Application of Nanotechnology-A review Paper

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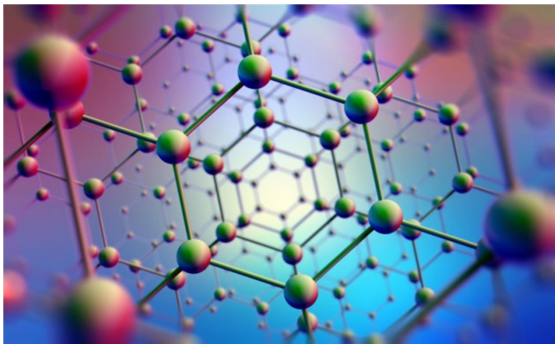
Abstract

Nanotechnology, also known as Nanotech, is the field of materials research, i.e., particles ranging between the scale of 1 and 100 nanometers used for industrial purposes. This paper is for anyone who wants to grasp a clear understanding of Nanotechnology and its Use Cases. This paper elaborates Nanotechnology, Various types of Nanomaterials, Applications of Nanotechnology, and drawbacks of Nanotechnology.

1. INTRODUCTION

Particles in Nanotechnology refer to handling materials on an atomic and molecular scale. The size of the molecules/particles are ranged from 0.1 to 100 nanometer (1 nm = 1 X 10^{-9} m) .The theory of nanotechnology relies on the basis that particle size of fewer than one hundred nanometers provides a material containing the structure and properties of different behaviors. However, these particles illustrate new physical and chemical theories, causing innovative behavior that relies on particle sizing. It has been detected, for instance, that the electronic structure, interactive connectivity, the degree of fusion, and mechanical properties of the material are all altered by a change in the size of the Particle by critical scale value. At this stage, the principles of quantum mechanics laws define the behavior of Particle rather than traditional physics laws.

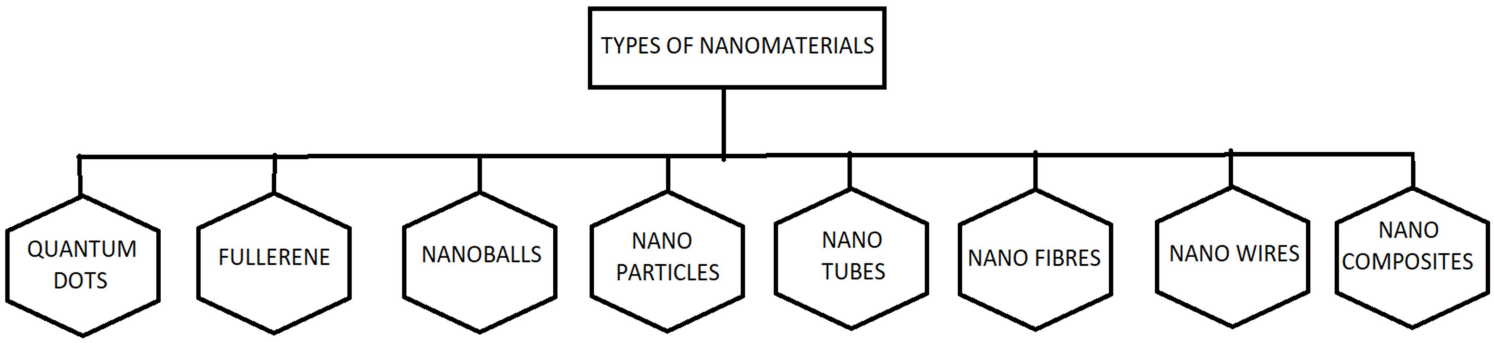


The behavior of material depends on the size of the engineering properties of a control. Finally, the researchers determined that this theory is a worthy technique effect on a wide variety of technical ranges, including the production of light and strong material, reduced drug delivery time, nanoscale to the human circulatory system, increasing the size of the absorption of magnetic tapes. In general, nanotechnology deals with several combinations of dimensions of the rank of nanometer materials [2].

