A REVIEW ON NANOPARTICLES

Jyothi Rani .L *, Allapu kondal Reddy, Battu Chinmai Reddy, Dumpala Sangeetha, Malavath Swetha .

Department of Pharmaceutics

Malla Reddy Institute of Pharmaceutical Sciences, Maisammaguda, Kompally-500100.

Corresponding Author Details

Jyothi Rani .L

Professor

Department of Pharmaceutics

ABSTRACT:

Interest in nanomaterial and especially nanoparticles has exploded in the past decades primarily to the novel or enhanced physical and chemical properties compared to bulk material. These extraordinary properties have created a multitude of innovative applications in the fields of medicine and pharma, electronic, agriculture, chemicals catalysis, food industry and many others. In green synthesis, biology methods are used for the synthesis of NPs because biological methods are eco-friendly, clean, safe, cost-effective, uncomplicated, and highly productive. Numerous biological organisms, such as bacteria, actinomycetes, fungi, yeast, and plants are used for the synthesis of NPs. The Nano particles show enhanced properties such as high reactivity, strength, surface area, sensitivity, and stability etc. They were synthesized by various methods for research and commercial uses which are classified into three types-chemicals, physical and mechanical processes which had improvement. We have prepared this paper to present a review on nanoparticles, their types, characterization, synthesis methods and applications in field of environment.

KEYWORDS:

Nanoparticles, Nanotechnology, biological synthesis, Nanomaterials, targeting, drug release, Toxicity.

1. INTRODUCTION:

Nanotechnology is a known field of research since last century. Since "nanotechnology" was presented by Nobel Laureate Richard P. Feynman during his well famous 1959 lecture. Nanotechnology produced materials of various types at nanoscale level. Nanoparticles (NPs) are wide class materials that in include particulate substances, which have one dimension less than 100nm at least (5). Nanoparticles have significant applications in different sectors such as the environment, agriculture, food, biotechnology, biomedical, medicines, etc like; for treatment of waste water, environment monitoring, as a functional food additive, and as antimicrobial agents. Cutting-edges properties of NPs such as; nature, biocompatibility, anti-inflammatory and antibacterial activity, effective drug delivery, bioactivity, bioavailability, targeting, and applied microbiological applications of NPs (1). The prefix comes from the ancient Greek through the Latin nanus meaning literally dwarf and by extension, very small. With in the convention of international system of Units (SI) It is used to indicate a reduction factor of 10 times. So, the nanosized world is typically measured in nanoparticles (1nm corresponding to 19 m) and it encompasses system whose size is above molecular dimensions and below macroscopic ones (generally >1 nm and < 100nm) (8). Nanoparticles differs from various dimensions, to shapes and sizes apart from their material. The nanoparticles can be either a zero dimensional where it can possess only one parameter for examples graphene, two dimensional where it has length and breadth for examples carbon nanotubes or three dimensional where it has all the parameters such as length, breadth and height for example gold nanoparticles (4).The International Organization for Standardization (ISO) defines nanoparticles as nano-objects with all external dimensions in the nanoscales, where the length of the longest and the shortest axes of the nano-object do not differ significantly. If the dimensions differ significantly (typically by more than three times), terms such as nanofibers or nanoplates may be preferred to the term NPs (2).

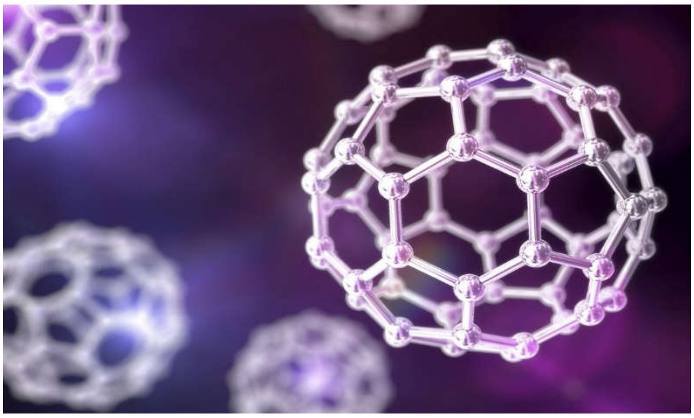

Figure:1 Nanoparticles

Nanoparticles can be of different shapes, sizes, and structures. They can be spherical, cylindrical, conical, tubular, hollow core, spiral, etc., or irregular. The sizes of NPs can be anywhere from 1 to 100nm. If the size pf NPs gets lower than 1 nm, the term atom clusters is usually preferred. NPs can be crystalline with single or multi-crystal solids, or amorphous. NPs can be either loose or agglomerated (2). One of the main reasons for a drug's insolubility is its complex and 65% of new active pharmaceutical ingredients (APIs) are either poorly soluble in water or insoluble. Due to their low aqueous solubility properties and high permeability, they are categorized as class 2 of the biopharmaceutics classification system (BCS), were the

