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NANOTECHNOLOGY, HISTORY AND APPLICATION

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ABSTRACT

An overview of microbiotechnology pharmacology, pharmaceutical microbiology and nanotechnology. Nanotechnology has several advantages in many scientific fields. Recent advances in nanotechnology have revealed the promise of nanoparticles in medical applications. The way we diagnose, treat and prevent a wide range of disorders in all areas of human life has been profoundly changed by recent advances in nanotechnology and nanoscience. The production, properties and applications of nanoparticles (NPs), which are incredibly tiny particles with sizes ranging from 1 to 100 nm and a variety of shapes. Some forms of nanoparticles have been thoroughly studied and are advised for use in a number of fields, such as biology, chemistry, medicine and cosmetics. Certain nanoparticles have been shown to be highly hazardous and to differ substantially in their properties from substances of the same volume. The industrial, agricultural, information, communication and medical sectors all considerably benefit from the myriad ways, processes and items that nanotechnology has made available.

KEYWORDS : Nanotechnology, Nanoparticles, Characterization, Synthesis method, Application.

INTRODUCTION

Nanotechnology is the term used to describe the commercialization and use of nanoscience.[1] Since a great deal of research on nanotechnology started in the 1980s, it has continued to be a modern marvel of scientific advancement.[2] Studying physics, material science and nanotechnology has several advantages and can aid in the resolution of many current global problems related to energy, food security, pollution, health and water and sanitation.[3] The use of nanomaterials for medical diagnosis and treatment is becoming popular these days. Nanotechnology plays an important role in both biotechnology and medicine.[4]The special issue "feature of review papers in nanotechnology and applied nanoscience" aimed to gather moderately length review articles that highlighted notable and recent developments or discoveries in the field of nanoscience.[5] There have been numerous reported and confirmed interactions between DFNs and biomolecules in vitro and in vivo.[6] nanotechnology may be able to help with this problem because it allows for the surface modification of nanoparticles (NPs), which increases their affinity and selectivity for brain tumors.[7] Many diseases could be treated and detected differently to nanotechnology.[8] The term "nano" was originally derived from the greek word "billionth." Nanoparticles are a more efficient way to deliver medications because cells use them more than large-sized micromolecules.[9] Copper, silver, zinc, titanium, magnesium, alginate and gold are currently used to create a variety of metallic nonmaterials. Nanomaterials have a wide range of applications, including medical treatments, energy storage in solar and oxide fuel batteries and widespread integration into everyday materials like clothing and cosmetics.[10] Nanotechnology, also known as nanoscience, is the study and applications that are developed. The prefix nano, meaning "literally one billionth of a meter," is derived from the greek word an, which means "dwarf.[11] The use of nanotechnology in consumer goods is causing a paradigm shift in some industries by creating previously unthinkable opportunities and capabilities. This review delves into the intricate realm of nanotechnology applications in consumer goods, providing a comprehensive examination of the diverse spectrum of uses and the crucial safety factors that accompany this ground-breaking technology.[12] A single metal atom is about a third of a millimeter in circumference, while a sheet of parchment is around 100,000 nanometers thick.[13] Sales of nanomedicine surpassed $16 billion in 2015, and at least $3.8 billion is allocated each year for research and development of nanotechnology.[14] Much emphasis has been focused on the remarkable electrical, optical and magnetic capabilities of nanoscale particles.[15] A wide range of anti-aging, anti-viral, antibacterial, anti-inflammatory and anti-cancer characteristics are shown by medicinal herbs.[16] Numerous sectors are using products with nanoscale capabilities. These include materials and environmental science, consumer and household products, technology, healthcare, agriculture, energy and transportation.[17] When single-walled carbon nanotubes were being purified in 2004, the most current class of carbon nanomaterials known as C-dots was discovered by accident. The length of these dots is less than 10 nm.[18] As noted in his comment above, he ended with a "final question," which wasn't fully understood until the 1980s and 1990s. Therefore, throughout these two decades, the term "nanotechnology" was first used and the creation of this topic from researchers under the direction of Eric Drexler's 1959 Bedrock by Feynman. Chris Toumeyn and other experts, however, downplay Feynman's contribution to the creation of the technological breakthrough known as nanotechnology.[19]