Thinking, Nanotechnology is innovative, but it has been there with us since birth. A living cell is the leading case of the ordinary nanotechnology technique, which is a cell origin of a significant number of biological machines. Nanosize is the synthesis of proteins inside lines joined the Nano size named (liposome). It is designed by the last Nano named (Golgi apparatus), but the Enzymes, Nano-machine, separate the particles collected by the need or the cell. Thus, it can be for machines manufactured nanomaterials that work together and achieve the anticipated goal, for example, the analysis of the cell contents, drug delivery to or destruction when they become harmless [3].

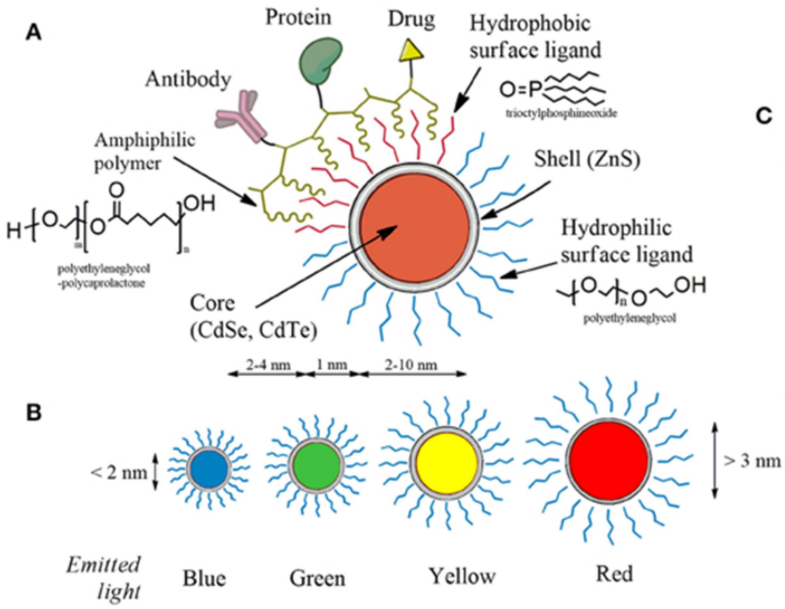
II. TYPES OF NANOMATERIALS

The Nanomaterials are classified into eight types listed below based on their behavior, and Properties are :



A. Quantum Dots :

QDs are inorganic nanocrystals, approximately 1–10 nm in size, with unique optical properties of broad excitation, narrow size-tunable emission spectra, high photochemical stability, and negligible photobleaching. They have been widely used, mainly as fluorophore alternatives, to develop optical biosensors to detections, organic compounds, pharmaceutical analytes, and biomolecules such as nucleic acids, proteins, amino acids, enzymes, carbohydrates, and neurotransmitters. They have also been employed for the in vivo detection of target sites in cancer. They are the ideal candidates for multiplexed optical bioanalysis due to their ultrahigh sensitivity, high specificity, cost-effectiveness, miniaturized size, size-dependent emission wavelength, and rapid analyte detection [4].

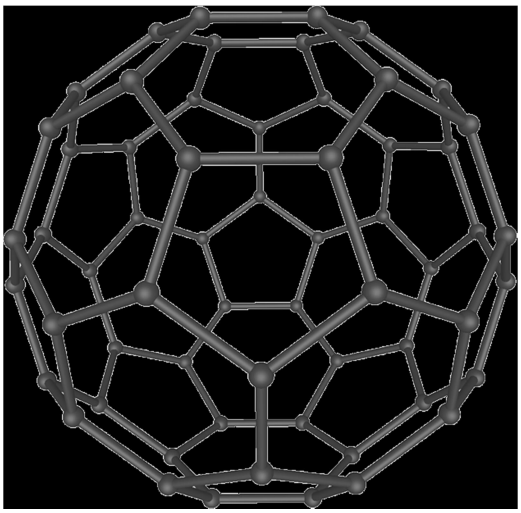


C *Fluorescence lifetimes*

Flurophore	Lifetime (ns)
Tyrosine	2.5
eGFP	2.71
Alexa 488	4
Tissue autofluoresence	1 – 10
Quantum dots	10 – 30
PEG-LPSiNPs	$1.2x10^4$