dissolution step is the rate limiting factor in drug facing a challenge to improve the dissolution characteristic of poorly water-soluble drugs which is the key factor in enhancing drug bioavailability (6). The prefix derives from the Greek word havoc through the Latin word nanus, which means literally "dwarf" and thus "very small"2. Due to their large surface area and nano scale size. NPs have distinct physical and chemical properties. These qualities make them suitable candidates for a variety of industrial and domestic applications, such as environmental, imaging, medical, energy-based research, and catalytic applications3.The structure of nanoparticles is intricate (7). Because of this, many of the physical characteristics of nanoparticles differ significantly from those of bulk materials, leading to a wide range of their novel uses (12).

1.1ADVANTAGES OF NANOPARTICLES:

1. The preparation of nanoparticles using biodegradable material enables sustained drug release at the target site over the course of days or even weeks.

2.Ease of modifying nanoparticles surface properties and particle size to target drugs both passively and actively after parental administration.

3.The nanoparticles surface can be modifying to alter bio distribution of drugs with subsequent clearance of the drug so as to achieve maximum therapeutic efficacy with minimal side effects of the drugs.

4.Nanobarcodes are used to label food products for safety and to track their distribution.

5.Nano supplements can be easily added using the encapsulation technique for effective drug accumulation at the body's target sites.

1.2 DISADVANTAGES OF NANOPARTICLES:

1. Nano technology is very expensive, and it can be even more expensive to develop.

2. Because of their small size and high surface area, nanoparticles are highly reactive in the cellular environment.

3. Atomic weapons are now easier to obtain, more potent, and mor destructive to use.

2. HISTORY OF NANOTECHNOLOGY:

Paul Ehrlich called as father of NPs, who has started up the concept of NPs after attending Karl Maria von Weber's Opera. His eminent concept was to improve drug therapy by targeting the principle (drug or biologically active materials). In the early years, NPs were trended in the drug targeting field due to their unique pharmaceutical, and pharmacokinetics parameters. The promoter, professor peter Paul Speiser and his illustrious research team prepared first beads of polyacrylic for oral administration, afterward they have investigated polyacrylic microcapsules and finally they have prepared NPs/nano capsules for the sustained release of drug treatment against vaccine, tetanus, diphtheria, and other infections (11). Long before the era of nanotechnology, people were unknowingly coming across various nanosized objects and using nano-level processes. In ancient Egypt, dyeing hair in black was common and was for a long time believed to be based on plant products such as henna Lenna. However, recent research on hair samples from ancient Egyptian burial sites showed that hair was dyed with paste from lime, lead oxide, and water. In this dyeing process, galenite (lead sulfide, PbS) nanoparticles are formed. The ancient Egyptians were able to make the dyeing paste react with Sulphur (part of hair keratin) and produce small PbS nanoparticles which provided even and steady dyeing (2).

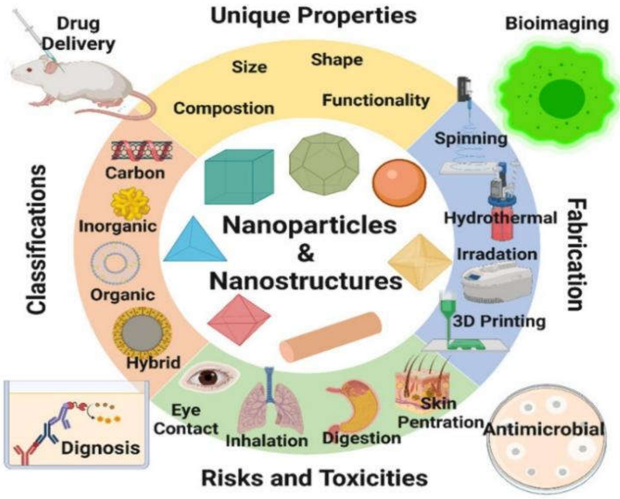

Figure:2 Nanoparticles and Nanostructures

3. EMERGENCE OF NANOTECHNOLOGY:

Nanotechnology emerged in the 1980s due to the convergence of experimental advances such as the invention of the scanning tunnelling microscope in 1981 and the discovery of fullerenes in 1985 (Bayda et al., 2019), with the elucidation. The popularization of a conceptual framework for nanotechnology goals began with the publication of the book Engines of Creation in 1896.

