An Introductory overview of nanotechnology

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Abstract

Exploiting the special characteristics of materials at the nanoscale is known as nanotechnology. Due of the improved quality and smarter goods that nanotechnology offers, it has becoming more popular across a variety of industries. Nanomedicine is the use of nanotechnology in healthcare and medicine, and it has been utilized to treat some of the most widespread illnesses, such as cancer and cardiovascular conditions. An overview of recent developments in nanotechnology in the areas of imaging and medication delivery is given in the current article.

Keywords – Nanotechnology, Nanoscience, Medicine, Cardiovascular disease.

Introduction

Nanotechnology is the use of this knowledge to make or change novel items. Nanoscience is the study of the special properties of materials between 1-100 nm. Nanomaterials can be made thanks to the capacity to modify atomic-scale structures. Nanomaterials can be employed in a variety of applications, including electronics and medical, since they exhibit special optical, electrical, and/or magnetic capabilities at the nanoscales. Because they offer a high surface area to volume ratio, nanomaterials are exceptional. Nanomaterials are regulated by the principles of quantum mechanics rather than the classical laws of physics and chemistry, in contrast to conventional large-scale manufactured objects and systems. Nanotechnology, in its simplest form, is the creation of useful things and working systems at the atomic or molecular size.

Since nanotechnologies offer better-built, safer, cleaner, longer-lasting, and smarter goods for agriculture, communications, everyday life, and other industries, they have significantly impacted practically all sectors of the economy and society. There are two main categories of how nanoparticles are used in common items. First, by incorporating some of its special features into a pre-existing product, nanomaterials can enhance the composite products' overall performance. Otherwise, due to their unique features, nanomaterials like nanoparticles and nanocrystals can be used directly to produce sophisticated devices with high power.

Nearly all industrial areas may be impacted by the advantages of nanomaterials in the future.Sunscreens, cosmetics, athletic goods, tyres, electronics, and many other commonplace objects all make use of nanoparticles for good. A further example of how nanotechnologies have significantly impacted medical advancements is how they have completely changed diagnostic techniques, imaging, and drug delivery.[1]

Definition of nanotechnology

The prefix "nano" refers to a Greek prefix that means "dwarf" or "very small" and represents one millionth of a meter (109 m). We must distinguish between nanotechnology and nanoscience. Nanotechnology, which applies nanoscience to make things like electronics and other objects, is the branch of technology that studies structures and molecules on scales between 1 and 100 nm.[2]

Application in medicine

It should be able to build machines on the micrometer size from components on the nanoscale scale within the next 10 to 20 years. Such devices may incorporate helpful robotic subassemblies like 100 nanometer manipulator arms, 10 nm sorting rotors for reagent purification on a molecule-by-molecule basis, and smooth, ultra-hard surfaces formed of automatically perfect diamond.

The crucial responsibility of activating, controlling, and deactivating such nanomechanical devices would fall to nanocomputers. To ensure the secure operation of the nanomechanical devices, nanocomputers would store and carry out mission plans, receive and process external signals and stimuli, communicate with other nanocomputers or external control and monitoring devices, and acquire contextual knowledge. Such technology has profound effects on the medical and dental fields.[3]

Medical professionals could carry out precise interventions at the cellular and molecular level with the help of programmable nanorobotic devices. In addition to mechanically reversing atherosclerosis, improving respiratory function, enabling near-instantaneous homeostasis, bolstering the immune system, rewriting or replacing DNA sequences in cells, repairing brain damage, and resolving gross cellular insults whether caused by irreversible processes or by cryogenic storage of biological tiss, medical nanorobots have been proposed.

Mechanism of drug delivery

Blood transports the medications contained inside the nanoparticle to the desired location in the bones. In order to create efficient methods of medication delivery and localisation, NP drug encapsulated encapsulation offers a number of benefits. Np characteristics like particle size and surface charge are crucial in developing efficient NP delivery systems that work via a variety of mechanisms.[4]

Mechanism of nanoparticle brain drug delivery

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Toxicology

Safety and toxicological concerns require complete attention if nanotechnology is to be used to its full potential in nanomedicine. To improve the so-called therapeutic ratio or index, which is the difference between the dose required for clinical efficacy and the dose causing harmful side effects (toxicity), particular drug delivery formulations may be used in the pharmaceutical industry. However, a toxicological assessment is required for these particular formulations as well. This is especially true for the use of nanoparticles in medication delivery applications. Particles are purposefully introduced into the environment and human body in various applications, and some of these novel applications are anticipated to significantly improve healthcare.[5]

Role of nanocarriers in Alzheimers diseases

Parkinson's disease is the second most prevalent neurological condition, and both its diagnosis and treatment confront challenges with dependable drug administration. The most perplexing issue with Levodopa, the traditional Parkinson's disease treatment, is that it has a limited bioavailability and deprived transport to the brain. Nanotechnology emerges at the forefront with clever ideas to address this issue. In order to treat PD, a variety of nanoparticles are used, including metal nanoparticles, quantum dots, organic nanoparticles, liposomes, and gene therapy.These nanoparticles allow medications to traverse the blood-brain barrier (BBB) in a variety of ways. Using a rat model of Parkinson's disease, Bhattamisra et al. revealed that Rotigotine medication was loaded on chitosan nanoparticles in human SH-SY5Y neuroblastoma cells and administered from the nose to the brain. The intranasal route is the greatest way to deliver rotigotine to the brain in a straight channel, according to a review of the pharmacokinetic data.[5]

Polymeric Nanoparticle

1. The drug Tacrine was loaded on polymeric nanoparticles and administered through an intravenous route. It enhanced the concentration of tacrine inside the brain and also reduced the whole-dose quantity .

2. II.Rivastigmine drug was loaded on polymeric nanoparticles and administered through an intravenous route. It enhanced learning and memory capacities .[5]

Solid Lipid Nanoparticles (SLNPs)

SLNPs enhanced drug retention in the brain area, raising absorption across the BBB . Some of the drug's effects are listed below.

1. Piperine drug is loaded on solid lipid nanoparticles through an intraperitoneal route inside the brain to decrease plaques and masses and to increase AChE enzyme activity .

2. II.Huperzine A improved cognitive functions. No main irritation was detected in rat skin when the drug was loaded on SLNPs in an in vitro study .[5]

Effect on blood and cardiovascular system

Engineered nanoparticles with ligand coatings are being investigated and exploited as molecular imaging agents or drug delivery techniques, as we previously stated. This has greatly advanced our understanding of the characteristics of particles that can influence tissue penetration without impacting tissue function. Anionic particles are often very non-toxic, but cationic NPs—including gold and polystyrene—have been proven to cause hemolysis and blood coagulation. This conceptual knowledge could be applied to stop inadvertent NP exposure's possible impacts. Drug-loaded nanoparticles have also been utilized to lengthen half-life or lessen adverse effects, and they have demonstrated which particle properties need to be changed to enable delivery while remaining biocompatible.[5]

Conclusion

The development of nanoscience and nanotechnology has impacted various scientific fields in a variety of ways. For example, in physics, different microscopes are now able to observe objects at scales ranging from micro to nano. In chemistry, carbon dots can be seen at scales ranging from micro to nano. In computer science, room-sized computers have been replaced by portable, thin laptops. And in biology, single complex biomolecules can be studied at the nano level. These advancements across the spectrum of science have all been broadly reviewed.

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