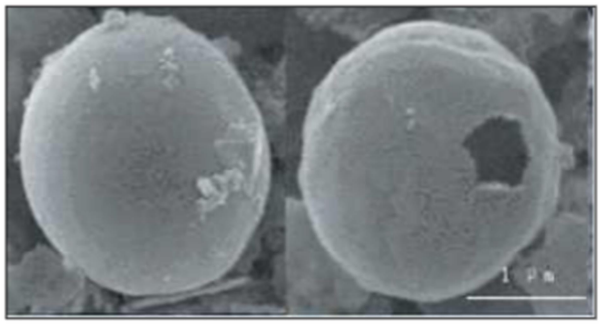
B. Fullerene :

A fullerene is an allotrope of carbon whose molecule consists of carbon atoms connected by single and double bonds to form a closed or partially closed mesh, with fused rings of five to seven atoms. The molecule may be a hollow sphere, ellipsoid, tube, or many other shapes and sizes. Graphene (isolated atomic layers of graphite), a flat mesh of regular hexagonal rings, can be seen as an extreme family member. The family is named after buckminsterfullerene (C60), the most famous member, which in turn is named after Buckminster Fuller. Other Fullerene cone and tubular forms have also been discovered in football [5].



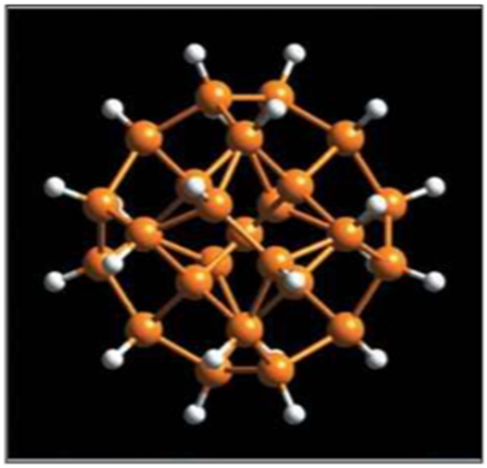
C. Nanoballs:

Nano-carbon balls, A fullerene category of material C_{60}, differ as they form multiple crusts. It also has an empty place, whereas the surface has no gaps, as is the situation in multiple cover nanotubes—the diameter of the balls up to 500 nm nanoparticles or more [5].



D. Nanoparticles :

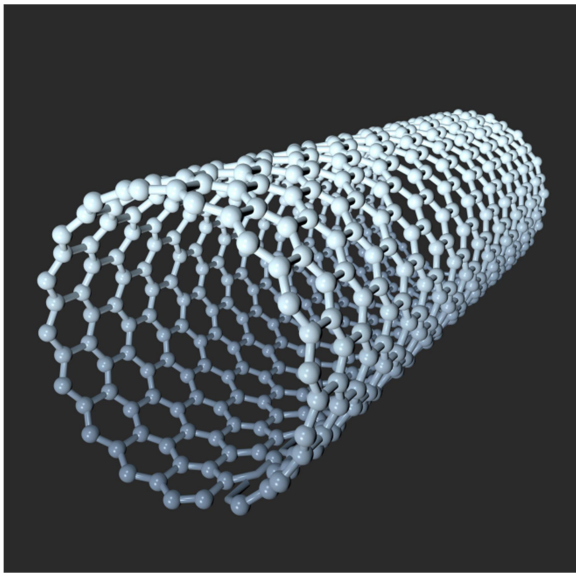
The nanoparticles have been present since ancient times. For example, the beautiful colors of rusty class windows are small clusters of metallic oxides in the glass where sizes are near enough the wavelength of light. Thus, the different sizes of particles distract the different wavelengths of light, causing the emergence of different glass colors [6].



