**An Introductory overview of nanotechnology**

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**Abstract –**

Nanotechnologyis the exploitation of the unique properties of materials at the nanoscale. Nanotechnology has gained popularity in several industries, as it offers better built and smarter products. The application of nanotechnology in medicine and healthcare is referred to as nanomedicine, and it has been used to combat some of the most common diseases, including cardiovascular diseases and cancer. The present review provides an overview of the recent advances of nanotechnology in the aspects of imaging and drug delivery.

Keywords – Nanotechnology, Nanoscience, Medicine, Cardiovascular diseases.

**Introduction –**

Nanoscience is the study of the unique properties of materials between 1-100 nm, and nanotechnology is the application of such research to create or modify novel objects. The ability to manipulate structures at the atomic scale allows for the creation of nanomaterials . Nanomaterials have unique optical, electrical and/or magnetic properties at the nanoscale, and these can be used in the fields of electronics and medicine, amongst other scenarios. Nanomaterials are unique as they provide a large surface area to volume ratio. 6Unlike other large-scaled engineered objects and systems, nanomaterials are governed by the laws of quantum mechanics instead of the classical laws of physics and chemistry. In short, nanotechnology is the engineering of useful objects and functional systems at the molecular or atomic scale.

Nanotechnologies have had a significant impact in almost all industries and areas of society as it offers i) better built, ii) safer and cleaner, iii) longer-lasting and iv) smarter products for medicine, communications, everyday life, agriculture and other industries . The use of nanomaterials in everyday products can be generally divided into two types. First, nanomaterials can be merged or added to a pre-existing product and improve the composite objects' overall performance by lending some of its unique properties. Otherwise, nanomaterials such as nanocrystals and nanoparticles can be used directly to create advanced and powerful devices attributed to their distinctive properties. The benefits of nanomaterials could potentially affect the future of nearly all industrial sectors .

The beneficial use of nanomaterials can be found in sunscreens, cosmetics, sporting goods, tyres, electronics and several other everyday items . Additionally, nanotechnologies have revolutionized advances in medicine, specifically in diagnostic methods, imaging and drug deliver.  illustrates the areas where nanotechnologies have had a significant impact.[1]

**Definition of nanotechnology**

The prefix ‘nano’ is referred to a Greek prefix meaning ‘dwarf’ or something very small and depicts one thousand millionth of a meter (10−9 m). We should distinguish between nanoscience, and nanotechnology. Nanoscience is the study of structures and molecules on the scales of nanometers ranging between 1 and 100 nm, and the technology that utilizes it in practical applications such as devices etc. is called nanotechnology [2]

**Application in medicine –**

Within 10–20 years it should become possible to construct machines on the micrometer scale made up of parts on the nanometer scale. Subassemblies of such devices may include such as useful robotic components as 100 nm manipulater arms, 10 nm sorting rotors for molecule by molecule reagent purification, and smooth super hard surfaces made of automically flawless diamond.

Nanocomputers would assume the important task of activating, controlling, and deactivating such nanomechanical devices. Nanocomputers would store and execute mission plans, receive and process external signals and stimuli, communicate with other nanocomputers or external control and monitoring devices, and possess contextual knowledge to ensure safe functioning of the nanomechanical devices. Such technology has enormous medical and dental implications.[3]

Programmable nanorobotic devices would allow physicians to perform precise interventions at the cellular and molecular level. Medical nanorobots have been proposed for genotological[applicatons in pharmaceuticals research, clinical diagnosis, and in dentistry, and also mechanically reversing atherosclerosis, improving respiratory capacity, enabling near-instantaneous homeostasis, supplementing immune system, rewriting or replacing DNA sequences in cells, repairing brain damage, and resolving gross cellular insults whether caused by irreversible process or by cryogenic storage of biological tissues.

