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Positive and Negative Impacts of Nanotechnology

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Abstract

Nanomaterials can be synthesized due to high surface energies of the constitutional elements. Higher surface energies help in greater adsorption. It is well known that nanomaterials are currently useful in almost all fields of human use. Positive aspects of nanotechnology are well researched upon However, the negative aspects of nanomaterials have not been studied much to date. Hence, there is a need to delve more into the negative aspects of nanomaterials This paper reviews both the positive and the negative effects of nanotechnology in a balanced way .The study suggests a good balance in the use of nanotechnology.

Keywords: Nanotechnology; Health; Negative impacts, Balanced approach; Nanorobots; Environment

Introduction

Nanotechnology has taken its roots in physics, chemistry and materials science as suggested by (Hulla et al., 2015). When we talk about Nano, everything positive strikes like improving mechanical and electrical properties of materials, enhanced drug delivery, nanorobots and nanosensors. Diseases can be cured/controlled by injecting minute quantities of nanomedicines through nanorobots. These are the positive aspects of nanotechnology. However, the same nanoparticles could be inhaled when used constantly, thereby getting lodged in the lungs. These nanoparticles, over a long period of time,could have the same effect as nicotine or other particulate matter being lodged in the lungs. The human body is designed in such a way that any foreign material that the body is not familiar with, is ejected out of the body. But, if the foreign material is too fine to affect the initial systems of defence, then the foreign particle can get absorbed into the system. Hence, we see that an effective balance should be maintained in the use of nanotech. The literature given below highlights both aspects of nanotechnology.

Literature review

Health hazards due to nanoparticles can be divided into 2 categories-(i)Known Risks(ii) Unknown risks. It is known that very fine particles can lodge in the lungs and in the long run give respiratory diseases. This phenomenon has been observed the world over due to Suspended Particulate Matter (SPM)in the atmosphere. SPMs in the atmosphere, especially during peak traffic hours has been known to cause allergies, asthma, running nose and other forms of respiratory trouble, especially in children and old people. So, it is expected that a similar effect could be possible when one inhales nanoparticles for an extended period of time. This can be called as known risk. A detailed analysis of known and unknown health risks has been dealt with by Hoet et al. (2004). Fine particles, when made into nanosize become Ultra Fine particles (UFPs).These UFPs, when they float around in the air and mix with other particles could potentially be a source of a toxic particle mixture(TPM). The effects of this toxic mix have not been studied in detail to date. This mix could lead to unknown risk factors. A good review of this type of health hazard is given by Gwinn et al. (2006). Figure 1 summarizes the modern applications of nanotechnology.

Positive impacts of nanotechnology

Silver is deposited on medical equipments to reduce the spread of microorganisms. Heart disease and cancer detection and prevention can be done using nanoparticles Massaro et al. (2021). Activated carbon can further be used in water purification and adsorption processes to kill

coronaviruses in a safe manner (Ruiz Hitski et al., 2020). Protective personal equipments are made using nanomaterials (Bassodan et al., 2021). Super-hydrophobic surgical masks have been developed by adding a layer of Graphene through Laser-induced forward transfer (LIFT) mechanisms (Konvalina et al., 2014). Research is being done by many Nanotech companies on developing vaccines for SARS type of diseases (Yayerhad et al., 2021). Nanofibers are used in air filtration and purification (Vaidiglasiasis et al., 2020). Ultraviolet protective coatings need nanomaterials (Pissarenko et al., 2020). Figure 2 shown below summarizes the positive applications of nanotechnology.