2. What is Nanotechnology

The use of science, engineering and technology at the nanoscale or between one and one hundred nanometers, is known as nanotechnology. The study and manipulation of incredibly small objects is known as nanotechnology and it has applications in every other field of research, including physics, chemistry, biology, materials science and engineering. It is the technique of employing minuscule material particles to create new materials on a big scale.[21] This hypothetical capacity was hypothesized by physicist R. Feynman in 1959.[22]

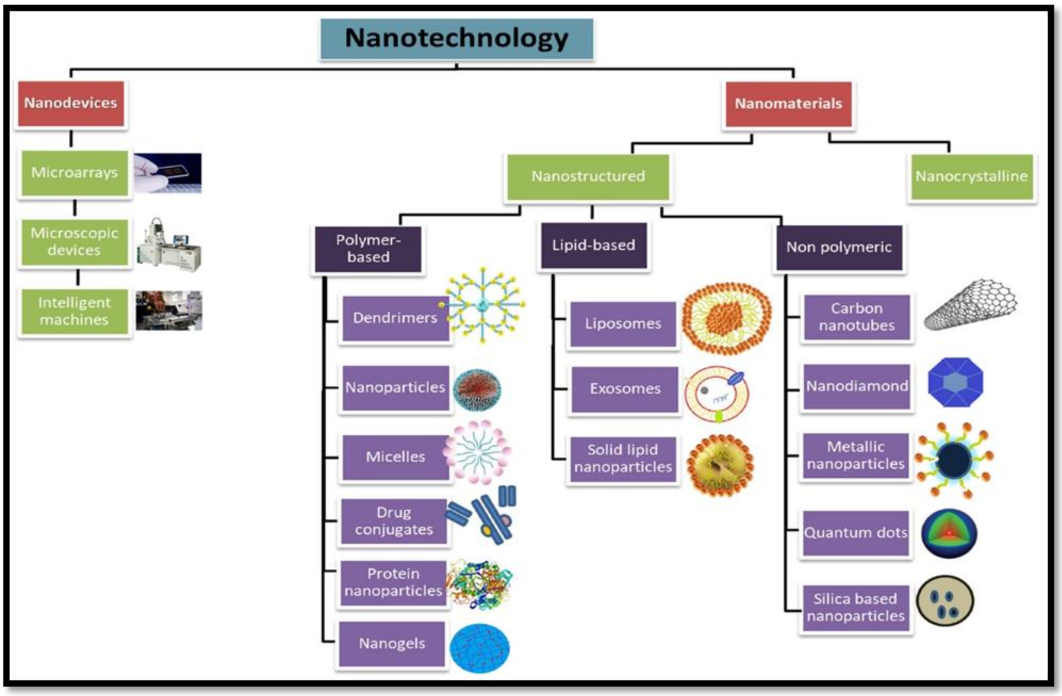

Figure 1 : Elements of nanotechnology, which are utilized in therapeutic applications.[20]

3. Benefits of Nanoparticles.[23]

The following are some significant benefits of nanoparticles:

- A greater ability to absorb.
- Proportionality of dosage.
- Formulations with smaller dosages.

• The active ingredient dissolves faster when the surface area is greater. Faster dissolving rates are frequently associated with increased absorption and bioavailability.

• Drugs are less dangerous at smaller dosages.

4. Nanotechnology advancement

Over the past few decades, advances in materials science, chemistry and engineering have produced nanotechnology, which is now applied in all fields where essential characteristics are mostly dictated by minuscule scale. They work in disciplines like physics, engineering, chemistry, biology and medicine.[24]

