The Impact of Ultraviolet Light on Plankton

Student Activity Sheet

Name ____________________________________ Date ____________ Class ____________

Most people think of sunlight when they think of energy from the sun, but there are many different kinds of energy besides the visible light that we are all familiar with. Microwaves and radio waves are both kinds of energy radiated from the sun. Light is one type of what scientists call electromagnetic radiation or energy. Light is the type of electromagnetic energy that is visible to the human eye.

Light travels at 186,000 miles per second (or 300,00 kilometers per second), which is much faster than the speed of sound. Both sound and light energy travel in waves. Some special terms describe wave energy. For instance, the length of a wave is called the ***wavelength*** and it is measured from the top or crest of one wave to the top of the next wave. The height of the wave is called the ***amplitude***. The amplitude tells how bright the light is. The ***frequency*** is the number of waves that pass by an object every second. Light that has short wavelengths will have a higher number of waves moving by per second, while light with long wavelengths will have fewer waves per second moving past on object. ***High frequency*** refers to a high number of waves per second and ***low frequency*** is a low number of waves per second. Since the different kinds of light will have different wavelengths, they will also have different frequencies.

Most people have seen a rainbow in the sky. When you see a rainbow you are seeing all the colors that make up the visible light spectrum. A ***spectrum*** is just an arrangement of things in increasing or decreasing order of size. Visible light is called white light and it consists red, orange, yellow, green, blue, indigo, and violet (“ROY G. BIV”) light. Together these colors combine to form white light. Red light has the longest wavelength and violet light has the shortest wavelength of visible light.

The figure at the top of the next page shows the spectrum of the different kinds of electromagnetic energy. Visible light is almost in the middle of the spectrum. Gamma rays are the shortest waves (or wavelengths) with the highest frequency while radio waves are the longest waves with the

High Frequency | **Short Waves or Wavelengths**

Low Frequency | **Long waves or Wavelengths**

lowest frequency. You can see that most kinds of energy from the sun are not visible to our eyes.

Humans have learned how to generate these different kinds of energy for our own use: microwave ovens, ultraviolet lamps (to grow plants indoors), x-ray machines (to look at our bones), and radios (which receive radio waves through the air). Some of these types of energy or radiation can cause problems for humans. Microwaves, gamma rays, and x-rays can all cause damage to the cells in our bodies if we are exposed to too many of their waves.

Ultraviolet light (UV) in particular causes some chemical effects that are important to point out. UV not only bleaches out colors on paper and other materials but it also causes plastic to break down after it has been exposed to sunlight for a long time. When human skin cells are exposed to strong sunlight, the ultraviolet part of the light can cause damage, as little as sunburn or as severe as skin cancer. UV rays can be blocked or filtered by sunblock lotions, water, and the ozone layer in the atmosphere. One very important part of global change is ozone breakdown. Humans have added certain chemicals to the atmosphere that are destroying ozone. Since the ozone in the earth's atmosphere protects the surface of the earth from too receiving too much ultraviolet light, we may begin to have severe problems if ozone continues to become depleted.

Although seawater also acts as a filter to UV, there isn't enough water above the organisms that live close to the surface of the ocean to really protect them. Scientists worry about what effects increasing amounts of ultraviolet light may have on such surface dwellers as plankton. Since the plankton can't just rub on some sunblock, what will happen to them? In this activity, you will see directly how different amounts of ultraviolet light affect a kind of plankton called brine shrimp. Some of you may know these plankton by the name "Sea Monkeys" or fairy shrimp. Brine shrimp are tiny animals that live in very salty water, such as salt ponds and lagoons. We will use them because they are very easy to grow in the classroom and they are large enough for you to see with your eyes or a magnifying glass.

Objectives:

- Hatch brine shrimp and observe their development.
- Observe the effects that differing amounts of UV light have on brine shrimp.
- Graph the growth of the shrimp against their exposure to UV light.