Nanoparticles are particles having an almost spherical radius of less than 100 nm. It just could manufacture nanoparticles of metals and insulators, semiconductors, and hybrid combinations (such as nanoparticles coated), as well as models of Nanoparticles with a semi-nature - a solid manufacturing liposomes[7].

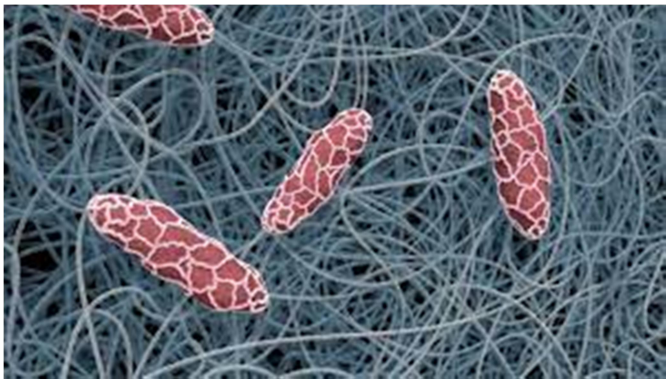
E. Nanotubes:

Nanotubes are nanoparticles of carbon discovered in 1991. Nanotubes have importance due to their characteristics and extensive applications in industrial, scientific, medical, and bio-electronic devices. Nanotubes are carbon nanotubes in which a graphite segment is folded around the axis of a cylindrical shape; atoms are linked with each end of the slide to close the tube. The tube ends might be in the form of a hemisphere.



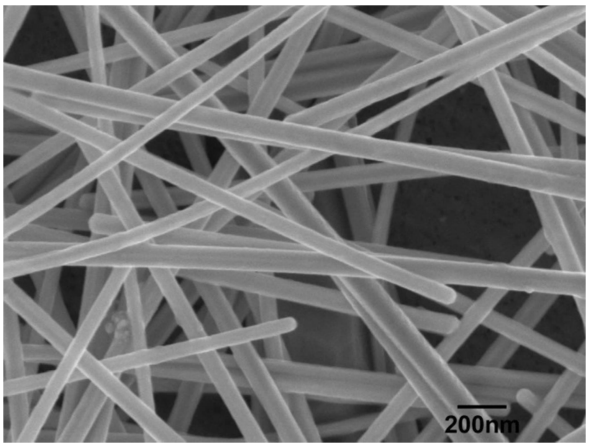
F. Nanofibers:

Fiber nanoparticles are those made of atoms polymers, and the surface area is relative to the size in the case of fiber. Nanoparticles and Nanotubes have many large surface atoms compared to the total number, making such fibers distinctive mechanical properties. For example, hardness and tensile strength, with no competitor for the usage as filters in the refinement of gases or liquids. In biomedicine, organ transplantation, such as arthritis and transport of drugs in the body, and military use such as reducing air resistance, especially after developing preparation methods [8].



G. Nanowires :

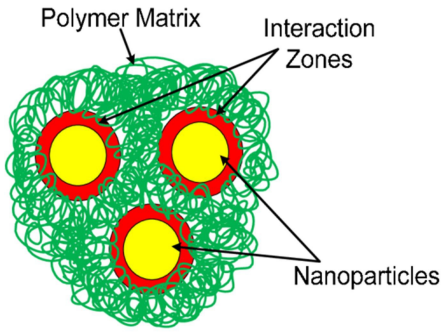
A nanowire is a nanostructure with a diameter of the order of a nanometre (10^{-9} meters). More generally, nanowires are thickness or diameter constrained to tens of nanometers or less and an unconstrained length. Quantum mechanical effects are significant at these scales, which coined the term "quantum wires." Many different types of nanowires exist, including superconducting (e.g., YBCO[1]), metallic (e.g., Ni, Pt, Au, Ag), semiconducting (e.g., silicon nanowires (SiNWs), InP, GaN), and insulating (e.g., SiO2, TiO2). Molecular nanowires are composed of repeating molecular units, either organic (e.g., DNA) or inorganic (e.g., Mo6S9−xIx) [9].



