The Science of Global Atmospheric Change

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Center for
Educational Outreach

Baylor College of Medicine

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The Science of Global Atmospheric Change

Complete instructions for conducting activities in this slide set, including materials needed, setup instructions, extensions, student sheets and answer more, can be found in *The Science of Global Atmospheric Change Teacher's Guide*, which is available free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/global-atmospheric-change/.

Introduction

This slide set is designed for use with *The Science of Global Atmospheric Change Teacher's Guide,* which contains lessons that enable students to explore what visible light is made of, characteristics of Earth's atmosphere, fossil fuels and the carbon cycle, combustion, food conversion to energy, skin protection, using heat from the sun, the greenhouse effect, and how climate affects how we live in different parts of the world. *The Science of Global Atmospheric Change Teacher's Guide* may be used alone or with the following integrated educational components.

- *Mr. Slaptail's Curious Contraption* (student storybook)
- *Explorations* (student magazine)

- *The Reading Link* (language arts supplement)
- *The Math Link* (mathematics activities supplement)

Activities are organized into the following science areas.

- Physical Science (visible light, spectrum, electromagnetic radiation, combustion, fossil fuels, carbon cycle, atmosphere, nitrogen, oxygen, carbon dioxide)
- Life Science (respiration, UV light, protecting skin, skin cancer, food as fuel)
- Environmental Science and Health (using energy, global warming, climate change, solar energy, greenhouse gas, greenhouse effect)

Reference

Moreno, N., Tharp, B., and Dresden, J. (2011) *The Science of Global Atmospheric Change Teacher's Guide*. Baylor College of Medicine: Houston. ISBN: 978-1-888997-75-0.

Image Reference

Key Words

lesson, life science, physical science, environment, atmosphere, climate, weather, global change, greenhouse gas, ozone, sun, Earth, ecology, energy, environment, pollution, visible light, radiation, fossil fuel, fuel, carbon cycle, CO2, geology, combustion, temperature, carbon monoxide, skin, skin damage, UV light, spectrum, sunscreen, solar energy,

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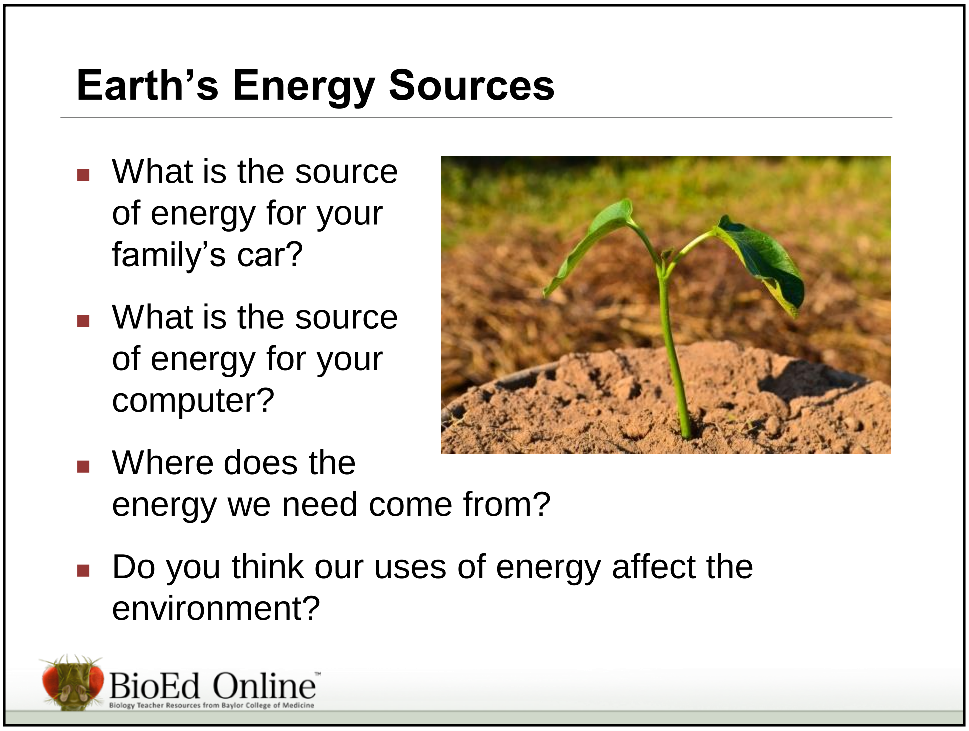

Earth's Energy Sources (pre-assessment)

Complete instructions for conducting activities in this slide set, including materials needed, setup instructions, extensions, student sheets and answer more, can be found in *The Science of Global Atmospheric Change Teacher's Guide*, which is available free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/global-atmospheric-change/.

Background
Global warming, ozone depletion, skin cancer risk . . . all of these themes appear frequently in the news. Yet, there are many misconceptions about them. This unit allows students to explore the science behind energy use and changes in the atmosphere. At the same time, students learn basic physical and earth/space science concepts related to light and electromagnetic radiation, the atmosphere, fossil fuels and combustion.

Students also learn about the carbon cycle, the role of carbon dioxide in living systems and the important role of skin in protecting living organisms.

Finally, students have opportunities to integrate their knowledge through explorations about the greenhouse effect, climate and alternative energy sources.

Overviews of the science content covered in each section of this guide can be found in the one-page Physical Science, Life Science, and Environment and Health Basics overviews. The introduction to each activity also provides a summary of science concepts covered.

This pre-assessment is designed to allow you, the teacher, to estimate students' existing knowledge about these topics before beginning the unit. It also can be used for self-assessment by students once the unit is completed.

Note

Global atmospheric change affects ecosystems, water, energy, transportation, agriculture and human health. The impacts differ from region to region and will grow under projected climate change. (Source: U.S. Global Change Research Program.)

Procedure

1.Initiate a class discussion about sources of energy and energy use. Ask questions such as, *What is the source of energy for your family's car? What about for your computer? Where does the energy we need come from?* To build awareness, have students make a class list of the many different ways in which they rely on energy each day.

2.Follow by asking, *Do you think our uses of energy affect the environment?* Tell students that they will find answers to these and other questions over the next few weeks.

3.Give each student a copy of the pre-assessment. Have students complete the pre-assessments individually. Tell students that they will not be graded. Rather, they will use the pre-assessments to gauge how much they have learned over the course of the unit.

4.Collect completed pre-assessments and save them. Students will refer back to their answers at the conclusion of the unit.

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Energy and the Atmosphere

- The sun is the source of Earth's energy.
- We feel part of this energy as heat and see another part as light.

- Radiation from the sun traveling to Earth passes through a thin layer of gases called the atmosphere.
- Green plants and algae absorb energy from the sun.

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Energy and the Atmosphere – Physical Science Basics

The sun is the source of Earth's energy. Every second, approximately five million tons of matter within this relatively small star are converted into energy, which is sent outward into space. We feel part of this energy as heat and see another part as light. Heat and light that we can detect, however, represent only a small portion of the radiation emitted by the sun.

Radiation travels in waves, similar in some ways to waves on the surface of a lake. The distance between the peaks, or crests, of two successive waves is known as the wavelength. The longest wavelengths— between 1 and 1,000 meters—correspond to television and radio signals. The shortest wavelengths, those of cosmic rays, are only 0.000,000,000,000,01 meters long!

Radiation traveling toward Earth passes through a thin layer of gases called the atmosphere. Without this protective layer, life on Earth would be impossible. Earth's atmosphere consists primarily of nitrogen and oxygen, along with other argon, carbon dioxide and water vapor. The atmosphere keeps the planet warmer than it would be otherwise; provides oxygen, moisture and carbon dioxide; and prevents most harmful radiation from reaching the surface.

Green plants and algae (related plant-like organisms that usually grow in water) are able to absorb energy from the sun and use it to combine carbon dioxide (CO_2) from the atmosphere with water to make energy-rich molecules, such as sugars and carbohydrates. Green plants and their products form the base of almost all food webs on Earth. They also are the source of our most common fuels.

Fuels such as wood, coal, oil and natural gas all are composed of matter originally produced by plants and other organisms. Each holds energy, originally trapped during photosynthesis, in the chemical bonds of carbon-containing molecules. When these substances are burned, they release heat energy that can be used for many purposes.

Our use of fossil fuels has grown dramatically since the 1800s. During the Industrial Revolution, coal was used to power steam engines in mines, factories, locomotives and ships. Later, it was used to generate electrical power. The discovery of large deposits of petroleum led to widespread use of fuels for transportation, heating and production of electricity. When fossil fuels are burned, carbon-containing molecules combine rapidly with oxygen. This chemical reaction releases energy in the form of heat. It also releases CO_2 into the air. Many other chemical substances also are produced by the burning or incomplete burning of fossil fuels.

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Rainbow in the Room

- What is visible light composed of?
- Do you think the colors are the same in every rainbow?
- How might we see the components of light energy?