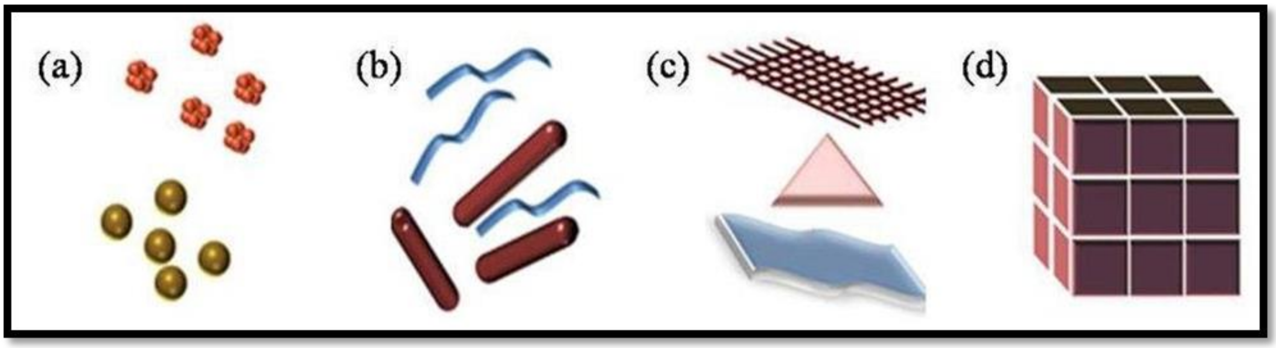

Figure 2 : Classification of nanomaterials (a) 0D spheres and clusters; (b) 1D nanofibers, wires And rods; © 2D films, plates and networks; and (d) 3D nanomaterials. Source: Adapted from Alagarasi.[25]

5. Classification of Nanoparticles

5.1 Non-living nanoparticles

Modern material science has produced inorganic nanoparticles, whose functions depend on their unique physical properties, particularly in biotechnology.[26]

5.2 Natural Nanoparticles

Organic materials microscopic particules or polymers, commonly known as dendrimers, micelles, liposomes, and ferritin, possess non-toxic and biodegradable properties; some (liposomes and molecules, for instance) possess closed sections and are susceptible to thermal and electromagnetic radiation, such as light and heat[27]

5.3 Dendrimers

Made of macromolecules such as polyamidoamine (PAMAM), polypropylene-imimine and polyaryl ether, dendrimers are highly branching nanostructures with an inner core. The particle size range is 1 to 100 nm, even though the majority are smaller than 10 nm. About 20 years ago, research on dendrimers concentrated on their production, physical properties and chemical composition. Despite the fact that research on their biological uses began about thirteen years ago.[28]

5.4 Liposomes

These phospholipid vesicles, which range in size from 50 to 100 nm, have good entrapment efficiency and biocompatibility. They can be used either passively or actively to transfer genes, proteins and peptides.[29]

5.5 Carbon-based nanoparticles

Two types of carbon-based NP that have shown promise against bacteria are graphene nanotubes and carbon quantum dots. Due to their antibacterial properties, carbon nanoparticles cause little chemical or physical damage. These substances' exact mode of action against bacteria is yet unknown, although a recent study showed that multi-walled carbon nanotubes are effective at preventing the establishment of biofilms made by klebsiella oxytoca, staphylococcus epidermidis and Pseudomonas aeruginosa.[30]

5.6 Nanotube of carbon

Enzyme was determined to have discovered the carbon nanotube first in 1991. Carbon nanotubes come in two varieties: single-walled and multivalued.[31] Charged compounds may be contained in the polymer core or adsorbed on their surface. Polymeric nanoparticles (NPs) provide great potential for targeted drug delivery in the treatment of various diseases. In recent years, polymer nanoparticles (NPs) have drawn a lot of attention due to their small size.[18]

5.7 Nanocrystalline

These can replace the less effective bulk material and are readily made. Implants, prosthetics, bone replacement and drug encapsulation all directly use these materials.[16] Since these medications are pure, no carrier molecules are present.

5.8 Graphene

Since graphene may be wrapped to form fullerene, stacked to create graphite or coiled into a nanotube, it is a basic component of other carbon allotropes. Excellent mechanical strength, a huge surface area, high conductivity, thermal stability and a honeycomb lattice structure with zero energy band gaps due to sp2 hybridization are all attributes of graphite.[31]

5.9 Fullerene

Fullerenes (allotropes o f carbon) are graphene sheets folded into tubes or spheres.It is hollow and spherical, with 60 carbon atoms (C60) joined by single and double bonds, giving it a cage-like appearance.[4]