H. Nan Composites:

The Nanocomposite is a multiphase solid material where one of the phases has one, two, or three dimensions of less than 100 nanometers (nm) or structures having nanoscale repeat distances between the different phases that and create new materials with unprecedented flexibility and improvement in their physical properties.

In the broadest sense, this definition can include porous make up the material. The idea behind Nanocomposite is to use building blocks with dimensions in nanometre range to design media, colloids, gels, and copolymers but is more usually taken to mean the solid combination of a bulk matrix and nano-dimensional phase(s) differing in properties due to dissimilarities in structure and chemistry. The mechanical, electrical, thermal, optical, electrochemical, catalytic properties of the Nanocomposite will differ markedly from that of the component materials. Size limits for these effects have been proposed:[10]



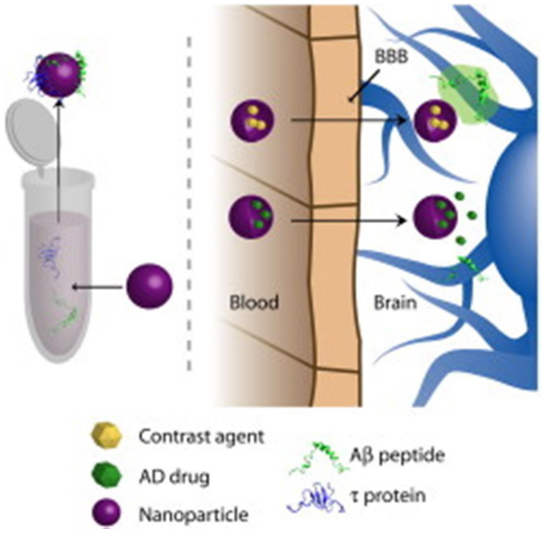
III. APPLICATIONS OF NANOTECHNOLOGY

There are many applications of nanotechnology in our daily lives. Some of them listed below are:-

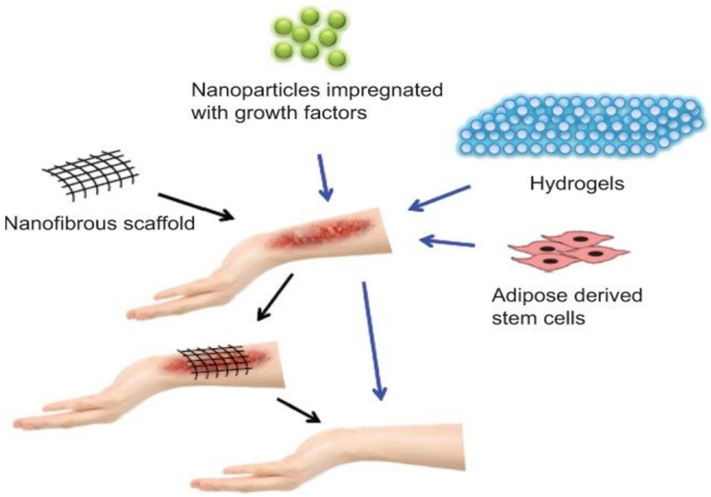
- Medical Applications

The medical applications of nanotechnology include using nanoparticles for medical treatment, which results in high precision curing diseases.

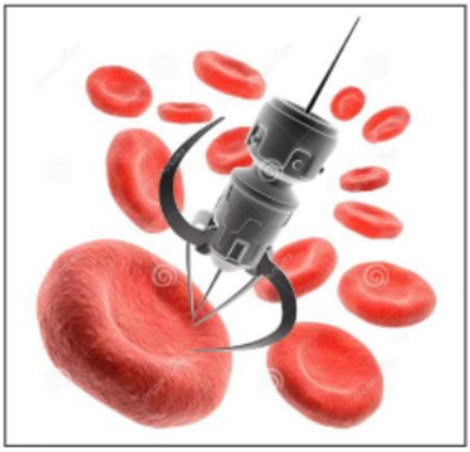
1. Disease Detector: Nanowires are used as sensors vital Nano are of large size nanoscale are used for sensitivity, where as the coating of these nanowires antibodies manufactured so that they only vital molecules stick (DNA), or proteins, or other biological inside the body particles, and no other molecules, and when linked these proteins or other nanowires coated the connection will change, and so it can use this vital nanoscale sensor to detect a large number of diseases in their early stages, and that the introduction of large numbers of nanowires inside the body is painted with different antibodies, representing different sensors [11].



