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Exploring Nanoparticle Toxicity

Ensuring that nanoparticles are safe for use in humans will be a key factor in determining how big of an impact nanotechnology has on the detection and treatment of cancer. Two new reports from research teams in Switzerland, both published in the journal *Environmental Science and Technology*, provide some insights into nanoparticle toxicity that could help in the development of biocompatible nanoparticles for biomedical applications.

Wendelin Stark, Ph.D., of the Swiss Federal Institute of Technology in Zurich, and his colleagues used human mesothelioma cells and rodent fibroblast cells to characterize the toxicity of seven industrially important nanoparticles. The investigators also used widely studied nontoxic silica particles and toxic asbestos fibers as reference materials. The investigators dosed each of the two cell lines with varying amounts of the nine materials and measured their effects on cells' metabolic activity and ability to proliferate.

One striking finding was that particle solubility strongly influenced toxicity. Low concentrations of soluble zinc oxide particles, for example, triggered a sharp drop in cell metabolism and proliferation. However, at higher concentrations, toxicity actually dropped, likely because zinc oxide particles clump together at the higher concentrations tested. Insoluble metal oxide particles showed virtually no effect on cell function at any concentration. The investigators did observe that uncoated iron oxide particles were particularly toxic regardless of concentration.

The researchers note that their assay is not designed to replace thorough toxicology studies. They added, though, that the data from their study shows that these assays do provide a relatively simple and straightforward method for pre-screening nanoparticle toxicity.

In a second report, a team of investigators led by Barbara Rothen-Rutishauser, Ph.D., and Peter Gehr, Ph.D., both of the University of Bern, used a variety of advanced microscopic techniques to study how nanoparticles penetrate red blood cell membranes. Unlike most other types of cells, red blood cells do not have receptors on their surfaces for transporting particles across the cell membrane via the process known as endocytosis. In endocytosis, particles and other materials bind to a receptor, causing the cell membrane to fold around the material, producing a sac-like bubble, or vesicle, into which the material is incorporated.

This team found that both gold and titanium nanoparticles did accumulate in red blood cells despite the absence of endocytosis receptors. This accumulation did not depend on the size or surface charge of the nanoparticles tested. These results, say the investigators, suggest that nanoparticles must cross the cell membrane by an as-yet undiscovered mechanism that needs further investigation.

The work on cellular toxicity is detailed in a paper titled, "*In vitro* cytotoxicity of oxide nanoparticles: comparison to asbestos, silica, and the effect of particle solubility." This paper was published online in advance of print publication. An abstract of this paper is available at the journal's website.

[View abstract.](#)

The work on observing nanoparticles in red blood cells is detailed in a paper titled, "Interaction of

fine particles and nanoparticles with red blood cells visualized with advanced microscopic techniques.” Investigators from the University of Calgary also participated in this study. This paper was published online in advance of print publication. An abstract of this paper is available at the journal’s website.

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