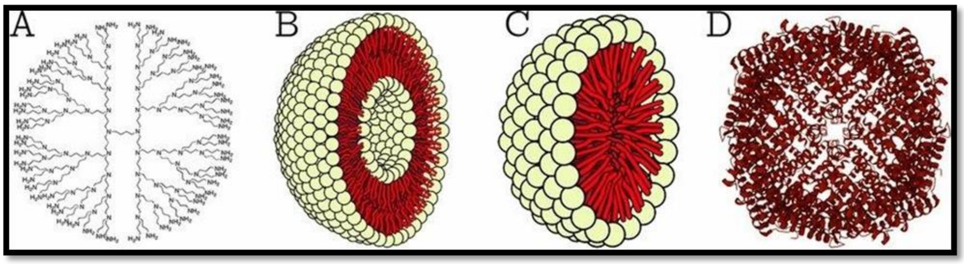

Figure 4 : Types of NPs. A) Dendrimers; B) Liposomes; C) Micelles; D) Ferritin.[23]

5.10 Metallic nanoparticles

which include iron oxide, gold, silver, gadolinium and nickel, have been studied for targeted cellular delivery. Gold exhibits a favorable optical and chemical composition at the nanoscale, making it suitable for scientific and therapeutic imaging applications . To get the desired size, it can be manipulated in the 0.8–200 nm range.[28]

6. Traditional Techniques for Preparing Metallic Nanoparticles

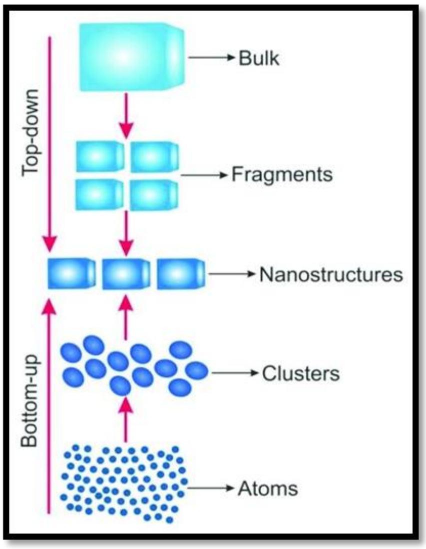

Figure 5 : Schematic illustrating the top-down and bottom-up methods for nanoparticle preparation.[36]

Nanostructures can be made in a variety of ways, but they can be broadly categorized into two groups: top-down and bottom-up approaches.[35]

6.1 The Top-Down Approach

A bulk material is repeatedly sliced or diced to produce particles the size of nanoparticles. In top-down techniques, solid state is used as the starting material. The mechanical method is one physical processing technique used in the top-down approach. Ball milling, grinding, etching and cutting are all steps in this procedure. The other is the lithographic method. In this process, we used electron beam lithography and photolithography.[37]

6.2 The Bottom-Up Approach

The constructive manner is another name for the bottom-up approach. This process creates nanoparticles with far fewer complex materials.[10]

7. Techniques to Produce Metallic Nanoparticles

7.1 Physical approaches[38]

Usually, evaporation-condensation is used in mechanical processes to turn metal into nanoparticles. In a tube furnace, this procedure can be completed at air pressure. When the source material inside an inflatable vessel centered at the furnace evaporates, a carrier gas is created.

- The length of the laser pulses,
- The laser's fluence,
- The length of the ablati on

7.2 Chemical approaches

The most widely used method for generating stable colloidal dispersions of AgNPs in water or organic solvents is chemical reduction. Reductants that are commonly employed in this context include ascorbate, essential hydrogen, citrate, and borohydride reduction. Silver ions (Ag^+) in aqueous solution are often reduced to produce particles several nanometers in size.[39]

7.3 Biological approaches

A silver salt (usually $AgNO_3$), a reducing agent (like ethylene glycol) and a stabilizing or aping agent (like PVP) to control the NPs' growth and stop them from aggregating are the three main components needed for the chemical production of Ag-NPs, as was previously mentioned.