2. Skin Treatment: Bio-Nano-generators, as nanoscale electrochemical devices, produce the electrical ability of blood glucose in the body and then utilize this ability to run different nanoscale devices planted within the human body, for instance, pacemakers devices or robots sugar nanoparticles injection. A promising medical application of nanotechnology is using polymer Nano-fibres to make prosthetic blood vessels. In recent times, growing prosthesis devices made of nanoscale protein fibers have been used in the central nervous system of the human body. Furthermore, the polymer Nano-fibres treat burns, wounds, and intervention in the cosmetics[7].



3. Cancer Treatment: When injected cadmium selenide nanoparticles (points quantity) within the body, they accumulate within cancer cells selectively in the case of exposure to the target region ultraviolet light, particles light up, assisting in defining the site of malignant cells and removing them carefully.



Energy applications

The energy applications of nanotechnology include using nanoparticles to store energy, which promotes renewable energy use without carbon dioxide emission.

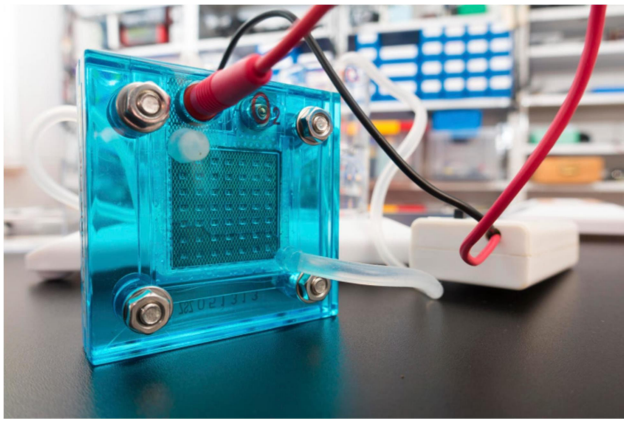
1. Solar Cells ;

Nanoparticles used in solar cells increase the amount of energy absorbed from sunlight [13].
Graphene-based solar cells say the researchers from the Ocean University of China, would derive energy from raindrops that happen to fall on the panel by taking advantage of the various salts present within the liquid.

The graphene sheets that make up the solar cells would separate the positively charged ions in rainwater, including sodium, calcium, and ammonium. These positive ions bind to the ultra-thin graphene layer to form a double layer (also called a pseudocapacitor) with the present electrons. The potential energy difference between the two layers generates the electrical current, making graphene one of the best-used materials for Solar Cells.

2. Hydrogen Fuel Cells :

Nanotechnology is enabling the use of hydrogen energy at a much higher capacity. Hydrogen fuel cells are a great source of storing sunlight eco-friendly without any Co_2 emissions. Traditionally, hydrogen fuel cells were not cheap and durable enough. However, researchers have discovered that nano blades can store more significant volumes of hydrogen that can then be saved inside carbon nanotubes for long-term storage. Affecting the durability and price over time improve significantly [15].



