THE SCIENCE OF Global Atmospheric Change

Measuring and Protecting Skin

Activity from *The Science of Global Atmospheric Change Teacher's Guide* and for *Mr. Slaptail's Curious Contraption*

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BioEd[SM]

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earthobservatory.nasa.gov

NASA’S EYES ON THE EARTH
climate.nasa.gov

NATIONAL ACADEMIES OF SCIENCES
dels.nas.edu/Climate/Climate-Change/Reports-Academies-Findings

NATIONAL INSTITUTE OF ENVIRONMENTAL HEALTH SCIENCES
niehs.nih.gov/about/od/programs/climatechange

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http://en.wikipedia.org/wiki/File:North_season.jpg

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
sis.nlm.nih.gov/enviro/climatechange.html

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http://www.bath.ac.uk/bio-sci/research/profiles/wheals-a.html

WORLD HEALTH ORGANIZATION who.int/global-change/environment

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.

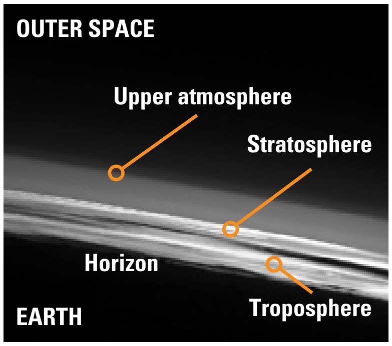
Most of the energy we use each day comes in some way from materials photosynthesized by plants and other producers, such as algae. During photosynthesis, energy from the sun is trapped to build molecules necessary for life. The oil, natural gas and coal that have been essential for the development of 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 statrosphere. 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.



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.

Photo courtesy of NASA.

SUN AND SKIN

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.

Measuring and Protecting Skin

Life Science

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.

Unit Links

Mr. Slaptail's Curious Contraption
Story, pp. 21–22;
Science box, p. 20

Explorations
What Is It?, p.6;
SkinWise, p. 8

SETUP

Begin with a class discussion. Have students conduct the activity in groups of 2–4.

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

CONCEPTS

- Skin is a vital part of the body.
- Skin must be protected from sun damage.

OVERVIEW

Students will compare and contrast their own skin (including the area covered) with that of an orange.

SCIENCE, HEALTH & MATH SKILLS

- Predicting
- Estimating
- Calculating
- Graphing
- Drawing conclusions

TIME

Preparation: 10 minutes
Class: Two sessions of 30–60 minutes

MATERIALS

Each group will need:

- 2–3 feet of wax paper
- Crayons or colored markers
- Metric tape measure
- Orange or tangerine
- Paper towels
- Plastic knife
- Roll of tape
- Sheet of centimeter ruled graph paper
- Sheet of paper or a notebook for observations
- Copy of "Skin Observations" sheet

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

SUNSCREENS

Commercial sunscreens protect the skin by shielding it from UV radiation. Without protection, the skin reacts to UV light by creating a protective layer of pigment. Unfortunately, even a tan that is acquired slowly with the benefit of tanning lotion still is evidence of skin damage that eventually could lead to premature aging and/or skin cancer.

Sunscreens may contain substances, such as zinc oxide, that physically block radiation or that provide chemical protection. Most broad spectrum sunscreens contain physical and chemical components.

The "Sun Protection Factor" (SPF) of a lotion serves as a measure of its protecting power. A product with an SPF of 10 reduces the the amount of radiation reaching the skin by a factor of 10. Most experts recommend that products with an SPF of at least 30 be reapplied every two hours.

It is particularly important for all children to wear sunscreen, even for short exposures.

CLIMATE CHANGE AND HUMAN HEALTH

For reliable information about climate change and human health, visit the following websites.

Center For Disease Control and Prevention
cdc.gov/climatechange

National Academies of Sciences
dels.nas.edu/Climate/Climate-Change/Reports-Academies-Findings

National Institute of Environmental Health Sciences
niehs.nih.gov/about/od/programs/climatechange

U.S. Department of Health and Human Services
sis.nlm.nih.gov/enviro/climatechange.html

U.S. Geological Services, Office of Global Change
usgs.gov/global_change

World Health Organization
who.int/globalchange/environment

Many aspects of circles and spheres are described mathematically using radius (r) and pi (π), ($\pi = 3.14$).

$2r$ = diameter
$2\pi r$ = circumference
$4\pi r^2$ = surface of a sphere
$4/3\pi r^2$ = volume of a sphere

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.