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Rainbow in the Room – Physical Science

Complete instructions for conducting activities in this slide set, including materials needed, setup instructions, extensions, student sheets and answer more, can be found in *The Science of Global Atmospheric Change Teacher's Guide*, which is available free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/global-atmospheric-change/.

Background

Light that we can see is just part of the entire spectrum of radiation produced by the sun (electromagnetic radiation). The sun bombards Earth with radiation of many different wavelengths at the same time. Some radiation emitted by the sun can be classified as infrared (which we feel as heat) or visible (which we see as light and color). However, the sun also produces higher energy radiation, such as ultraviolet (or UV) radiation, x-rays, and gamma rays.

Radiation from the sun, including light, behaves as if it travels in waves. The distance between wave crests (wavelength) and the speed with which they pass a fixed point (frequency) are related to the amount of energy contained in photons (basic units of light) that make up the wave. Radiation of shorter wavelengths (which travel at higher frequencies) has more energy than radiation of longer wavelengths. Visible light falls between the longer wavelengths of infrared radiation and shorter, higher energy wavelengths of ultraviolet radiation.

Visible light consists of a mix of wavelengths that we detect as different colors. We can see these colors when white light (light as we usually see it) passes through a prism—or drops of water—and forms a rainbow.

The colors of the rainbow always appear in the same order, because they correspond to different wavelengths of light. You may have learned the acronym, "ROY G. BIV," to help you remember the colors of the rainbow from longest to shortest wavelengths: red, orange, yellow, green, blue, indigo and violet.

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Image Reference

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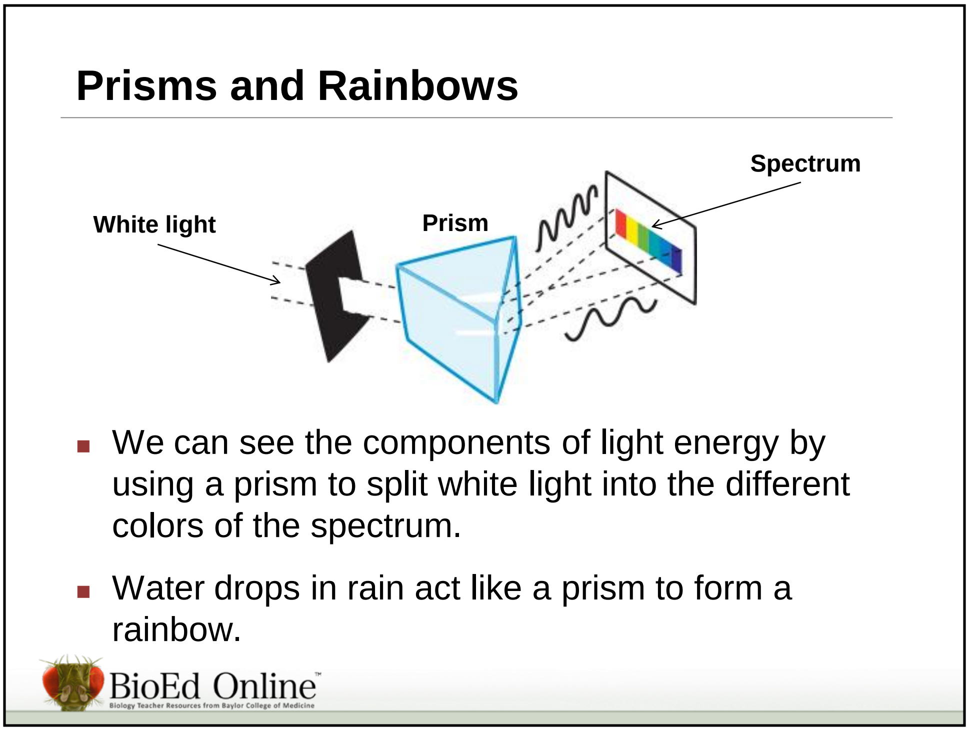

Prisms and Rainbows

•More than 300 years ago, Sir Isaac Newton, a famous physicist, demonstrated how a prism splits white light into a continuous spectrum.

•The energy waves corresponding to different colors of light travel at different frequencies, so they are dispersed differently by the second material.

Procedure

1.Fill a clear, liter-sized glass or plastic container with water and place it on the lighted “stage” of an overhead projector.

2.Darken the classroom as much as possible. You and your students will be able to observe a circular rainbow projected around the classroom.

3.Allow a few moments for students to observe the rainbow. Ask, *Have you ever seen anything like this before?* Students will provide a variety of responses. Follow by asking, *Do you think the colors are the same in every rainbow?*

4. After students have shared or written their predictions, place another, smaller cup or glass filled with water on the overhead. Have students observe and compare the sequence of colors in the rainbow produced by the second cup.

5.Repeat with a second cup or glass of water. Repeat the question*, Do you think think the colors are the same in every rainbow?* Make sure students are able to observe that the sequence of colors always follows the same pattern. With older students, explain that the colors of light represent energy of different wavelengths.

6.Have students identify the source of light for the rainbow (white light from the overhead projector). Then, help them understand that the light is being separated into its constituent colors as it passes through the water in the container.

7.Let each student make his or her own “rainbow” drawing that incorporates the sequence of colors observed in the classroom rainbow. Display the rainbow drawings.

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Image Reference

Illustration © Baylor College of Medicine\M.S. Young

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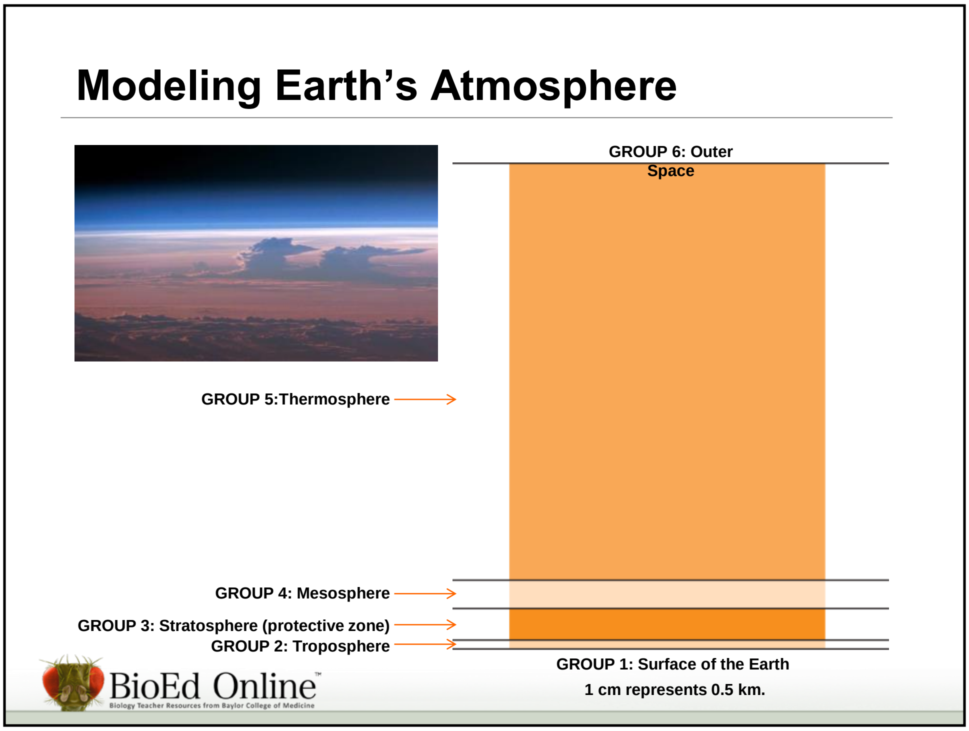

Modeling Earth's Atmosphere – Physical Science

Complete instructions for conducting activities in this slide set, including materials needed, setup instructions, extensions, student sheets and answer more, can be found in *The Science of Global Atmospheric Change Teacher's Guide*, which is available free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/global-atmospheric-change/.

Background

The air surrounding Earth is known as the atmosphere. Gas molecules in the atmosphere are held relatively close to Earth's surface by gravity. The atmosphere is mostly nitrogen (78%) and oxygen (20%). The amount of water vapor in the atmosphere varies, but can be as much as 5% by volume. Other gases, present in much smaller amounts, also are extremely important parts of the atmosphere. Carbon dioxide (CO_2), methane (CH_4) and other gases, including water vapor, help radiate heat back toward Earth's surface, thus keeping it much warmer than it would be otherwise. Ozone, which is present in tiny amounts in part of the atmosphere, filters out most of the harmful ultraviolet radiation from the sun.

Life on Earth would not be possible without the atmosphere, which protects the planet's surface from extremes of temperature and harmful radiation, and also provides essential water, carbon dioxide, oxygen and nitrogen. This activity helps students learn about Earth's atmosphere by creating a scale model.