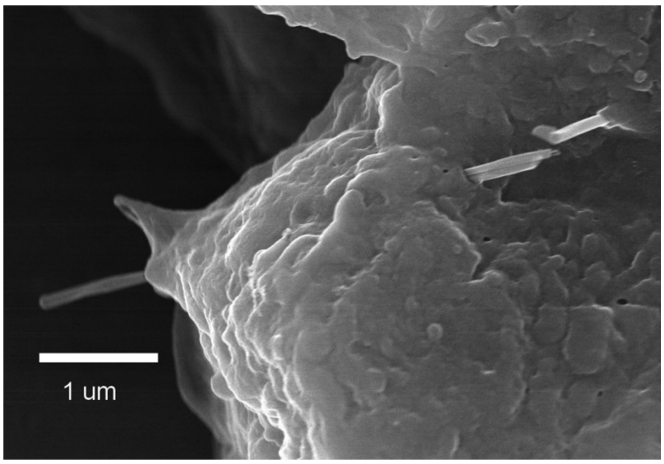
IV. DANGERS OF NANOTECHNOLOGY

Due to their shape and size, Nanoparticles are extremely useful but can be highly hazardous on the other side. Nanotoxicology is the field that studies the potential health risks of nanomaterials. The potential risks and dangers involved are discussed in this section below :

- Medical Hazards

1. Respiratory :

The deposition of the nanoparticles due to their smaller shape and size in the respiratory tract causes pulmonary effects, including inflammation, granulomas, and pulmonary fibrosis [16].



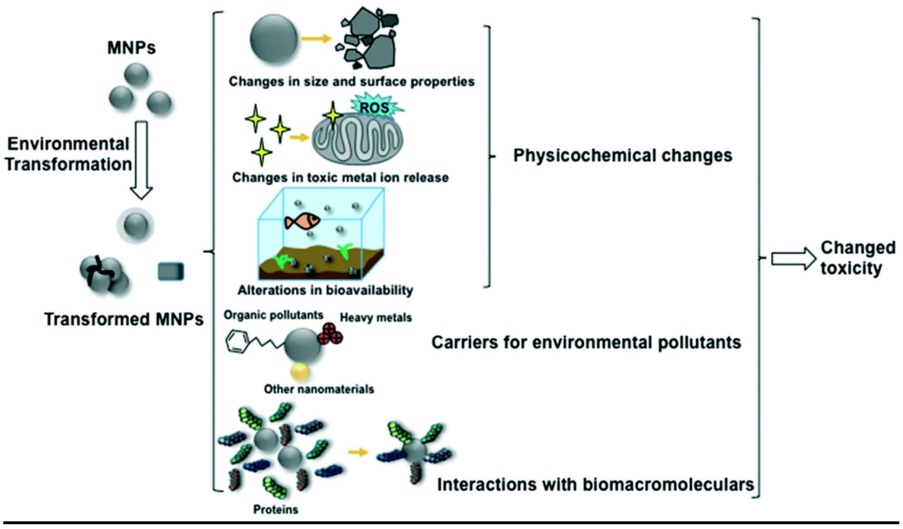
2. Gastrointestinal :

Ingestion of nanoparticles occurs from the unintentional hand-to-mouth transfer of materials; It can be assumed that this can reasonably happen while handling nanomaterials. Causing swelling issues [16].

- Environmental Hazards

Several scientific studies have indicated that nanoparticles can cause a series of adverse physiological and cellular effects on plants, including root length inhibition, biomass reduction, altered transpiration rate, developmental delay, chlorophyll synthesis disruption, cell membrane damage, and chromosomal aberration.[17] Though genetic damage induced by metal nanoparticles in plants has been documented, the mechanism of that damage, its severity, and whether the damage is reversible remain active areas of study.[18]

Studies of CeO2 nanoparticles were shown to diminish nitrogen fixation significantly in the root nodules of soybean plants, leading to stunted growth. Positive charges on nanoparticles were shown to destroy the membrane lipid bilayers in animal cells and interfere with overall cellular structure. For animals, it has been shown that nanoparticles can provoke inflammation, oxidative stress and modify mitochondrial distribution. These effects were dose-dependent and varied by nanoparticle type.



V.
CONCLUSION

Nanotechnology is a vast field of research, and due to the hyperlinked and interference of various applied fields, it is more difficult to summarize. During this paper, we have defined nanotechnology based on some research and introduced different types of nanotechnology in detail. In the future, we will see more applications of nanotechnology in household purposes but also need to keep in mind their dangers while handling nanomaterials.

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