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Synthesis and Characterization of Nanoparticles: An Overview

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Abstract
Nanoparticles are used in a wide range of fields including biological diagnostic probes, optoelectronics, display devices, catalysis, the fabrication of biological sensors, the diagnosis or monitoring of diseases like cancer cells, drug discovery, the detection of environmental toxic metals or reagents, and therapeutic applications due to their special properties, which include having a higher surface area to volume ratio, size, shape like a sphere or rod, etc. This includes a biotechnological element. Both chemical and biological processes can make nanoparticles. They are produced by a variety of biological processes, such as bio mineralization, fungus, and bacteria. Metallic nanoparticles come in a wide range of varieties, including gold, silver, alloy, magnetic, and others. All of them are frequently utilised in industry. There are many different types of metallic nanoparticles, including gold, silver, alloy, magnetic, and others, all of which are widely used in industry. In order to give a comprehensive review of nanoparticles, this paper will focus on their variations and biogenesis process.
Keywords: Nanoparticle, silver, metallic, biotechnology, biosynthesis.

Introduction
Nanoparticles are microscopic objects that typically range in size from 1 to 100 nanometers. Due to their high surface area to volume ratio and special features compared to bulk materials, they are useful for a wide range of applications in industries like electronics, biology, energy, and more. There are numerous techniques for generating these tiny particles, which is referred to as nanoparticle synthesis.

Physical synthesis is a well-liked technique for creating nanoparticles. In this procedure, nanoparticles are produced using physical processes like evaporation or high-energy grinding. Metals or alloys are frequently utilised to make nanoparticles through physical synthesis, which can produce particles with good crystallinity and uniformity. Chemical synthesis is another technique for creating nanoparticles. This technique produces nanoparticles through chemical processes, frequently through the reduction of metal salts to yield metal nanoparticles. Chemical synthesis allows for control over the size and shape of the nanoparticles generated and can be carried out in a range of solvents, including water and organic solvents.

A more recent technique for producing nanoparticles is called biological synthesis, which uses biological components like bacteria, fungi, and enzymes. This technique is appealing because it can create nanoparticles with advantageous features for biological applications, such as biocompatibility and biodegradability. In summary, the creation of nanoparticles is an essential stage in the creation of numerous new technologies. The synthesis technique is determined by the desired characteristics of the nanoparticles and the intended use of the particles. The capacity to create high-quality nanoparticles, whether through physical, chemical, or biological methods, has opened up fascinating new opportunities for research and innovation.

Microbial Synthesis of nanoparticles

Chemical or biological methods can be used to create nanoparticles. Due to the presence of some harmful chemicals absorbed on the surface, chemical manufacturing processes have been linked to numerous negative effects. Chemical and physical procedures have eco sustainable substitutes, such as Microorganisms are used to create nanoparticles in a biological manner.[2][3][5]
enzymes , fungus[1] , and plants or plant extracts.

Microbes can produce either intracellular or extracellular nanoparticles, depending on the environment.[15] The intracellular method involves particular ions being transported into the negatively charged cell wall, where they interact electrostatically with positive charged metals to diffuse through the cell wall. The poisonous metals are then changed into non-toxic metal nanoparticles by enzymes found in the cell walls of microorganisms. While the extracellular method uses enzymes that are generated by numerous fungi or prokaryotic species, such as nitrate reductase or hydroquinone[16].

Biosynthesis: Mechanism

Synthesis by fungal strains:

In comparison to other microorganisms like bacteria and algae, filamentous fungi offer distinct benefits due to their high metal tolerance and capacity for bioaccumulation. The use of endophytic fungi for the production of metallic nanoparticles has drawn more attention due to their metal toleration, metal uptake and accumulation capability. In addition, they secrete extracellular enzymes, of which large scale production is easily possible. They are helpful in the scale up, handling of biomass, downstream processing, economic viability, and they also aid in the handling of extracellular enzymes.

