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Nanotoxicological Studies: Still in their Infancy

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Abstract
Nanoparticles have existed for millions of years on Earth and have been employed by people for different purposes. Similar in size to biological molecules like proteins, nanoparticles can exist in nature. Nanoparticles have dimensions that cannot exceed one hundred nanometers, making them much smaller than human cells. However, because of the comparatively huge amount of surface area that they cover, they are capable of having considerable specific effects. In recent years, because of the enhanced human capacity to produce synthetic nanoparticles, significant attention has been focused on nanoparticles. Nanoparticle toxicity studies have just lately emerged and are still in their infancy. More attention is needed in the field of nanoparticle toxicology in the years to come.

Keywords: Nanoparticles; Toxicological studies; Applications; Environment

Introduction
Today, nanoparticles are used in numerous industries, such as the electronics industry, medicinal applications, medicines, cosmetics and environmental activities (Taghavi et al., 2013). Nanotechnology is used in a wide variety of applications, including the delivery of medications to cancer cells, the improvement of the efficiency of solar panels, and the reduction of emissions from biodiesel engines. The economy based on nanotechnology is still expected to surge forward. However, research and development of nanomaterials have surpassed the rate at which new information regarding their effects on the environment has been accumulated (Ogden, 2013).

Depending on the surface features of the nanoparticles, the ability of molecules to "stick" to their surface might be crucial for drug delivery applications. Indeed, nanoparticles may be designed to adsorb on the surface of a particular cell in the body and deliver medicine directly to that cell (Nanotechnologies, 2022). New nanomaterials are constantly being created for a wide range of applications. Parallel to this, our scientific knowledge and capacity to explain and define the characteristics of nanomaterials is improving, although it is still restricted. More significantly, our understanding of the possible negative impacts of nanomaterials is lagging behind technological advancements. Scientific knowledge is improving, but generic descriptive models are still lacking; more practical data and a better understanding of the processes are needed to help this process (Health and environmental risks of nanoparticles and nanomaterials, 2022).

The presence of nanoparticles in the environment is spreading. Nanoparticles, which have distinct qualities, are an ingredient in countless goods. Cells respond differently to exposure to nanosilver alone compared to exposure to a mixture of nanosilver and cadmium ions. Cadmium ions can be found in nature all around the world (Nanoparticles in the environment are more harmful than thought). Nanomaterials represent a challenge in terms of determining how they vary from conventional materials in terms of physical, chemical and biological characteristics, and how this determines possible adverse consequences. New scientific and accurate procedures must be developed since existing methods may not be applicable to nanomaterial testing.

Nanoparticle toxicity studies have just lately emerged and are still in their infancy. Nanomaterials, among other things, have been employed in pharmaceutical investigations to enhance drug delivery in studies on inhaled nanoparticles and medicinal nanomaterials. (Nanotechnologies, 2022). Certain nanoparticles can harm genes and produce localized lung inflammation and allergic responses when inhaled. Some nano-fibres have the potential to cause similar reactions to asbestos, such as chronic inflammation.

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Concerns about internal exposure arise from the possibility that some particles might enter the circulation and build up in internal organs like the liver and spleen. It is possible for nanoparticulate materials to infiltrate cells and have both direct and indirect genotoxic effects (Health and environmental risks of nanoparticles and nanomaterials, 2022).

When inhaled nanoparticles enter the body via the nose, another possible pathway is the olfactory nerve; nanoparticles may pass the mucous membrane and then go to the brain. Only one of three human investigations revealed that inhaled nanoparticles entered the circulation after being breathed into the lungs. It is plausible to believe that the findings of these studies may be generalized to other species; however, further study is needed to confirm this assumption. Several studies have evaluated the absorption and impacts of nanoparticles at the cellular level to evaluate their influence on humans. In addition, thorough analysis and interpretation of the available data as well as careful planning of new research are required to determine the true impact of nanoparticles on the environment and the distinctions between them and larger, conventional forms of the substances (Nanotechnologies, 2022). Various nanomaterials can also trigger chemical reactions that might be harmful to the environment because they can wipe out bacteria, plankton and other small organisms. The nanoparticles of many metals and metal oxides are effective catalysts. These catalytic nanomaterials may enhance chemical reactions that result in hazardous chemicals like free radicals or reactive oxygen species if they are released into the environment. One of these nanomaterials is titanium dioxide (TiO_2), which is a good photocatalyst (ultraviolet light exposure activates its catalytic capabilities). When exposed to sunlight, titanium dioxide nanoparticles may catalyze chemical processes that raise the quantities of numerous ROSs (including hydroxide and superoxide radicals) in natural waters. These reactive oxygen species are known to be toxic to many aquatic creatures, including plankton and tiny fish (Lohse, 2014).

The bulk and molecular equivalents of nanoparticles are very different from those of their bulk counterparts (Biswas and Wu, 2005). Natural and artificial nanoparticles (NPs) entering the environment are impacted by several physicochemical processes and display diverse behaviour in different systems (e.g., natural waters showing different characteristics). Determining the physicochemical features and forecasting the behaviour of nanoparticles ending up in the natural aquatic environment are crucial parts of their risk assessment (Swirog et al., 2022). Because certain nanomaterials have unique features, conventional risk assessment methodologies must be changed to evaluate the danger of exposure to nanoparticles in real-world situations. In addition to taking a lot of time, this also demands a lot of work. Pragmatic ways have been developed to help evaluate and then manage exposure to nanoparticles in the workplace (Health and environmental risks of nanoparticles and nanomaterials, 2022). The bioavailability of nanoparticles and the patterns that relate toxicity to particle size, roughness, shape, charge, composition, surface coating and physiological processes are still not well understood. Neither are the patterns themselves. Due to the vast number of unanswered issues posed by these nano moieties, a greater number of investigations into the toxicological aspects of nanoparticles are needed.

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ZS conceived the concept, wrote and approved the manuscript.

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