Lesson Plan 13

All That Glitters...

Focus

Light in the deep sea

Focus Question

What happens to light in the ocean? How do deep-sea creatures compensate for lack of light?

Learning Objectives

Students will experiment with a model of what happens to light and colors as one descends into the ocean.

Students will describe at least two adaptations to low or no ambient light on the part of deep-sea organisms.

Additional Information for Teachers of Deaf Students

In addition to the words listed as Key Words, the following words should be part of the vocabulary list:

Transparent
Counterillumination
Countershading
Pelagic

The Key Words are integral to the unit, but will be difficult to introduce prior to the activity. They are really the material of the lesson. There are no formal signs in American Sign Language for any of these words and many are difficult to lipread. Having the vocabulary list on the board as a reference during the lesson will be extremely helpful. This activity may require a bit more time to complete. It would be very helpful to copy the Background Information and hand it out to the students to read at the start of the lesson. You can then cover the key elements prior to the activity.

Materials

For the teacher:

- ❒ 3" x 5" card with 1-in slit cut in middle
- ❒ 35 mm slide projector
- ❒ Prism
- ❒ Glow stick (from dive shops, fishing tackle or sporting goods stores or "dollar" stores)
- ❒ One hole punch
- ❒ Optional: vial of ostracods from Carolina Biological Catalog: GR-20-3430; $32.80

Per student:
Deep sea dive googles made with:
Blue plastic - blue plastic report covers or blue color filter gel plastic; depending upon the ambient light in your room, you will need 4-8 strips of plastic per goggle. Each strip should be about 8.5" x 3". Blue color filter gels are available from StageLight Louisiana LLC, phone (540) 818-1880; SLD Lighting, phone 800-245-6630, www.sldlighting.com; or check your local yellow pages under "Theatrical and Stage Lighting Equipment." Ask for Roscolux #80 primary blue, Lee #079 just blue, or Gam #850. These sheets are 24" x 20", producing 21 strips per sheet. Six sheets should produce 31 4-layer goggles. Blue plastic report covers or index dividers are available from office supply stores. Office Depot Insertable Index Dividers Item #455-801 is one source for the color of blue needed for this activity.
Elastic - about 12"
One "regular" paper clip

One "binder" paper clip (the black and silver kind used for thick bundles of paper)

Per student pair:
- ❒ Four each 2 square cm. pieces of craft foam or felt in red, orange, yellow, green, blue, black/dark brown
- ❒ Sheet of black construction paper or black craft foam
- ❒ "Color in the Sea" Student Handout chart

Audio/visual Materials
- ❒ Slide projector
- ❒ Movie screen or white wall
- ❒ Internet access for students

Teaching Time
One 45 minute period

Seating Arrangement
Pairs

Key Words
Photic

Aphotic
Mesopelagic
Bathypelagic
Twilight zone
Midnight zone
Bioluminescence
Spectrum
Wavelength
Reflect
Absorb

Background Information
This activity allows students to explore the nature of light, ask what happens to light as it passes through the ocean and speculate on how deep-sea animals deal with living in the dark.

During the 2002 South Atlantic Bight Expedition, Islands in the Stream, two scientists from the Harbor Branch Oceanographic Institution, Dr. Tamara Frank and Dr. Edith Widder, studied vision and bioluminescence in the deep sea. Of particular interest were animals with large eyes that live on the sea floor in the aphotic zone. Many animals that swim in open water (pelagic) in the mesopelagic or twilight zone have large eyes relative to their body size. Large eyes capture what little light is available. As depth increases below the mesopelagic, eye size in many organisms decreases. For example, two species of bristlemouths, *Gonostoma denudatum*, a midwater fish, and *Gonostoma bathyphilum*, a deeper water fish, have different eye sizes. The midwater species has much larger eyes. The deep water species has much smaller eyes—the result you would expect if eyes had no value in the total absence of light. However, an enigma exists. Many animals living on the deep-sea floor sea have huge eyes! One possible value of vision where there is no ambient light is that some deep-sea organisms make their own light—they are bioluminescent.

Learning Procedure
Teacher Prep
1. Cut a thin slit, just a few millimeters wide and about an inch long, in the card.

2. Tape a small piece of blue plastic over the light source. Ask students to note what color is projected (blue). Make sure that students understand that the blue plastic blocks part of the spectrum by absorbing colors of light other than blue.

3. Place prism in beam of light and practice rotating prism to project the colors of the spectrum on the movie screen or white wall.

4. Cut the blue plastic into strips approximately 8.5 inches long by 3 inches wide.

5. Punch a hole in the middle of one end of every strip of plastic. Thread 4-8 sheets of plastic through the regular paper clip. Tie one end of the elastic to this paper clip. Tie the other end of the elastic to one of the silver ends of the binder clip.

6. Separate felt or foam squares by colors so that each student pair has four of each: black (dark brown), red, orange, yellow, green and blue.

Learning Procedure

1. Ask your students to tell you what they know about light. Dim the lights and project a visible spectrum on the wall. Have the students write down the colors they observe in the order they see them in the spectrum. Review colors, absorption and reflection.

