CENTERS FOR OCEAN SCIENCES EDUCATION EXCELLENCE
BEST OF COSEE HANDS-ON ACTIVITIES

Activity Title: What is Light?

Learning Objectives

Goal: Students will discover the exciting world of light – the most important form of energy in our world – and be able to identify and describe different types of light.

Ocean Literacy Principles

5. The ocean supports a great diversity of life and ecosystems

a. Ocean biology provides many unique examples of life cycles, adaptations and important relationships among organisms (such as symbiosis, predator-prey dynamics and energy transfer) that do not occur on land.

f. Ocean habitats are defined by environmental factors. Due to interactions of abiotic factors such as salinity, temperature, oxygen, pH, light, nutrients, pressure, substrate and circulation, ocean life is not evenly distributed temporally or spatially, i.e., it is "patchy". Some regions of the ocean support more diverse and abundant life than anywhere on Earth, while much of the ocean is considered a desert.

g. There are deep ocean ecosystems that are independent of energy from sunlight and photosynthetic organisms. Hydrothermal vents, submarine hot springs, methane cold seeps, and whale falls rely only on chemical energy and chemosynthetic organisms to support life.

National Science Standards

- Physical Science - Light, Heat, Electricity and Magnetism
- Life Science - Regulation and Behavior; Diversity and Adaptations

Supplies and Materials

See Materials/Supplies Appendix for information on where to purchase materials.

- A somewhat dark room

Activity 1:

- Lamp with incandescent (filament) light bulb (your average, run of the mill bulb)
- 1 Light Stick – any color
- Fluorescent clay or other fluorescent material (may substitute with highlighter on paper)
- Phosphorescent stars or glow in the dark paint

Activity 2:

- Red flashlight
- UV or Black light
- Fluorescent clay or other fluorescent material (may substitute with highlighter on paper)
- Phosphorescent stars or glow in the dark paint

Activity 3:

- 2 Green light sticks
- 2 Clear glasses large enough to submerge light sticks
    - One filled with ice water (labeled)
    - One filled with hot water (labeled)

Activity 4:

- *Pyrocystis fusiformis* dinoflagellate culture (See Appendices for supply and care information)
- Small dish or cup to hold culture
- Coffee stir stick
- Microscope and depression slide (optional)

Background

Descend two hundred meters into the ocean and the world is dark blue; another three hundred meters and your surroundings have faded to a dim, bluish-gray twilight. There is enough illumination for a person to see at that depth, but too little for photosynthesis. Descend through this twilight zone another 500 meters and it becomes eternal night.

The conditions in deep ocean waters include crushing pressure and frigid temperatures. The inhabitants are some of the most amazing organisms you could ever dream exist.

The amount of sunlight in oceanic waters decreases with depth, and the color changes as the wavelengths of light become scattered and absorbed. Longer wavelengths of light, red, orange, and yellow, are absorbed quickly in the ocean. Shorter wavelengths, blue and violet, reach further into the ocean and scatter – which is why the ocean is 'blue'. The increased pressure in the deep sea is because the deeper you go in the ocean, the greater the amount of water you have pressing in upon you. These characteristics of the deep ocean, in addition to the denser cold water, combine to create an environment that was once thought to be inhospitable. Through deep sea technology, some of which include crude net systems, deep diving submersibles, and equipment like the Eye-in-the-Sea (EITS) and Medusa camera systems, we now have a glimpse of deep sea life. The animals we have observed have an array of brilliant adaptations that rival any imagination.

Deep sea organisms must find food, evade predators, and find mates. One fascinating way many organisms are successful in this is through the production of light. Light production through other means than heating is called luminescence. Examples of luminescence include fluorescence, phosphorescence, and chemiluminescence. In fluorescence, energy from an external source of light is absorbed by a substance and immediately reemitted at a longer wavelength until the source of light is removed. Phosphorescence is similar to fluorescence, however due to the more stable state of the electrons; the reemitted light will persist after the radiant energy has been removed.

Bioluminescence is a form of chemiluminescence, and refers to the ability for living organisms to produce light through a chemical reaction. Most of the animals living in the open ocean – out away from shore – are bioluminescent. This is because there is nowhere to hide from predators in the midocean, except down in the dark depths. Bioluminescence is used to distract or blind predators, lure prey, and attract mates. In the twilight depths it is also used as camouflage making animals harder to see from below.

