

**Skin Cancer Curriculum
Table of Contents**

- I. Overview**
 - A. What is Cancer**
 - B. Cancer Statistics**

- II. Causes of Cancer**
 - A. Acquired Mutations**
 - B. Other Causes**

- III. UV Light and Skin Cancer**
 - A. Introduction to the Skin**
 - B. What is Ultraviolet Radiation**
 - C. Types of UV Radiation**
 - D. Absorption of UV Radiation by Earth's Atmosphere**
 - E. Effects of UV Radiation on Humans**
 - F. Effects of UV Radiation on Cells**

- IV. Exposure to UV Radiation**
 - A. How We Are Exposed**
 - B. How to Limit Exposure**
 - C. How to Reduce Risk While Being Exposed**

- V. Other Causes of Skin Cancer**
 - A. Occupational Exposure**
 - B. Inherited Gene Defects**

- VI. Skin Cancer: A Detailed Look**
 - A. Types of Skin Cancer**
 - B. Detection of Skin Cancer**

- VII. Mythbusters**
 - A. Myths**
 - B. Facts**

- VIII. Real Life Applications**
 - A. Sunlight & Skin Cancer**

- IX. Inquiry Based Learning Exercise**
 - A. Lab Activity**

- X. Related Topics For Discussion**
 - A. Ozone Layer**



Grade level: High School (9th – 12th)

Standards: SCS_h3, SCS_h6, SCS_h7, SCS_h8, SCS_h9, SB2

Science Characteristics of Science high School Standard

Science Biology Standard

Title: Tan Now, Pay Later!!!

Prerequisite: None necessary

Purpose of activity: Educate students about the risks of sunlight overexposure and skin cancer, thereby promoting healthy behaviors.

Goals/ Objectives:

- The students will be able to define the link between sun exposure and skin cancer.
- The students will be able to discuss the benefits of sunscreen and the dangers of exposure to excessive sun light.
- Students will be able to debunk myths related to sun exposure, skin cancer, and UV radiation.
- Students will apply knowledge to make healthy decisions about behaviors that put them at risk for exposure to UV radiation.

Materials: Sunscreen (optional)

cancerquest.org

I. Overview

A. What is Cancer

- i. Cancer is a condition that develops when normal cells are damaged in ways that cause them to reproduce in an unregulated manner. The changes in cellular behavior are caused by mutations; changes to the DNA of a cell.

These mutations enable the cancer cell to divide continuously, without the need for normal signals. In some cancers the unchecked growth results in a mass, called a **tumor**. Cancerous cells may invade other parts of the body, interfering with normal body functions. If normal body functions are impaired significantly, death may occur.

Although cancer is often referred to as a single disease, it is really a group of diseases that affect many different organs and types of cells. The likelihood that a person will develop any particular type of cancer

depends on their genes, environment and lifestyle. Of particular importance is that fact that some cancers may be prevented by wise lifestyle choices.

B. Cancer Statistics From the American Cancer Society (1)

- i. The GOOD: Some types of cancer can be prevented.
 - The American Cancer Society estimates 170,000 US cancer deaths in 2007 are expected due to tobacco usage and another 185,000 are predicted due to other preventable cancers.
 - That's a grand total of 355,000 potentially preventable cancer deaths in ONE YEAR!
- ii. The BAD: Cancer is the second leading cause of death in the United States.
 - **1 in 4 deaths** in the US is caused by cancer.
 - Over half a million people (564,830) are expected to die in 2006 from cancer.
- iii. The UGLY: **Skin cancer is the most common cancer in the US**
 - Skin cancer will account for half of all cancers diagnosed in 2007, totaling over 1 million cases
 - 1.4 million people are expected to be diagnosed with a cancer other than skin cancer in 2007.
- iv. The COST: The NIH estimated cancer costs at \$206 billion in 2007.
 - 78.2 billion direct medical care; 17.9 billion indirect morbidity (lost productivity due to illness); 110.2 billion indirect mortality cost (lost productivity due to death).

