New nano-canary in the nanotoxicology coalmine: The body itself

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There is growing consensus among scientists, regulators, politicians, industry and the public that we need to know more about the possible harmful or adverse effects of nanoparticles on human health.

Likewise, most agree that these incredibly small materials can behave quite differently from conventional materials. Nonetheless, neighborhood stores feature products that promise benefits from these near-atomic level materials, from paints and cosmetics to toothpaste and sunscreens. But, could we be putting human health at risk by exposing consumers to potentially toxic materials?

To investigate the damage potential of sub-micron sized particles, S.K. Sundaram and Thomas J. Weber, scientists at the Department of Energy's Pacific Northwest National Laboratory in Richland, Wash., have harnessed living cells to monitor responses to a variety of biologically active test agents. They presented their findings Friday at the American Association for the Advancement of Science annual meeting.

"Our process requires that live cells be grown on an infrared transparent substrate giving us an opportunity to closely examine the biological effects in living cells," said Sundaram. Live cell Fourier transform infrared, FTIR, spectroscopy offers several attractive features for these investigations. These include the potential to detect biologically active nanoparticles without any prior knowledge of cell signaling pathways affected by them or need of a contrast agent to detect the biological response. Thus, live cell FTIR spectroscopy is expected to be a sentinel of exposure to help identify the physico-chemico properties of nanoparticles that mediate biological activity, without bias of what that biological activity represents.

The PNNL scientists are also developing infrared transparent chemistries that are expected to improve FTIR measurements in live cell experiments. "We believe this report outlines the first use of FTIR spectroscopy to examine the biological response of living cells to nanoparticles, and expect this technology will enable us to identify chemical changes associated with the biological response," said Weber. FTIR spectroscopy measures a broad spectrum of chemical bonds and will provide information that is complementary to genomic and proteomic approaches.

FTIR spectra are captured in minutes in live cell studies, offering a tool to rapidly detect whether nanoparticles are biologically active. This information can be used to prioritize nanoparticles for further study to ascertain the nature of the biological activity in terms of toxicity.

A broader approach underway at PNNL for discovering what environmental nanomaterials can do once they enter the body – and how they enter and where they go – is part of a large collaborative effort funded by NIH, DOE and private industry. This research is aimed at developing predictive respiratory system models for laboratory animals and humans. A key component of this multi-institution collaborative effort is a $10 million, 5-year Bioengineering Research Partnership, BRP, funded by the National Heart Lung and Blood Institute that is designed to devise 3-D imaging and computational models that provide unsurpassed detail of respiratory systems in humans and other mammals.

Advancements in medical imaging, data analysis and computation have increased "the speed and accuracy of developing detailed models of the complete respiratory system," reported Richard Corley, PNNL staff scientist and director of the multi-institutional BRP. "New imaging techniques also show promise for validating particle deposition models. Atlases of airway geometries and functional characteristics are also being constructed to facilitate analyses of variability, reduce uncertainties in animal to human extrapolations and contribute to a more quantitative representation of environment-disease interactions."

Source: Pacific Northwest National Laboratory

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