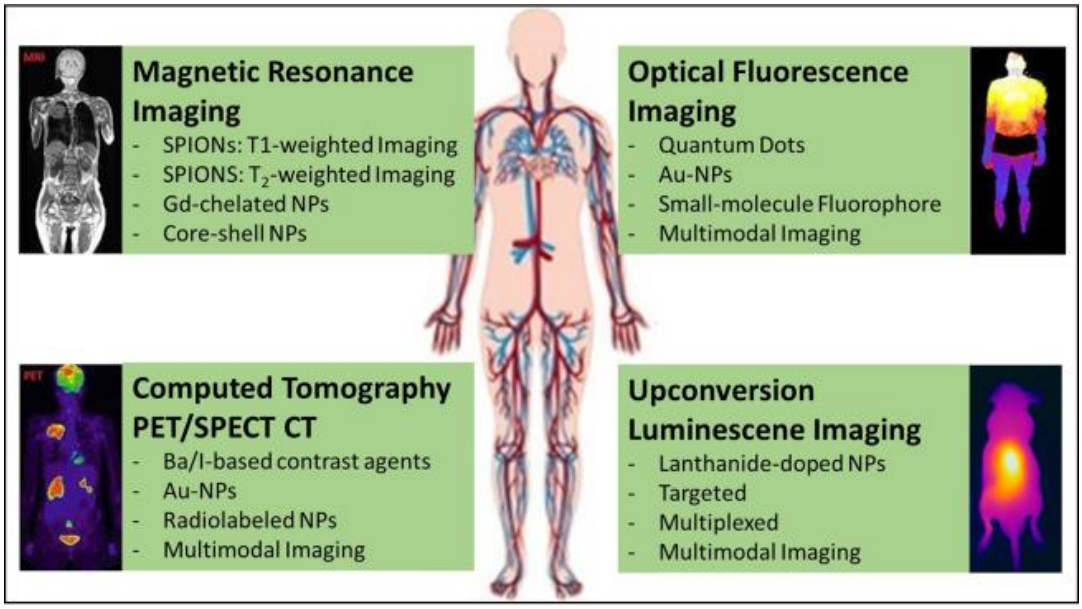

Figure 1. shows the applications of nanotechnology in the current age (Amit Singh et al.,2021)

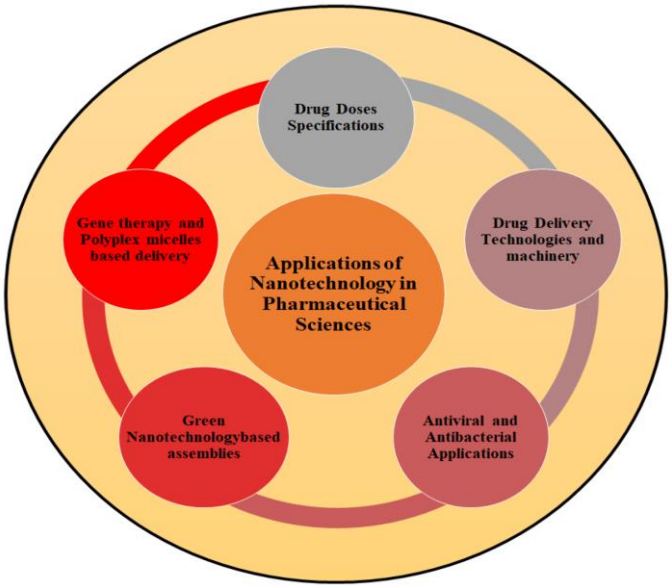

Figure 2. Nanotechnology applications for health (Shiza Malik et al., 2023)

Negative impacts of nanotechnology

Nanotoxicology is the study of the effects of nanotechnology in negative ways. Mancuso et al. (2014) found that the level of toxicity is dependent on size, composition, surface functionality and crystal and crystallinity. Warheit et al. (2003) and Lam et. (2003) have studied the effect of single-walled nanotubes on the trachea of mice and rats. Both groups found interstitial inflammation and granuloma formation when carbon nanotubes were instilled in the trachea. Another study has shown that carbon nanotubes are much more toxic than both carbon black and quartz, when they somehow reach upto the lungs. Fortunately, a study by the National Institute for Occupational Safety and Health (NIOSH) has indicated that only a fraction of the carbon nanotubes present in the air are capable of being inhaled. Maynard et al. (2004) noted that the major fraction which is not inhaled could react with the already toxic mix present in the atmosphere, leading to the creation of new chemical compounds whose overall effect on mankind has not been known so far. These

chemicals' overall effect on mankind has not been known so far. Yokel et al. (2011) have found that frequent exposure to nanoparticles has been regarded as a public health hazard.

