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A mini review on toxic effects of nanomaterial's on human health

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Abstract
Humans are already exposed to a range of natural and man-made nanoparticles in the air, and exposure via the food chain, water supply, and medical applications. Nanoparticles are very tiny particles of nanometre size have a great deal to offer to improve our quality of life but A challenges were posed by Nanoparticles is to determine in what way their physical, chemical and biological properties are different to conventional materials and how this influences potential harmful effects. Nanoparticles are toxic materials, because it may interact with biological systems. Inhaling certain Nano-sized particles may result in local lung inflammation, allergic responses or harmful effects on genes. Some specific types of Nano-fibres may cause similar reactions as asbestos. Nanoparticles concerns are related to internal exposure, as some particles may enter the bloodstream and accumulate in organs like the liver and spleen. Nanoparticles easily enter cells, which might in turn lead to direct and indirect nontoxic effects.
During literature review it is found that several researchers have found toxic effects of Nanomaterial's. Much more studies are needed to evaluate the stability of these matrices in a variety of test systems to fully determine the potential for human exposure to the Nano scale components of commercially available products, as well as future products.

Keywords: Nanoparticles, toxic effects, biological systems etc

Introduction
Nanotechnology is rapidly developing fields with many opportunities for innovation. However, numerous uncertainties exist regarding their possible impact on the environment and human health. Despite its uncertain environmental, health and safety impacts, nanotechnology has shown a great potential for multifunctional and high-performance products for innumerable commercial and industrial applications. The advancing knowledge in Nano science, nanomaterial's have a wide spectrum of applications in our society. The Measures taken to protect the environment from possible adverse effects caused by nanomaterial's may have unidentified effects on society. The society as well as individuals, might accept the potential risks, if the benefits of nanotechnology (e.g., applications in cancer treatment and other areas of medicine and in more-efficient energy systems) are clear. Most nanomaterials are being used in products with direct exposure to humans [Fig. 1 and 2]. For example, TiO_2 nanoparticles are used in food colouring, cosmetics, skin care products, and tattoo pigment [1-3]. Nanoparticles have attracted a lot of attention because of our increasing ability to synthesize and manipulates such materials. The other most important factors on toxicity of nanomaterials are their shape and morphology. Numerous studies showed that shape of NM can highly influence their rate of uptake. The forecasted huge increase in the manufacture and use of nanoparticles makes it likely that increasing human and environmental exposure to nanoparticles will occur.
The nanoparticles influence how they interact with cells and, thus, their overall potential toxicity. Recent studies have begun identifying various properties that make some nanoparticles more toxic than others. Theoretically, particle size is likely to contribute to cytotoxicity. Small nanoparticles of same mass have a larger specific surface area (SSA) and thus more available surface area to interact with cellular components such as nucleic acids, proteins, fatty acids, and carbohydrates. The smaller size also likely makes it possible to enter the cell, causing cellular damage. In some nanoparticles, toxicity was found to be a function of both size and specific surface area.

Fig 1: Hyperpigmentation

Fig 2: Titanium Dioxide the toxic effects on human health

Toxic effects of nanomaterial's

The toxicity of Nanoparticles is largely determined by their physical and chemical characteristics, such as their size, shape, specific surface area, surface charge, catalytic activity, and the presence or absence of a shell and active groups on the surface. Due to small size of nanoparticles is one of the main factors which may make them harmful to human health.

Size of nanoparticles

Reduction in size to the Nano scale level results in an enormous increase of surface to volume ratio, so relatively more molecules of the chemical are present on the surface, thus enhancing the intrinsic toxicity [4]. This may be one of the reasons why nanoparticles are generally more toxic than larger particles of the same insoluble material when compared on a mass dose base.

In addition to being able to cross cell membranes, reach the blood and various organs because of their very small size, nanoparticles of any material have a much greater surface to volume ratio (i.e. the surface area compared to the volume) than larger particles of that same material. Therefore, relatively more molecules of the chemical are present on the surface. This may be one of the reasons why nanoparticles are generally more toxic than larger particles of the same composition.

The small size of Nanoparticles allows them to penetrate through epithelial and endothelial barriers into the lymph and blood to be carried by the bloodstream and lymph stream to different organs and tissues, including the brain, heart, liver, kidneys, spleen, bone marrow, and nervous system [5, 6], and either be transported into cells by transcytosis mechanisms or simply diffuse into them through the cell membrane.

Chemical composition and surface characteristics

The toxicity of nanoparticles depends on their chemical composition, but also on the composition of any chemicals adsorbed onto their surfaces. However, the surfaces of nanoparticles can be modified to make them less harmful to health.