Notes

In the atmosphere model created by students, 1 cm represents 0.5 km. Based on these proportions, the diameter of the Earth would have to be drawn as approximately 25,000 cm. The sun would be positioned 300,000,000 cm away!

Ozone, a highly reactive gas molecule made of three oxygen atoms, is found naturally in the stratosphere. Even though it is present only in tiny amounts, ozone is vital to the planet. It absorbs most of the harmful ultraviolet radiation emitted by the sun and prevents it from reaching Earth's surface. Near the ground, ozone often is produced as a byproduct of burning fossil fuels. Unfortunately, in this instance, ozone is very harmful. It can damage lungs and is harmful to other living things, such as plants.

Procedure

1.Ask students if they ever have seen pictures of astronauts in space. Ask, *Why do the astronauts wear special suits?* Mention that the space suits keep astronauts warm, provide them with air to breathe and protect them from harmful rays from the sun. Follow by asking if we need to wear space suits on Earth. Help students recognize that the thin layer of gases surrounding Earth—the atmosphere—provides protection for all of the planet, as space suits protect the astronauts.

2.Mention that, as a class, the students will create a scale model of Earth's protective layer of gases. Lay a sheet of brown or white paper (at least 2.5 m long) on the floor where students can work on it. Discuss the scale of the model with students (1 cm = 1/2 km; 2 cm = 1 km).

3.Distribute the Job cards to student groups. Each group will create and decorate a different part of the atmosphere model. Older students should measure and draw their own lines on the model. To facilitate work in groups, you may want students to cut off their sections of the model to complete in separate locations. (Groups 1 and 2 work on the same section.) Once completed, the sections can be taped together.

Group 1–Planet Earth. Draws a vertical line about 15 cm from the bottom of the sheet of paper (this line represents the Earth's surface); creates figures (mountains, forests, cities, etc.), using construction paper or other materials and adds them to the model. Remind students that the figures they create should be no more than 5 cm tall.

Group 2–First layer of the atmosphere (troposphere). Draws a line about 22 cm from the line designating Earth's surface (represents the upper limit of the first layer); adds figures of weather phenomena (clouds, rain, lightning, etc.), as well as low-flying aircraft and hot air balloons. Point out to students that much of the pollution produced by burning wood and fossil fuels remains in the troposphere. The gases responsible for keeping Earth warm (greenhouse gases) are found in this layer. Temperatures within the troposphere decrease with altitude.

Group 3–Second layer of the atmosphere (stratosphere). Draws a line about 100 cm from the line for the Earth's surface (represents the upper limit of the second layer); adds figures of storm clouds, jet aircraft, wind, and a representation of the protection provided by ozone molecules in this layer. The stratosphere is warmer due to absorption of UV light by ozone.

Group 4–Third layer of the atmosphere (mesosphere). Draws a line about 170 cm from the line for the Earth's surface (represents the upper limit of the third layer); adds figures of feathery ice clouds and weather balloons. The mesosphere is very cold.

Group 5–Fourth layer of the atmosphere (thermosphere). Adds figures of spacecraft, satellites and meteors (shooting stars) to the model. If students were to draw a line, the upper limit of the thermosphere would be 1,200 cm (12 m) from the baseline of the model. This group may use the remainder of the space on the sheet.

This layer is very hot in some parts—up to 1,700° C or more—due to absorption of radiation by different atoms and molecules.

Group 6–Outer Space. Creates figures representing other components of the solar system and universe, and places them around the room. The exosphere contains very small amounts of hydrogen and helium, and continues until it merges with space.

3. Have each group label its layer on the model. Display the model somewhere in the classroom. Encourage students to note that most activities involving the atmosphere occur very close to Earth's surface. Leave the model available for students to refer to throughout the unit.

Reference

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Image Reference

Photo courtesy of NASA.

Key Words

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Fossil Fuels and the Carbon Cycle

- We burn fossil fuels for energy.
- Fossil fuels are found within Earth's crust.
- The presence of certain layers of soil and rock helps predict the presence of oil, coal and natural gas. Geologists drill deep into the Earth to look for fossil fuels.
- Earth has a limited amount of fossil fuels.

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Fossil Fuels and the Carbon Cycle – Physical Science

Complete instructions for conducting activities in this slide set, including materials needed, setup instructions (recipe for making GeoMuffins), extensions, student sheets and answer more, can be found in *The Science of Global Atmospheric Change Teacher's Guide*, which is available free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/global-atmospheric-change/.

Background

In the United States, more than 75% of the energy used in homes and businesses, and for transportation comes from coal, oil or natural gas. These fuels are known as "fossil" fuels because they are the remnants of ancient plants and other living things buried under intense heat and pressure over millions of years. They are very efficient sources of energy. However, it is important to keep in mind that the energy in fossil fuels originally came from the sun and was trapped by plants and similar organisms during photosynthesis. During this process, plants also consumed carbon dioxide (CO_2) from the atmosphere. So when fossil fuels are burned, trapped carbon is released back into the atmosphere, principally as CO_2.

Petroleum, or crude oil, is a thick, gooey liquid that can be found within Earth's crust on land or beneath the sea floor. It was formed principally from tiny marine organisms that were buried in layers of sediment, such as sand. In addition to containing high-energy carbon compounds, petroleum contains varying amounts of substances such as oxygen, sulfur and nitrogen. Crude oil must be heated and distilled to separate it into gasoline, heating oil, diesel oil, asphalt and other materials. Some components of crude oil are used to manufacture industrial chemicals, fertilizers, pesticides, plastics, medicines and other products.

Natural gas is a mixture of methane (CH_4) and smaller amounts of related gases. It often is found above deposits of crude oil. Natural gas burns hotter and produces less air pollution than any other fossil fuel. When burned, it also releases less CO_2, relative to the amount of energy produced.

Coal is a solid that is formed in several stages. It is a mixture of many different substances, with varying amounts of water, nitrogen and sulphur. Coal is formed from peat—a moist soil substance made of partially decayed plant material. When peat is subjected to intense heat and pressure, it becomes lignite—a brown coal. Lignite will become bituminous coal if it is placed under more heat and pressure. Bituminous coal often is used as fuel because it produces high levels of heat and is abundant. The most desirable form of coal is anthracite, a hard mineral that results from the transformation of bituminous coal under more conditions of very high heat and pressure. Anthracite is a very attractive fuel because it burns cleanly and produces great quantities of heat.

When geologists look for fossil fuels, they often drill deep into Earth. They remove narrow cores of rock and sediments and examine them for clues about the presence of oil and other fuels. This activity lets students explore the layers in a muffin representing Earth's crust, using a straw to drill "cores."

Note

One kind of fossil fuel, coal, can be found between layers of earth and rocks. The coal seam shown above (darkest layer) is in cliffs that are approximately 335 million years old. Earth has a finite amount of fossil fuels.

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Image Reference

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GeoMuffin Observations

1. Look at your GeoMuffin. Do not peel or eat it. Write a sentence to describe your GeoMuffin.
2. What do you think the GeoMuffin would look like if you cut it in half? Draw a cross section based on what you can observe.
3. Draw a top view of your GeoMuffin. Mark North on your muffin with a toothpick. Starting just right of your North marker, make your first core sample. Push the core out of the straw. Draw the core and color the layers. Mark it Sample Number 1.

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GeoMuffin Observations

GEOMUFFIN LEGEND

•RED = Oil

•GREEN = Predicting layer for oil

•YELLOW = Soil or rock layer

•BROWN = Soil or rock layer

Questions for Students to Think About

•*How many different uses of fossil fuels are there?*

•*What will happen when we use up the supplies of fossil fuel? Do you think that we can get any more? Why or why not? Are there any good substitutes for fossil fuels?*

•*How much oil and natural gas still are left on Earth?*

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Image note

Coal seam in a cliff that is approximately 335 million years old.

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GeoMuffin Observations *(continued)*

4. Make at least 5 more samples. Draw each core in order on your sheet.
5. Now, use the information from your core samples to draw what you predict a side view of your GeoMuffin would look like if you cut it in half. Then cut the muffin half and draw what you see. Compare your two drawings.
6. Do you think there is any "oil" in your GeoMuffin? Is there a pattern in the layers that predicts where oil will be?

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GeoMuffin Observations *(continued)*

GEOMUFFIN LEGEND

- •RED = Oil
- •GREEN = Predicting layer for oil
- •YELLOW = Soil or rock layer
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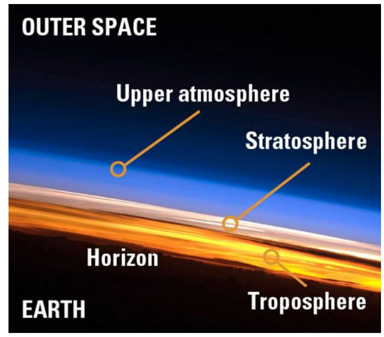
Solar Energy and Living Things

- Life on Earth depends on energy from the sun.
- Ozone in the stratosphere absorbs UV radiation.
- When ozone is destroyed, more UV radiation gets through the atmosphere to strike Earth.



