When particles are so small that they seep right through skin

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Scientists are finding that particles that are barely there – tiny objects known as nanoparticles that have found a home in electronics, food containers, sunscreens, and a variety of applications – can breech our most personal protective barrier: The skin.

The particles under scrutiny by Lisa DeLouise, Ph.D., are almost unfathomably tiny. The particles are less than one five-thousandth the width of a human hair. If the width of that strand of hair were equivalent to the length of a football field, a typical nanoparticle wouldn't even belly up to the one-inch line.

In the September issue of the journal *Nano Letters,* a team led by DeLouise at the University of Rochester Medical Center published a paper showing that nanoparticles pass through the skin of a living organism, a type of mouse commonly used as a model to study the damaging effects of sunlight.

It's the strongest evidence yet indicating that some nanoparticles are so small that they can actually seep through skin, especially when the skin has been damaged.

The health implications of nanoparticles in the body are uncertain, said DeLouise, an assistant professor of Dermatology and Biomedical Engineering and an expert on the properties of nanoparticles. Other scientists have found that the particles can accumulate in the lymph system, the liver, the nervous system, and in other areas of the body. In

her study, she found that the particles accumulate around the hair follicles and in tiny skin folds.

DeLouise, a chemist, points out that her study did not directly address the safety of nanoparticles in any way. "We simply wanted to see if nanoparticles could pass through the skin, and we found that they can under certain conditions," she said.

DeLouise's work is part of a broad field known as nanomedicine that is a strategic area at the University of Rochester Medical Center. The area includes research, like hers, looking at the properties of nanoparticles, as well as possibilities like new forms of drug delivery and nano-sensors that can immediately identify microbes and other threats to our health.

While nanoparticles are becoming widely used in the manufacture of consumer products, they are also under a great deal of study in research labs, and there are some processes – including ordinary candle flames – that produce them naturally. Some of the particles are so small, less than 10 nanometers wide (a nanometer is one-millionth of a millimeter), that they are nearly as small as the natural gaps between some skin cells.

In its paper in Nano Letters, the team studied the penetration of nanoparticles known as quantum dots that fluoresce under some conditions, making them easier to see and track compared to other nanoparticles. The scientists looked at the distribution of quantum dots in mice whose skin had been exposed to about the same amount of ultraviolet light as might cause a slight sunburn on a person. The team showed that while the nanoparticles were able to breech the skin of all the mice, the particles passed more quickly through skin that had been damaged by ultraviolet light.

Part of the explanation likely lies with the complex reaction of skin when it's assaulted by the Sun's rays. In response to ultraviolet light, cells

proliferate, and molecules in the skin known as tight-junction proteins loosen so that new cells can migrate to where they're needed. Those proteins normally act as gatekeepers that determine which molecules to allow through the skin and into the body, and which molecules to block. When the proteins loosen up, they become less selective than usual, possibly giving nanoparticles an opportunity to pass through the barrier.

In the future, DeLouise plans to study titanium dioxide and zinc oxide, two materials that are widely used in sunscreens and other cosmetic products to help block the damaging effects of ultraviolet light. In recent years the size of the metal oxide particles used in many consumer products has become smaller and smaller, so that many now are nanoparticles. The effects of the smaller particle size are visible to anyone who takes a walk on the beach or stops by the cosmetics counter at a department store: The materials are often completely transparent when applied to skin. A transparent lip gloss that protects against UV light, for example, or a see-through sunscreen may contain nanoparticles, DeLouise says.

"A few years ago, a lifeguard at the swimming pool wearing sunscreen might have had his nose completely covered in white. Older sunscreens have larger particles that reflect visible light. But many newer sunscreens contain nanoparticles that are one thousand times smaller, that do not reflect visible light," said DeLouise, who noted that many people apply sunscreens after their skin has been damaged by sunlight.

Source: University of Rochester