8. Characterization

8.1 Visible and UV spectroscopy

This UV-visible analysis is one of the simplest and most reliable methods for establishing the basic characteristics of produced nanoparticles. In the process described above, prepared AgNPs can interact with the specific wavelength of light. In the case of colloidal suspension, there is no need to calibrate the sample or that suspension.Is easy to understand, re-leasable, sensitive, efficient and selective in a wide range of nanoparticles.[41]

8.2 FTIR Fourier Transformed Infrared Spectroscopy

FTIR, which stands for fourier transformed Infrared spectroscopy, is primarily used to identify the functional groups of proteins that are attached to the surface of nanomaterials or the functional groups of exopolysaccharides that serve as capping agents to increase stability during biological synthesis of nanomaterials. Finding these biomolecules is essential for altering or improving their chemical makeup, which could help us understand how their properties have developed and what their potential future uses are. These kinds of molecules in biological suspension fall between 1000 and 1800 cm-1 in the absorption spectrum (C=C, C=O, C-N and C-O), which suggests that they may have a role in maintaining the stability of nanoparticles.[42]

8.3 Transmission electron microscopy

An picture is produced by the interaction of electrons passing through the specimen; this image is then magnified and focused onto a fluorescent screen, a layer of photographic film or a sensor such as a CCD camera to be found.[26] Using an elliptical microscope with an FEI 200 kV parameter, the morphology image was acquired.[43]

8.4 Scanning Electron Microscopy (SEM)

Magnetic nanoparticle size and shape can be examined using scanning electron microscopy or SEM. SEM can create images of three-dimensional objects because it often captures secondary electrons created through the material being investigated by the electron beam impinging on it rather than electrons flowing through it.[15]

8.5 Atomic force microscope (AFM) measurement

The size of the generated AgNP was investigated using atomic force spectroscopy (SPA 300, Seiko Inc., Japan). After being immersed in incredibly pure water, the siliconized glass cover slides selected for the AFM measurement were heated for ten minutes in an ultrasonicator.To prepare the samples for AFM analysis, the siliconized glass cover slides were cleaned with an ethanol solution, left to air dry at room temperature in a laminar box and then the AgNP was dried.[16]

9. The physicochemical properties of NPs

9.1 Optic Properties

The optical approach is a straightforward and precise tool for figuring out the electrical structure of nanowires. Because optical measurements require minimum sample preparation and are sensitive to quantum effects. Phonons are spatially confined by the cross-sectional area, crystalline boundaries and surface disorder of nanowires. The phonon confinement and uncertainty in the phonon wave vector caused by these limited size effects typically cause a broadening of the lineshape and a change in frequency.[13]

9.2 Magnetic properties

At the nanoscale, materials can exhibit a range of magnetic behaviors based on the size of magnetic nanoparticles. When nanostructuring is applied to bulk magnetic materials, the curves alter, leading to hard or soft magnets that exhibit enhanced properties at the nanoscale.Minerals that do not exhibit electromagnetic properties in bulk form may become attracted at the nanoscale level. As an illustration, while gold and platinum are non-magnetic in their bulk forms, they exhibit magnetic properties at the nanoscale.[44]

9.3 Mechanical properties

Due to the unique mechanical properties of NPs, researchers can explore innovative applications across various significant domains, including tribology, surface engineering, nanofabrication, and nano manufacturing. A variety of mechanical metrics including adhesion, friction, elastic modulus, hardness, stress and strain can be assessed to determine the precise mechanical characteristics of NPs. Lubrication, coagulation, and surface coating further enhance the mechanical properties of NPs.[45]