I) Intracellular synthesis of nanoparticles by fungi:

This technique includes introducing ions into microbial cells where they combine with enzymes to produce nanoparticles. The size of intracellularly generated nanoparticles is less than that of extracellularly reduced nanoparticles. The size restriction is likely related to the particles' ability to form clusters inside living things. The process of fungi used in biogenic nanoparticle formation may be internal or extracellular. The metal precursor is added to the mycelial culture and internalised in the biomass in the case of intracellular synthesis.
The fungus have interacted with waste products from several industries, including those related to agriculture, transportation, mining, tanning, etc. Soils are one of the primary sinks for these metal elements, whether they are deposited through air or water, and because they are not biodegradable, they accumulate in soils where fungus interact with the elevated metal concentrations[17].

II)Extracellular synthesis of nanoparticles by fungi:

The enzymes found in the fungal filtrate operate to decrease silver ions, generating elemental silver (Ag0) at a Nano metric scale during the extracellular creation of nanoparticles. Following the reaction, the filtrate's colour changes, and surface Plasmon resonance bands reflecting altered optical characteristics of the material can be seen using UV-visible spectroscopy[38]. These bands' absorbance wavelengths range between 400 and 450 nm, and an absorbance peak at a greater wavelength denotes the presence of bigger nanoparticles[39,40]. The size is determined by the synthesis conditions, including the type of fungus, temperature, pH, the dispersion media, and whether or not the nanoparticles have capping[41,42]. The surface Plasmon resonance, which varies depending on the size and absorbance of the nanoparticles, is also directly related to the colour of the dispersion[43].

Nanoparticles synthesized by endophytic actinomycetes:

In fact, compared to fungi and other bacteria, only a small number of publications have been published in the burgeoning subject of endophytic actinobacteria nanoparticles. The majority of works discussing endophytic actinomycetes and describing the synthesis of nanoparticles utilising endophytes belong to the genus Streptomyces; nevertheless, a small number of papers have described the production of nanoparticles by uncommon actinobacteria. employ a rare actinobacteria to manage the Staphylococcus warneri illness, which has an important effect on human health[9,10].

The endophytic strains are cultured in a revolving shaker under ideal conditions, such as the right culture media, pH, temperature, and agitation, to produce nanoparticles. The culture is centrifuged to remove the biomass from the supernatant after incubation. The ability of microorganisms to manufacture nanoparticles extracellularly or intracellularly is assessed in both supernatant and biomass.

Microbial Synthesis of Nanoparticles Through Bio Mineralization:

Some microbes have the special ability to reduce metal salts into metal ions that precipitate inside or outside of the microbial cells, mobilising or immobilising the metal salts. They change the oxidation state of the metals through redox processes to achieve complexation and inactivation, followed by their precipitation, with the aid of efflux pumps[11].

For instance, gold (I)-thiosulfate is metabolised into Au(I) and thiosulate (SO) ions upon entry into Acidithiobacillus thiooxidans cells. Thiosulfate provides energy as Au(I) undergoes intracellular reduction to elemental gold. During the late stationary growth phase, this elemental gold precipitates inside the bacterial cells to form nanoparticles and is later expelled from the cells[12].

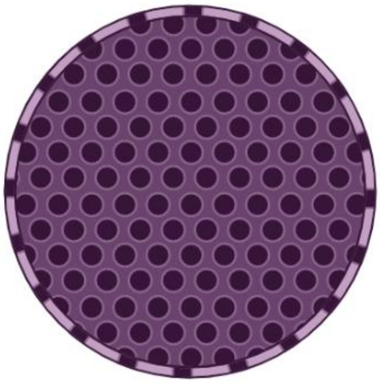

Fig 1. Mesoporous nanoparticles

Microbial Organic Particles for Nanoparticle Synthesis:

Nanofibers are created using bacterial cellulose (BC), which is also employed to give the nanofibers a bactericidal quality[14]. In a procedure that is regarded as green, bactericidal chitin (Ch) and bacterial cellulose (BC) nano fibres were combined to create a nanocomposite of BC-Ch. Additionally, Ch was fed to Acetobacter aceti in order to biosynthesize bio-BC-Ch79d nanocomposites and create nanofibrils that were 50–100 nm in width[2].

