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Effects of engineered metal and metal oxide nanoparticles on model aquatic organisms: Finding protein targets by redox proteomics

Biological systems interact with environmental chemicals in complex ways and biochemical markers (biomarkers) often provide information on both extent of toxicity and biochemical toxicity mechanisms. In aquatic toxicology, it is common to use bivalve species as sentinels in marine and estuarine contexts and Daphnia as a sentinel in freshwater. We have applied redox proteomics as a means of assessing environmental stress in aquatic environmental contexts for many years. Nanomaterials represent a novel category of environmental chemicals which pose unusual questions to the toxicologist. What is meant by dose? Are particles taken up by organisms and can we follow their fate in multi-organ organisms? What aspects of the nanomaterial's structure and chemistry impacts on toxicity? In particular, a key unanswered question is, how does the context of nanoparticle exposure influence toxicity? In aquatic systems there is scope for particles to agglomerate, dissolve or otherwise interact with the aquatic or sediment surrounding them. This talk focuses on three experiments in our lab in which well-characterised, engineered metal or metal oxide nanoparticles were exposed to test organisms: 1) the bivalve *Mytilus eduli*; 2) the water-flea *Daphnia magna* and 3) cultured human astrocyte cells. Our approach is to expose to doses of nanoparticles and to identify redox proteomics targets which then yield insights to likely biochemical consequences of these nanoparticles. We have developed a toolkit of gel-based and gel-free approaches for identifying and enriching for proteins yielding insights in particular to their carbonylation or thiol oxidation. The proteome seems to adapt quite quickly and in a dose-related manner to challenge by certain metal oxide nanoparticles in terms either of change of protein abundance or change in protein oxidative status. These effects are also somewhat species-specific.

Biography

David Sheehan is Head of the School of Biochemistry and Cell Biology at University College Cork (UCC), Ireland. He holds a PhD from Trinity College Dublin (1985) and a DSc (published work) from the National University of Ireland (2009). He has taught at UCC since 1989 but previously worked in the biotechnology industry (US, UK and Ireland). He is a protein biochemist with a strong interest in molecular toxicology and use of redox proteomics approaches to elucidate stress scenarios. He has published more than 100 peer-reviewed journal articles, two editions of his textbook Physical Biochemistry: Principles and Applications (Wileys) and edited several books. He serves on numerous editorial boards including Journal of Integrated Omics, Journal of Proteomics and Bioinformatics, Toxins and Drug Testing and Analysis.

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