Name:

Class:

Does Sunscreen Protect my DNA?

Instructions

Does the SPF of your sunscreen really make a difference? Do some brands of sunscreen provide better protection than others? How effective are other forms of sun protection such as sunglasses or clothing?

You will have the opportunity to carry out an experiment that will help you answer these questions. The following information will assist you learning more about this topic and in designing your experiment.

What is ultraviolet radiation?

The sun radiates energy over a broad spectrum of wavelengths. About half of this radiation is visible light. The other, invisible, light includes ultraviolet (UV) radiation whose short wavelengths have the potential to cause sunburn and other health problems. Fortunately the ozone layer in the earth's atmosphere shields us from most UV radiation. Scientists classify UV radiation into three types:

- UVA, which is not absorbed by the ozone layer. It penetrates deep into the skin, causing premature aging and immune system problems.
- UVB, which is partially absorbed by the ozone layer. It mostly impacts the surface of the skin. After exposure to UVB the skin increases production of the pigment melanin which darkens the skin and protects it by absorbing UV light. UVB is the primary cause of sunburn and skin cancer. The amount of UVB radiation reaching the earth's surface is increasing as the ozone layer thins.
- UVC, which is completely absorbed by the ozone layer and oxygen in the atmosphere.

How can your health be affected by exposure to ultraviolet radiation?

UV radiation harms cells by causing changes in their DNA. While most cells repair this damage, occasionally one does not. This "glitch" can cause a change, called a mutation, in the DNA of a gene. When this gene is transcribed and translated into a protein, the protein may contain an error that causes it to function improperly and lead to cancer. Extensive DNA damage can also lead to skin cells killing themselves. This is one reason why skin peels after a bad sunburn.

Skin cancer is one of the major diseases linked to overexposure to UV radiation. One in five Americans will develop skin cancer and one American dies from this disease every hour. People who have had several blistering sunburns before age 18 are at higher risk of developing melanoma, the most serious form of skin cancer. While individuals with fair skin and

Name:

Class:

Does Sunscreen Protect my DNA?

freckles have a higher risk of developing skin cancer, dark-skinned individuals can also get this cancer. Both UVA and UVB radiation contribute to the formation of skin cancer.

Overexposure to UV radiation can have other effects on your health, regardless of your skin color. UVA radiation can lead to premature aging of the skin, causing it to become thick, wrinkled and leathery. Proteins in the lens of the eye can be changed by UV radiation, leading to the formation of cataracts. The resulting cloudiness of the lens can lead to partial or complete blindness. UV radiation may also suppress proper functioning of the body's immune system.

Most tanning beds contain less UVB radiation than normal sunlight and significantly more UVA. While this results in more tanning and less burning, it leads to more UVA damage to the skin.

What does SPF mean and how do sunscreens work?

Sunscreens are labeled with a Sun Protection Factor (SPF) rating which is really a sunburn protection factor. For example, suppose that your skin begins to redden after 10 minutes in the sun. If you protected it with an SPF 15 sunscreen, it would take 15 times as long, or 2.5 hours, to get a comparable burn. However, the testing laboratories use 2 milligrams of sunscreen per square centimeter of skin for their tests – much less than most people usually use. SPF relates only to UVB protection; there is no standard for UVA protection in the U.S.

Sunscreens act like a very thin bullet proof vest by stopping the UV radiation before it can enter the skin and cause damage. Some sunscreens contain organic molecules (such as oxybenzone, homosalate and PABA) that absorb UVB and/or UVA radiation. Others use inorganic pigments (such as titanium dioxide and zinc oxide) that absorb, scatter and reflect both UVA and UVB light. Many sunscreens contain both to provide better protection.

Why use yeast to study the effects of UV radiation?

Ordinary baker's yeast (*Saccharomyces cerevisiae)* contains genes for DNA repair that are very similar to human genes with the same function. Therefore we can use yeast as a model system to explore the effects of UV radiation on cells. Like human cells, most yeast cells effectively repair DNA damage caused by UV radiation. However, some yeast strains have mutations that prevent them from making certain types of DNA repairs. Because they cannot repair DNA damage, these cells usually die after exposure to UV radiation. This sensitivity enables us to observe how much DNA damage occurs when the cells are exposed to or protected from UV light.