Types of Nanoparticals:

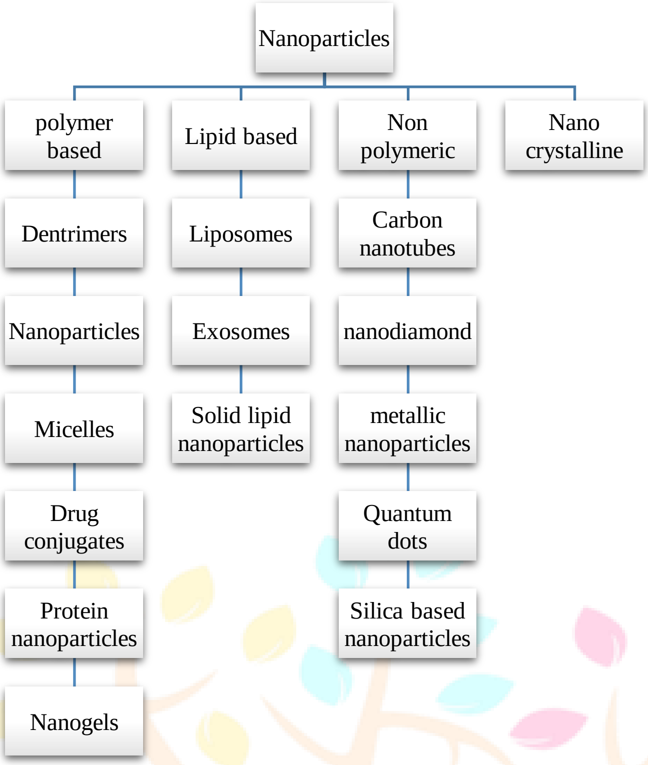

Chart No1. Types of Nanoparticles

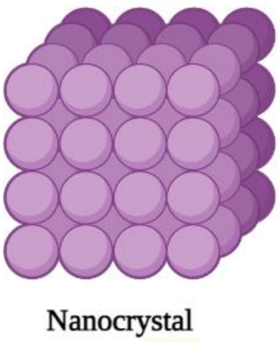

Fig. 2 Nanocrystal

fig. 3 Nanosphere

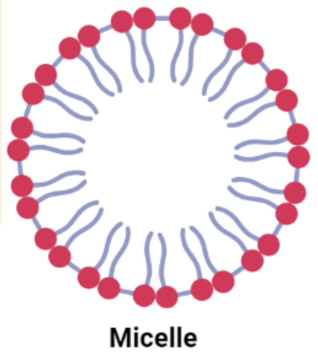

Fig.4 Micelle

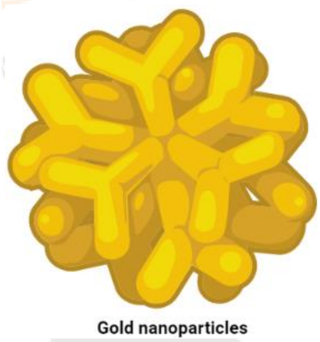

Fig.5 gold Nanoparticles

1. polymer based

Dentrimers:

The synthesis, characterization, and uses of dendrimer-encapsulated nanoparticles (DENs), which were first described by our lab in 1998, are summarised in this paper[38,39,40,41]. In a nutshell, dendrimers are combined with metal ions to create these nanocomposite materials, which are subsequently reduced to produce zerovalent DENs. Because they combine the advantageous physical and chemical characteristics of the nanoparticles in their encapsulation with the variable solubility and surface reactivity of the dendrimer template, DENs are intriguing. By utilising the dendrimer structure and the method by which the metal ions are delivered into the dendrimer, it is also possible to manipulate the nanoparticle size, composition, and structure. Although there are many potential uses for DENs, the focus in this article is on their function as catalysts.