Two types of chemicals are required for the chemical reaction. Luciferins are the substrate and produce the light, while the catalyst is a luciferase enzyme. There are different types of luciferins, and the luciferase will differ among organisms as well. Most animals produce these chemicals from the food they eat. A few animals, like flashlight fish and angler fish, get their light by means of a symbiotic relationship with bioluminescent bacteria. The fish provides the bacteria with food and a good place to grow and the bacteria provide the fish with light to see by for the flashlight fish or to attract prey for the angler fish. Animals can also use their bioluminescence to attract a mate just the way fireflies do on land. Many animals use bioluminescence to avoid being eaten, and some can release their bioluminescent chemicals into the water to distract or temporarily blind a predator.

While most terrestrial bioluminescence is yellow and green, bioluminescence in the ocean is primarily blue. This is because evolution has favored those organisms that can communicate over greater distances. Counterillumination is used to mimic the small amount of light found in the mesopelagic zone. Organisms use photophores (light organs) to match the color and intensity of light coming from above. This makes these animals almost invisible to the predators below them. Animals can adjust the light from these ventral lights to match the light fluctuations from above. Other adaptations increase the predatory and defensive success of animals in this environment. The cock-eyed squid has one eye larger than the other- the large eye looks upward, searching for silhouettes, while the small eye looks below for bioluminescence. Dark coloration is another common adaptation to life in the deep, red in particular because being red is the same as being black when there is no red light available to reflect back to your eye.

We have discovered these amazing adaptations from animals we could collect and observe with slow, loud, and bright equipment. As technology advances, we will be able to observe other new animals and new adaptations of organisms that were once beyond our reach.

Duration

60 – 90 minutes

Audience

Students in grades 6 through 8

Procedure

A. Review the following information/definitions with students.

Light: Light is a source of energy and a means of communication. Light results from changes that occur in atoms when they absorb energy. Different types of light are distinguished by their different sources of energy. The two main forms of light are **incandescence** or hot light and **luminescence** or cold light.

In **incandescence** the energy to produce the light comes from heat so these sources generate both heat and light. Examples include the sun, a candle flame and an incandescent light bulb.

In **luminescence** the energy to produce the light is produced by some means other than heating. Four examples of luminescence are:

- **Fluorescence** – The energy comes from light. Wavelengths of light are absorbed by a substance and then luminescence is immediately emitted by the substance at a longer wavelength. Luminescence is emitted only when stimulated by radiant energy. Luminescence ceases when radiant energy is removed. “Black light” posters are fluorescent.
- **Phosphorescence** – The energy comes from light. Wavelengths of light are absorbed by a substance and then luminescence is emitted slowly by the substance, at a lower intensity and for a longer duration. Luminescence emitted by the substance persists after the radiant energy has been removed. Glow-in-the-dark paint and toys are phosphorescent.
- **Chemiluminescence** – The energy comes from a chemical reaction. Luminescence is generated by the release of energy, as a result of the chemicals combining. Light sticks are chemiluminescent.
- **Bioluminescence** – The energy comes from a chemical reaction, and is a form of chemiluminescence. The chemicals are produced by living organisms like fireflies and lantern fish.

B. Ask students to read the poem at the top of their handout and answer #1 and #2. Students should complete the remainder of the handout following activities.

C. Students should divide into small groups and rotate through the following activities.

Activity 1: Incandescence and Luminescence

Set up “Incandescence and Luminescence activity card” and an example of each of the following at this activity: Incandescence, Fluorescence, Phosphorescence, Chemiluminescence

Students should:

- Read the description for the different forms of light.
- Use the incandescent bulb or an additional UV light to stimulate the materials.
- Match the description to the examples.
- Use the activity to answer questions in handout.

Activity 2: Fluorescence and Phosphorescence

Set up “Fluorescence and Phosphorescence activity card” and an example of fluorescent and phosphorescent material. Descriptions of materials are included in activity card.

Students should answer the following questions:

1. Use the UV flash light to shine on the fluorescent material. Turn the light off. Did the fluorescent material emit light after the flashlight was turned off?
2. Use the UV flash light to shine on the phosphorescent material. Turn the light off. Did the phosphorescent material emit light after the flashlight was turned off?
3. Use the flashlight with the red light. Do you observe a difference in luminescence emitted using the red light and UV light?
4. Hold each light source over the putty for several seconds and then remove it. Which light produced the larger amount of luminescence in the putty, and why?