- Large amounts of UV radiation can cause harm to humans other living things.

Solar Energy and Living Things – Life Science Basics

Life on Earth depends directly or indirectly on energy from the sun. Solar energy, which reaches us as heat, light and other types of electromagnetic radiation (such as ultraviolet, or UV, radiation), also can be harmful to living things.

Most of the energy we use each day comes in some way from materials photosynthesized by plants and other producers, such as algae. During photosynthesis, energy from the sun is trapped to build molecules necessary for life. The oil, natural gas and coal that have been essential for the development of our modern industrial world all are made up of the remains of dead organisms that relied on photosynthesis. Similarly, all of our food, which provides energy for our bodies, ultimately comes from plants and other producers— whether we eat plants directly or eat other organisms that consume plants.

The pathway of energy through Earth's living and non-living systems closely parallels the routes followed by carbon in the carbon cycle. This simple element (the fourth most abundant element in the universe) forms the backbones of the molecules produced and used by all living things—from DNA to fossil fuels. Plants and similar organisms create food molecules from carbon dioxide (CO_2), water and energy from the sun. They use this energy to drive all other processes necessary for life. When carbon-containing substances (wood, oil, natural gas or coal, for example) are burned, CO_2 is released back into the atmosphere. Similarly, when living cells use the chemical energy stored in food, CO_2 is released. This process is known as respiration.

Shorter wavelengths of solar radiation (such as UV radiation) can damage cells. This is important because more UV radiation is reaching Earth's surface as a result of ozone depletion in the stratosphere. Stratospheric ozone, which absorbs UV radiation, is destroyed by certain chemicals, particularly those known as chlorofluorocarbons (CFCs). Exposure to UV radiation can increase a person's chances of getting skin cancer or of developing cataracts. Other organisms, from frogs to marine algae, also can be harmed by UV radiation.

It is particularly important to protect skin from the sun. Less than one millimeter in thickness, skin plays an essential role in the body. It protects inner tissues and provides communication (through the sensory system) with the outside environment. The skin also aids in maintaining a constant temperature within the body. The numerous blood vessels in the skin and sweat glands help cool the body when outside temperatures are warm.

The skin is composed of layers, each with different characteristics. The layers of skin act like thin boards pressed together in a sheet of plywood, giving skin greater strength than it would have otherwise.

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Photo courtesy of NASA.

Key Words

lesson, life science, physical science, environment, atmosphere, climate, weather, global change, greenhouse gas, ozone, sun, Earth, ecology, energy, environment,

pollution, visible light, radiation, fossil fuel, fuel, carbon cycle, CO2, geology, combustion, temperature, carbon monoxide, skin, skin damage, UV light, spectrum, sunscreen, solar energy,

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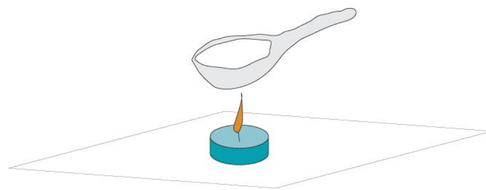
Finding the Carbon in Sugar



1. Mold the foil into a spoon with a long handle.
2. Put the sugar into the bowl of the spoon. What do you think will happen to the sugar if you heat it for a long time over a candle flame?
3. Hold the spoon by the handle and heat the sugar over a candle. For safety, place the candle on a wet paper towel, and follow your teacher's instructions.

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Finding the Carbon in Sugar – Life Science

Complete instructions for conducting activities in this slide set, including materials needed, setup instructions, extensions, student sheets and answer more, can be found in *The Science of Global Atmospheric Change Teacher's Guide*, which is available free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/global-atmospheric-change/.

Background

Most of the fuels we use come from dead plant or animal matter. The origin of fuel wood, of course, is obvious. However, all fossil fuels also are derived from decomposed organisms that have been buried at high temperatures and pressures for millions of years. The energy in these fuels was captured from the sun during photosynthesis by plants, some bacteria and algae.

When something burns, it combines rapidly with oxygen in a reaction that releases energy. Most of this energy is given off in the forms of light and heat. Other things are given off at the same time. Carbon dioxide, once trapped by green plants during photosynthesis, is formed again and released. Water, also essential for photosynthesis, is released as well. In addition, most fuels produce substances such as smoke and soot, and other gases like methane and carbon monoxide, when they are burned. Some fuels, such as natural gas, burn much more cleanly than others, such as coal. However, all fossil fuels release carbon back into the atmosphere during combustion.

Notes

All living things are made out of molecules containing carbon. Plants take in carbon as carbon dioxide from the air. During photosynthesis, plants make energy-rich molecules, such as sugars, that have carbon as a backbone. Plants and all other organisms use these simple molecules to provide energy and raw materials to manufacture other substances necessary for life. We can see the evidence of the carbon in sugar as a black residue that appears when the sugar begins to burn.

The formula for table sugar (sucrose) is: $C_{12}H2_{2}O_{11}$.

Procedure

Session 1: What happens when something burns?

1.Have the following materials ready: large beaker or tempered glass bowl, candle, matches and several wet paper towels folded together to make a mat larger than the opening of the beaker or bowl.

2.Direct students' attention to the materials you have gathered. Light the candle and ask, *What is happening to the candle?* After students answer that it is burning, ask, *What do you think it means to burn something? Are we seeing a physical change in the candle or a chemical change?* Remind students that a chemical change produces substances different from the ones that originally were present. Chemical changes usually give off or take in energy.

3.Ask students to predict what might happen if the candle is covered with the beaker. After students respond, place the lighted candle on the wet towels and cover it with the container. Fold the edges of the towels around the lip of the container to create a seal.

4.Have students observe what happens to the candle. The flame will become smaller until it finally extinguishes (this usually takes less than a minute). Ask, *What happened to the candle? Did it run out of material to burn? Do you think it ran out of something else?* Help students understand that the candle used as much oxygen gas (one of the gases in air) as was possible.

5.Lift the container slowly and have students observe the other substances present: smoke and condensed water vapor on the sides of the container. Let them examine the candlewick. Ask, Wh*at can we see or feel that was produced by the burning candle?* (heat, water, smoke, charred wick). *What was used by the burning candle?* (melted wax and the wick as fuel, oxygen gas from air).

Session 2: Sugar as fuel

1.Have each Materials Manager collect a candle, a square of aluminum foil, a wet paper towel and one or more copies of the student sheet. Students should clear all papers and place their candles on the wet toweling in the center of their work areas.

2.Let students create a "testing spoon" by forming the foil into a spoon-like shape with a long handle. The bowl of the spoon should be made of only one layer of foil.

3.When students have completed their spoons, have one person from each group measure about 1/2 teaspoon of sugar into the spoon.

4.Have the students in each group predict what will happen when they heat the sugar over a lighted candle. They should record their predictions on their student sheets.

5.Light the candles (which should be placed on the wet paper towels) for each group. Direct each principal investigator to hold the bowl of the "spoon" over the candle flame. Other group members should observe and record what happens to the sugar. (It will become liquid and turn amber-colored. This is caramel, similar to the topping used for desserts like flan and custard. Finally, the sugar will burn and become blackened.)

6.Ask, *What happened to the sugar?* Help students recognize that the sugar underwent a physical change (solid to liquid) and a chemical change (burning of liquid sugar). Also ask, *Where did the carbon in the sugar come from*? Lead students to understand that the carbon was taken from air as carbon dioxide during photosynthesis. Have students examine the bottom of the spoon. Ask, *Where did that carbon come from?*

Reference

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Image Reference

Illustration © Baylor College of Medicine\M.S. Young.

Key Words

lesson, life science, physical science, environment, atmosphere, climate, weather, global change, greenhouse gas, ozone, sun, Earth, ecology, energy, environment, pollution, visible light, radiation, fossil fuel, fuel, carbon cycle, CO2, geology, combustion, temperature, carbon monoxide, skin, skin damage, UV light, spectrum, sunscreen, solar energy,

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Fuel for Living Things

- All organisms need a source of energy.
- Plants and some other organisms (producers) take in energy from the sun.
- All other living things rely on producers for energy and raw materials.
- Carbon dioxide usually is given off when living things use food.

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Fuel for Living Things – Life Science

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Background

Some living things, especially plants and algae, are able to build all the materials they need from very simple substances. Using energy from light, carbon dioxide and water, these organisms, known collectively as producers, are able to make carbohydrates, which serve as fuel and raw material for the processes of life. All other organisms (consumers) rely on producers for food. Food provides energy and needed raw materials.