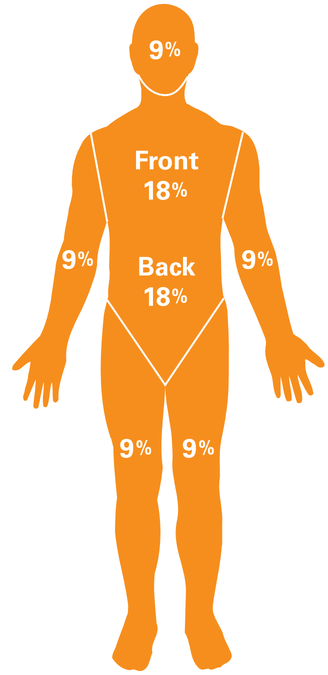
VARIATIONS

- Wrap the entire body of one or more students in wax paper; then spread the paper out and measure its area. Compare the result to the estimate calculated using the area of only one arm.
- Have students calculate the area covered by a t-shirt, shorts, bathing suit or other clothing. Challenge them to figure out the amounts of skin that are exposed when wearing short sleeves and shorts instead of long sleeves and trousers.

QUESTIONS FOR STUDENTS TO THINK ABOUT

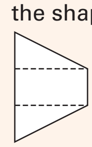
Read about ozone depletion and the role of CFCs (chlorofluorocarbons) on page 3 of the *Explorations* magazine for this unit. Ask students, *What else can you find out about the ozone layer? What is being done to protect this vital part of the atmosphere?*

LAW OF NINES



Each major part of the body represents about 9%, or 1/11, of the total amount of skin.

The area of an irregular geometric shape with straight sides (such as the students' wax paper "arm wraps") can be estimated by dividing the shape into one or more



rectangles and/or triangles. Find the area of each of the smaller shapes and sum the individual areas to find the total area.

To find the area of a rectangle, multiply length times width.

To find the area of a right triangle (a triangle with a 90° angle) multiply height times length of the base and divide the result by two.

Divide other kinds of triangles into two right triangles and calculate the areas as above.

Skin Observations

Name ____

Skin of an Orange

1. Observe the skin of an orange. Describe your observations on the back of this sheet.

2. Put a check beside the observations that are the same for human skin.

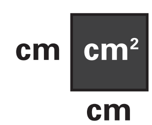
3. How much skin do you think is on an orange? Write your prediction in cm^2 beneath your observations.

4. Now, peel an orange, flatten the pieces of skin and lay them on graph paper.

5. Trace around the pieces. Color in the spaces that were covered by the orange skin.

6. Count the number of squares that are colored. How many centimeter squares did you count? Write the number below.

   Area of skin on orange = ____________________ cm^2



My Skin

1. How much skin do you think is on a person? Write your prediction in cm^2 beneath your predictions for the amount of skin on an orange.

2. Wrap your partner's arm in wax paper—making sure to cover only the arm.

3. Lay the wax paper over graph paper and calculate the area that is covered. This is the number of square centimeters of skin on the arm. Write the number below.

   Area of skin on arm = ____________________ cm^2

4. Multiply this number by 11 to figure out the total area of skin on the body.

[ ] cm^2 **x 11 =** [ ] cm^2

Observaciones sobre la Piel

Mi Nombre ____

Piel (cáscara) de una Naranja

1. Observa la piel de una naranja. Escribe tus observaciones en el otro lado de esta hoja.

2. Haz una marca junto a las observaciones que son similares para la piel humana.

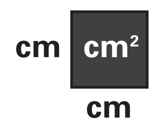
3. ¿Que tanta piel crees que tenga una naranja? Escribe tu predicción en cm^2 abajo de tus observaciones.

4. Ahora, pela la naranja, extiende los pedazos y colocalos sobre el papel cuadriculado.

5. Traza alrededor de los pedazos y colorea los espacios que fueron cubiertos por la piel de la naranja.

6. Cuenta el número de cuadros que están pintados. ¿Cuantos cuadros de un centímetro contaste? Escribe el número aquí.

   Area de la piel de una naranja = ____________________________ cm^2



Mi Piel

1. ¿Que tanta piel crees que tenga una persona? Escribe tu predicción abajo de tu predicción de la piel de una naranja.

2. Envuelve el brazo de tu compañero en papel encerado — cuidando de cubrir justo el brazo.

3. Coloca el papel encerado sobre un papel cuadriculado y calcula el área que queda cubierta. Esto es el número de centímetros cuadrados de piel que hay en un brazo. Escribe el número aquí.

   Area de la piel del brazo = ________________________________ cm^2

4. Multiplica este número por 11 para obtener el área total del cuerpo cubierto por la piel.

[ ] cm^2 **x 11 =** [ ] cm^2