Micelle nanoparticles

Micelle nanoparticles are 5 to 100 nm in size. Although a wide range of polymers can be utilised to make micelles, the selection is constrained for applications involving drug delivery because the micelle needs to be biocompatible and biodegradable. Since PEG is neutral, harmless, and water soluble, it is frequently utilised to create micelles. The hydrophobic portion of the amphiphilic macromolecule is frequently made from degradable hydrophobic polyesters[42]. Micelles can avoid uptake by the MPS without additional modification since they are naturally stealth particles when created with a hydrophilic outer shell. Micelles can be used for passive and active targeting. Due to passive targeting by way of the EPR effect, drug-encapsulated micelle systems target tumours more effectively. Release of polymeric micelles that are not ligand-conjugated takes place intratumorally, or in the tumour tissue itself, away from the cancerous cells. Micelles may have ligands attached for active targeting and medication release inside the cell. Pinocytosis is used to internalise ligand-conjugated micelles[43].

Drug conjugates

With various conjugates successfully adapted into clinical practise, polymer-drug conjugates have long been a mainstay of the drug delivery sector. Therapeutic drugs can be conjugated to polymeric carriers like polyethylene glycol, which has the benefit of extending circulation, reducing immunogenicity, allowing for regulated release, and improving safety. The rational design, physicochemical properties, and most recent developments in the creation of many classes of polymer-drug conjugates—including dendrimers, polymer nanoparticles, polymer-protein, and polymer-small molecule drug conjugates—are covered in this review. Future potential are also discussed, along with current challenges to the clinical translation of polymer-drug combination therapies[44,45].

Protein nanoparticles

Hydrophobic chemicals can now be delivered intravenously thanks to delivery systems for chemotherapeutic drugs based on solvents. But these solvents have been linked to harmful and dose-restrictive toxicities. Taxanes are a highly active class of cytotoxic medicines, and solvent-based formulations of them are linked to hypersensitivity responses, neutropenia, and neuropathy. Utilizing natural routes, human protein albumin-based nanoparticle technology targets tumours with greater medication concentrations while avoiding some of the toxicities associated with solvent-based formulations. Recently, the use of 130 nm albumin-bound paclitaxel in patients with metastatic breast cancer who had received ineffective combination therapy was approved[44,45].

Nanogels

Hydrogen peroxide (H2O2), a prominent reactive oxygen species (ROS) in living things, is important for a variety of biological activities, including immune response and cell communication. In addition, increased H2O2 generation contributes to the pathophysiology of numerous disorders, including cancer and angiogenesis. In order to prevent, diagnose, and keep track of various diseases, it is crucial to develop sensitive and focused technologies for detecting H2O2, particularly endogenous H2O2 in live cells. Small-molecule fluorescent probes have become an effective tool for cellular imaging of biomolecules because of their special benefits in terms of high sensitivity, quick response, real-time imaging, and noninvasiveness. Numerous small-molecular fluorescent probes for the detection of H2O2 have been created thus far[46,47].

2. **Lipid based**

Liposomes:

Liposomes are closed, spherical vesicles that contain an aqueous phase and a lipid bilayer that can be used to store pharmaceuticals. The diameter of the liposome ranges from 400 nm to 2.5 m. When combined with pharmaceuticals, nanoparticles (NPs), which are particles with sizes ranging from 1 to 100 nm, exhibit special physical and chemical characteristics that can be used for drug delivery. Understanding of these novel technologies is required for the advancement of chemotherapy with improved efficacy and reduced toxicity. Both of these emerging nanoscale drug delivery techniques can be employed to enhance present treatment regimens[49]. The best example of this are cytotoxic cancer medications. Although the medications are particularly successful in vitro, they work on both malignant and healthy tissues when used in humans. Serious and unpleasant side effects can include everything from nausea and hair loss to neuropathies, neutropenia, and kidney failure. Drug non-specificity so restricts efficacy. explains current medications and conditions being researched for the use of nanoscale drug delivery.This study describes current advances in the utilisation of NPs and liposomes for cancer treatment medication delivery. For the development of chemotherapy with improved efficacy and reduced toxicity, an understanding of these emerging technologies is required[48].