When organisms consume food, it is broken down to release energy and to obtain building blocks for other molecules. During this process, oxygen is consumed and some carbon is given off as carbon dioxide. This can be compared to the burning of fuels, which also uses oxygen and releases carbon dioxide. When something burns, most of the energy released is given off as heat. Inside living things, some of the energy is used to maintain the body and conduct reactions necessary for life.

All organisms (with a few exceptions) release carbon dioxide when they use food. In mammals, the released carbon dioxide is carried through the bloodstream to the lungs, where it is given off when we breathe out (exhale).

In this activity, students observe how carbon dioxide gas is given off by yeast cells, when the cells use sugar as food. Red cabbage "juice" will serve as an indicator for the presence of carbon dioxide. Cabbage "juice" turns bright pink in the presence of acids, such as the carbonic acid produced by dissolved carbon dioxide in water.

Notes

- When sugar is used for energy inside living things, CO2 is released. This is comparable to what happens when fuels are burned for energy.
- Students can observe how they exhale CO2 by blowing vigorously with a straw into the cup of indicator solution for 5–10 minutes.

Procedure

Session 1: Making the indicator (can be done in advance)

1. Have Materials Managers collect the materials for their groups.
2. Have students place the sliced red cabbage in the plastic bags, along with 1/2–1 cup warm water, and seal the bags tightly. Direct students to take turns gently rubbing the cabbage inside the bags until the water becomes dark purple (usually about 10–15 minutes). This is the indicator solution.

Session 2: Demonstration of cabbage juice indicator

1. Tell students that they will be using an indicator to look for the presence of an acid. If students are not familiar with things that are acidic, list some common examples, such as lemon juice and vinegar. Explain that the indicator will be used to test for the presence of carbon dioxide (CO_2), which becomes a weak acid in water.
2. Pour some indicator liquid into a clear cup. Ask, *What color is the liquid? What do you think will happen if I put something acidic into the water?* Add a few drops of vinegar to the solution until it turns pink. You also may show how the indicator solution reacts to bases by adding about 1/2 teaspoon (or more) of baking soda (the

solution will turn pale blue or green).

3. Explain to students that they will be using the indicator to test for the presence of carbon dioxide (CO_2), a gas that is given off when living things use food for energy.

Session 3: Conducting the investigation

1.Talk about yeast with students. Ask, *Did you know that yeast is a living thing?* Explain that yeast is a living, microscopic single-celled organism. Under the right conditions, yeast begins to grow and multiply.

2.Direct the students to label two cups as “no food” and “food.” Have them add about 1/2 cup of warm water and 1/2 teaspoon of yeast to each cup. Ask, *Do you think the yeast cells have very much to eat in the cup now?* Help students understand that all living things need food to survive and grow. Ask, *What do you think will happen if we add yeast food to one of the cups?* Have students record their predictions.

3.Have one person in each group add one teaspoon of sugar to one cup. He or she should swirl or stir the contents of the cup gently.

4.Direct the groups to set the cups side-by-side and to observe both cups at 5–10 minute intervals. The yeast in the cup with sugar will begin to produce CO_2 (making the liquid foamy) after a short period of time. Students should stir the cups (with separate stirrers) each time they make their observations.

5.After 30–45 minutes, instruct students to pour small, equal amounts of cabbage “juice” into both cups and to stir the mixture. Ask them to observe the colors. Have students record their observations. (The cup with sugar will be pinker in color than the other cup.)

6.Ask, *What happened when you fed the yeast?* Point out that the gas given off by the yeast is the same as that given off when wood, coal or oil is burned. Help students understand that the yeast cells were using the sugar as a source of energy.

7.Assess student understanding by having the members of each group write a paragraph describing its investigation and results.

Reference

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Image Reference

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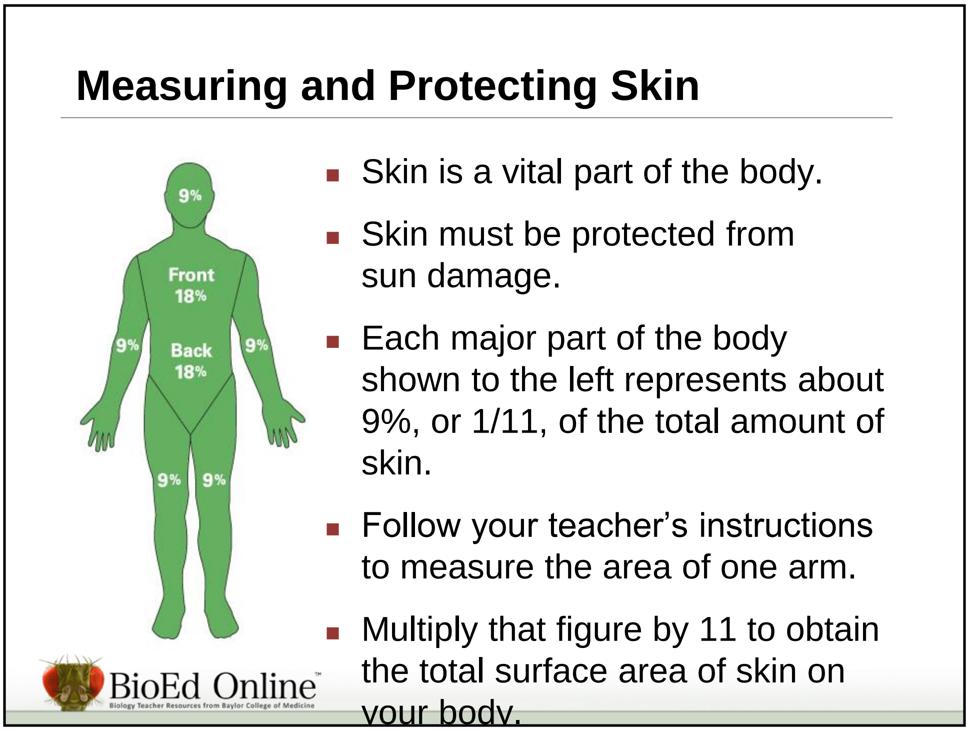

Measuring and Protecting Skin – Life Science

Complete instructions for conducting activities in this slide set, including materials needed, setup instructions, extensions, student sheets and answer more, can be found in *The Science of Global Atmospheric Change Teacher's Guide*, which is available free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/global-atmospheric-change/.

Background

Skin protects inner tissues of the body and provides communication (through the sensory system) with the outside world. The skin also helps maintain a constant temperature within the body by aiding in cooling (through increased blood flow to the surface and perspiration) and heating (by reducing blood flow near the surface).

The skin is comprised of different layers. The outermost layer, the epidermis, consists of an inner layer of living cells and a top layer of compacted dead cells. In fact, most skin that is visible on our bodies actually consists of dead cells! Skin color is determined by special cells, called melanocytes, located near the base of the epidermis. The lower layer, the dermis, is fibrous and gives strength to skin. Most nerve receptors that capture information from the outside world are located at the top of the dermis or the base of the epidermis.

Skin can be damaged by ultraviolet (UV) radiation from the sun or tanning lights, which can cause premature wrinkling and loss of elasticity of the skin, as well as skin cancer. Sunburns and suntans both are evidence that skin has been exposed to too much harmful radiation. Due to ozone depletion in the upper atmosphere, more UV radiation is reaching Earth's surface. This has increased the risks for damage to skin and eyes (particularly through the development of cataracts).

This activity builds awareness of skin by having students contrast and compare the "skin" of an orange to human skin. Students also will compare the surface area of an orange to the area of a person's skin.

Notes

Skin is especially vulnerable to the effects of ozone depletion in the upper atmosphere. Ultraviolet radiation produced by the sun can damage skin, causing premature wrinkling and loss of elasticity, as well as skin cancer. As increased amounts of UV radiation reach the surface of the planet, the risks for skin damage also increase. Sunburns and suntans both are evidence that skin has been exposed to too much damaging radiation.

Reductions in the amount of ozone in the stratosphere are allowing more ultraviolet radiation (UV) from the sun to reach Earth's surface. The effects of some kinds of UV exposure are cumulative and may not show up for many years. In humans, increased exposure to UV radiation (especially UV-B, with wavelengths between 290–320 nanometers) is linked to skin cancer, the development of cataracts and effects on the immune system. UV-B radiation also is toxic to plants, including crop plants, and phytoplankton, which forms the basis of marine food chains.

Procedure

Session 1: Estimating surface area of an orange

1.Generate student interest by brainstorming about things that have a skin. List student ideas on the board. Older students may record the list in their science notebooks.

2.Discuss the purposes of skin (tree bark, skin on a banana, lizard skin, bird skin, etc.) based on the list of things with skins.

3. Holding an orange, explain to students that they will be examining the skin of an orange and comparing it with their own skin. Ask, *How is the skin of an orange like your skin? How is it different?*

4.Have Materials Managers collect materials for the groups. Each group will need: an orange, paper towels, plastic knife, tape measure, sheet of writing or notebook paper, and two or more sheets of centimeter square graph paper.