3.1. Early stage of Nanoparticles.

Carbon nanotubes have been discovered in pottery from Kelada, India, dating from around 600–300 BC (Bayda et al., 2019; Kaneswaran et al., 2020). Cementite nanowires have been discovered in Damascus steel, a material that dates back to around 900 ADS; nevertheless, its origin and creation method are unclear (Kaneswaran). However, it is unknown how they developed or whether the material containing them was used on purpose (1).

3.2. Discovery of C, Ag, Zn, Cu, and Au Nanoparticles

Carbon NPs were found in 1991, and Iijima and Ichihashi announced the single-wall carbon nanotube synthesis with a diameter of 1 nanometre in 1993 (Chen et al., 2021). Carbon nanotubes (CNTs), also known as Bucky tubes, are a kind of nanomaterial made up of a two-dimensional hexagonal lattice of carbon atoms (1).

4. CLASSIFICATION OF Nanoparticles:

Based on their composition, NPs are generally placed into three classes: organic, carbon-based, and inorganic (2).

4.1 Organic Nanoparticles:

This class comprises NPs that are made of proteins, carbohydrates, lipids, polymers, or any other organic compounds (2). The most prominent examples of this class are dendrimers,

liposomes, micelles, and protein complexes such as ferritin. These NPs are typically non-toxic, bio-degradable, and can in some cases, e.g., for liposomes, have a hollow core. Organic NPs are sensitive to thermal and electromagnetic radiation such as heat and light. In addition, they are often formed by non-covalent intermolecular interactions, which makes them more labile in nature and offers a route for clearance from the body. When exposed to heat or light, ferritin, liposomes, micelles, and dendrimers become highly sensitive polymers (7).

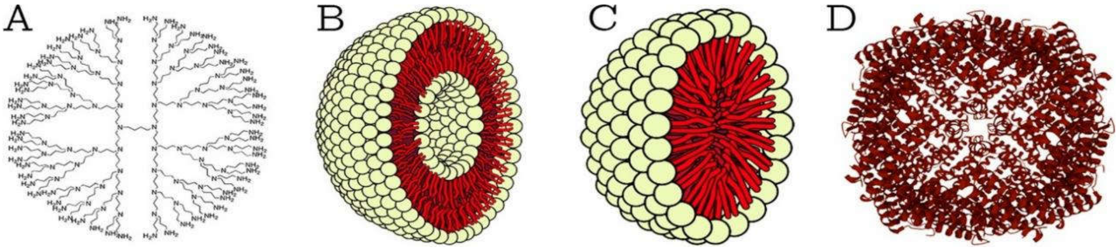

Figure: 3 Organic nanoparticles: a) Dendrimers, b) Liposomes and c) Micelles.

4.2 Inorganic Nanoparticles:

This class comprises NPs that not made of carbon or organic materials. The typical examples of this class are metal, ceramic, and semiconductor NPs. Metal NPs are purely made of metal precursors, they can be monometallic, bimetallic, or polymetallic. Bimetallic NPs can be made from alloys or formed in different layers (core–shell). Due to the localized surface plasmon resonance characteristics, these NPs possess unique optical and electricals properties. In addition, some metal NPs also possess unique thermal, magnetic, and biological properties (2).

4.2.1 Carbon-based Nanoparticles:

Fullerenes and carbon nanotubes (CNTs) are the two essential sub-categories of carbon-based NPs. NPs of globular hollow cages, like allotropic forms of carbon, are found in fullerenes. Due to their electrical conductivity, high strength, structure, electron affinity, and adaptability, they have sparked significant economic interest (1). Carbons quantum dots consist of discrete, quasi-spherical carbon NPs with sizes below 10nm. Carbons-based NPs united the distinctive properties of SP2-hybridized carbon bonds with the unusual physicochemical properties at the nanoscale (2).

4.2.2 Metal Nanoparticles:

Metal NPs are purely made of metals. These NPs have distinctive electrical properties due to well-known localized surface Plasmon resonance (LSPR) features. Cu, Ag, and Au nanoparticles exhibit a broad absorption band in the visible region of the solar electromagnetic spectrum (12). These nanoparticles can be synthesized by chemical, electrochemical, or photochemical methods (6).

