

Dr. Kirsten Kulinowski

It turns out that there is some similarity to asking questions about environmental impact and impacts on the body. The answers to these questions are all interconnected: what happens to nanoparticles once they are “out there,” will this be a problem and what tools do we have to minimize the risks? There have been a few studies describing the environmental impact of creating and using nanomaterials but their fate, transport and transformation in the natural environment are still largely unknown. Some nanoparticles are likely to be broken down by exposure to sunlight, oxygen or other substances or organisms in the environment while others may “persist” for longer times. Some nanoparticles are being intentionally introduced into the environment to clean up pollutants (e.g., zero-valent iron (ZVI) can “neutralize” some pollutants in contaminated water by harnessing the energy of sunlight to speed up their breakdown) and others probably shouldn’t be released because the substances they are made of are known to be toxic (e.g., cadmium). Once released into the environment, it might be difficult to retrieve them but people are working on clever strategies for their use.

Studies of nanomaterials in the body have shown that many nanoparticles can be successfully cleared by the body’s normal waste-clearance organs and processes (e.g., gold nanoshells are excreted in the feces and urine after their use as cancer therapy) while others may have problems being broken down by the body and may therefore accumulate, with unknown consequences. It really all depends on the precise type of nanoparticle and how it is introduced into the body. As an intriguing example of just how much variety there is in different nanomaterials, consider recent research at Rice that compared the toxicity to cells of two types of fullerenes. [Fullerene or  $C_{60}$  is a soccer ball-shaped molecule of pure carbon and is  $\sim 1$  nanometer in diameter.] The pure fullerenes were very toxic to the cells; modified fullerenes that had many small molecules attached to the surface were not toxic. This may point the way toward a more general strategy of reducing the intrinsic toxicity of

a given nanomaterial with a simple chemical fix.

It will take a large, focused effort to be able to predict these interactions. This is 5-10 years in the future and, until then, we can't generalize about nanomaterial behavior or impact. On the bright side, there is a growing community of researchers working on the answers to these questions and increased levels of funding from the federal government to support them.