5.Begin the group activity by having one student (Recorder) list the group's observations about the skin of the orange. Then place a check next to all observations that also would apply to human skin.

6.Next, ask, *How much skin does an orange have? How could we find out?* Instruct students to estimate the amount of skin on their oranges by coloring a similar area on their graph sheets. They may want to measure their oranges using tape measures. With older students, use this opportunity to investigate the relationships among diameter, circumference and area.

7.Ask, *How could you check your estimates?* Have students peel the oranges and, within each group, trace the peelings onto graph paper. Have them color the traced areas orange. Have students calculate the area that is colored by counting or measuring the number of squares filled in, and decide how much skin their oranges really have. Let students devise their own methods for counting partially colored squares, or instruct them to count every other partial square. Ask, *Are you surprised about the area covered by the skin? Why or why not?*

8.Next, have the students examine the peeled oranges. Discuss what might happen if oranges didn't have skin.

Session 2: Estimating the amount of skin on a person

1.Explain that, just like oranges, our bodies need protection. Mention some of the characteristics of skin: it is the body's largest organ; skin provides protection from germs; it houses our cooling and heating systems; skin contains receptors for our sense of touch, etc. Refer students to the diagram of skin on page 8 of the *Explorations* magazine.

2.Ask, *How much skin do you have and how do you protect it?* Students can record their estimates in cm^2 in their science notebooks and list ways they protect their skin.

3.Tell students that the area of skin on the body can be measured with relative accuracy by applying the Law of Nines. This rule of thumb was developed to help doctors estimate the amount of skin damaged on people with burns. Roughly, each of the 11 major sections of skin on the body accounts for 9% (or 1/11) of the total (see illustration, right). Using this rule, students can estimate the total surface area of skin on their bodies by measuring the area of one arm.

4. Working in teams of two, have one student wrap another's arm in wax paper. Have them mark any areas of overlap, so that they will not be counted for the estimate of surface area.

5.Have them spread the paper out over two or more sheets of centimeter graph paper and count the number of squares covered (or have older students measure the dimensions of the wax paper and calculate the area as if it were a rectangle, or a rectangle and one or more triangles, showing area calculations).

6.Once students have found the surface area of an arm, have them multiply that figure by 11 to obtain the total surface area of skin on the entire body.

7.Ask students to imagine how they might look and feel without their skin—just like the peeled orange. Mention the importance of protecting skin from damaging UV radiation. Discuss strategies for protecting skin, including wearing clothes with long sleeves, always applying sunscreen, wearing hats, etc.

Reference

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Image Reference

Illustration © Baylor College of Medicine\M.S. Young.

Key Words

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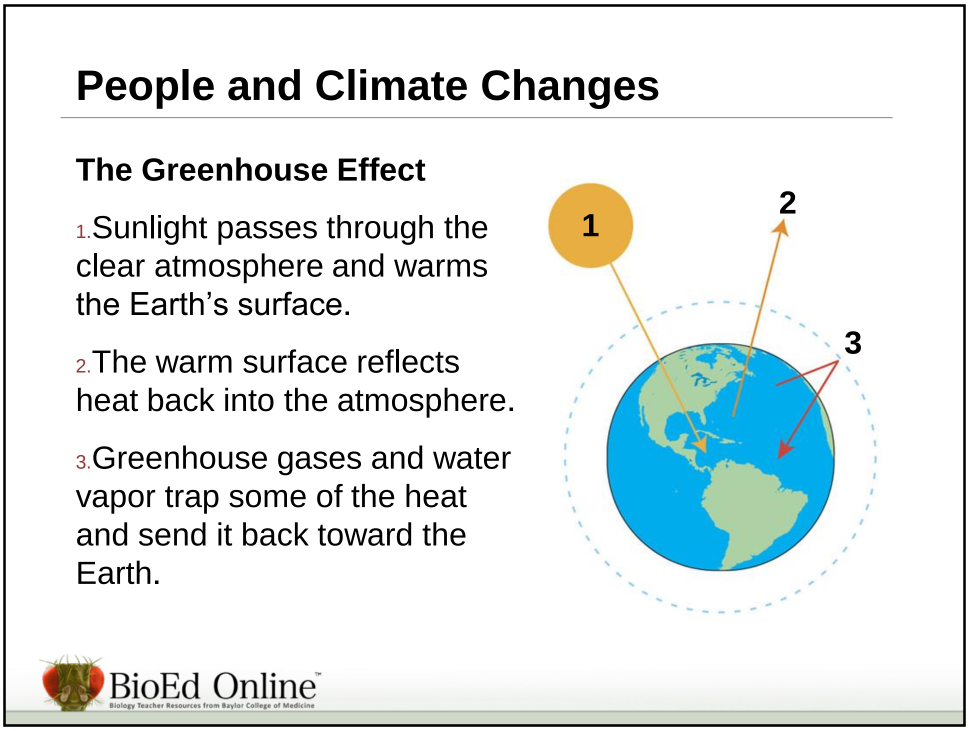

People and Climate Changes – Environment and Health Basics

Life on Earth has been possible because of the very special characteristics of our atmosphere. The planet is warm enough to support life, thanks to the presence of certain gases in the lower atmosphere. The atmosphere also absorbs almost all of the potentially damaging radiation produced by the sun before it reaches the surface. Our atmosphere contains elements necessary for life—nitrogen, carbon and oxygen—as well as abundant water vapor to maintain the water cycle.

Human actions, particularly during the last several decades, are changing the composition of Earth’s atmosphere. Since the industrial revolution, people have been removing stored carbon from Earth in the forms of coal, crude oil and natural gas, and burning it to make heat. In the process, water vapor, carbon dioxide and small amounts of other substances are produced. Other activities, such as clearing land (by burning) for agriculture, also have added CO_2 to the atmosphere. As a result, levels of carbon dioxide in the lower atmosphere have increased from around 260 parts per million (ppm) by weight to more than 350 ppm.

Carbon dioxide is one of the gases responsible for trapping heat near Earth’s surface and lower atmosphere. Many scientists believe that increases in the amounts of CO_2

and other greenhouse gases, such as methane (CH_4), will lead to warmer temperatures on Earth. Even minor increases in the surface temperature of the planet could have far-reaching effects. Major climactic patterns of winds, temperature and rainfall could change drastically. This would impact water resources, coastlines, agriculture, forests, energy production and patterns of disease.

Climate, the characteristics of weather in a particular region over long periods of time, determines which kinds of plant and animal life are present, which crops can be grown, how people construct their houses and, to a great extent, people's clothing and diet. The climate of any given region depends on its distance from the equator, altitude and rainfall patterns.

Even slight changes in the world's climate affect human health and well-being in countless ways.

Note

The release of chemicals known as CFCs (chlorofluorocarbons) is contributing to changes in the atmosphere that will affect climate and human health and well-being. Freon and other CFCs are greenhouse gases that increase the amount of heat trapped near the surface of Earth. In addition, chlorine molecules released by these chemicals in the stratosphere break apart the ozone molecules responsible for shielding Earth from ultraviolet radiation.

Over the last decade, the amount of ozone in the stratosphere has decreased (especially in the polar regions)—leading to greater risks of skin cancer for people and also damaging vital populations of plants, animals and marine life.

Reference

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Using Heat from the Sun

- Some of the energy given off by the sun can be felt as heat.
- Heat from the sun can be used as a source of energy.
- Wind power generates electricity. From where does the wind get its energy?

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Using Heat from the Sun – Environment and Health

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Background

We seldom think about the sun's importance to our planet. It is the ultimate source of almost all the energy we use. Besides the sun, the only other sources of energy on the planet are radioactive rocks and the molten core deep below Earth's surface. The sun keeps us warm. It is responsible for weather, which is caused by uneven heating of large masses of air. Our food and common fuel sources depend or depended on solar energy trapped by producers, such as plants.

This activity is designed to build student awareness of the importance of the sun as the ultimate source of almost all energy on Earth. It also provides insight into harnessing the sun's power directly as a source of energy, as Mr. Slaptail does with his solar water heater in the adventure story that accompanies this unit.

Note

Energy from the sun creates the air currents used to generate electricity from "wind power."

Procedure

1.Ask students, *How do we get hot water in our homes? Does the water come that way or do we have to heat it?* Lead students into a discussion about different energy sources, such as electricity or gas, that usually are used to heat water for houses.

2.Follow the discussion by asking, *What if we didn't have any electricity or fuel to burn? Are there other ways to heat water?* Guide students into a discussion of the sun's importance as a source of heat and other energy for Earth. Ask, *How could we find out if the sun provides energy to heat water?* Tell students they will be investigating this question.

3.Have each group of students label two identical cups—one as "light" and one as "dark." Next, have them measure 50 mL of water into each cup.