2. Tape a small piece of blue plastic over the light source. Ask students to note what color is projected (blue). Make sure that students understand that the blue plastic blocks part of the spectrum by absorbing colors of light other than blue.

3. Challenge the students to observe what the underwater world looks like by using Deep Sea Diving Goggles. Pass out the black paper or craft foam, Deep Sea Diving Goggles, and foam or felt squares to each pair of students.

4. Explain that the black piece of paper represents the darkness of the deep sea. Spread the felt or foam squares on the black paper.

5. Use only one layer of the Goggles to observe the colors of the foam or felt squares. Add another layer and observe. Continue adding layers, simulating what it looks like to go deeper into the ocean. What happened with each color? The blue plastic enables students to see how colors appear in deeper water. The blue plastic filters out other colors just as water absorbs them. Students should observe that the color black disappears first, followed by red, then orange, then yellow. Distribute the "Color in the Sea" Student Handout chart to each student group if you would like them to quantify their observations.

6. If they were fish wishing to hide in the mesopelagic twilight zone, what colors would be the best camouflage? Black and then red.

7. Introduce bioluminescence using the glow stick. Demonstrate "turning it on"—shaking it makes it brighter as you are mixing the chemicals that produce light when they react. Ask the students for their experiences with bioluminescence: fireflies are the most common among eastern US students. Black light posters are fluorescence—a very different process. Observe the glow stick with the goggles on. How might deep-sea species use the light they make? Discuss counter-illumination, finding a mate, finding prey, attracting prey and startling predators by blinding them. What color would be the most effective for bioluminescence—blue as it penetrates water most easily.

8. You may wish to go into detail about the chemical nature of bioluminescence if your students have sufficient foundation. If you have the ostracods, place three to five in your palm. Add two drops of water and crush the dried animals using a finger. Show your palm; a bright blue results. When you crush the dried animals, two chemicals mix to create blue light.

9. Visit the South Atlantic Bight OE expedition on the web or the OE CD and see what the scientists were studying about bioluminescence.

The BRIDGE Connection

Go to the BRIDGE web site at http://www.vims.edu/bridge/ Under the Navigation side bar click on Human Activities to learn more about the technology used to study deep sea environments.

The "Me" Connection

If you were to become a SCUBA diver, what color wetsuit would wear to become less visible to fishes (like sharks)? Your wetsuit choices include yellow, orange, red, green and blue.

Connection To Other Subjects

Chemistry, Physics

Evaluation

Provide students with the following hypothetical newspaper article. Ask them to explain why the journalist's hypothesis regarding the brown cloud was wrong.

> *"Yesterday I was SCUBA diving with a young woman in eighty feet of water just off the coast of South Carolina. The woman was studying the abundance of fish on an offshore rocky reef when she became tangled in some clear, nylon fishing line. Fortunately she was carrying a dive knife and was able to cut herself free. However, in the process she cut a five-inch gash across her left calf. I saw a brown cloud of something in the water around her leg. I thought it might be blood, but knew it couldn't be since it wasn't red. An octopus must have come by and released some ink or some other substance to camouflage itself."*

Extensions

Over the next week, have students conduct independent research on any of the following animals:

- anglerfish
- bristlemouth
- fangtooth
- filetail catshark
- sixgill shark
- giant ostracod
- giant red mysid
- gulper eel
- hatchetfish
- lanternfish
- eelpout
- blackdragon
- hagfish
- viperfish
- shining tubeshoulder
- snipe eel
- spiny king crab
- ratfish
- squat lobster
- snailfish
- midwater shrimp (*Sergestes* sp.)

Descriptions of these animals can be found on the Monterey Bay Aquarium's web site http://www.mbayaq.org/efc/living_species/ Although this site displays animals in the Pacific, they share many characteristics with the Atlantic species. Students should include a physical description of the animal, noting the animal's eye size relative to the overall size, whether or not the animal can bioluminesce, and at what depth(s) it lives.

For an art project, use glow in the dark paint and construction paper to recreate deep sea animals, in 3-D, that bioluminesce. Hang them from the classroom ceiling and shut off the lights. *The Bioluminescence Coloring Book*, by Edith Widder, Harbor Branch Oceanographic Institution. ISBN 0-9659686-0-X is a good source of information.

Resources

http://www.mbayaq.org/efc/living_species/

http://www.mbari.org/

http://www.biolum.org

http://www.bioscience-explained.org/EN1.1/features.html

http://www.pbs.org/wgbh/nova/abyss/

http://oceanlink.island.net/oinfo/deepsea/deepsea.html

http://www.marine.whoi.edu/ships/alvin/alvin.htm

Student Handout

Color In The Sea

You are hunting for bits of food in the "twilight zone." Randomly arrange your colored foam or felt squares on the black foam. Put on your blue goggles to simulate light conditions in the twilight zone, using 2 or 3 layers (depending upon the ambient light in the room). Quickly pick up the first ten pieces of "food" you see. Record your results. Repeat with another partner, record of results. Analyze overall findings.

Partner	Red	Orange	Yellow	Green	Blue	Black
1						
2						
3						
4						
TOTAL:						