Materials:

Hatched brine shrimp	Sunscreens: SPF 8, 15, 20, and 30
5 Large petri dishes	1 Small transfer petri dish
Saltwater	Eyedropper
Magnifying glass	Graduated cylinder
Grease pencil (china marker)	Sunny windowsill
Graph paper	Colored pencils (Student provided)

Procedures:

1. Divide into teams of four students each and agree on some name or letter to identify your team. Each team should take five large petri dishes and with the grease pencil, label them from one through five on the top cover. Make sure this number is not too large, just make it big enough for you to tell your dishes apart. On the bottom of each dish you will need to write your team's identification. Using the graduated cylinder, measure out 20 milliliters of saltwater into each of the dishes.
2. Using an eyedropper, remove a concentrated amount of brine shrimp out of the large culture bottle and add to a small, transfer petri dish. From this small dish, you will need to carefully

count out and place 10 live (moving) brine shrimp into each of the larger petri dishes (that is, 10 shrimp per petri dish). Note this amount on your Data Table.

3. You will me rubbing sunscreen onto the top cover of four of your five dishes. This will allow you can see the results of varying levels of UV with the control receiving a full dose. Dish #1 will be your control and so will have no sunscreen on it. Using your finger, smear the top cover of dishes 2-5 with sunscreen. Refer to the table below to see which sunscreen to smear on which dish. Make sure you put the same amount of sunscreen on each cover. It should leave a transparent film on the petri dish after it dries.

Petri Dish	Sunscreen SPF #
1	None
2	8
3	15
4	20
5	30

4. Place your dishes on a sunny windowsill so that they can be exposed to ultraviolet light. All the dishes should receive the same amount of sunlight. Rotate the dishes daily. Make sure you don't stack the dishes on top of one another and check to make sure they aren't getting too hot from the sun. You don't want the shrimp to cook in the dishes!
5. Every other day you will be given ten minutes to check your dishes. You will count the number of live brine shrimp in each plate by using a piece of graph paper as a grid. Place each of the dishes on top of the graph paper and count the number of moving or live brine shrimp remaining. The grid just helps you count the shrimp. You may need a magnifying glass for this step. Keep track of your results on the Data Table below.
6. After one week you will stop collecting data and make a graph from the information you have observed. Plot the number of live shrimp on one axis and the time (day number) on the other axis. Use a different color to plot each of the different dishes (ex., red for the control, blue for dish 1, etc.). Look at your graph and decide what it tells you about which dish was exposed to the most UV light and which dish had the most surviving brine shrimp. Your teacher will help you graph and interpret your results. Choose someone from your team to present your results to the class. Also answer the discussion questions.

Data Table

Petri Dish #	1 (Control)	2 (SPF 8)	3 (SPF 15)	4 (SPF 20)	5 (SPF 30)
Day	**Number of Living Brine Shrimp Remaining**				
1					
3					
5					
7					

Brine Shrimp

Discussion Questions:

1. Discuss the results of this experiment. Did the ultraviolet light harm or kill the brine shrimp?

2. What relationship did the strength of the sunscreen have on whether the brine shrimp survived?

3. If the ozone layer continues to thin, what can you predict will happen to the organisms which live close to the surface of the ocean?

4. Can you think of any solutions to this potential problem?

Vocabulary

Wavelength: The distance from the top or crest of one wave to the top of the next wave.

Amplitude: The height of a wave; this gives an indication of how bright the light is.

Frequency: The number of waves that pass by a point or object every second.

High frequency: A short light wave (short wavelength) with many waves per second.

Low frequency: A wave with a long wavelength (long wave) with few waves per second.

Spectrum: An arrangement of things in either increasing or decreasing order. The spectrum of visible light (ROY G. BIV) is in decreasing order from red light with the longest wavelength down to violet light with the shortest wavelength.