Activity 3: Chemiluminescence

Note: This activity station requires an adult facilitator. Set up "Chemiluminescence activity card".

Place labeled HOT and COLD glasses of water on table and proceed to discussion below:

When chemicals mix together inside the light stick, they make light just the way bioluminescent organisms do. Explain that animals produce their light producing chemicals from the food they eat. Ask why it is important that the light animals make be cold light.

Tell them that the amount of light that is produced by the light stick depends on how often the light producing chemicals bump into each other. Just like bumper cars, where the number of collisions depends on the number of bumper cars and how fast they're all moving, the amount of light produced depends on the number of light producing chemicals (the concentration) and how fast the chemicals are moving, which depends on the temperature. Ask the students to conduct the following experiment.

Students/facilitator should:

1. Break both green light sticks at the same time and place one in the ice water (labeled COLD) and one in the hot water (labeled HOT). Ask the students if they think the temperature will change the light output. Have them predict which light stick will be brighter than the other.
2. After 20 minutes remove the two light sticks and place them side by side. Ask the students to describe the light coming from the two light sticks and speculate about why they appear different.
3. Answer the question at the activity station: Imagine the light sticks have been submerged an hour at these different temperatures. If you allow each light stick to come back to room temperature, do you think they will emit the same amount of light or will one be brighter than another? If the latter, which one will be brighter and why?

Activity 4: Bioluminescence

Set up "Bioluminescence activity card". Keep dinoflagellates under fluorescent light over night to photosynthesize. Two hours before class, place dinoflagellates in dark area. Culture should remain in dark during observations and stimulate only enough to observe light. A microscope can be set up for a closer view of a sample of the dinoflagellates.

Students should:

1. Gently stimulate the dinoflagellates by moving container back and forth.
2. Record your observations and discuss the following:
    - What color is the light emitted and how long did it last?
    - Why would this light be beneficial for the dinoflagellates?

D. Review the experiments with students.

Expected Results:

Incandescence will emit heat, and the other forms of light do not emit heat. To see fluorescence or phosphorescence you need a light source. When you turn off the light the phosphorescence keeps glowing. Chemiluminescence glows and gets dimmer over time as the chemicals are used up.

The green light stick from the cold water should be noticeably dimmer than the one taken from the hot water because the chemicals are moving slower and bumping into each other less often. If you allow the light sticks to come to room temperature and then compare them you will find that the light stick that was in the cold is the brighter one. This is because while it was cold it was using up its light producing chemicals more slowly than the light stick in the hot water. So now the difference in brightness is due to different concentrations of the reacting chemicals, rather than to different speeds.

Bioluminescent dinoflagellates are single celled organisms. They are large – almost 1 mm long – so you can see them as specks floating in the water if you don't have a microscope. Note that they flash when disturbed and each flash is dimmer than the last because just as with the light sticks the chemicals are used up. Given time and sunlight, so that they can photosynthesize, these dinoflagellates can produce new chemicals. Students should realize that living organisms need to produce cold light to keep from burning up.

E. Instruct students to complete their hand outs.

Assessment

Students should complete the activity handouts after conducting all activity stations. Instructors should refer to answer sheets to assess student success.

Additional Resources

Internet Resources

Electromagnetic Spectrum

- Discovery Education Lesson Plan Library: The Electromagnetic Spectrum: Waves of Energy Objectives, materials, procedures, adaptations, discussion questions, evaluation, extensions, links, and standards: http://school.discoveryeducation.com/lessonplans/activities/electromagneticspectrum/
- NASA: Understanding Light Lesson: http://science.hq.nasa.gov/kids/imagers/teachersite/UL3.htm
- Deep Light: NOAA and Dr. Edie Widder - How water transforms light http://oceanexplorer.noaa.gov/explorations/04deepscope/background/deeplight/deeplight.html
- WHOI Oceanus: Shedding Light on Light in the Ocean http://www.whoi.edu/oceanus/viewArticle.do?id=2472

Deep Sea Adaptations

- http://marinebio.org/Oceans/Deep/
- http://www.ted.com/talks/edith_widder_glowing_life_in_an_underwater_world.html