Exosomes

One of the most popular techniques for imaging or therapeutic medication administration is nanoparticles. Nanovesicular transporters called exosomes carry information for intercellular communication. These nanovesicles are connected to the pathology of several serious diseases, and in some situations, they play a crucial part in the development of those diseases. A new and promising method of treating diseases like cancer and Alzheimer's disease uses these carriers to convey therapeutic medications. Due of their restricted physiological output, these structures are difficult to collect and then purify. The hunt for mimetic substitutes was sparked by these shortcomings. Since they are simpler to extract and do not have the disadvantages of those made in animal cells, the collection of exosome-like nanoparticles from plants can be a good substitute[50].

Solid lipid nanoparticles

As an efficient carrier method for correcting dynamic medication and water-soluble medication, solid lipid nanoparticles (SLNs) are introduced. Nanoparticles are colloidal particles with a size between 10 and 1000 nm. They are made of synthetic distinctive polymers and designed to improve drug delivery and reduce lethality[51]. They have evolved as a flexible alternative to liposomes as a drug delivery system. They are made from synthetic or unique polymers and are best suited to increase sedate delivery and reduce lethality[52]. SLN have appealing qualities that could improve the execution of medicines, such as small size, a large surface zone, high medication stacking, and the communication of stages at the interface[53]. Aqueous colloidal dispersions called Solide lipid nanoparticles (SLN) have Solide biodegradable lipids as their matrix. SLNs combine the benefits of a few colloidal carriers in its class while avoiding some of their drawbacks, such as physical stability, the assurance of incorporated labile drug protection from degradation and fusion with other labile pharmaceuticals, regulated release, and great tolerability. SLN formulations have been created and comprehensively characterised in-vitro and in-vivo for a variety of administration routes (parenteral, oral, dermal, ocular, pulmonar, and rectal[54].

3. **Non polymeric**

Carbon nanotubes:

Carbon nanotubes are distinctive tubular structures with a significant length/diameter ratio and a nanometer diameter. The concentric carbon shells that make up the nanotubes can range in number from one to hundreds, with a distance between each shell of about 0.34 nm. The honeycomb configuration of the carbon atoms in the graphite sheets and the carbon network of the shells are closely connected. The fascinating mechanical and electrical characteristics of nanotubes are due to their almost one-dimensional (1D) structure and the arrangement of the carbon atoms in the shells, which is similar to graphite. As a result, the nanotubes have high tensile strength and Young's modulus, making them an excellent choice for composite materials with enhanced mechanical properties. Depending on the features of their structural design, nanotubes can be either metallic or semiconducting. This makes it possible to use nanotubes as key components in electronic devices including field-effect transistors (FET), single-electron transistors, and rectifying diodes. The use of the nanotubes as a high-capacity hydrogen storage medium was also taken into consideration. This study aims to provide an overview of some of the key developments in the experimental and theoretical research on carbon nanotubes in light of potential industrial uses[55].

Nanodiamond:

This makes it possible to use nanotubes as key components in electronic devices including field-effect transistors (FET), single-electron transistors, and rectifying diodes. The use of the nanotubes as a high-capacity hydrogen storage medium was also taken into consideration. This study aims to provide an overview of some of the key developments in the experimental and theoretical research on carbon nanotubes in light of potential industrial uses[56].