4.2.3 Lipid-based Nanoparticles:

These NPs are helpful in several biological applications because they include lipid moieties. Lipid NPs typically have a diameter of 10–1,000 nm and are spherical. Lipid NPs, i.e., polymeric NPs, have a solid lipid core and a matrix consisting of soluble lipophilic molecules (12). These NPs are helpful in several biological applications because they include lipid moieties. Lipid NPs typically have a diameter of 10–1,000 nm and are spherical (1).

4.2.4 Semiconductor Nanoparticles:

Semiconductor NPs have qualities similar to metals and non-metals. That is why Semiconductor NPs have unique physical and chemical properties that make them useful for various applications. For example, semiconductor NPs can absorb and emit light and can be used to make more efficient solar cells or brighter light-emitting diodes (LEDs). They can make smaller and faster electronic devices, such as transistors, and can be used in bio imaging and cancer therapy (12).

4.3 Carbon-based Nanoparticles:

Carbon-based nanoparticles include two materials, namely, carbon nanotubes (CNTs) and fullerenes. CNTs are nothing but graphene sheets rolled into a tube. These materials are mainly used for the structural reinforcement as they are 100 times stronger than steel. CNTs can be classified into single-walled carbon nanotubes (SWCNTs) (6). The nanoparticles made completely of carbon are knows as carbon based. They can be classified into fullerenes, graphene, carbon nano tubes (CNT), carbon nanofibers and carbon black and sometimes activated carbon in nano sizes (4).

5. TYPES OF NANOPARTICLES:

Metal NPs are purely made of metal precursors. Due to well-known localized surface plasmon resonance (LSPR) characteristics, these NPs possess unique optoelectrical properties. NPs of the alkali and noble metals, i.e., Cu, Ag, and Au, have a broad absorption band in the visible zone of the solar electromagnetic spectrum. The facet, size, and shape-controlled synthesis of metal NPs are essential in present-day s cutting-edge materials (1). polymeric nanoparticles are colloidal structures composed of synthetic polymers. The drug is dissolved, entrapped, encapsulated or attached to a nanoparticle matrix. Depending upon the method of preparation, nanoparticles, nanospheres or nano capsules can be obtained (8).

5.1. Silver nanoparticles (Ag NPs):

Ag NPs are particles with a size range of 1–100 nano meters made of silver. They have unique physical and chemical properties due to their small size, high surface area-to-volume ratio, and ability to absorb and scatter light in the visible and near-infrared range. Because of their relatively small size and high surface-to-volume ratios, which cause chemical and physical differences in their properties compared to their bulk counterparts, silver nanoparticles may exhibit additional antimicrobial capabilities not exerted by ionic silver (1). Silver NPs (AgNPs) are notably used in numerous fields, such as medicine, food, HealthCare, and industrial purposes, due to the fact of their specific bodily and chemical properties, morphology and distribution, size, shape, and excessive floor area (11). Under atmospheric condition, silver ions are decreased with the aid of ethanol at 800°C to 1000°C to reap the silver. They are the most typically used kind of nanoparticles. They have properly antimicrobial efficacy and so they are used in cloth industries for sunscreen lotions and water treatment (15). Besides, Ag NPs can be created in various sizes and forms depending on the manufacturing process, the most common of which is chemical reduction. The Ag NPs were created by chemically reducing a 12 mM AgNO3 aqueous solution. The reaction was carried out in an argon environment using 70 mL of this solution containing PVP (keeping the molar ratio of the repeating unit of PVP and Ag

equal to 34) and 21 mL of Aloe Vera. The mixture was agitated in ultrasonic for 45 min at ambient temperature, then heated 2°C/min to 80°C and left for 2 h to generate a transparent solution with tiny suspended particles that must be removed by simple filtering.

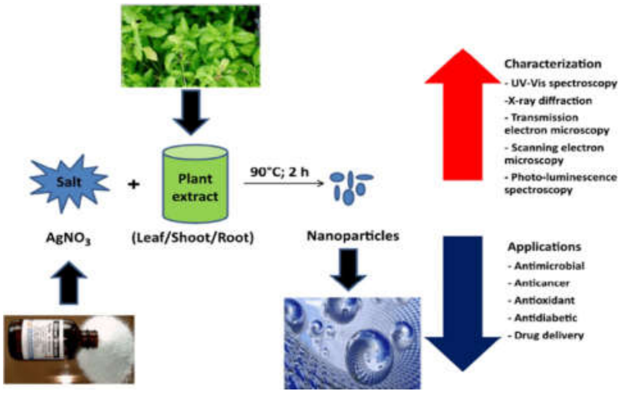

Figure:4 Green synthesis of silver nanoparticles by plants extract and AgNO3, its characterization and applications in various bio-medical fields.