Bioluminescence

- http://www.teamorca.org/cfiles/bioluminescence.cfm
- http://www.lifesci.ucsb.edu/~biolum/
- http://siobiolum.ucsd.edu/Biolum_q&a.html
- http://www.ted.com/talks/edith_widder_glowing_life_in_an_underwater_world.html

Ocean Science Lesson Plans & Resources

- NOAA Ocean Explorer - http://oceanexplorer.noaa.gov/welcome.html
- Smithsonian Ocean Portal - http://ocean.si.edu/for-educators
- MBARI Lesson Plans - http://www.mbari.org/earth/lesson_grid.htm
- NOAA Lesson Plans - http://oceanexplorer.noaa.gov/explorations/09bioluminescence/background/edu/lessonplans.html
- NOAA Explorations - http://oceanexplorer.noaa.gov/explorations/explorations.html
- COSEE Florida - http://www.cosee.net/about/aboutcenters/florida/
- Smithsonian Marine Station at Fort Pierce - http://www.sms.si.edu/
- ORCA - www.teamorca.org

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- Marshall, N.B. Deep-Sea Biology. New York and London: Garland STPM Press, 1979.
- Barton, Chris. The Day Glo Brothers. Watertown: Charlesbridge Publishing, 2009.
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This lesson plan was provided by COSEE Florida. For more information, please contact: Laura Diederick at Diederick@si.edu.

----Activity Card 1----

Incandescence and Luminescence

Emitted light results from changes that occur in atoms when they absorb energy. Different types of light are distinguished by their different sources of energy. The two main forms of light are **incandescence** or hot light and **luminescence** or cold light.

In **incandescence** the energy to produce the light comes from heat so these sources generate both heat and light. Examples include the sun, a candle flame, and an incandescent light bulb.

In **luminescence** the energy to produce the light is produced by some means other than heating.

Procedures:

1. Observe the real world examples of light.
2. Match the description cards with the appropriate examples of incandescence and luminescence.
3. Record the observations in question #3 on your handout.

Descriptions – Cut out and place descriptions at activity station 1.

Fluorescence: The energy comes from light. Wavelengths of light are absorbed by a substance, and the substance immediately re-emits the light at a lower intensity. The re-emitted light stops when you remove the light source. "Black Light" posters are fluorescent.

Incandescence: The energy comes from heat. The emission of visible light is produced by a hot object.

Phosphorescence: The energy comes from light. Wavelengths of light are absorbed and the substance slowly re-emits the light at a lower intensity. The re-emitted light does not stop when you remove the light source. It may continue re-emitting light for a long time. Glow-In-The-Dark paint and toys are phosphorescent.

Chemiluminescence is an example of luminescence. The energy comes from a chemical reaction, and is generated by the release of energy created from the chemicals combining.

----Activity Card 2----

Fluorescence and Phosphorescence

Emitted light results from changes that occur in atoms when they absorb energy. Different types of light are distinguished by their different sources of energy. The two main forms of light are **incandescence** or hot light and **luminescence** or cold light.

In **luminescence** the energy to produce the light is produced by some means other than heating.

Procedures:

1. Use the UV flash light to shine on the fluorescent material. Turn the light off. **Did the fluorescent material emit light after the flashlight was turned off?**
2. Use the UV flash light to shine on the phosphorescent material. Turn the light off. **Did the phosphorescent material emit light after the flashlight was turned off?**
3. Use the flashlight with the red light on both objects. **Do you observe a difference in luminescence emitted using the red light and UV light?**
4. Hold each light source over the putty for several seconds and then remove it. **Which light produced the larger amount of luminescence in the putty, and why?**

Descriptions – Cut out and place descriptions at activity station 2.

Fluorescence: The energy comes from light. Wavelengths of light are absorbed by a substance, and the substance immediately re-emits the light at a lower intensity. The re-emitted light stops when you remove the light source. “Black Light” posters are fluorescent.

Phosphorescence: The energy comes from light. Wavelengths of light are absorbed and the substance slowly re-emits the light at a lower intensity. The re-emitted light does not stop when you remove the light source. It may continue re-emitting light for a long time. Glow-In-The-Dark paint and toys are phosphorescent.

----Activity Card 3----

Chemiluminescence

Emitted light results from changes that occur in atoms when they absorb energy. Different types of light are distinguished by their different sources of energy. The two main forms of light are **incandescence** or hot light and **luminescence** or cold light.