II. Causes of Cancer

A. Mutations

- i. Cancer is caused by mutations resulting from internal or external factors
 - Internal: inherited mutations, spontaneous mutations
 - External: tobacco, chemicals, radiation, infectious organisms

B. Others

- i. Some agents, such as viruses, can induce cancer without altering cellular DNA

III. UV Light and Skin Cancer

A. Introduction to the Skin

- i. The skin is your body's largest organ and one of the most important. It protects everything inside of the body, including your bones, muscles, and organs. That isn't the only job of the skin; it also prevents water loss, regulates body temperature, senses outside stimulus, and is the first line of defense against infection. Needless to say, you should do everything you can to protect your skin because you can't live without it.

Click here to view file: [SKIN LABEL](#)

B. What is Ultraviolet Radiation

- i. The nuclear reactions that fuel the sun and other stars release an enormous amount of energy. This energy is emitted as radiation of several kinds, including the light we use to see and the heat that warms the earth.

The different types of radiation emitted by the sun differ in their wavelengths. Because of its important role in skin cancer, we will focus on ultraviolet (UV) radiation. UV light is a short wavelength (high energy) type of radiation light that comes from the sun.

Click here to view file: [ELECTROMAGNETIC SPECTRUM](#)

Teaching Suggestion: Strings, slinky's, musical instruments and other elastic cords may be used to demonstrate waves and wavelength.

Teaching Suggestion: A prism may be used to demonstrate the component colors in white light.

C. Types of UV Radiation.

- i. The 3 Types of UV Radiation
 - UVA: Longest UV wavelength (400 - 315 nm)
 - may be harmful to humans
 - very little absorbed by atmosphere
 - not absorbed by ozone layer
 - penetrates deeper into the skin than all UV wavelength
 - responsible for most sunburns

- long term exposure can cause significant damage to skin
- UVB: Middle UV wavelength (315 - 280nm),
 - may be harmful to humans
 - approximately 90% absorbed by the atmosphere
 - mostly absorbed by ozone layer
 - penetrates skin and is absorbed by DNA
 - causes DNA damage leading to carcinomas
- UVC: Shortest UV wavelength (280 – 100 nm),
 - not harmful to humans
 - completely absorbed by atmosphere

D. Absorption of UV Radiation by Earth's Atmosphere

- i. The gases and dust that surround the Earth act as a shield against the radiation bombarding the planet. The most important gaseous layer surrounding the Earth is the **ozone layer**. Ozone blocks a large portion of UVB, the most harmful wavelength to humans. Much of the solar radiation that reaches Earth either gets reflected off the atmosphere or is absorbed and prevented from reaching the surface.

Click here to view related file: [EARTH ATMOSPHERE](#)

E. Effects of UV Radiation on Humans

- i. When UV radiation penetrates the atmosphere, it may be harmful to humans and other living things. **UV radiation is the leading cause of skin cancer.**

UV Radiation can be beneficial to humans. **Vitamin D** is important for healthy bones and an effective immune system. UV rays from the sun trigger vitamin D synthesis in skin.

There are safer ways to attain Vitamin D. These include: milk, cheese, eggs (yolk), fatty fish, and cereals fortified with Vitamin D.

F. Effects of UV Radiation on Cells

- i. UV radiation causes changes in the DNA of cells. The absorption of UV radiation by adjacent pyrimidine bases in DNA can cause them to form covalent bonds, distorting the DNA helix. If not corrected properly, these changes can result in mutations.

IV. Exposure to UV Radiation

A. How We Are Exposed

- i. Mainly from the sun!

Artificial methods: tanning beds

B. How to Limit Exposure

- i. The sun's UV rays are the strongest between 10 a.m. and 4 p.m. When possible, limit exposure to the sun during these hours.

Exposure varies with times of the year. UV levels highest when the sun is higher in the sky (summer).

C. How to Reduce Risk While Being Exposed

- i. SUNSCREEN!!! Your personal ozone layer!

Sunscreen blocks UV radiation from reaching the skin, but it does **not** block all of it. Sunscreen is available in different 'strengths' which are indicated by **SPF** numbers (Sun Protection Factors): 15, 30, 45. The higher the SPF number the better the protection. Sunscreen does wear off, so remember you must reapply it every few hours, especially if you are sweating, swimming, or toweling off.