5.2. Zinc nanoparticles (ZnO NPs):

Zinc nanoparticles (ZnO NPs) are particles with a size range of 1–100 nm made of zinc. Zinc oxide (ZnO) NPs are a wide band gap semiconductor with a room temperature energy gap of 3.37 eV. Its catalytic, electrical, optoelectronic, and photochemical capabilities have made it widely worthwhile. ZnO nanostructures are ideal for catalytic reaction processes (1). Zinc oxides nanoparticles have draw considerable attention from researches and scientists in the past 4-5 years due to its wide applications field of the biomedical field as well as in optics and electronic (10).

5.3. Copper nanoparticles (CuNPs):

Copper nanoparticles (CuNPs) comprise a size range of 1–100 nm of copper-based particles. Cu and Au metal fluorescence have long been known to exist. For excitation at 488 nm, a fluorescence peak entering on the metals' interbond absorption edge has been noted. Additionally, it was noted that the fluorescence peaked at the same energy at two distinct excitation wavelengths (457.9–514.5 and 300–400 nm), and the high-energy tail somewhat grows with increased photon energy pumping. A unique, physical, top-down EEW approach has been used to create Cu nanoparticles (1). Copper nanoparticles are synthesized by various plant extracts such as Aloe vera flower extract via the reduction of aqueous copper ions (10). Copper nanoparticles (Cu-NPs) displayed one-of-a-kind residences such as been price effective, much less hazardous, showcase excessive floor vicinity to quantity ratio and properly warmth switch homes that are traceable.to their bodily traits such as morphology, crystallinity and composition. Easy manufacturing and bendy amendment into preferred form and dimension of nano-sized are different exquisite first-class of Cu-NPs (15).

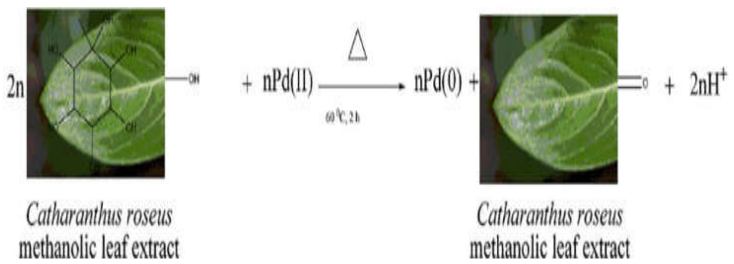

Figure:5 Synthesis of Palladium nanoparticles using Catharanthus roseus methanolic leaf extract and palladium ion.

5.4. Gold nanoparticles (AuNPs):

For identification of protein interactions in immunochemical research gold nanoparticles (AuNPs) are used In DNA fingerprinting they are used as lab tracer to observe existence of DNA in a. Aminoglycoside antibiotics i.e. streptomycin, gentamycin and neomycin are additionally detected through the usage of these nanoparticles. Detection of most cancers stem cells, prognosis of most cancers and identification of unique instructions of bacteria done by way of the use of gold nano rods (15). Gold nanoparticles (AuNPs) are nanometres made of gold. They have unique physical and chemical properties and can absorb and scatter light in the visible and near-infrared range (1).

5.5. Aluminium nanoparticles (Al NPs):

Aluminium nanoparticles (AlNPs) are nanoparticles made of aluminium. Aluminium nanoparticles' strong reactivity makes them promising for application in high-energy compositions, hydrogen generation in water processes, and the synthesis of alumina 2D and 3D structures (1). The green synthesis of silver nanoparticles, the key requirements are silver metal ion solution and a reducing biological agent (10).

6. APPROACHES FOR THE SYSTHESIS OF METAL NANOPARTICLES:

. There are mainly three types of approaches for the synthesis of NPs: the physical, chemical, and biological approaches. The physical approach is also called the top-down approach, while chemical and biological approaches are collectively called the bottom-up approach. The biological approach is also named green systems of NPs. All these approaches are further sub-categorized into various types based upon their method adopted NPs.

6.1. Top down/physical approach:

Bulk materials are fragmented in top-down methods to create nano-structured materials. They are additionally known as physical approaches. The following techniques can achieve a top-down approach (1). Destructive synthesis is employed in the process. The bigger molecular broke down into smaller ones, and then changed into nanoparticles (7).

6.1.1. Mechanical milling:

The mechanical milling process uses balls inside containers and may be carried out in various mills, typically planetary and shaker mills, which is an impact process with high energy (1). The energy transferred from the balls to the powder during mechanical milling or alloying depends on the kinetics if the process (7).