4.Direct students to measure the temperature of the water in each cup and to record the temperature on their student sheets. Have each group place the cup labeled "light" in direct sunlight (outside or inside the classroom). The other cup should be left inside the classroom, preferably in a dark area, away from any heating vents or radiators.

5.Have students predict the final temperature of the water in each cup and write their predictions in the appropriate spaces on the "Sunlight Observations" sheet.

6.If possible, have students wait at least one hour before checking the "light" cup. Have them measure the temperature of the water in the cup and record it on their sheet. Afterward, have them measure and record the temperature of the water in the "dark" cup.

7.Ask, What happened to the water in the cup that you placed in the sun? Did it become warmer or colder, or stay the same? What about the water in the cup you left inside? Help students understand that energy from the sun warmed the water in the "light" cup. Ask, *Where are other places that we can observe energy from the sun?*

Reference

Moreno, N., Tharp, B., and Dresden, J. (2011) *The Science of Global Atmospheric*

Change Teacher's Guide. Baylor College of Medicine: Houston. ISBN: 978-1-888997-75-0.

Image Reference

Photo courtesy of the U.S. Global Change Research Program.

Key Words

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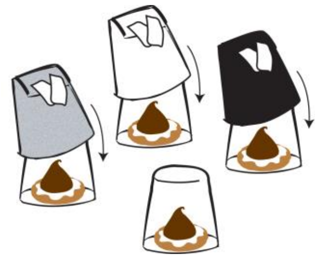
Greenhouse S'Mores

1. Collect 4 clear cups and 4 paper plates.
2. Make covers for 3 cups: 1 out of aluminum foil, 1 out of white paper and 1 out of black paper. Cover three of the cups.
3. Create 4 S'Mores and place each on a paper plate.
4. Cover each S'More with a cup/cover cover.
5. Follow your teacher's instructions on where to place each cup and make observations.



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Greenhouse S'Mores – Environment and Health

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Background

Several transparent gases in the lower layer of the atmosphere (troposphere) have an important role in determining the temperature of Earth's surface. These gases, which act like glass windows in a greenhouse or automobile, let light and other forms of radiation from the sun pass through the atmosphere. Much of this energy is absorbed into Earth's surface, which becomes warmer (just like the seats in a car parked in the sun). Some heat, however, is radiated back into the atmosphere. There, gases like carbon dioxide, methane, ozone and water vapor (the so-called "greenhouse gases") absorb some of the heat and sent it out again in all directions, including back toward the surface. This warms Earth's surface and the lower atmosphere.

Without the warming effect of greenhouse gases, Earth's average surface temperature would be around –18° C (0° F), instead of the actual temperature of about 15° C (59° F). Much of the planet would be frozen. On the other hand, if there were more of the greenhouse gases, Earth's surface would be too hot to support life. Scientists around the world are concerned that increased levels of greenhouse gases (especially carbon dioxide), resulting from human activities, are causing additional warming of the planet's surface. Levels of carbon dioxide in the atmosphere have increased more than 30% since the industrial revolution. This increase is due primarily to the burning of fossil fuels and changes in land use (burning forests to clear land for farming, for example). Even minor increases in the surface temperature can have far-reaching effects. Major climactic patterns of winds, temperature and rainfall could change drastically, impacting water resources, coastlines, agriculture, forests and energy production, as well as patterns of disease.

This activity is designed to provide a simple introduction to the concepts underlying the greenhouse effect and to provide background information for thinking about climate change.

Procedure

1.*Ask students, Have you ever noticed how warm a car can become when it is parked in the sun? Where do you think the heat inside the car comes from? How do you think we can learn more about light and heat?*

2.Tell students that they will investigate the heat-trapping qualities of different materials by using the sun to make a treat. Have Materials Managers collect 4 cups and 1 sheet of each of the 3 coverings for their groups. Have students make the following covers for three of the cups: white construction paper, black construction paper and aluminum foil. All covers should be about the same size and shape. Have students follow the instructions described at left OR challenge students to create their own cover designs. One cup will not have a cover.

3.After students have made covers for three cups, have each Materials Manager pick up four round cookies, four chocolate candies, a spreader and a small container of marshmallow cream or frosting.

4.Ask students if they have ever made S'Mores using marshmallows and chocolate squares. Tell students they will be using solar energy to make S'Mores in class. Each student will create one S'More by placing a small amount of marshmallow creme or frosting on the cookie, followed by a chocolate candy.

5.Direct students to place the cookies on a plate or tray and to cover each cookie with one of the cups. (If the experiment will be conducted outside, have students tape the cups to the plate.)

6. Within their groups, have students discuss the cover treatments and predict which treatment will result in the most softened or melted chocolate. Have students rank their predictions using a scale of 1 to 4, in which 1 = least softened and 4 = most softened.

7.Have students place the plates and cups in a sunny spot near a window, or outside in direct sunlight, preferably on a lawn. (Do not place the plates on hot pavement in the sun. The heat from the already warm surface will affect the results.)

8.Let students make their first observations after about 15 minutes. They should use a toothpick to test the candies. Depending on the air temperature, some of the chocolate candies may begin to soften by this time. Continue observing at 10–15 minute intervals, until at least one of the candies has become very soft. (Note: some chocolate candies may retain their shape even when they are very soft.)

9.Have students bring their plates indoors and observe the condition of each of the four chocolate candies. Ask students to rank the candies from least melted to most melted—giving a score of "1" to the least softened or melted and a score of "4" to the most softened or melted.

10.Make a chart on the board and have each group report its results.

11.Add (or have students add) all of the points received by each treatment. Usually, the clear /uncovered cup treatment will end up with the most points (clear cups result in the most melted chocolate, followed by the white cover and the black cover). The foil cover will have the fewest points (least melted chocolate). Because the observations are subjective, there usually will be some discrepancies among the results reported by each group. Use this as an opportunity to point out the importance of conducting an experiment more than once.

12.Discuss the results with the class. Ask, *Which treatment melted the chocolate the most? The least? Why do you think so?* Help students understand that more light energy was able to pass into the clear cup than into the others. Much of this energy was transformed into heat. The cup covered with foil reflected more light energy away. The white paper reflected some of the light energy away. The black paper absorbed more energy than the white cup.

13.Let each student eat his or her S'Mores, while you lead a discussion connecting their observations to what happens inside a car parked in the sun. You also may want to refer to page 9 in the story, *Mr. Slaptail's Curious Contraption*. Help students understand that certain gases in the atmosphere, especially carbon dioxide, act like the clear cups in their experiments. These gases keep the surface of the planet warmer than it would be otherwise.

Reference

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Image Reference

Key Words

lesson, life science, physical science, environment, atmosphere, climate, weather, global change, greenhouse gas, ozone, sun, Earth, ecology, energy, environment, pollution, visible light, radiation, fossil fuel, fuel, carbon cycle, CO2, geology, combustion, temperature, carbon monoxide, skin, skin damage, UV light, spectrum, sunscreen, solar energy,

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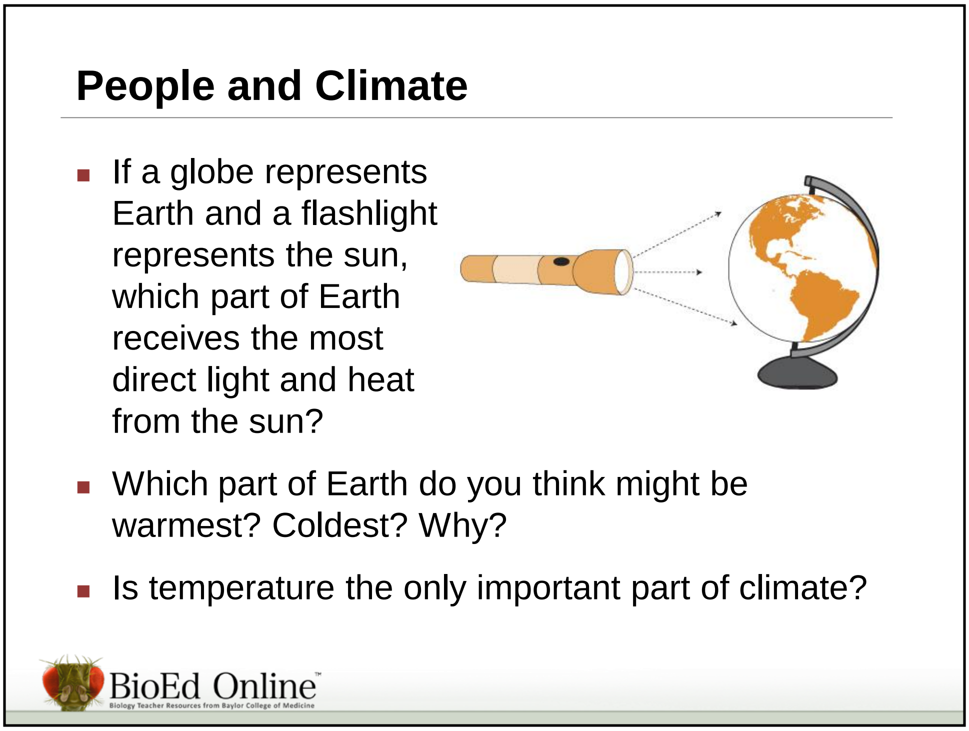

People and Climate – Environment and Health

Complete instructions for conducting activities in this slide set, including materials needed, setup instructions, extensions, student sheets and answer more, can be found in *The Science of Global Atmospheric Change Teacher's Guide*, which is available free-of-charge at http://www.bioedonline.org/lessons-and-more/teacher-guides/global-atmospheric-change/.