In **luminescence** the energy to produce the light is produced by some means other than heating. **Chemiluminescence** is an example of luminescence. The energy comes from a chemical reaction, and is generated by the release of energy created from the chemicals combining.

Procedures:

1. Break both green light sticks at the same time and place one in the ice water (labeled COLD) and one in the hot water (labeled HOT). **Do you think the temperature will change the light output? Which light stick do you think will be brighter?**
2. After 20 minutes remove the two light sticks and place them side by side. **Describe the light coming from the two light sticks. Why might they look different?**
3. Imagine the light sticks have been submerged for an hour at these different temperatures**. If you allow each light stick to come back to room temperature, do you think they will emit the same amount of light or will one be brighter than another? If the latter, which one will be brighter and why?**

----Activity Card 4----

Bioluminescence

Emitted light results from changes that occur in atoms when they absorb energy. Different types of light are distinguished by their different sources of energy. The two main forms of light are **incandescence** or hot light and **luminescence** or cold light.

In **luminescence** the energy to produce the light is produced by some means other than heating.

Bioluminescence: The energy comes from a chemical reaction and is a form of chemiluminescence, created by living organisms. Fireflies and lanternfish bioluminese.

Procedures:

1. Gently stimulate the dinoflagellates one time by moving container back and forth.
2. Record your observations.
3. **What color is the light emitted and how long did it last?**
4. **Why would this light be beneficial for the dinoflagellates?**

Student Name:____ Date:____________________

What is Light?

Awak'd before the rushing prow,
The mimic fires of ocean glow,
Those lightnings of the wave;
Wild sparkles crest the broken tides,
And flashing round, the vessel's sides
With elfish luster lave;
While far behind, their vivid light
To the dark billows of the night
A blooming splendor gave
From *Lord of the Isles* (1815)
By Sir Walter Scott

1. How many words that describe light can you find in this poem?

2. How many different sources of light can you name?

3. Consider the different types of light you explored in the activities. What are some of the differences between these different sources of light?

	Incandescence	Fluorescence	Phosphorescence	Chemiluminescence	Bioluminescence
Hot or Cold?					
Energy Source?					
Colors?					

4. In the experiment with the two light sticks, after 20 minutes which light stick is brighter: the one in the hot water or the one in the cold water?

5. Explain why you think this is.

6. How do you get light from bioluminescent plankton? Why might this be?

7. Does the bioluminescence from the plankton flash or glow?

8. Does the light change? Brighter or dimmer?

9. Why do you think this happens?

INSTRUCTOR ANSWER SHEET

What is Light?

Awak'd before the rushing prow,
The mimic **fires** of ocean **glow**,
Those **lightnings** of the wave;
Wild **sparkles** crest the broken tides,
And **flashing** round, the vessel's sides
With elfish **luster** lave;
While far behind, their vivid **light**
To the dark billows of the night
A **blooming splendor** gave
From *Lord of the Isles* (1815)
By Sir Walter Scott

1. How many words/phrases that describe light can you find in this poem?
Eight.

2. How many different sources of light can you name?
e.g. sunlight, candle flame, light bulb (incandescent or fluorescent), light emitting diode, starlight, moonlight (reflected sunlight), lightening, light sticks, aurora borealis

3. Consider the different types of light you explored in the activities. What are some of the differences between these different sources of light?

	Incandescence	Fluorescence	Phosphorescence	Chemiluminescence	Bioluminescence
Hot or Cold?	**Hot**	**Cold**	**Cold**	**Cold**	**Cold**
Energy Source?	**Electricity**	**Light**	**Light**	**Chemical**	**Chemical**
Colors?	**All Colors**	**All Colors**	**All Colors**	**All Colors**	**All Colors- mostly blue and green**

4. In the experiment with the two light sticks, after 20 minutes which light stick is brighter: the one in the hot water or the one in the cold water?

The one in hot water.

5. Explain why you think this is.

Because the chemicals are moving faster and bumping into each other more often.

6. How do you get light from bioluminescent plankton? Why might this be?

You must mechanically stimulate them.

7. Does the bioluminescence from the plankton flash or glow?

Flash.

8. Does the light change? Brighter or dimmer?

Yes. It gets dimmer.