Quantum dots:

Due to their extraordinary potential for a wide range of technical applications, the peculiar properties of carbonic nanomaterials, such as nanodiamonds, fullerenes, carbon nanotubes, graphene sheets, and fluorescent carbon nanoparticles or carbon quantum dots (CQDs), have inspired extensive research on them. The optical properties and fluorescence emissions of CQDs, in particular, have drawn growing attention in recent years among their electronic and physicochemical qualities. For many years, semiconductor quantum dots have been the subject of intensive research because to their robust and controllable fluorescence emission characteristics, which allow for biosensing and bioimaging applications. However, due to the utilisation of heavy metals in their manufacturing, semiconductor quantum dots have some drawbacks, such as high toxicity[57,58,59].

Silica based nanoparticles:

Due to their good biocompatibility and adaptable physiochemical properties, silica-based nanoparticles (SNPs) are a traditional type of material used in biomedical applications. SNPs are frequently created as nanocarriers for the delivery of medicines, which can address a lot of the inherent problems with treatments, such as their poor biodistribution, short circulation lifespan, and low bioavailability. Massive efforts have been made to tailor SNPs' physiochemical characteristics, such as their particle size, morphology, and mesostructure, as well as to conjugate targeting ligands and/or "gatekeepers" to provide them with superior cell selectivity and on-demand release patterns. Despite great advancement, traditional SNPs are primarily used as nanocarriers for targeted distribution and controlled release due to the biological inertness of the naked silica framework[60].

4. **Nano crystalline:**

Pure drug crystals with diameters in the nanometer range that have been stabilised or are covered in a thin layer of surfactant are known as nanocrystals. Nanocrystals are made entirely of drugs and have no carriers. Nanosuspension is created when nanocrystals are dispersed in a dispersion medium. Depending on the technique of preparation, such as bottom-up technology or top-down technology, nanocrystals can be crystalline or amorphous in nature. Commercially scalable nanocrystal technology is an appealing and potential method to deliver poorly soluble medicines via parenteral route in addition to oral mode of administration[62].

Metallic nanoparticles types:

Aspergillus species and Penicillium species were discovered to be two of the most resilient genera to metal poisoning[19]. Fungal strains that have been isolated from polluted locations typically have higher tolerances[20]. There were certain instances, too, where there was no connection between enhanced resistance and isolation from contaminated and non-contaminated locations, such as with the Cd-resistant Piptoporus betulinus[21].

Silver:

Due to their strong antibacterial efficiency against bacteria, viruses, and other eukaryotic microorganisms, silver nanoparticles have proven to be the most effective[1,9]. Among the various synthetic techniques for AgNPs, biological techniques appear to be the most straightforward, quick, safe, dependable, and environmentally friendly ways that can generate well-defined size and morphology under the ideal circumstances for translational research[6]. The production of AgNPs using green chemistry has great potential, in the end[3].Amazing properties of nanoparticles are greatly influenced by their manufacturing process, stabiliser interactions, NP size and shape, and interactions with surrounding media[24]. Therefore, a major obstacle to achieving their (nanoparticles') superior applicable features is regulated synthesis of nanocrystals. Nanoparticles' size, shape, and chemical environment all affect their optical, electrical, magnetic, and catalytic characteristics. New techniques have been put out recently to create non-spherical nanoparticles that are both planar (such as triangles, 5 or 6 diagonal surfaces, round surfaces, etc.) and three dimensional (cubic, pyramid, etc.). When one-capacity silver ions are reduced under well regulated thermodynamic circumstances, the major result will be spherical nanoparticles because they have the least surface area per unit volume and are therefore thermodynamically more stable[26].

Gold:

In order to identify the presence of DNA in a sample, they are utilised as lab tracers in DNA fingerprinting. They are also employed in the detection of antibiotics known as aminoglycosides, such as streptomycin, gentamycin, and neomycin[5]. Several environmentally friendly techniques, including the seed-mediated growth method, conducting the synthesis in the presence of ionic liquids, and other reduction techniques like the hydrazine reduction method and sodium borohydride reduction method, have been used to create 4,5 Gold nanoparticles.Plasmonic AuNPs have been synthesised in a wide range of sizes and shapes, and each one has distinct optical properties. Distinct particle kinds have very different AuNP synthesis processes, and there are numerous ways to achieve forms that are similar. Although it is outside the scope of this page, there are other articles that explore other synthesis methods in greater detail[22,23].

