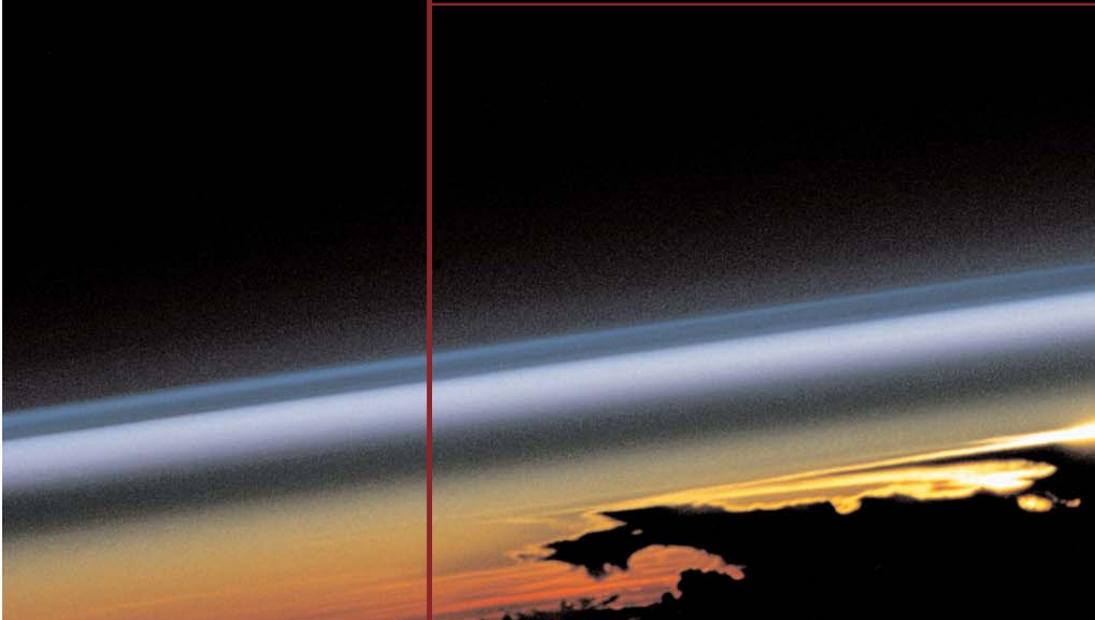


Activity 6
Caught! Atmosphere Protects



Atmosphere

CHANGE IS IN THE AIR



Smithsonian
National Museum of Natural History

ACTIVITY 6

Caught!

Atmosphere Protects

UV Light and its Effect on Living Things

Overview

Students will simulate the ozone hole in a lab. The ozone “hole,” which is actually a thinning of the ozone layer in the stratosphere, allows more than the usual amount of ultraviolet radiation from the Sun to reach Earth. They will test the effects of exposure to ultraviolet radiation on living cells and consider how this information could apply to them.

Grade Level

6–9

National Standards Alignment*National Science Education Standards*

Science as Inquiry Standards: Students at all grade levels and in every domain of science should have the opportunity to use scientific inquiry and develop the ability to think and act in ways associated with inquiry, including asking questions, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments.

Physical Science Content Standard B: As a result of their activities in grades 5–8, all students should develop an understanding of transfer of energy. As a result of their activities in grades 9–12, all students should develop an understanding of the interaction of matter and energy.

Life Science Content Standard C: As a result of their activities in grades 5–8, all students should develop understanding of structure and function in living systems. As a result of their activities in grades 9–12, all students should develop understanding of the cell, matter, energy, and organization in living systems.

Time

Several days, depending on how long the organisms are allowed to grow.

Materials

- a selected organism to study, such as a plant, yeast culture, ant farm, algae, etc.
- a safe UV light source, such as the goggle box in your chemistry laboratory, tanning light, black light. (You can also use a fish tank with UV light, but the results won't be as dramatic.)
- a microscope, cell stains and slides (if desired)
- sunscreen

ACTIVITY 6

Vocabulary

ULTRAVIOLET (UV) LIGHT—a portion of the light spectrum with shorter wavelengths and more energy than visible light. UV light enables cells in the skin to make Vitamin D, but it can also cause wrinkles, skin cancer, and cataracts over the lens of the eye.

UVA AND UVB LIGHT—the portions of ultraviolet light from sunlight that are not completely blocked by the ozone layer in the stratosphere. UVB gives you a suntan and can cause skin cancer. UVA makes skin age prematurely.

VISIBLE LIGHT—the portion of the light spectrum that you can see

WAVELENGTH—light travels in the form of waves. The distance between waves is called the wavelength.

DNA—the genetic material in the nucleus of living cells

OZONE—a highly reactive gas that is formed from three oxygen atoms

OZONE HOLE—a thinning of the ozone layer over Antarctica, caused by the use of chlorofluorocarbons in aerosol sprays and refrigerants

OZONE LAYER—a layer of ozone in the stratosphere 14.5 to 50 km (9 to 31 mi) above Earth that blocks much of the sun's UV light



An Ozone molecule is comprised of three Oxygen atoms. Ozone in the stratosphere absorbs most of the sun's ultraviolet radiation, reducing its ability to damage DNA by 97 to 99 percent.

Illustration by Funny Garbage © Smithsonian Institution

OBJECTIVES

Students will be able to:

- 1 Illustrate how they can lessen the effects of UV light on their own bodies and health.
- 2 Describe in writing the effect of UV light on living cells.

