

Putting Nanotechnology Under the Microscope

Nanotechnology is all over the news: Particles that become translucent or change color according to size! Particles smaller than viruses in the shape of hollow soccer balls! Particles that can destroy tumors, prevent sunburn, and keep your windows clean! Learning about nanotechnology can inspire young minds and give educators a tangible, creative application for many of the concepts they teach every day.

While researchers, foundations, and institutions of higher learning are promoting the positive applications for nanoparticles of all shapes and sizes, classroom teachers are offered the opportunity to help their students become critical thinkers as they weigh the benefits and risks of this emerging technology. As educators, we are in a unique position with nanotechnology because while cutting-edge scientists and engineers are pushing forward with breakthrough discoveries and applications, the importance of environmental, health, and safety (EHS) research is coming to the forefront. It is critical-thinking time!

The carbon in the pencils that your students hold everyday takes on entirely different properties when formed into carbon nanotubes or C_{60} fullerenes. Hundreds of products containing nanotubes, fullerenes, and other nanoparticles are currently on the market, according to the Woodrow Wilson International Center for Scholars (2006). Yet, a recent review in the journal *Science* describes research that suggests the very properties that make nano-sized particles beneficial also make them potentially dangerous (Nel et al. 2006). Inhaled nanoparticles can cause pulmonary inflammation, oxidative stress, and even travel from the lungs into the bloodstream and affect distant organs such as the heart, liver, spleen, and bones. Targeting the mitochondria in cells, several different types of nanoparticles have been shown to overwhelm the body's natural antioxidant defenses and create an inflammatory response that results in programmed cell death.

Research on nanoparticles of titanium dioxide, which are used in many consumer products (e.g., sun creams, toothpaste, cosmetics) and in environmental decontamination products, indicates that these particles may be toxic to the brain (Long et al. 2006). Nanoparticles may bypass the blood-brain barrier and have been shown to cause oxidative stress, damaging and killing neurons in the brain cells of mice. The results of this and other similar investigations are tentative, however. Following standard protocol, evaluation of the biological effects of nanoparticles is taking place at the *in vitro* cell culture level, and it

is too early to extrapolate to whole organisms or systems.

While the U.S. Federal Government is currently funding research into EHS issues surrounding nanotechnology, this research takes time—more time than it takes to create and find uses for new types of nanoparticles. In the past, too few studies have looked at the direct and indirect effects of exposure to nanomaterials (Colvin 2003). The UK government is now studying the impact of nanotechnologies, and in a 2004 report by The Royal Society and The Royal Academy of Engineering, recommendations are spelled out for the regulation of nanotechnologies, stating that “ingredients in the form of nanoparticles should undergo a full safety assessment by the relevant scientific advisory body before they are permitted for use in products” (Chapter 10). Meanwhile, the Canadian Action Group on Erosion, Technology, and Concentration (ETC) is calling for a complete moratorium on the deployment of nanomaterials (ETC Group 2003).

The debate is raging between futurists who see nanotechnology as a panacea for the ills of society and the naysayers who see it as our potential downfall—the next asbestos; the newest terrorist weapon. Your students will be hearing and reading about this debate in the media, and the scientific literacy you encourage will help them mediate the divide between compelling but contradictory opinions.

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References

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