Alloy:

The structural characteristics of alloy nanoparticles differ from those of their bulk samples. In order to create metallic alloy nanoparticles, two or more distinct metals must be combined. Due to their synergistic properties, bimetallic or trimetallic nanoparticles are thought to be more effective than monometallic nanoparticles[7,8].High concentrations of these substances function as a significant stressor for soil fungi, preventing their growth and interfering with several fungi-plant symbiotic relationships, which reduces soil fertility and causes plants to accumulate more metals, which can have a variety of detrimental impacts[18].

Magnetic:

Fe3O4 (magnetite) and Fe2O3 (maghemite), two types of magnetic nanoparticles, are known to be biocompatible[11]. Magnetic recording media and biological uses, such as magnetic resonance contrast media and therapeutic agents in cancer treatment, are only a few of the several fields in which magnetic nanoparticles are used industrially. Different qualities are necessary for each possible use of magnetic nanoparticles. For instance, to represent information bits that are unaffected by temperature changes in data storage applications, the particles must have a stable, switchable magnetic state[10].

Microorganism	Types	Location	Size
Fungi			
Phoma sp.	Au	extracellular	71.06 -74.46
Fusarium oxysporum	Ag	extracellular	20-40
Aspergillus fumigates	Ag	extracellular	5-25
Trichoderma asperellum	Ag	extracellular	13-18
Phaenerochaete chrysosporium	Ag	extracellular	50-200
Verticillium sp.	Ag	extracellular	25-12

Table No. 1 Synthesis of metallic nanoparticles by different microorganisms

Iron nanoparticals:

Utilizing fungi like Fusarium oxysporum and Verticillium sp. with mixes of ferric and ferrous salts at room temperature can produce various sizes of magnetic particles extracellularly. The anionic iron complexes are hydrolyzed extracellularly by cationic proteins released by the fungus. As a result, crystalline magnetite particles with little spontaneous magnetization at low temperature are produced. These particles show a ferrimagnetic transition signature[12,13].

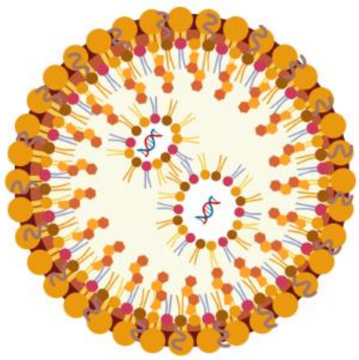

Fig. 6 Iron nanoparticals

Stability and toxicity of the Nanoparticles

The capacity of released nanoparticles to form metastable aqueous suspensions or aerosols in ambient fluids determines their environmental distribution and mobility. By calculating how likely the nanoparticles are to combine or interact with the environment, one may assess how stable they are there. While the stability of the suspension is mostly influenced by the size of the particles and their affinity for other environmental components, accumulation is a time-dependent phenomenon linked to the rate of particle impact. After being introduced to an aqueous environment, the "green" synthesis of AgNPs from tea leaf extraction was discovered to be stable[27].Controlling the particle size, surface capping, or functionalization processes can be used to alter the colloidal stability (or rate of dissolution) of nanoparticles[28,29].

Nanoparticles sources:

From combustion processes that involve both stationary[30] and mobile sources[31], nanoparticles can be released directly. They may originate in the atmosphere as a result of radioactive decay, vapour precursor reactions, or vapour precursor nucleation[32,33]. Additionally, nanoparticles are frequently created in industrial environments. The existence and possible emissions of manufactured nanoparticles have recently been a hot topic due to advances in nanotechnology. Although they are a significant contributor to pollution and the economy, combustion processes. emissions from industrial boilers, fireplaces, cars, diesel trucks, and meat-cooking processes were characterised by their aerosol size distributions. The mass distribution's primary peak was found to be at or below 0.2m (200 nm). When the number distribution is examined, it becomes clear that many of these sources have their primary peak much below 100 nm. A nuclei mode peak between 20 and 60 nm may be seen in the bimodal distributions of many of these sources (even in the mass distributions). This makes it quite evident that nucleation occurs and is significant[34].