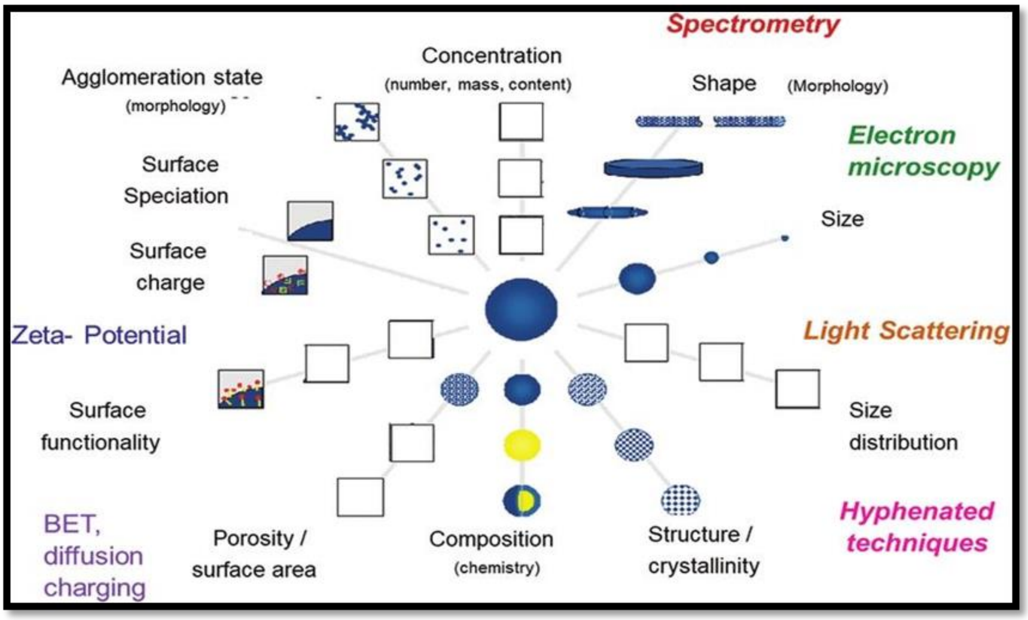

Figure 6 : Nanoparticles Characterization[46]

10. Nanoparticle characterization

10.1 Particle size

The two most crucial features for distinguishing nanoparticles are shape and particle size distribution. Electron microscopy can be used to measure size and form. Drug targeting and medication administration are the two main uses for nanoparticles. It has been found that therapy release is influenced by particle size. Smaller particles provide more surface area. The majority of the drug applied to them will be exposed to the particle surface, resulting in rapid drug release. Conversely, drugs progressively disperse into larger particles. The.[47]

10.2 Surface Area

When identifying nanoparticles, the surface area is extremely important. For this reason, nuclear magnetic resonance (NMR) spectroscopy is used. The surface area of nanoparticles in the gaseous phase is measured using a modified SMPS and a differential mobility analyzer (DMA)[27]

10.3 Concentration

The overall concentration of nanoparticles in a sample post-manufacturing is an essential aspect to take into account. Sometimes the total concentration of nanoparticles is known based on the characteristics of the materials. It might be necessary to ascertain the concentration of particles.[36]

10.4 Composition

The optimal method for determining the exact nature of nanoparticles the type and amount of their unique constituents varies based on these characteristics. The chemical or elemental makeup of nanomaterials determines their purity and performance, so it is theoretically possible to assess their purity. A nanoparticle that contains a larger quantity of secondary or unwanted elements may experience performance degradation, as well as secondary reaction and contamination. The analysis of the chemical composition of nanomaterials is more complicated than that of a single unit.[36]

11 .Application

11.1 Drug Release

A primary objective of research into nanotechnology is the delivery of pharmaceuticals; thus, it is essential to understand the manner and extent of drug molecule release. To collect such information, most release strategies require the drug and its delivery vehicle to be separated. This investigation employs classical analytical techniques such as UV spectroscopy and high-performance liquid chromatography (HPLC), as well as gel filtration, centrifugal ultrafiltration, ultracentrifugation and ultrafiltration. For quantification, HPLC or UV spectroscopy are employed.[47]

11.2 Antimicrobial activity

After discovering that silver metal has been employed as an antiseptic to aid in wound healing, the functions of Ag NPs as antimicrobial agents against both fungi and bacteria. Ag NPs show significant promise against multi-drug resistant bacteria and fungi, although their susceptibility and antibacterial mechanisms differ among species. The microorganisms that exhibit the most potent antibacterial activity include methicillin-resistant staphylococcus aureus, methicillin-resistant staphylococcus epidermidis and streptococcus.[38]

11.3 Antiviral Activity

First and foremost, an effective antiviral approach necessitates a comprehensive understanding of the virus's replication cycle. Even though our comprehension of viral life cycles may evolve, it is conceivable to achieve viral suppression at each phase of the current model, which encompasses attachment, entry, biosynthesis, assembly of new viruses and release.[49]

11.4 Anticancer Activity

It is widely acknowledged that cancer is treated with chemotherapy, surgery and radiation therapy; but, the cost and pain involved in targeted therapy are both very high. Thus, it is essential to identify molecules for cancer treatment that are effective, affordable, and sensitive. It is found to be the most suitable option and an alternative to other cancer treatments. They can only target specific cells or tumors at that location by enclosing a therapeutic agent within a nanoparticle and employing it as a medication delivery system.[41]