**Mechanism of drug delivery –**

The drugs encapsulated inside the nanoparticle is delivered through blood to the targeted area in the bones. NP drug encapsulated encapsulation offers several advantages in creating effective means of drug delivery and localization. Np traits such as particle size, surface charge plays important role in creating effective NP delivery system that function through variety of mechanism.[4]

**Mechanism of Nanoparticles’ Brain Drug Delivery (across BBB) -**

The NPs are commonly administered via intranasal, intraventricular, intraparenchymal routes. All these routes enabled nanoparticles to cross the BBB due to their small size. When nanoparticles reach the BBB, several mechanisms are used, like receptor-mediated mechanisms, active transport, and passive transport to deliver nanoparticles into the brain. Nanoparticles are small in size, can diffuse passively across the endothelial cells of the BBB, and can interact favorably with brain receptors and recognize ligands for interaction.[4]

**Toxicology –**

To use the potential of Nanotechnology in Nanomedicine, full attention is needed to safety and toxicological issues. For pharmaceuticals specific drug delivery formulations may be used to increase the so called therapeutic ratio or index being the margin between the dose needed for clinical efficacy and the dose inducing adverse side effects (toxicity). However, also for these specific formulations a toxicological evaluation is needed. This is particularly true for the applications of nanoparticles for drug delivery. In these applications particles are brought intentionally into the human body and environment, and some of these new applications are envisaged an important improvement of health care[5]

**Role of Nanocarriers in Parkinson’s Disease (PD)**

Parkinson’s disease is considered the second most common neurological ailment, and it faces problems in reliable drug delivery for treatment and diagnosis [[137](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9781272/#B137-nanomaterials-12-04494)]. The conventional anti-Parkinson’s drug is Levodopa, but it experiences low bioavailability and deprived transfer to the brain; this is the most thought-provoking problem [[138](https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9781272/#B138-nanomaterials-12-04494)]. To solve this problem, nanotechnology comes to the fore with insightful solutions to solve this problem. Various nanoparticles like metal nanoparticles, quantum dots, cerium oxide nanoparticles, organic nanoparticles, liposomes, and gene therapy are used in PD treatment . All these nanoparticles enable drugs to enter through numerous ways across the blood–brain barrier (BBB) . In the current study, Bhattamisra et al. reported Rotigotine drug loaded on chitosan NPs in human SH-SY5Y neuroblastoma cells and delivered from the nose to the brain in rat model of Parkinson’s disease. A study of the pharmacokinetic data proposed that the intranasal route is the best path for a straight channel of rotigotine to the brain .[5]

**Ropinirole (RP)**

Ropinirole (RP) is a dopamine agonist used for Parkinson’s treatment. RP-loaded solid lipid nanoparticles (RP-SLNs) with nanostructured lipid carriers (RP-NLCs) comprising hydrogel (RP-SLN-C and RP-NLC-C) formulations are better for oral and topical distribution . Generally, the results confirmed that lipid nanoparticles and consistent hydrogel formulations can be measured as another carriage methodology for the upgraded oral and topical delivery of RP for the active treatment of PD . Neurodegenerative pathologies such as AD and PD can be treated with solid lipid nanoparticles, as this permits the drug to cross the BBB and reach the damaged area of the central nervous system..

**Role of Nanocarriers in Alzheimer’s Disease**

Alzheimer’s disease is one of the fastest growing neurodegenerative diseases in the elderly population. Clinically, it is categorized by abstraction, damage to verbal access, and diminishing in spatial skills and reasoning . Furthermore, engrossment of amyloid β (Aβ) aggregation and anxiety in the brain have significant parts . The treatment of different diseases with nanotechnology-based drug delivery uses nanotechnology-based approaches . In Alzheimer’s diseases, polymeric nanoparticles, liposomes, solid lipid nanoparticles, nano-emulsions, micro-emulsions, and liquid-crystals are used for treatment.

**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 .

**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]

**Effectson blood and cardiovascular system**

As we discussed earlier, ligand coated engineered nanoparticles are being explored and used as agents for molecular imaging or drug delivery tools. This has led to a considerable understanding of particle properties that can affect penetration in tissue without affecting tissue function. Cationic NPs, including gold and polystyrene have been shown to cause hemolysis and blood clotting, while usually anionic particles are quite non-toxic. This conceptual understanding maybe used to prevent potential effects of unintended NP exposure. Similarly, drug loaded nanoparticles have been used to prolong half-life or reduce side-effects and have shown which particle properties need to be modified to allow delivery, while being biocompatible.[5]

**Conclusion**

The progress of nanoscience and nanotechnology in different fields of science has expanded in different directions, to observe things from micro to nano, to even smaller scale sizes by different microscopes in physics, from micro size bulk matter to small size carbon dots in chemistry, from room size computers to mobile slim size laptops in computer science, and to observe deeply the behavior of the cell′s nucleus to study single complicated biomolecules at the nano level in biological science. All these progressions in different fields of science have been generally overviewed.

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