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Bacteria as an early warning system for human risk assessment to engineered nanoparticles

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The distinctive characteristics of engineered nanoparticles (ENPs) such as high surface-to-volume ratio and quantum confinement find immense application in personal care products (sunscreen cream, cosmetics, conditioner, clothing, toothpaste etc.), food packaging, drug delivery systems, therapeutics and biosensors among others. The exponential increase in the ENP containing consumer products in the market has aroused a global concern towards their safety to human and environmental health. Since the human safety to ENPs is a multi-factorial phenomenon, new paradigms are being developed. Due to the small size and reactive nature of ENPs, it has been observed that they can even interact with the macromolecules. Bacteria are amongst the simplest living organisms. They are ubiquitously present on the surfaces and in deep layers of human skin, saliva, oral mucosa, conjunctiva, and gastrointestinal tract where they play an important role in homeostatis. However, a decrease in the number of bacteria or genome alteration could lead to adverse health effects in human. These beneficial bacteria are one of the first cells to be affected by the ENPs exposure to human. It was therefore prudent to study the effect of metal oxide nanoparticles (ZnO ENPs) used in cosmetics on bacteria. Our observations provided evidence for the internalization of ENPs, transfer to next generation and frame shift mutations in bacteria. ENPs were also found to induce a significant oxidative stress as evident by the depletion in glutathione content with a concomitant increase in the production of malondialdehyde, reactive oxygen species generation and lactate dehydrogenase. Also, the genomic and proteomic analysis demonstrated a significant change in the overall expression of proteins especially the accumulation of stress and envelope protein precursors. Similar results were also observed in studies using mammalian models and human cell line. Due to these consistent responses from bacteria to mammals, it is proposed that bacteria can serve as 'early warning system' for human risk assessment to engineered nanoparticles.

Biography

Ashutosh Kumar works as an Assistant Professor in the Institute of Life Sciences, Ahmedabad University, Gujarat, India from June 2012. Before this, he worked in CSIR-Indian Institute of Toxicology Research, Lucknow as a research fellow and has been involved in understanding the adverse effects of nanomaterials on biological systems. His research areas of interest are microbiology and biotechnology with special reference to nanomaterials. He established several new methods for nanomaterial toxicology in India. He developed a novel method for the detection of uptake of nanoparticles in live bacteria for several generations.

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