Safety of nanomaterials

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Nanotechnology represents one of the key technologies of the twenty-first century and includes all methods that allow production, and analysis of objects sized between one and 100 nm. A large number of nanomaterials and consumer products are already used, such as paints, car tyres, tennis rackets, textiles and sunscreens. Technologically more important than use of nanomaterials in consumer products are applications in electronics, construction materials or coatings. It is expected moreover that in some areas, nanotechnologies will bring large social benefits, as with pharmaceuticals, medical technology and water purification. There are also hopes that nanotechnologies will make an important contribution to protecting the environment.

While great expectations are placed in the potential of nanotechnologies, there are also increasing warnings of possible risks due to insufficient knowledge about the effects of these technologies on the human organism and the environment (SRU 2011a). Available knowledge on the risks of nanoparticles and nanofibres varies in extent, and

in many cases, notably regarding exposures, there are major gaps in that knowledge. In recent years, the number of contributions about nanotechnology submitted to our journal has massively increased (Gibson et al. 2011; Truong et al. 2011; Heng et al. 2011a; Jeong et al. 2010). Cutting-edge topics in our journal are uptake and biodistribution (Zhang et al. 2011; Gehrke et al. 2011; Xie et al. 2010), inflammation and apoptosis (Heng et al. 2011b; Lee et al. 2011; Marano et al. 2011) as well as oxidative stress and genotoxicity (Foldbjerg et al. 2011; Clift et al. 2011; Kim et al. 2011) induced by nanoparticles.

From the research findings to date, there is no proof of adverse changes in the environment or in human health as a result of the manufacture and use of nanoparticles and nanofibres currently on the market. This cannot be taken as an all-clear, however, because understanding of the risks of these materials remains very incomplete and some research findings raise substantial concerns. A distinction can be made between materials that have been on the market for some time, where there are already toxicology and exposure studies, and new materials where hardly anything is known about toxicological profiles and environmental fate. Public debate about the opportunities and risks of nanotechnology has started (SRU 2011b) and need to be addressed by toxicologist.

There are already initial efforts at classifying nanoparticles and nanofibres into risk categories. Such materials should nonetheless be subjected case by case to science-based risk assessment for time being, as too much information on risk-determining characteristics is lacking and even very small differences, such as a coating, can critically alter a material's effects in biological systems. A crucial property for science-based risk assessment is the ability of nanoparticles and nanofibres to reach parts of organisms and cells where comparable materials at a larger

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scale are not encountered. Very little is known to date, however, about the particle characteristics that determine biopersistence within cells or organisms and may be crucial for adaptive responses or toxic reactions. Some materials such as zinc oxide and silver nanoparticles are able in physiological media to release ions that interact with cell components and thus induce effects. In comparative studies carried out so far, some of these materials had a similar effect to comparable, soluble materials, which speaks in favour of the hypothesis that ions released by the nanoparticles concerned determine their toxicity (SRU 2011a).

However, despite an enormous amount of work invested into nano research, a number of key questions have still not been answered sufficiently: Do nanoparticles have qualitatively different effects resulting from their physico-chemical properties—in other words: Is nanotoxicology more than the toxicology of the ions released from particles? Can nanoparticles accumulate in cells and organs? If yes do they reach thresholds critical for toxicity under relevant exposure scenarios? Do nanoparticles cause cardiovascular diseases as suggested by some epidemiological studies? Can certain types of nanoparticles be subsumed into classes to facilitate risk evaluation?

Considering the high relevance and topicality of nanotoxicology, the editors are pleased to present this special issue regarding the safety aspects of nanomaterials.

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