Sunscreen Note: "Most people benefit from sunscreens with sun protection factor (SPF) numbers of 15 or more. The SPF number gives you some idea of how long you can stay in the sun without burning. For example, if you burn in 10 minutes without sunscreen and you apply a liberal dose with a SPF number of 15, you should be protected from sunburn for 150 minutes. Although sunscreens with identical SPF numbers give you equivalent sunburn protection from UVB rays, no sunscreen product screens out all UVA rays. Some may advertise UVA protection, but there is no system to rate UVA protection yet."
(4)

- ii. Clothing and Accessories

- Clothing provides extra UV radiation protection

- Hats protect the head area from UV radiation and should provide shade for all areas of the head (face, ears, and back of the neck)
- Umbrellas can be used but must not be transparent to be effective.

V. Other Causes of Skin Cancer

A. Occupational Exposure

- i. Repeated exposure to arsenic, x-rays, and coal tar has been shown to elevate risk for skin cancer. Anyone with repeated exposure to any of these should be extra attentive to any suspicious marks on their bodies. (6, 7, 10)
- ii. Historical note: One of the first epidemiologic associations of cancer with a particular occupation was Sir Percival Pott's observation that chimney sweeps (who are exposed to coal tar) had high levels of scrotal (skin) cancer.

B. Inherited Gene Defects

- i. Nevoid basal cell carcinoma syndrome is a rare condition caused by an inherited genetic mutation. It is an autosomal dominant disorder that may cause cancerous lesions on the skin and throughout the body. (5)

VI. Skin Cancer: A Detailed Look

A. Types of Skin Cancer

- i. Basal cell carcinoma:
 - **Basal cells** form the deepest layer (basal layer) of the **epidermis** (the outer layer of skin) and they function as the precursors of all the skin cells above them
 - Most common form of skin cancer
 - Easily detected and generally successfully treated
 - Frequently develops in individuals of light complexion who have had significant exposure to sunlight
 - Develops when cells in the epidermis become mutated (possibly because of UV radiation)
- ii. Squamous cell carcinoma:

- **Squamous cells** are the most abundant cells in skin. They are located primarily in the outermost layer of the epidermis.
- Second most common skin cancer
- Frequently found in Caucasians and those with fair complexion
- Develops when cells in the epidermis become mutated
- Considered “more aggressive” than basal cell carcinoma, although they are both highly treatable when detected early

iii. Malignant melanoma:

- Develops from cells called **melanocytes** which are found in the basal layer of the epidermis and produce the skin pigment **melanin**.
- Has highest death rate of all skin cancers, **responsible for 75% of deaths from skin cancer**
- Rarest form of skin cancer

B. Detection of Skin Cancer




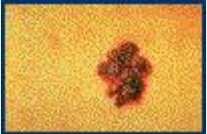




No one has perfectly even colored skin and there is no need to panic because almost all blemishes are NOT cancerous and WILL NOT become cancer.

Dermatologists are doctors who specialize in conditions affecting the skin; they are able to determine if a skin blemish could be dangerous to your health

There are a few ‘hallmarks’ that distinguish normal skin blemishes from conditions that could be problematic.

- i. The hallmarks are recognized by the acronym **ABCDE**
 1. **A** - asymmetry - one half doesn’t look like the other
 2. **B** - border - irregular, ragged or blurred edges
 3. **C** - color - a mixture of colors or marks that change color
 4. **D** - diameter - a growth more than 6 millimeters
 5. **E** - evolution - changes in shape, size or color

NOTE: Not all skin markings fulfilling one or more of these characteristics are cancerous. Any suspicious lesion should be examined by a professional.

Normal Mole	Melanoma	Sign	Characteristic
		Asymmetry	when half of the mole does not match the other half
		Border	when the border (edges) of the mole are ragged or irregular
		Color	when the color of the mole varies throughout
		Diameter	if the mole's diameter is larger than a pencil's eraser

Photographs Used By Permission: National Cancer Institute

VII. Mythbusters

A. Myths

i. Myth #1 Tanning is OK. **FALSE!**

Tanning provides excessive exposure to harmful UV radiation, which can cause skin cancer.

