in each others eyes

## Conclusion

Fluorescence is very important and seen in everyday life! But more importantly, let the mentees know that they are very important and loved by BEAM. Don't let anyone dim your glow!

## References

- <https://www.sciencebuddies.org/stem-activities/tonic-water-glow>s
- [https://www.goldbio.com/blogs/articles/everything-about-luciferin-luciferase?srsId=AfmBOoopgCste5LYuqPzt6n\\_GrvXRhpm5EO4jaKgOAXQNdSt9zB7dCjV](https://www.goldbio.com/blogs/articles/everything-about-luciferin-luciferase?srsId=AfmBOoopgCste5LYuqPzt6n_GrvXRhpm5EO4jaKgOAXQNdSt9zB7dCjV)
- <https://www.easypeasyandfun.com/jellyfish-cupcake-liner-crafts/>

## Summary Materials Table

Material	Amount per Site	Expected \$\$	Vendor (or online link)
Ping pong ball	5 per site	\$0	MCL
Blacklight	5 per site	\$10 for 10	<a href="#">Link</a>
Glow sticks	2 per mentee	\$38 for 1000	<a href="#">Link</a>
Paper	Full sheet per mentee	\$0	MCL
Highlighters -yellow, orange	1 per 3-4 mentees	\$17 + \$14 for 60	<a href="#">Link</a> for yellow <a href="#">Link</a> for orange
Tonic water	5 small bottles	\$11 for 6 bottles	<a href="#">Link</a>