6.1.2. Electrospinning:

Typically, it is used to create nanofibers from various materials, most often polymers. A technique for creating fibres called electrospinning draws charged threads from polymer melts or solutions up to fibre sizes of a few hundred nanometres (1).

6.1.3. Laser ablation:

A microfeature can be made by employing a laser beam to vaporize a single material. Laser ablation synthesis produces nanoparticles by striking the target material with an intense laser beam. Due to the high intensity of the laser irradiation used in the laser ablation process, the source material or precursor vaporizes, causing the production of nanoparticles (1). By concentrating a laser beam, which absorbs energy to cause melting, evaporation, or vanish ablation, a substance is removed from a surface (7).

6.1.4. Sputtering:

Microparticles of a solid material are expelled off its surface during the phenomenon known as sputtering, which occurs when the solid substance is assaulted by intense plasma or gas particles (1). The materials that sputtered together make up a vapour steam (7).

6.1.5. Electron explosion:

In this technique, a thin metal wire is subjected to a high current pulse that causes an explosion, evaporation, and ionization.

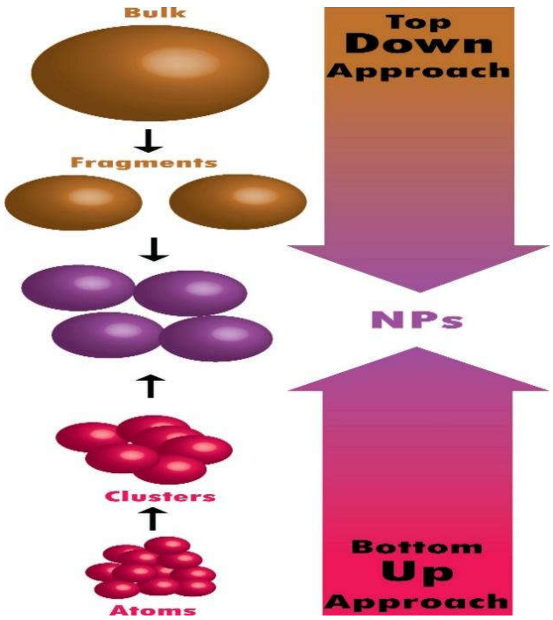

Figure :6 Different between Top-Down Approach and Bottom-Up Approach

6.2. Bottom -up method:

Tiny atoms and molecules are combined in bottom-up methods to create nano-structured particles. These include chemical and biological approaches:

6.2.1. Chemical vapor deposition (CVD):

Through a chemical process involving vapor-phase precursors, a thin coating is created on the substrate surface during CVD. Precursors are deemed appropriate for CVD if they exhibit sufficient volatility, high chemical purity, strong evaporation stability, cheap cost, a non-hazardous nature, and long shelf life (1). A Solid is deposited on a heated surface using the well-known CVD process, which involves a chemical reaction between the gaseous and vapours phases (7).

6.2.2. Sol-gel process:

A wet-chemical approach, called the sol-gel method, is widely utilized to create nanomaterials. Metal alkoxides or metal precursors in solution are condensed, hydrolysed, and thermally decomposed.

6.2.3. Co-precipitation:

It is a solvent displacement technique and is a wet chemical procedure. Ethanol, acetone, hexane, and non-solvent polymers are examples of solvents. Polymer phases can be either synthetic or natural. By mixing the polymer solution, fast diffusion of the polymer-solvent into the non-solvent phase of the polymer results.

6.2.4. Inert gas condensation/molecular condensation:

Metal NPs are produced using this method in large quantities. Making fine NPs using the inactive gas compression approach has been widespread, which creates NPs by causing a metallic source to disappear in an inert gas. At an attainable temperature, metals evaporate at a tolerable pace. Copper metal nanoparticles are created by vaporizing copper metal inside a container containing argon, helium, or neon.

6.2.5. Hydrothermal:

In this method, for the production of nanoparticles, hydrothermal synthesis uses a wide temperature range from ambient temperature to extremely high temperatures (1).

7. CHARACTERIZATION OF NANOPARTICLES:

7.1. Mechanical properties:

Mechanical properties refer to the mechanical characteristics of a material under different conditions, environments, and various external forces. As for traditional materials, the mechanical properties of nanomaterials generally consist of ten parts: strength, brittleness, hardness, toughness, fatigue strength, plasticity, elasticity, ductility, rigidity, and yield stress (2). NPs show dissimilar mechanical properties are compared to microparticles and their bulk materials (5).