The tanned color on the skin's surface is actually a response to possible DNA damage and is the body's way of trying to shield the skin from additional harmful ultraviolet (UV) rays. Even though the color may fade in just a few days, the damage remains, beneath the skin's surface

where the UV radiation has penetrated and altered your DNA. These changes are permanent and they accumulate with every UV exposure throughout your life. (2)

“A tan is actually the result of skin injury...[w]hen a person's skin darkens from a tan, it is an indication that damage has occurred to the skin and the skin is trying to protect itself by producing more pigment or melanin.”

- James Spencer, MD, FAAD, professor of clinical dermatology at Mount Sinai School of Medicine (17)

**ii. Myth # 2 Tanning beds are safer than the sun.
FALSE!**

Tanning salon exposure causes DNA alterations that increase the risk of skin cancer. (11)

The tanning salon industry is booming with up to 28 million Americans tanning yearly, over 25,000 salons across the country and annual revenue of \$2 billion. (16)

**iii. Myth # 3 Darker skinned people don't get skin cancer.
FALSE!**

Although the pigment in darker skinned people filters more UV radiation than lighter skinned people, they are not immune to skin cancer.

“There's a perception that dark skinned people don't have to worry about skin cancer, but that's absolutely not true. Dark-skinned people do get skin cancer, and because of this false perception most cases aren't diagnosed until they are in more advanced—and difficult to treat—stages” –Hugh Gloster, MD (Associate Professor of Dermatology, University of Cincinnati) (13)

Overall the death rate from cancer for African American men is 35% higher than white men and 18% higher for African American women than white women. This difference is likely due to the fact that African Americans face social barriers to quality cancer prevention, detection, and treatment. (14)

**iv. Myth #4 Clouds block UV radiation
FALSE!**

Clouds do block some UV rays, but some rays still get through and can cause damage to the eyes and skin. Light cloud cover can let up to 90% of UV radiation through. (9, 12)

v. **Myth #5 Clothes block UV radiation**
FALSE!

Clothes do block some UV radiation, but a common lightweight T-shirt blocks less radiation than a sunscreen with SPF 15. Heavy, thick clothing does provide more UV protection. (15)

B. Facts

i. **FACT#1 Reflected UV rays can cause damage to humans**

UV radiation is reflected or scattered to varying extents by different surfaces. Reflection of UV rays of sand and snow can increase UV exposure at the beach or on the slopes. Because, dry beach and sand can reflect 25% of UV radiation and snow can reflect 80% of UV radiation. Other surfaces such as water, grass, and soil reflect less than 10% of UV radiation. (12)

ii. **FACT#2 Glass blocks some UV radiation**

Most UVB rays are blocked by normal glass, but UVA is *not* blocked by normal glass. Tinted windows block more UVA rays than normal glass, but they do not provide 100% protection. (15)

VIII. Real Life Applications

cancerquest.org

A. Questions for Students: What is the price of “beauty?”

- i. Who likes to be tan?
 - Show pictures of what may happen to due to excess UV exposure.
 - Show online video: “Skin Cancer the danger too much sun” available from <http://www.epa.gov/sunwise/about.html#skin>
- ii. Who uses sunscreen? What SPF?
 - Alternatives: fake tans, spray on tan/lotion tan
- iii. How can you make an impact?
 - Tell friends and family
 - Protect yourself

IX. Inquiry Based Learning Exercise

A. Lab activity

- i. Measurement of mutations in cultured cells exposed to UV radiation. Yeast cells cultured in Petri dishes may be exposed to UV light of varying intensities or for varying times and the generation of mutant organisms can be measured by replica plating and screening for auxotrophs. Variations include rubbing sunscreen on part of the lid prior to UV exposure or passing UV light through different types of clothes.
 - If budget allows sunscreen can be brought to class and distributed to students. If funding is not available, samples may be obtained by contacting manufacturers or distributors of sunscreen products.
 - For details, contact CancerQuest (cancerquest@emory.edu).

X. Related Topics for Discussion

A. The Ozone Layer

- i. The Earth's ozone layer protects all forms of life from the sun's harmful radiation; however human activities have damaged this shield.