Stationary Sources

It has long been recognised that stationary combustion systems are a significant source of fine particle emissions. However, characterization of ultrafine or nanometer-sized particulate matter emission is only now beginning to get attention. examined ultrafine particles in a municipal trash incinerator's flue gas and stack. At 700 °C, the peak size was determined to be 90 nm (in the combustor). In the cooler downstream regions, the particles increased in size through the processes of coagulation, condensation, and reactive chemical bonding with the nucleated particulate matter. After the wet electrostatic precipitator (ESP), there were sporadic episodes of high ultrafine particle emissions that were likely caused by the nucleation of gas-phase constituents in cooler locations downwind of the ESP[35].

Mobile Sources

Diesel engines are significant generators of nanoparticles (50 nm), which dominate by number concentration, although the accumulation mode (50 nm particle diameter1m) dominates the mass distribution. Recent improvements in instrumentation have also demonstrated that newly generated particles have a nucleation mode (10 nm). When it comes to nanoparticles from diesel engines, hydrocarbons (soluble organic component) or sulphate particles created by nucleation are more common than carbonaceous soot aggregates. According to Tobias et al.'s report, lubricating oil and unburned gasoline make up the majority of the nanoparticles in diesel exhaust. Despite making up a modest percentage, sulfuric acid was essential because it served as the nucleus on which organic species might condense[36,37].

Discussion:

Micron-sized particles known as nanoparticles have at least one dimension that is in the nanometer range (1-100 nm). They are desirable for a variety of applications in industries like electronics, energy, healthcare, and environmental protection because to their special qualities, such as high surface area to volume ratio and size-dependent behaviour.

Nanoparticles can be created using a variety of techniques, including chemical and physical ones.

Physical processes include physical vapour deposition, sputtering, and laser ablation are used to create nanoparticles. These procedures entail the condensation of a substance in vapour or gaseous form onto a substrate, which produces nanoparticles. On the other hand, chemical approaches use chemical reactions to create nanoparticles. Precipitation, chemical reduction, and template-assisted techniques are some of these techniques. A precursor is reduced chemically to create nanoparticles. Nanoparticles are created during precipitation when two or more reactants react. A template is employed in template-assisted procedures to regulate the size and shape of the nanoparticles.

Metal nanoparticles, metal oxide nanoparticles, semiconductor nanoparticles, and polymer nanoparticles are just a few of the several kinds of nanoparticles.

Metal nanoparticles are frequently utilised in fields like catalysis and biomedicine and are composed of metals like gold, silver, and palladium. Metal oxide nanoparticles are utilised in solar cells, catalysis, and environmental protection applications. They are formed of metal oxides such titanium dioxide, zinc oxide, and iron oxide.

Optoelectronics, solar cells, and catalysis all make extensive use of semiconductor nanoparticles, which are composed of substances like cadmium selenide, lead sulphide, and indium arsenide.

Polymer nanoparticles are comprised of polymers and are utilised for environmental protection, sensing, and medication delivery.

In conclusion, the synthesis of nanoparticles is an essential stage in the development of several applications, and the particular application determines the synthesis process and kind of nanoparticle to use.

Conclusion:

The microorganisms provide diverse environment for biosynthesis of nanoparticles. These particles are safe and eco-friendly with a lot of applications in medicine, agriculture, cosmetic industry, drug delivery and biochemical sensors. The challenges for readdress include optimal production and minimal time to obtain desired size and shape, to enhance the stability of nanoparticles and optimization of specific microorganisms for specific application.

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