7.2. Thermal properties:

Heat transfer in NPs primarily depends on energy conduction due to electrons as well as photons (lattice vibration) and the scattering effects that accompany both. The major components of thermal properties of a material are thermal conductivity, thermoelectric power, heat capacity, and thermal stability (2).

7.3. Magnetic properties:

All magnetic compounds include a ‘magnetic element’ in their formula, i.e., Fe, Co, or Ni (at ambient temperatures). There are only three known exceptions that are made from mixed diamagnetic elements, Sc_3In, $ZrZn_2$, and $TiBe_{2-x}Cu_x$ [2]. The literature revealed that NPs perform best when the size is <critical value i.e. 10-20 nm (5).

7.4. Electronic and optical properties:

Metallic and semiconductor NPs possess interesting linear absorption, photoluminescence emission, and nonlinear optical properties due to the quantum confinement and localized surface plasmon resonance (LSPR) effect. LSPR phenomena arise when the incident photon frequency is constant with the collective excitation of the conductive electrons (2). Actually, the free electrons on the surface in these NPs are freely transportable trough the nanomaterials (5).

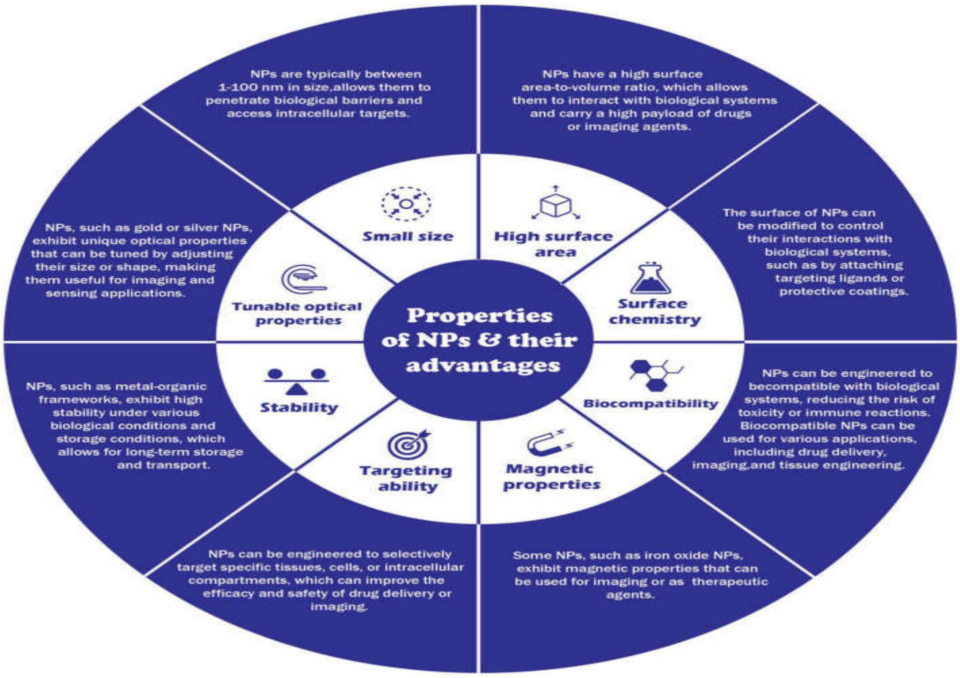

Figure:7 properties of Nanoparticles and their advantages

8. APPLICATION OF NANOPARTICLES:

8.1. Application of NPs in environment industry:

8.1.1. Bioremediation:

Nanoparticles (NPs) can remove environmental pollutants, such as heavy metals from water or organic contaminants from soil. For example, silver nanoparticles (AgNPs) effectively degrade certain pollutants, such as organic dyes and compounds found in wastewater. Several nanomaterials have been considered for remediation purposes, such as nanoscale zeolites, metal oxides, and carbon nanotubes and fibres (1).

8.1.2. Sensors in environment:

Nanotechnology/NPs are already being used to improve water quality and assist in environmental clean-up activities (1).

8.1.3. Catalysts in environment:

Nanoparticles (NPs) are used as catalysts in chemical reactions, such as in the production **of** biofuels or environmental remediation processes, and to catalyse biomass conversion into fuels, such as ethanol or biodiesel (1).

8.2. Applications of NPs in medicine industry:

Nanoparticles (NPs) have unique physical and chemical properties due to their small size, making them attractive for use in various applications, including the medicine industry. Some potential applications of NPs in medicine include:

8.2.1. Drug delivery

Technological interest has been given to AuNPs due to their unique optical properties, ease of synthesis, and chemical stability. The particles can be used in biomedical applications such as cancer treatment, biological imaging, chemical sensing, and drug delivery (1).