Teacher Strategies

Preparation:

You will need to make seawater for culturing the brine shrimp and to use in the activity itself. It might be a good idea to draw the water you'll need a day ahead of time if your tap water has a high chlorine content. Let the tap water sit in an open container overnight to allow the chlorine to dissipate. A small amount of Instant Ocean™ has been included in the kit. Use the Instant Ocean™ to make the saltwater as long as there is any left in the kit. Add 1/4 cup of Instant Ocean™ to 2 quarts of distilled water. The Instant Ocean™ has been measured out into 1/4 cup packets for your convenience. A 2 quart bottle has been provided. When the Instant Ocean™ has been used up, add 70 g. of coarse salt (also included) to 2 quarts of distilled water to make the standard seawater. You will only need about 1 liter of seawater for the activity itself, assuming 7 groups of students with sufficient left in case of spillage (100 ml/group). You can make up half the above recipes to equal this amount (1 quart is approximately equal to 1 liter). Please only make the amount of saltwater that you will need.

You will also have to hatch the brine shrimp eggs prior to initiation of the activity. You may do this yourself or have your class help you. The brine shrimp eggs have been included in the kit, but please carefully measure out only the amount you will need for your activity. Add about $^1/_{16}$- $^1/_8$ teaspoon of brine shrimp eggs to the 2 quarts of seawater. Mix or stir the eggs into the water. Don't worry if the eggs rest on the water's surface as they will eventually settle. Aerate the bottle if possible and keep it at room temperature (a simple aquarium pump and air stone work well). The shrimp will hatch within 36-72 hours. This species is a rugged survivor of some of the harshest conditions of sunlight, salinity, and desiccation. Feel free to substitute another, less rugged species.

Instructional Hints:

Divide students into teams or groups of four students. You may want to label one petri dish to show your students what they are supposed to do. The students may also need some help measuring their seawater if they have never before used a graduated cylinder. Feel free to give them as many dishes as they need to extract their brine shrimp from the culture stock. Make sure they pick living shrimp. You may also want to demonstrate how much sunscreen to smear on the petri dish covers. Remember that only a thin film is needed. The control with no sunscreen will receive the full dosage of UV radiation from the sunlight and the dish with SPF 30 will receive the least. Make sure the dishes don't receive sunlight that is too strong and hot-you don't want cooked brine shrimp! You can decide exactly how many days the experiment should last. We've suggested a week, but it can go on longer if you have time and there are still living shrimp to count.

If you don't have a sunny windowsill in your classroom, you can set up UV lights such as those used to grow plants indoors. Your students may need to have their graphing skills refreshed. Graph paper has been included for photocopying. Simple line graphs are suggested with time (days) versus number shrimp. Have your students use a different color for each of the dishes and plot all the data on one graph. They may need help interpreting their data and graphs, but encourage them to try before you help them. Don’t be surprised if your results are not dramatic proof of the deleterious impact of UV radiation!

Approximate Time Required: One class period for set up and one week afterwards.

Target Audience: Science.

Extensions:

Grades 4-6

Students can make posters depicting the results of too much UV light on plankton and how this would affect the ocean food web. This poster could be followed up with a story the student writes from the perspective of an organism living in the ocean. They describe how the ocean and larger organisms would be affected if plankton and other tiny organisms are depleted from the surface.

Grades 9-12

Students conduct the activity as written but using a more sensitive organism instead of brine shrimp and artificial light. The teacher can obtain an indoor plant-growing bulb and lamp (ex., Gro-lux™) or other source of safe ultraviolet light. Wavelengths of the UV light should be obtained, if possible, from the manufacturer. Students repeat the experiment using only the Gro-lux bulb as a light source. Students compare data from both light sources and determine the effect of increasing amounts of UV on unprotected (no sunscreen) and protected (sunscreen) organisms. Students may then research UV light: the wavelengths, amount reaching the earth, effects of ozone decrease, etc.

Questions:

a. How does the artificial UV light simulate what is happening on the earth’s surface? Explain.

b. Do you think sunscreens adequately protect humans against UV light? Why or Why not?

c. What is expected to happen to humans as a result of increased UV exposure? To the earth's climate?