Since ozone filters out harmful UVB radiation, less ozone means higher UVB levels at the earth's surface. The more the ozone layer is depleted, the larger the increase of incoming UVB. Less protection from ultraviolet light will, over time, lead to higher skin cancer and cataract incidences. (8)

XI. Resources for Teachers

- <http://www.epa.gov/sunwise/evaluation.html>
- <http://www.sunsafetyforkids.org/curriculum.htm>
- <http://www.pamf.org/skincancer/>
- <http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5104a.htm>

XII. Scientific Resources

1. American Cancer Society. *Cancer Facts and Figures 2007*. Atlanta: American Cancer Society, 2007.
2. American Academy of Dermatology. *The Darker Side of Tanning*. <http://www.fda.gov/cdrh/consumer/tanning.html>, (accessed 6/29/2006)
3. Centers for Disease Control. *Skin Cancer: Preventing America's Most Common Cancer, Fact Sheet 2002*.

- <http://www.cdc.gov/HealthyYouth/skincancer/facts.htm>. (accessed June 30th, 2006).
4. Federal Trade Commission. 2001. Sunscreens and Sun-Protective Clothing. <http://www.ftc.gov/bcp/conline/pubs/health/sun.htm>. (accessed July 3rd, 2006).
 5. Gorlin, R. J., and R. W. Goltz. "Multiple Nevoid Basal-Cell Epithelioma, Jaw Cysts and Bifid Rib. A Syndrome." *N Engl J Med* 262 (1960): 908-12.
 6. Partanen, T., and P. Boffetta. "Cancer Risk in Asphalt Workers and Roofers: Review and Meta-Analysis of Epidemiologic Studies." *American Journal of Industrial Medicine* 26, no. 6 (1994): 721-40.
 7. Smith, A. H., C. Hopenhayn-Rich, M. N. Bates, H. M. Goeden, I. Hertz-Picciotto, H. M. Duggan, R. Wood, M. J. Kosnett, and M. T. Smith. "Cancer Risks from Arsenic in Drinking Water." *Environment Health Perspective* 97 (1992): 259-67.
 8. U.S. Environmental Protection Agency. 2006. The Process of Ozone Depletion. <http://www.epa.gov/ozone/science/process.html>. (accessed August 24th, 2006).
 9. US Environmental Protection Agency. SunWise Program: UV Radiation. September 1999. <http://www.epa.gov/sunwise/uvradiation.html>. (accessed July 5th, 2007).
 10. Wang, J. X., L. A. Zhang, B. X. Li, Y. C. Zhao, Z. Q. Wang, J. Y. Zhang, and T. Aoyama. "Cancer Incidence and Risk Estimation among Medical X-Ray Workers in China, 1950-1995." *Health Physics* 82, no. 4 (2002): 455-66.
 11. Whitmore, S. Elizabeth, Warwick L. Morison, Christopher S. Potten, and Caroline Chadwick. "Tanning Salon Exposure and Molecular Alterations." *Journal of the American Academy of Dermatology* 44, no. 5 (2001): 775-80.
 12. World Health Organization. "Global Solar UV Index: A Practical Guide." World Health Organization, 2002.
 13. Amanda Harper. New Research Shows Cancer Prevalent in Darker Skin. University of Cincinnati: Health News. August 2006. <http://healthnews.uc.edu/publications/findings/?/2981/2983/> (accessed 07/05/07).
 14. American Cancer Society. *Cancer Facts & Figures for African Americans 2007-2008*. Atlanta: American Cancer Society; 2007.

15. American Cancer Society. Skin Cancer Prevention and Early Detection .
http://www.cancer.org/docroot/PED/content/ped_7_1_Skin_Cancer_Detection_What_You_Can_Do.asp (accessed 11/13/06).
16. Catherine A. Demko, PhD; Elaine A. Borawski, PhD; Sara M. Debanne, PhD; Kevin D. Cooper, MD; Kurt C. Stange, MD, PhD. Use of Indoor Tanning Facilities by White Adolescents in the United States. *Arch Pediatric Adolescent Medicine*. 2003;157: 854-860.
17. Innovative Public Service Advertisement Campaign Sends Strong Message To Teens About Dangers Of Indoor Tanning American Academy of Dermatology. October 19 2006.
<http://www.medicalnewstoday.com/medicalnews.php?newsid=54504>
(accessed 11/13/2006)
- 18.