8.2.2. Diagnostics:

Nanoparticles (NPs) can be used as imaging agents to help visualize specific body areas. For example, iron oxide nanoparticles (Fe_3O_4 NPs) have been used as magnetic resonance imaging (MRI) contrast agents to help visualize tissues and organs (1).

8.2.3. Tissue engineering:

Nanoparticles (NPs) can help stimulate the growth and repair of tissues and organs. For example, titanium dioxide nanoparticles (TiO2 NPs) have been explored for tissue engineering due to their ability to stimulate the growth of bone cells (1).

8.3. Applications of NPs in agriculture industry:

There are several ways in which nanoparticles (NPs) have the potential to alter the agricultural sector. NPs may be used in agriculture for a variety of reasons, including:

8.3.1. Pesticides and herbicides:

Nanoparticles (NPs) can be used to deliver pesticides and herbicides in a targeted manner, reducing the number of chemicals needed and minimizing the potential for environmental contamination (1). AgNPs and CuNPs have antimicrobial properties, making them potentially useful for controlling pests and diseases in crops.

8.3.2. Fertilizers and plant growth:

Nano fertilizers offer an opportunity for efficiently improving plant mineral nutrition. Some studies have shown that nanomaterials can be more effective than conventional fertilizers, with a controlled release of nutrients increasing the efficiency of plant uptake and potentially reducing adverse environmental outcomes associated with the loss of nutrients in the broader environment (1).

8.3.3. Food safety:

Nanoparticles (NPs) can detect and eliminate pathogens in food products, improving food safety, and reducing the risk of foodborne illness (1). The enhancement in production, processing, safety and packaging of meals is completed by way of incorporating nanotechnology. For instance, a nanocomposite coating in a meals packaging procedure can without delay introduce the anti-microbial resources on the covered movie (15).

Table :1 Nanoparticles in drug deliver-properties and applications

9. FUTURE PERPSPECTIVE:

Nanotechnology has been expanding quickly and has many uses in many different fields. NPs affect both humans and animals and results in a variety of health issues with kidneys, lungs. And other organs. It is necessary to produces NPs with consistent sizes, properties, biocompatibility with drug loading, and limited release to the intended cells. Nanoparticles and Nano formulations have already been applied as drug delivery systems with great success; and still greater potential; for many applications, including anti-tumour therapy, gene therapy, AIDs therapy, radiotherapy, in the delivery of proteins, antibiotics, biostatics, vaccines and as vesicles to pass the blood- brain barrier.

Types of nanoparticle	Size	Materials	Properties	Application
Quantum dots	2-10 nm	CdSe, CdTeetc	wide range of excitation, no photo bleaching	Optical imaging
Lipids	50-1000 nm	Liposomes, micelles	Biocompatible, carry hydrophobic cargo	Drug delivery
Superparamagnetic iron oxide (SPIO)	3. 2-7. 5 nm	Iron oxide or cobalt based, aggregates in dextran	Superparamagnetic, ferromagnetic, paramagnetic	Hyperemia therapy, MRI
Gold	50-100 nm	Spheres, rods or shell	Biocompatibility	Drug delivery, hyperthermia
Silica	200 nm	Spheres, shells	Biocompatibility	Encapsulation
Carbon based	~ 1 nm	Carbon nanotube, fullerene, graphene	Biocompatible	Drug delivery
Dendrimer	1-5 nm	PAMAM etc	Less polydispersity, biocompatible	Drug delivery
Polymers	10-1000 nm	Chitosan, PLGA etc	Biodegradable	Drug delivery, passive or controlled release

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11. CONCLUSION:

The foregoing show that nanoparticulate systems have great potential, being able to convert poorly soluble, poorly absorbed and labile biologically active substance into promising deliverable drugs, the core of this system can enclose a variety of drugs, enzymes, genes and is characterized by a long circulation time due to the hydrophilic shell which prevents recognition by the reticular-endothelial system. Different techniques, such as top-down and bottom-up synthesis, are used to prepare NPs. Various types of nanomaterials, such as carbon-based, gold, titanium, dendrimers, and liposomes, are being researched for the purpose of targeted drug delivery. Nanostructured scaffolds have a higher surface-area-to-volume ratio, which makes them suitable as selective substrates for absorbing particular proteins and encouraging cell adhesion. The development of biosensors using NPs based on metal and carbon has numerous applications in the biomedical and agricultural sectors.

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