Although the toxicity of nanoparticles strongly depends on their size and shape, the influence of other factors, such as the nanoparticle chemical composition and crystal structure, should not be disregarded. Comparison of the effects of 20-nm silicon dioxide (SiO_2) and zinc oxide (ZnO) nanoparticles on mouse fibroblasts has shown that they differ in the mechanisms of toxicity. ZnO NPs cause oxidative stress, whereas SiO_2 nanoparticles alter the DNA structure.

The size, morphology, concentration, aggregation mode, charge, surface properties all have an impact on toxicity and must be considered in order to prevent the harmful effects of NPs. It was known that toxicity of metallic and metal oxide NPs is directly related to its surface properties hence alterations in the surface of these NPs can be a good idea for mitigating their possible harmful effects.

The effect of nanoparticles shape on toxicity

Nanoparticles can have a variety of shapes and geometries including spheres, ellipsoids, cylinders, sheets, cubes, spikes, and rods which considerably affect the toxicity. In this relation, the round-shaped NPs are more susceptible to endocytosis than NPs with fiber and tube geometry [7]. Also, it was indicated that [8] plate-like and needle-like NPs induce larger necrosis proportions than other spherical and rod-like NPs since these shapes have more capacity to induce physical damages to cells and live tissues by direct contact. In addition, in gold NPs, geometry and shape of the NPs have an impact on the accumulation kinetics and its excretion and only star-like shapes can be stored in the lung, also it was confirmed that shape and geometrical variations do not considerably increase their chance to pass the blood-brain barriers [9].

Toxic effects

- Allergy
- Organ failure
- Immune functions as Liver, kidney, spleen, lung, membrane integrity and oxidative stress.
- Tissue damage
- DNA damage
- Increase inexpression of genes
- Decreases the rate of aerobic respiration

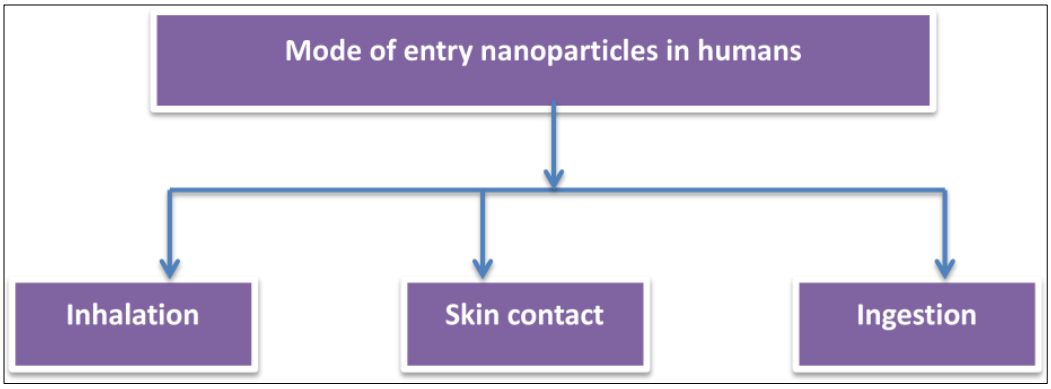
Toxicity of nanoparticles depending on

- Nature of chemical used for the synthesis
- Type of precursor
- Concentration of precursor
- Duration of Exposure
- Personal susceptibility
- Mode of entry
- Environmental factors
- Threshold value

Characteristics of nanomaterial's that can give rise to toxicity

- Particle size and surface area are most important material characteristics from toxicological perspective.
- Surface area to volume ratio of the particles is increased.
- Accumulation of inert particles in the body.

The synthesis of nanoparticles at large scale will cause exposure through these routes.



Conclusions

Recently, many researches have been continuously carrying out to test the possible Nanoparticles activities and several concerns related to their use have been raised. The physical and chemical properties of Nanoparticles must be taken into close consideration before interpreting the results and drawing conclusions. In fact, it appears clear that, first, characterization of the specific nanoparticle through its size, shape, surface charge and surface area, etc. properties, is an indispensable and critical step to obtain reliable studies. In addition, more regard should also be devoted to the possibility that crystal structure after interaction with water or other liquids or biological structures could be modified giving different properties. Thus, much attention should be addressed to the relationship between the exact Nanoparticles property and toxicity.

Actually, although several inconsistent outcomes related to their toxicity are reported, it is nevertheless clear that regardless of their origin, man-made or unintentionally released Nanoparticles may share several common adverse effects on health. Toxicity of nanoparticles has been reviewed in several reports and the most severe problem is related to the carcinogenic potential of NPs that has been associated both to the chemistry as well as to the physical properties. In particular, chemistry was considered to be relevant for the oxidative DNA damage and the formation of radical oxygen species (ROS) involved via direct mechanisms, whereas size, morphology and surface seem to be more important in all the other indirect mechanisms that underlie of cancer.

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