Name: ______________________

Class: ______________________

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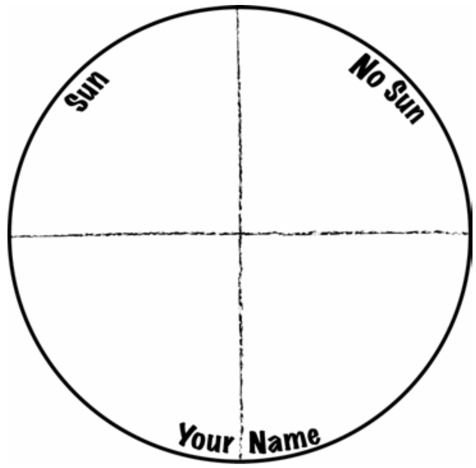
Procedure

1. Clean your hands and work area.
    - Wash your hands with soap and water.
    - Wipe your hands and your work area with alcohol and a paper towel.



2. Label your Petri dish using a waterproof marker.
    - Write your name in small letters around the outside edge of the bottom of the dish.
    - Draw lines on the top and bottom of the dish to divide it into 4 parts.
    - Label one area "sun". Why?
    - Decide what sunscreens or other items you want to test in the other 3 areas. You may want to have "no sun" in one area.
    - Label each area on both the top and the bottom of the dish.
    - Write in small letters around the edge.
3. Spread yeast cells on the agar in the Petri dish.
    - Swirl the container of UV-sensitive yeast.
    - Place 1 ml of yeast solution on the media.
    - Gently tilt and rotate the dish to spread the liquid.
    - If there are places the liquid does not cover, use the rounded end of a sterile toothpick to move the liquid over them.
4. Let the liquid soak into the agar.
    - Place the Petri dish in a dark place for 10-20 min. until the liquid disappears.
5. Tape the 2 halves of the Petri dish together along the side.
    - Use small pieces of clear tape; do not place tape on the top of the Petri dish.
    - Make sure that the lines on the top and bottom halves of the Petri dish are aligned and tha the label for each treatment is in the same area.
6. Spread sunscreen on the lid of the Petri dish.
    - Spread sunscreen in the places you marked; use an equal amount in each section and spread the sunscreen evenly.
    - If you labeled an area "no sun", tape a square of dark paper over it.
7. Expose the Petri dish to the sun or to a UV light.

Name:

Class:

Does Sunscreen Protect my DNA?

- Your teacher will supply the appropriate exposure time.
- If you are exposing the Petri dish to the sun, hold it so that the surface of the agar is aimed directly at the sun.

8. Prepare to let the yeast grow.
    - Wipe the sunscreen off the lid of the Petri dish.
    - Place the Petri dish upside down in an incubator or in a dark place.

9. **Let the yeast grow for several days** until you can see differences between areas on the Petri dish. This will take 1-2 days in an incubator at 30^{oC} or 3-4 days at room temperature.

10. **Compare the amount of yeast that has grown in different areas of the Petri dish.**
    - Do you see any differences between areas of the Petri dish? If so, describe them.
    - Did some SPF's of sunscreen protect the yeast cells better than others? If so, which ones?
    - Why did the yeast in some areas grow more than in others?
    - What can you conclude from the results of your experiment?
    - Describe another experiment you could carry out to obtain more information about the effects of UV radiation on cells.

Name:

Class:

Does Sunscreen Protect my DNA?

Resources for learning more

The Sun, UV and You. Information about UV radiation and stratospheric ozone, health risks from exposure to UV radiation, and the UV Index. http://www.epa.gov/sunwise/SUNUVU.PDF

The Ultraviolet Index. Learn what it is and how it is calculated, and get today's UV Index for cities across the U.S. http://www.epa.gov/docs/ozone/uvindex/uvover.html

On the Trail of the Missing Ozone: The causes, effects and solutions to ozone depletion. This comic book follows intrepid reporter Farley as he investigates **why we need the ozone layer, the causes of ozone depletion, and** some of the actions the world is taking to correct the problem. http://www.epa.gov/docs/ozone/science/missoz/index.html

The Skin Cancer Foundation. Descriptions and photographs of different types of skin cancers. http://www.skincancer.org/index.html

Sunscreen: The Burning Facts. Information about UV radiation and SPF. Includes a list of active ingredients in sunscreens and rates their effectiveness in UVA and UVB protection. http://www.epa.gov/docs/ozone/uvindex/sunscreenfact.pdf

Sunscreens: Some don't block rays as well as they claim. Information about SPF and ratings for 23 sunscreens. *Consumer Reports, June 2001, pages 27-29.*

Check your knowledge

Who Wants to be Sunwise? animated trivia game.

http://www.epa.gov/sunwise/activities2.html

UV Radiation Crossword Puzzle.

http://www.epa.gov/docs/ozone/puzzles/uvpuzzle.html

All websites were accessed on February 12, 2002.