9. Why do you think this happens?

Because the light producing chemicals are being used up.

APPENDIX: Materials and Additional Resources

What is Light?	Materials	Source	Cost
Incandescence	1 Lamp	Walmart	$9.99
	1 Incandescent bulb	Walmart	$1.00
Fluorescence	1 Black light	www.puttyworld.com	$5.95, 1 keychain
	1 Fluorescent clay	www.sciplus.com	$4.50, 4 colors
	6 Highlighters	Walmart	$4.00, multi 4-pack
Phosphorescence	Phosphorescent putty	www.puttyworld.com http://www.puttyworld.com	$11.00, ea
	Multi- color flashlight	www.sciplus.com	$8.50
	Black light	www.puttyworld.com	$5.95,1 keychain
Chemiluminescence Light Sticks	1 red, 1 blue light stick	Glowstickfactory.com	$6.95, 10 count
Chemiluminescence Hot/Cold Demo.	2 green light sticks	Glowstickfactory.com	$6.95, 10 count
	2 containers to submerge lights	Walmart	$.99, ea.
Bioluminescence	Dinoflagellate culture	Sunnyside sea farms www.seafarms.com	$6.00, 50 ml

Appendix: Bioluminescent Dinoflagellates

Growing and Experimenting

By: Edith A. Widder, CEO, President and Senior Scientist

You can order bioluminescent dinoflagellates from Sunnyside Sea Farms, 475 Kellogg Way, Goleta, CA 93117-3804 (Tel 805-964-3755, e-mail: sunnyside@seafarms.com). The first 50 ml bag is $6.00 and the price drops the more bags you purchase. These dinoflagellates have the scientific name *Pyrocystis fusiformis*, which literally means spindle-shaped (fusiform) fire (Pyro) cell (cystis).

These cells need to photosynthesize in order to make their bioluminescent chemicals so you will need to set them up under fluorescent lights. Although they are usually only bioluminescent during the night you can fool them by having the lights on during the night and keeping them in the dark during the day. Then if you take them out and shake the container you will see them flash. Be careful not to let them get too warm. They grow best at about 68-75 degrees F. You can blow a fan over them to help keep them cool if you need to. You can keep the cultures going indefinitely by transferring them to sterile seawater with some added nutrients. You can pasteurize seawater in a microwave if you can adjust the temperature so the water doesn't boil. Put 100 ml of seawater in a 250 Erlenmeyer flask with 0.05 ml of Micro Algae Grow (Aquaculture Supply 5532 Old St. Joe Road, Dade City FL 33525 Tel. 904 567 8540 A 200 ml bottle cost $4.20). Put a 50 ml beaker upside down on the flask. Microwave the seawater for 20 mins at 180 degrees F. Don't let it boil! Allow the seawater to sit for at least a day before inoculating the culture. Transfer a little of the old dinoflagellate culture to the flask by lifting the beaker but holding it over the mouth of the flask. If you don’t have a microwave with a temperature probe – they used to be more common than they are now – you will either need an autoclave or a pressure cooker. Both of these methods use pressure to keep the seawater from boiling. You need to prevent boiling because it causes some of the essential nutrients to precipitate out and then the cells won’t grow in the medium. After you’ve pasteurized the seawater you should let it sit for a day or two before you inoculate it with dinoflagellates.

Once you have a few flasks going, try growing them under different light/dark cycles and look at the cells with a microscope to see how different they appear in their day phase, compared to their night phase. See what happens if you keep one of the cultures in constant darkness. What about under constant light? How long does it take for the bioluminescence to turn on when you place a culture in the dark? How long to turn off when you place it in the light? Can you mechanically stimulate the cells to exhaustion, so they don't bioluminesce any more? Do they recover during their night phase? How about after their next day phase? Are there other ways to stimulate bioluminescence than mechanically? Place some of the culture in a test tube and add a drop or two of 10% acetic acid or if you don't have any laboratory acids try vinegar. What happens? Can you get any more bioluminescence out of the cells after they have been chemically stimulated?

Enjoy!

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Web resources

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http://www.bioscienceexplained. org/ENvol1_1/index.html

The Bioluminescence Web Page: http://www.lifesci.ucsb.edu/~biolum/

Bioluminescence Exploration Dive: http://www.teamorca.org/cfiles/bioluminescence.cfm