11.5 Antibacterial activity

CIP also exhibits a low frequency of spontaneous resistance. AgNPs have been acknowledged for their bactericidal effects since antiquity. AgNPs have been shown to affect a wide range of bacteria, including Gram-positive, Gram-negative and even antibiotic-resistant strains.[50]

11.6 Antifungal Activity

Silver nanoparticles (NPs) exhibit a strong bactericidal effect on both gram-positive and gram-negative bacteria, including strains that are resistant to several antibiotics. Moreover, at low concentrations (measured in mg/L), silver nanoparticles eliminate bacteria without causing immediate harm to human cells. Moreover, there is no proof that silver nanoparticles cause bacterial resistance, which would complicate the treatment of bacterial infections with antibiotics. NPs may serve as an antifungal agent for treating mycoses.[40]

11.7 Anti-Inflammatory

TNF-α, a key macrophagic agent, promotes the production of pro-inflammatory markers in response to liver damage. Pen-Toxifylline, a widely used methylxanthine derivative, reduces oxidative stress and inhibits the production of TNF-α and numerous pro-inflammatory cytokine mediators.[51]

12. In the regions listed below, carrier systems are commonly utilized

12.1 Treatment for cancer

It is often believed that anticancer medications are superior if the active ingredient can arrive at the intended target location without producing any adverse effects. It is possible to improve the necessary targeted delivery through chemical surface modifications on nanoparticle carriers. Polyethylene oxide, also known as PEG, serves as an excellent illustration of surface modifications at the nanoparticle level through inclusion. The ability to target tumors and the specificity of drug uptake are enhanced by these modifications. The use of PEG allows nanoparticles to navigate the bloodstream and arrive at the tumor, as they are not identified as foreign entities by the body's immune system. In addition, the application of hydrogel in treating breast cancer serves as an excellent illustration of this. This state-of-the-art technology. Herceptin, a monoclonal antibody used in breast cancer treatment, targets the human epidermal growth factor receptor 2 (HER2) on cancer cells.[32]

12.2 Delivery systems implanted

While nanoparticles may pose a greater risk than IV, their regulated and nearly zero-order kinetics make them suitable as delivery systems. The transporters include transferosome, ethosome, and liposome. They reduce the likelihood of adverse reactions and peak plasma levels, improve patient acceptance and compliance, allow for more predictable and extended action durations, and lower the re-dosing frequency.[52]

12.3 Biosensors and bio-labels

AuNPs play a more active role in plasmon-related sensing compared to the imaging and distribution techniques, which are mainly passive. Simply put, the NPs must be able to identify analyte molecules. AuNPs' most reliable intrinsic characteristic is their plasmon resonance frequency, which can be utilized for sensing.[53]

12.4 Drug discovery

The overall consumption of medication and adverse effects can be greatly reduced by placing the effective agent exclusively in the melancholic area and limiting its quantity to what is necessary. This highly specific tactic minimizes costs and the need for intensive work. Dendrimers and nonporous materials serve as one instance. They were able to convey small pharmaceutical components to the targeted location. Another perspective is based on small-scale electromechanical systems. Implantable distribution methods, made possible by advancements in nanotechnology, often outperform injectable medications. This is due to the fact that the latter tend to exhibit first-order kinetics, characterized by a rapid increase in blood concentration followed by a significant decline.[36]

13. The Used of Nanotechnology

13.1 Medical

In the context of the extensive domains of biology, biotechnology and medicine, one cannot ignore the beginnings of nanomedicine. Nanotechnology is starting to take shape within the broader scope of Nano biotechnology. The successful application of nanotechnology within medicine has led to a continuous enhancement of the quality of human life and the establishment of a new field known as nanomedicine. As a result, researchers have been able to devise enhanced strategies for preventing disease, screening and diagnosing patients, treating illnesses, and implementing proactive healthcare measures.[54]

13.2 Diagnoses

Molecular imaging characterizes and quantifies biological processes in animals, such as gene expression, protein-protein interactions, signal transduction, cellular metabolism and intra- and intercellular transport.[29]

