Nanoparticles can damage DNA, increase cancer risk

April 17 2007

Tissue studies indicate that nanoparticles, engineered materials about a billionth of a meter in size, could damage DNA and lead to cancer, according to research presented at the 2007 Annual Meeting of the American Association for Cancer Research.

Nanoparticles are small enough to penetrate cell membranes and defenses, yet they are large enough to cause trouble by interfering with normal cell processes, researchers at the University of Massachusetts say.

Such nanoparticles are currently in use in electronics, cosmetics, and chemical manufacturing, among others industries. Because of their extremely small size, they can be difficult to isolate from the larger environment, as they are much too small for removal by conventional filtering techniques.

When nanoparticles find their way into cancer cells, they can wreak havoc, according to Sara Pacheco, an undergraduate researcher at the University of Massachusetts. Yet very little is known about how they behave in the environment or how they interact with and affect humans.

"Unfortunately, only a very small portion of research on nanoparticles is focused on health and safety risks, or on threats to the environment," Pacheco said. "I am concerned because so many new nanoparticles are being developed and there is little regulation on their manufacture, use and disposal."

Pacheco and her colleagues looked at how two different types of nanoparticles could cause DNA damage in the MCF-7 line of breast cancer cells.

She and her team examined the genotoxicity of silica and C60 fullerene nanoparticle suspensions using the alkaline single-cell gel electrophoresis assay (Comet assay) to quantify breaks in single and double stranded DNA. The team chose these particular nanoparticle types because they are commonly used commercially – in electronics, textiles and sporting goods – and easy to work with in the laboratory setting.

"We observed both dose-dependent and time-dependent increases in DNA damage in breast cancer cells exposed to either aqueous colloidal silica or C60 fullerenes," Pacheco said. "The DNA damage could potentially lead to mutations and ultimately increase the risk of cancer."

One problem is that, while it's clear that some nanoparticles can be more toxic than others, there's not enough data as yet to determine the most dangerous types.

"A lot is unknown about nanoparticle function, but clearly both size and composition are important," Pacheco said. "Several studies have shown that smaller particles are more likely to enter cells and cause more toxicity."

According to Pacheco, what makes matters worse is the fact that so far, aside from preventing their release, there are no known ways to prevent the harmful effects of environmental nanoparticles.

"It is important to know whether the nanoparticles are entering the cell and causing DNA damage directly or if they are acting on the membrane and inducing a cascade of events resulting in DNA damage," Pacheco said. "Once we understand the mechanisms by which nanoparticles induce their toxicity, we will be better able to prevent or mitigate their harmful effects."

In the meantime, the experimental team suggests that great caution should be taken in handling such nanoparticle suspensions and that any uncontrolled release should be avoided.

"Until we understand which types of nanoparticles are harmless and which have the potential to be harmful, I think it is prudent to limit their introduction into the environment," recommended Pacheco.

Source: American Association for Cancer Research