GOAL:

Visitors will understand how nano-scale particles are used in mineral sunblocks to increase their transparency.

MATERIALS:

Real Product

- Strips of black construction paper (7 x 15 cm)
- Zinc oxide ointment (non-nano sunblock)
- Sunscreen with zinc oxide (nano-sunblock)
- Paper towels (optional)

Macro-scale

- Picture with large white dots/black background
- Picture with small white dots/black background

- List of common mineral sunblocks/sunscreens

PROCEDURE:

Set-up:

1. Lay out all supplies.

2. You may want to have paper towels on hand to wipe up any excess sunscreen and protect the workspace with newspaper or a towel.

Doing the demonstration:

1. Begin by asking the visitors if they use sunblock. Discuss that the purpose of using sunblocks/sunscreens is to protect the skin from ultraviolet light, which can cause short-term (sunburn) and long-term (pre-mature aging and skin cancer) damage.

2. Apply a small dot (half the size of a pea is more than enough) of both types of zinc oxide onto a strip of black construction paper (be consistent when you give strips to multiple visitors – e.g. nano-sunblock always on the left side). Challenge visitors to rub each dab of sunblock into the paper until it disappears. Once they have completed this task, ask them to identify which dot disappeared more quickly.

3. Explain that both sunblocks contain zinc oxide, a mineral that is very effective at absorbing UV radiation to prevent it from reaching your skin. The difference between the two sunblocks is in the size of the zinc oxide particles. The regular zinc oxide leaves a more visible film (a.k.a. "the lifeguard nose") because the particles are large enough to reflect visible light. The nano-sunblock is transparent because the zinc oxide nanoparticles are too small to reflect visible light. They are still large enough to absorb UV radiation, so protection is equally effective.

4. Show visitors the two pictures of large and small white dots. Ask the visitors which dots are easier to see. The visitors should choose the picture with the large dots. This image represents the regular sunblock – the large white dots reflect more visible light than the smaller dots, so they are more visible. The image of the small dots represents the nano-sunblock – each smaller particle reflects less visible light, so collectively they are harder to see and the nano-sunblock appears transparent. The large dot image has been scaled down and tiled to form the image of the small dots, so the ratio of black to white is the same in both pictures; only the distribution is different.

5. Discuss the list of common sunblocks. (Optional) Print and provide visitors with a copy if they are interested.

Clean-up:

1. Throw away used construction paper.

2. Gather all materials and return to storage.

EXPLANATION:

When the diameter of a zinc oxide molecule is reduced below the wavelength of visible light (380–780 nm), the nanoparticle no longer scatters visible light so the substance containing the mineral will look transparent. However, the particles are still larger than the wavelength of ultraviolet light and the chemical composition of the particle is not altered, so zinc oxide does not lose its ability to absorb UV radiation.

Although the public and manufacturers often use the words "sunblock" and "sunscreen" interchangeably, they technically refer to two different types of sun protectants. Sunblocks refer to sun protectants that contain minerals such as zinc oxide or titanium dioxide. They block about 99% of UV radiation, but non-nano formulations are opaque in nature and users rarely apply the amount recommended for effective protection as a result. Sunscreens refer to chemically based sun protectants, few of which individually protect against both UV-A (320–400 nm) and UV-B (290–320 nm) radiation and are usually combined into broad-spectrum products. Although chemical sunscreens also degrade when exposed to UV light, they are more transparent than traditional mineral sunblocks when rubbed on the skin. In light of this, chemical sunscreens tend to be more popular than mineral sun blocks, even though mineral sun

blocks are better at blocking UV radiation and are better for the skin because they do not degrade.

Nanoparticles used in sun blocks are some of the most extensively researched topics in nanotechnology. Although Australian and European governments have approved the use of nanoparticles in sunblocks, cosmetics are not regulated by the U.S. Food and Drug Administration (FDA). It is often difficult to tell which commercially available products contain nano and non-nano mineral formulations, since cosmetics companies are not required to indicate whether nanoparticles are present in their product.

To date, toxicity studies have shown that nano-zinc and titanium based minerals do not penetrate the outer later of healthy skin and are largely safe to use. However, a possible penetration risk remains in areas where skin is thinner (i.e. lips, underarms, eyelids and at the joints) or if skin has been damaged by prior sun exposure or other physical trauma. Additionally, the elderly and young children may have a higher risk of skin penetration, as these age groups tend to have thinner skin. The primary health concern about nanoparticles is that if they are exposed to UV radiation they can generate oxygen free radicals; these can cause oxidative stress and inflammation as well damage proteins, lipids and DNA.

WHAT COULD GO WRONG?

Visitors may want to try applying the different sunblocks on their skin. Although the sunblocks should be safe to use, some visitors may have sensitive skin conditions, so stick to the construction paper unless they are adults or have explicit permission from an adult. (If they do apply it to their skin, putting one sunblock on the back of each hand facilitates easy comparison.)

GENERAL MAINTENANCE:

Maintain a supply of precut construction paper. Throw away used construction paper after each demonstration to keep things clean. Wipe down laminated pictures with a paper towel if they get greasy.