13.3 Cancer Treatment

Anti-genomic nanoparticles (AgNPs) are utilized as a therapeutic method for diagnosing and treating cancer. Numerous laboratories have utilized enhanced AgNPs as enhancers in radiation and photodynamic therapies, as “nanocarriers,” and in basis delivery chemotherapeutics. Plasma magnetic nanoparticles consist of multiple nanoparticle components integrated within a single system, coated with silver-gold nanoparticles to enhance MRI images. The exact mechanism behind the harmful impact of AgNPs on the virus is still uncertain. However, AgNPs have been discovered to engage with structural proteins on the surfaces of extracellular viruses, thereby hindering the viruses’ capacity to attach or penetrate or even leading to their destruction by removing the surface protein.[55]

13.4 Tissue Engineering

In organ transplants or artificial implant therapy, nanotechnology can play a role in life extension by using suitable scaffolds derived from nanomaterials and growth hormones to stimulate cell proliferation artificially.[56]

13.5 Environmental Protection

The increasing use of engineered nanoparticles in both industrial and residential contexts has resulted in the release of these substances into the environment. To assess the risk these NPs pose to the environment, it is essential to understand their mobility, reactivity, ecotoxicity and persistence. Due to their high surface-to-mass ratio, natural nanoparticles play an important role in the solid/water Contaminant partitioning can happen when nanoparticles (NPs) aggregate after absorbing pollutants on their surface, when contaminants co-precipitate during the formation of natural NPs, or through a combination of both processes. Pollutant interactions with NPs are determined by their characteristics, including size, composition, morphology, porosity, aggregation/disaggregation behavior and aggregate structure.[45]

13.6 Food

Several sectors, such as robotics, electronics and medicine, are beginning to embrace nanotechnology. Some of the most important applications in this field include food processing, packaging, preservation, monitoring food quality and other related tasks. A variety of sensors are created to identify the presence of pathogens, leaks, gases, discoloration, pH changes, odors or temperature variations.[19]

14.7 Agriculture

It has emerged as a novel, interdisciplinary field that integrates engineering and scientific principles with agricultural and food systems, representing a fusion of skills and knowledge that could yield significant advancements in this area. With the advent of innovative tools for addressing genetic diseases, rapid disease detection and improved plant nutrient absorption, nanotechnology holds the potential to revolutionize the agricultural and food sectors.[57]

14.8 Cosmetics

Many cosmetic products, including moisturizers, hair care items, makeup and sunscreens, incorporate nanotechnology and nanomaterials. Various formulations, such as liposomes, niosomes, nanoemulsions, microemulsions, solid lipid nanoparticles, nanostructured lipid carriers and nanospheres, have replaced traditional delivery systems with novel nanocarriers. These innovative nanocarriers offer the advantage of enhanced skin penetration of vitamins and other antioxidants. Additional advantages comprise a regulated and extended release of medication, increased stability of vitamins, unsaturated fatty acids and antioxidants encapsulated within nanoparticles, targeted delivery to specific sites, high entrapment efficiency and enhanced visual appeal of the final product.[35]

14.9 Space

Nanotechnology might be the crucial factor in enhancing the viability of space travel. The development of nanomaterials has progressed to a stage where it is now possible to create lightweight solar sails and cables for space elevators. Moreover, the incorporation of innovative materials with nano-sensors and nano-robots could improve the functionality of spacecraft, spacesuits and exploration tools, thereby reinforcing nanotechnology’s role as an essential element of the “ultimate frontier”[21]

CONCLUSION

This research introduced nanomaterials and explored their classification based on different characteristics, the relationship between their properties and uses and various synthesis methods, as well as the application of nanotechnology in various sectors via the fabrication of nanomaterials. The properties of bulk materials be they physical, chemical, electrical, optical, magnetic, or mechanical are typically not influenced by their size. This review categorizes nanomaterials into five major groups based on different perspectives. Depending on their origin, the structural arrangement of both natural and synthetic nanomaterials, the dimensions of organic, inorganic, carbon-based, and composite materials, as well as their pore diameters (0D, ID, 2D and 3D), microporous materials, mesoporous materials and the possible toxicity of mesoporous materials. We have conducted a critical examination of different synthesis methods for nanomaterials. Nanomaterials can be synthesized using both top-down and bottom-up approaches. Nanomaterials have a significant role in society due to their remarkable and powerful applications across various fields, such a tissue engineering, medicine and agriculture.

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