Studies have also been done on the clearance of these particles from the lungs. UltrafineTiO_2(<20nm) is expelled out slowly from the lungs. This meant that they had a higher tendency to stay in the lungs. showed a higher tendency to occupy interstitial sites than fine TiO_2(>200nm) (Oberdoster et al., 1994). Studies on inflammation showed that the key factor giving higher inflammation of the lungs is specific surface area. The higher the specific surface area, the higher the inflammation. This could be due to higher adsorption effects when the specific surface area is more. Similarly, the incidence of tumours in lungs has been shown to be dependent on specific surface area (Driscoll, 1997; Oberdoster et al., 1994). Clearance from the lung depends not only on the total mass of particles inhaled but also on the particle size and, by implication, on the particle surface, as shown in the following studies. Figure 3 summarizes the negative applications of nanotechnology. Merchant et al. (2009) and Ajazuddeen et al. (2015) found that human gastrointestinal tract and lungs are found to be adversely affected. Sastry et al. (2003) have recommended that there is a necessity to perform toxicity listing of nanomaterials.

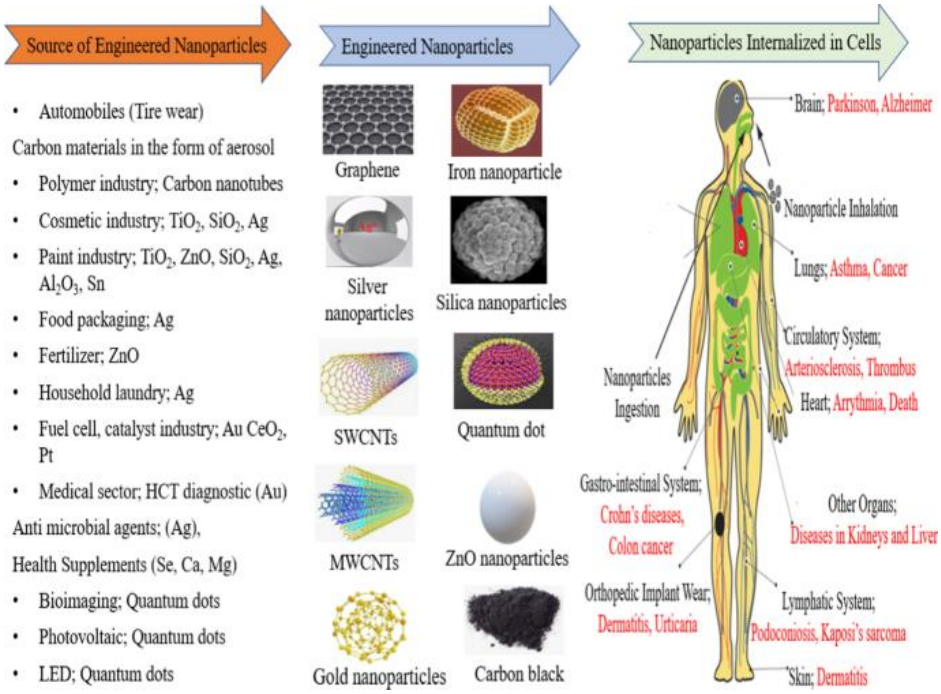

Figure 3. Sources of nanoparticles and their effects on the human body (Cristina Buiza et al., 2008)

Hence, we see that the negative effects of nanotechnology are serious and one should take stringent steps while handling nanomaterials.

Conclusions

Nanotechnology is here to stay and will benefit society at large, in all areas of existence. However, overuse of any technology is not good and one should use this technology judiciously. There is information in the literature to prove that a critical size of the nanoparticle may exist below which the particle can be absorbed by the internal organs. This may vary depending on the organ. In conclusion, we may state that nanotechnology has both positive and negative uses and care should be taken in the use of these nanomaterials.

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