Background

Sunlight, like all light, consists of energy that moves in the form of waves in different sizes, or wavelengths. The light you can see is the visible spectrum. Invisible ultraviolet (UV) waves have shorter wavelengths and more energy than visible light.

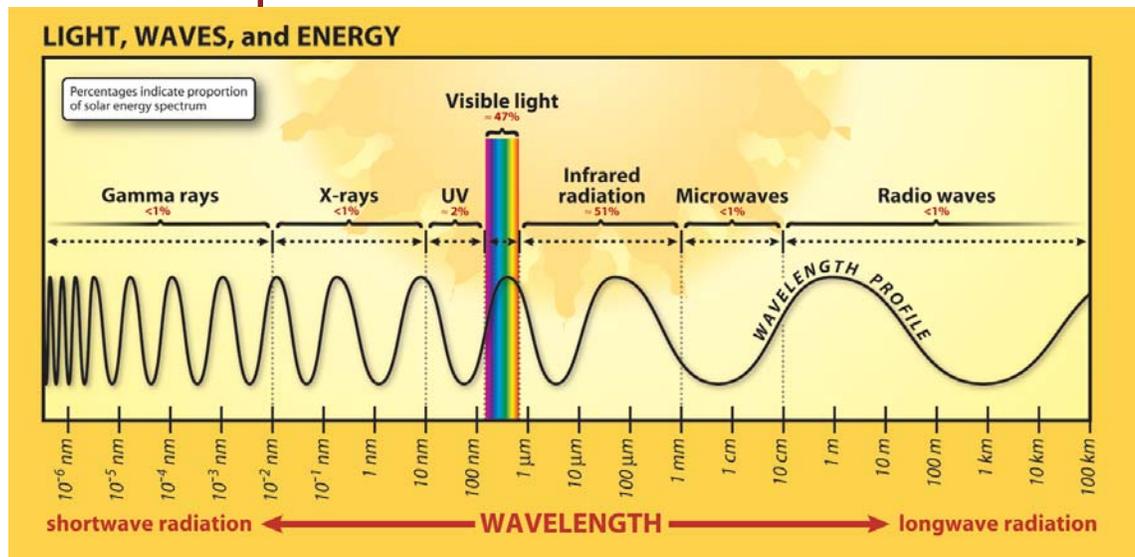
The ozone layer in the stratosphere, 14.5 to 50 km (9 to 31 mi) above Earth, absorbs most of the sun's ultraviolet radiation. But even the small amount of UV light that penetrates the ozone layer has enough energy to damage the DNA in cells in plants and animals. Although cells have a natural ability to repair some UV damage, there's a point where they lose the battle. Thinning of the atmosphere's protective ozone layer means that more UV light sneaks through.

ACTIVITY 6

Background (continued)

About 95 percent of the UV light that passes through the ozone layer gives you a suntan. It's called UVA. The other five percent, known as UVB, gives you a sunburn. Exposure to UVB in sunlight can alter the DNA in your body's skin cells and increase the risk that they will become cancerous years later. UVA causes skin to age and wrinkle and may affect the development of skin cancer, too. UV light can also cause cataracts to form over the lenses of the eye.

Although thinning of atmospheric ozone (the ozone hole) has stopped, it will take a long time for the hole to recover. With this experiment you will investigate what happens to living things when the protective ozone layer is diminished.



The sun's energy is concentrated around the visible spectrum. UVB radiation has shorter wavelengths than UVA and is strongest in the middle of the day, when the sun is high in the sky and your shadow is short.

Illustration by The M Factory © Smithsonian Institution

Activity

1. Collect initial data on your organism of choice by recording such characteristics as size, shape, color, mass, texture, etc. You could also count individual organisms or leaves, or make microscopic slides for observing and measuring respiration.
2. Determine the variables that will control your experiment. Some suggested variables include:
 - overall length of exposure
 - type of UV bulb used
 - length of time of the overall study
 - type of food and liquid supplied
3. Each student should write down a prediction of what will happen to the organism if it is exposed to UV light.

ACTIVITY 6

Activity (continued)

4. Use a safe source of UV radiation and expose the organism to UV light.
5. Remove from UV light and make a write-up of any/all changes you observe.
6. Put some sunscreen on a part of your organism. Re-expose the organism to UV light and write down any observed changes.
7. Compile all your notes and observations and create a formal lab report for this experiment.

In addition to a formal lab report, write responses to the following questions:

1. Based on your studies, could you hypothesize what might happen to human cells under the same condition?
2. What concerns about UV light and the ozone layer do you have after completing this investigation?
3. Evaluate your lifestyle. Can you do anything to change what is happening in the atmosphere or do you feel the dilemma of the ozone layer will not affect you? List how you could protect your body from the effects of UV light.
4. Find out more about how the ozone layer protects us from UV light. What reactions are going on when the UV light hits the ozone?

Extensions

- UV radiation can interfere with photosynthesis in plant leaves, causing lower crop yields. Discuss how reduced quantities of produce could affect the economy. Would this have an impact on the buying and eating habits of your family? If so, please describe or list how.
- UV radiation has been found to slow the growth of phytoplankton, the mainstay of the ocean food chain. How could this affect marine life? What might increased levels of UV radiation do to the human food chain?

References

http://www.epa.gov/ozone/science/sc_fact.html

http://www.nasa.gov/mission_pages/aura/main/index.html

Satellites have tracked ozone levels over Antarctica for the past 25 years. This image shows the depletion of the ozone level in October 2005.

TOMS photo courtesy of NASA/Modis Rapid Response Team

