ULTRAVIOLET TESTING WITH COLOR CHANGING UV BEADS

Not all sunscreen lotions are the same, as can be evidenced by a lobster-like appearance after a day of working outside. Sometimes SPF 15 just doesn’t do the trick. Instead of using your skin as a detector of ultra-violet light (UV), we will experiment with UV Beads. These indicator beads change color when exposed to UV light and will be a way to test the effectiveness of sunscreen. Please perform this experiment without losing the beads!

MATERIALS:
- Color Changing UV Beads
- Zipper-Lock Bags
- Sunscreen
- Sunglasses (optional)
- Permanent marker

PROCEDURE:
1. With all of the SPF (Sun Protection Factor) numbers available, we want to know what SPF lotion really works best at keeping out the sun’s harmful UV rays.
2. Start by collecting 4 different strengths of sunscreen (SPF 4, 15, and 30, for example). You may have to share with other groups.
3. Place 3-5 beads in a zipper-lock bag and apply a layer of sunscreen to the outside of the bag. The sunscreen layer should be clear and not white. This means that you need a small amount like a pencil eraser sized drop.
4. Use a permanent marker to write the SPF number of the sunscreen you’re testing on the outside of the bag.
5. Be sure to set up one bag without any sunscreen coating for comparison purposes. The bag with no sunscreen coating will serve as the control in your experiment. Expose the beads to direct sunlight for 5 minutes and look for any changes in color. The beads will always change color, regardless of how well the sunscreen blocks UV - the beads are very sensitive! The key is to rate the color of the beads on a scale of 1-5, with 5 showing the most color or "burning" and 1 showing the least color. The bag without any sunscreen is an automatic "5." On your worksheet, fill out your data table with the data you collected.
6. CLOUDY DAY: If it is a cloudy day, test to see if the beads change color. If it isn’t cloudy, find some shade to put the beads under. If they change color, then you can see why doctors warn people to wear sunscreen even on a cloudy day or in the shade. Observe how well the beads change color when exposed to sunlight vs. cloudy day or the shade on your worksheet.
7. SUNGLASSES (OPTIONAL): If you have sunglasses, test the ability of your sunglasses to block out ultraviolet light by covering a few beads with the lens of your sunglasses. If the beads do not change color, your sunglasses block out harmful ultraviolet light from your eyes. If not, you paid too much for that UV coating! Observe how the beads did or did not change color from your sunglasses on your worksheet.
8. CLEAN UP: Return all the beads and sunscreen back to the teacher and dispose of your plastic bags in the trash can. Clean up any other mess in your area and finish your worksheet.

HOW DOES IT WORK?
The term "light" is often used as a generic word to describe many different forms of light such as incandescent light, fluorescent light, or sunlight, for instance. However, not all light is made up of the same energy. Using UV Beads, you will be able to uncover an invisible form of light energy called ultraviolet light. None of the energy in the ultraviolet region of the light spectrum is visible to the naked eye. Just as there are many different colors of wavelengths in the visible spectrum (red, yellow, green, blue...), so are there many wavelengths of ultraviolet light.

UVA radiation
First, there is long wave ultraviolet light (300 to 400 nanometers), which most of us recognize as "black light" - the light that is often used to make decorations glow in discos and theatrical productions. UVA is long wavelength (320-400 nm) UV and accounts for up to 95 percent of the solar UV radiation reaching the Earth’s surface. It can penetrate into the deeper layers of the skin and has for years been thought to play a major part in skin aging and wrinkling.Importantly, recent studies strongly suggest that it may also initiate and exacerbate the development of skin cancers. UVA rays are
present during all daylight hours and throughout the winter months. Although UVA rays are less intense than UVB rays, they are present all year round and depending upon the time of the year, can be 30 to 50 times more prevalent than UVB rays. Furthermore, UVA radiation can penetrate glass, plastic and clouds. Thus, we are exposed to large doses of UVA throughout our lifetime.

**UVB radiation**
Short wave ultraviolet light (100 to 300 nm) is used to kill bacteria, hasten chemical reactions (as a catalyst), and is also valuable in the identification of certain fluorescent minerals. Unlike long wave UV, the short wave UV cannot pass through ordinary glass or most plastics. The shortest wavelengths cannot even travel very far through the air before being absorbed by oxygen molecules as they are converted into ozone. UVB is the middle-range of UV with wavelengths between 290-320 nm. It responsible for burning, tanning, acceleration of skin aging and plays a very key role in the development of skin cancer. The intensity of UVB varies by season, location and time of day. The most significant amount of UVB hits the U.S. between 10 AM and 4 PM between April and October. UVB rays do not penetrate glass.

**UVC radiation**
UVC is the shortest and highest energy UV with wavelengths less than 290 nm. However, since it is filtered by the ozone, these wavelengths do not reach the earth's surface and do not contribute to skin damage in humans.

**Sun Protection Factor and How it relates to UV radiation**
The most important issue to understand about an SPF rating is that it mainly indicates relative protection from erythema produced by UVB. In order to get adequate protection against both UVA and UVB, you should select a sunscreen that provides multispectrum protection, broad-spectrum protection or UVA/UVB protection - not just a sunscreen with a high SPF (UVB) rating. Additionally, the label should list a FDA-recognized long wavelength UVA sunscreen, such as avobenzone or zinc oxide.

Sunscreens are classified by the Food & Drug Administration (FDA) as an over-the-counter drug rather than a cosmetic. There are currently 16 active ingredients approved by the FDA for use in sunscreens in the United States. These active ingredients fall into two broad categories: organic ("absorbers") and inorganic ("blockers"). Most UV filters are organic and protect by absorbing UV. They form a thin, protective film on the surface of the skin and absorb the UV radiation before it penetrates the skin. The inorganic sunscreens, such as metal oxides or particulate UV filters, are often termed "physical" or "mineral". The metal oxides, namely titanium dioxide and zinc oxide, are insoluble particles which absorb and reflect UV away from the skin. Today, many sunscreens contain a mixture of organic and inorganic sunscreens and are offered with new base formulations and methods of application, making sunscreen use more appealing. In addition, new UVA filters such as Tinosorb currently being used in Europe are under FDA review.

- **UVB absorbers/blockers**: Padimate O (Octyldimethyl PABA), Homosalate, Octisalate (Octyl salicylate), Octinoxate (Octyl methoxycinnamate or OCM)
- **UVA absorbers/blockers**: Avobenzone (Parsol 1789), Zinc Oxide, Ecamsule (Mexoryl)
- **UVA and UVB absorbers/blockers**: Octocrylene, Titanium Dioxide, Zinc Oxide

UV Beads are the perfect tool for understanding how solar radiation can be harmful and to recognize preventative measures that can be taken to reduce the risks associated with exposure to sunlight. When you expose bare skin to sunlight, your skin will either burn or tan (which doctors warn is still not healthy for your body). UV radiation wavelengths are short enough to break chemical bonds in your skin tissue and, with prolonged exposure, your skin may wrinkle or skin cancer may appear. These responses by your skin are a signal that the cells under your skin are being attacked by UV radiation.

Sources:
http://www.stevespanglerscience.com/lab/experiments/uv-reactive-beads