Background

We don't often think about it, but many aspects of life are determined by climate, the characteristics of the weather in a particular region over long periods of time. Climate determines which kinds of plant and animal life are present, which crops can be grown, how people build their houses and, to a great extent, people's clothing and diet.

There are three major climate zones on the planet, determined by distance from the equator. The zone nearest the equator—the tropical zone—is warmest because it receives the most direct radiation from the sun. The zones closest to each pole—the polar zones—are the coldest, because they receive the least direct radiation. The broad areas between the tropical and polar zones— known as the temperate zones—generally have snow or rain during cool or very cold winters. The temperate zones lie between 30° and 60° latitude in both hemispheres.

Factors other than latitude also affect climate. Nearness to an ocean usually keeps temperatures cooler in summer and warmer in winter. Altitude also influences temperature; mountainous areas are colder than sea-level regions at the same latitude. In addition, rainfall varies from region to region depending on wind patterns and characteristics of the land. Some parts of the world receive little or no rainfall. Most of these desert areas are located near or within the tropical zone. Other parts of the tropical zone receive large amounts of rain during certain seasons.

Most scientists are concerned that human activities are modifying Earth's climate. The addition of greenhouse gases, such as carbon dioxide, may lead to increases in global temperatures (global warming). This could cause changes in rainfall and temperature patterns in many parts of the planet, with enormous consequences for ecosystems, cities and agriculture.

The release of chemicals known as CFCs (chlorofluorocarbons) also is contributing to atmospheric changes that affect climate and human health. Freon and other CFCs are greenhouse gases that contribute to the trapping of heat near Earth's surface. In addition, chlorine molecules released by these chemicals in the stratosphere break apart the ozone molecules that shield Earth from ultraviolet radiation. Over the last decade, the amount of ozone in the stratosphere has decreased (especially in the polar regions)—leading to greater risks of skin cancer for people and also damaging vital populations of plants, animals and marine life.

This activity is designed to raise students' awareness of how climate influences all aspects of people's lives.

Procedure

1.Darken the room and shine a flashlight at the center of a globe (or balloon, or large ball). Ask, *If the globe represents Earth and the flashlight represents the sun, which part of Earth receives the most direct light and heat from the sun?* Help students understand that the central part of the planet (near the equator) receives light at the most direct angle from the sun. Follow by asking, *Which part of Earth do you think might be warmest? Coldest? Why?*

2.Distribute copies of the "Global Climate Map" page to each student or group of students. Help students find the equator and relate it to the central portion of the balloon or ball used for your demonstration. Help students identify the polar and temperate regions.

3. Ask, *Is temperature the only important part of climate?* Lead students to understand that rainfall also is an important part of weather and climate. If students are not familiar with these concepts, introduce them at this point. We use the term “weather” to describe conditions in the atmosphere at a given time or place. We usually measure several variables to describe weather, including temperature, rainfall, wind speed and humidity. The normal weather in a region over long periods of time is called climate. Ask, *What is our climate like?* Lead a discussion of the climate characteristics in your location (winter conditions, amounts of rainfall, temperatures in summer, etc.).

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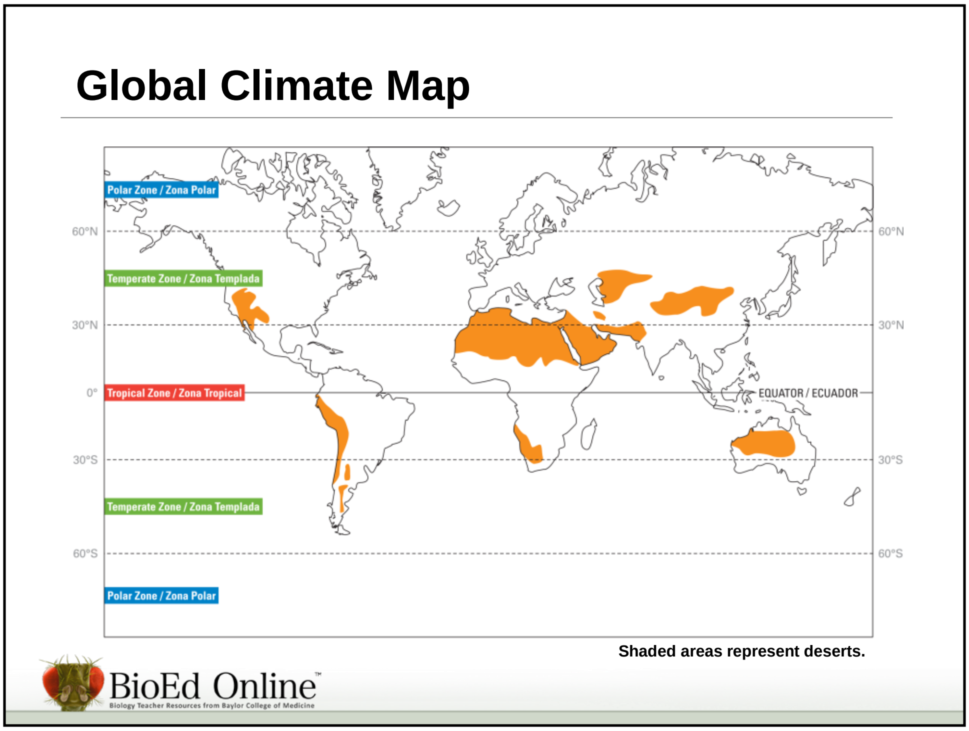

Global Climate Map

Procedure *(continued)*

4.Point out that regions with very little rainfall (deserts) also are shown on the "Global Climate Map" sheet.

5.Assign a climate zone and geographic area from the student page to each group of students. Examples might include: temperate zone of North America; tropical zone of South America; tropical desert zone of Africa; and so forth. Give more explicit geographic locations (by country or region) to older students, and have them use outside resources to gather additional information about their assigned regions. Explain that students should think about how people might live in the given climate type. Have each group discuss and decide the types of clothing that people might wear in summer and winter (or during rainy and dry seasons), what the houses might look like, and what foods people might eat. Refer students to the cover of the *Explorations* magazine accompanying this unit for ideas. Older students may want to use resources in the library or on the Internet to find additional information.

6.Prompt each group to write a description of the climate in its region and a description of how people live in this region and climate. Have students illustrate their descriptions.

Climate Zone:

Geographic Area:

Describe:

The Seasons

Major crops

Major foods

Types of clothes

Types of houses

Other important factors

4.Display each group's descriptions and pictures around the classroom.

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Image Reference

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Everyone Counts

- Global atmospheric change includes global warming and loss of atmospheric ozone.
- All of us do things every day that contribute to these problems.
- Can we protect the atmosphere by changing behaviors and ways of doing things?
- Select an issue related to global atmospheric change and write a letter to try and convince someone to help protect the atmosphere.

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Everyone Counts (post-assessment)

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Background

For more than 100 years, human actions have been changing the composition of Earth's atmosphere. Increases in the levels of heat-trapping greenhouse gases (especially carbon dioxide) and decreases in the amounts of stratospheric ozone both have been measured. These processes have the potential to impact humans in many ways.

This activity is designed to assess student understanding of concepts related to global atmospheric change. Each student will write a persuasive letter about a topic related to protecting the atmosphere.

Procedure

1.Tell students that they will write persuasive letters to each other related to global atmospheric change. Introduce letter writing skills if needed. Mention that global atmospheric change is a broad category that includes global warming and loss of atmospheric ozone. Also mention that all of us do things every day that contribute to these problems. Each student should try to convince the reader to help protect the atmosphere by changing behaviors to reduce the possibility or impact of global warming or ozone depletion.

2.Review the importance of our global environment to individual health and to the health of the planet. You may use the "Tips for Healthy Living" on page 3 of *Exploration*s or pages 34–35 in *Mr. Slaptail's Curious Contraption*, or a review of the activities in this unit to guide students.

3.Each student should select one issue presented in this unit and write a letter to try to convince someone to help protect the atmosphere.

4.Distribute pre-assessments back to each student. Ask students to examine their answers and, using a different color, to circle new answers based on information they have learned.

5.Discuss students' changes as a group.

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