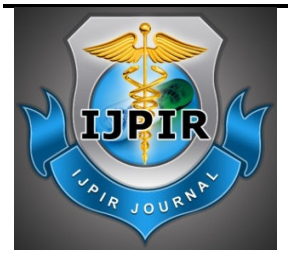
Review Article



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A review on nano particles

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ABSTRACT

Nanoparticles are the most basic type of structure with dimensions in the nanometer range. A nanoparticle is a group of atoms bound together with a structural radius of less than 100 nanometers. Because of their high solubility, small size, and greater penetrability, nanoparticles are now frequently used in a variety of dosage forms. Emulsion-Solvent Evaporation Method, Double Emulsion and Evaporation Method, Salting Out Method, Emulsions Diffusion Method, Solvent Displacement/Precipitation Method, Polymerization Method, and Coacervation or ionic gelation Method are some of the methods used to make nanoparticles.Cell specificity, internalisation, vaccine delivery, & gene delivery are among applications of nanoparticles in micro wiring. Nanoparticles are employed in medicine for a variety of purposes, including cancer treatment and orthopaedic implants. Nanoparticles have a high solubility & penetration rate, which is why they are now used in almost every formulation.

Keywords: Nanoparticles, Polymerization, amorphous, micelles and chitosans

INTRODUCTION

Nanoparticles are the most important part of nanotechnology. Nanoparticles are made up of carbon, metal, metal oxides, or organic substances and range in size from 1 to 100 nanometres [1]. When compared to their counterparts at larger scales, nanoparticles have distinct physical, chemical, and biological features. This is owing to a greater surface area to volume ratio, improved reactivity or stability in a chemical process, increased mechanical strength, and other factors [2]. Nanoparticles' features have led to their employment in a variety of applications. Apart from their substance, nanoparticles come in a variety of dimensions, shapes, and sizes [3].A nanoparticle can be 0 dimensional, with size, breadth, & height remedied at a specific point, like nano dots, one directional, with only one parameter, like graphene, two dimensional, with length and breadth, like carbon nanotubes, or three dimensional, with all three parameters, like gold nanoparticles. Different shapes, sizes, and structures of nanoparticles exist. It can be spherical, cylindrical, tubular, conical, hollow core, spiral, flat, or irregular, with sizes ranging from 1 to 100 nm. Surface variations might be

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uniform or uneven.Certain nanoparticles were crystalline / amorphous, with single or multi-crystal solids that are loose or clumped together [4]. To improve characteristics and lower production costs, a variety of synthesis processes are being developed or enhanced. To boost the optical, mechanical, physical, and chemical properties of certain nanoparticles, some approaches have been modified [3].A significant advancement in instrumentation has resulted in enhanced nanoparticle characterisation and application. Nanoparticles are currently found in a wide range of products, including kitchen utensils, electronics, renewable energy, as well as the aerospace industry. Nanotechnology holds the key to a future that is both clean and sustainable.

Nanotechnology has risen to prominence in current science, with promising applications in electronics and medicine. Nanotechnology is the engineering and use of materials with a size range of 1-100 nanometers [5]. Nanoparticles are minuscule objects having fewer than 100 nm in at least one dimension [6]. Nanoparticles frequently have size-dependent characteristics due to their very large surface area [7]. Furthermore, a particle at the nanoscale has a length less than the charge carrier's de Broglie wavelength (holes and electrons) or the wavelength of the light.As a result, crystalline particle periodic boundary conditions vanish at that length. As a result, the physical properties of nanoparticles differ significantly from those of bulk materials, resulting in novel and exciting applications. Nanoparticles, for example, are injected into matrix materials that serve as carriers for therapeutic molecules [8.9]. Copper, zinc, titanium, magnesium, gold, alginate, and silver are currently being used to create diverse metallic nanomaterials [10].

The term "nanotechnology" refers to things with a diameter of a few nanometers [11]. Cells are the building blocks of living beings. These cell parts, on the other hand, are nanoscale [12]. Nanotechnology is primarily concerned with the design, manufacture, &characterisation of nanoscale particles [13]. Nanoparticles are minuscule things that behave as a single unit in terms of transport & characteristics. Fine particles range in size from 100 to 2500nm, while ultrafine particles are smaller than 100nm [14]. These could also be made to enhance the medications' biological and pharmacological effects [15].Those do have a large surface area, which allows for the attachment of many functional groups, which can then bind to tumour cells [16]. They've proven to be a great alternative to chemotherapy and radiotherapy because they can easily assemble in the tumor's microenvironment. A variety of nano-sized particles, including as metals, semiconductors, or polymeric particles, have recently been produced for use in molecular imaging & particulate delivery vehicles [17-19].Drug distribution with minimal adverse effects is aided by polyethleneimine liposomes, silica nanoparticles, micelles, and chitosans [20-21]. They've also been used as cancer-fighting agents [22]. Basically, nanotechnology is concerned with the creation of artificial cells, enzymes, and genes, as well as the repair of protein synthesis [23].

Nanocapsules are matrix systems in which the drug is physically and uniformly spread, whereas nanospheres are matrix systems in which the drug is restricted to a hollow enclosed by a unique polymer membrane. Biodegradable polymeric nanoparticles, particularly those coated with hydrophilic polymers such as poly(ethylene glycol) (PEG) known as long-circulating particles, have been investigated as potential drug delivery devices in recent years due to their ability to circulate for long periods of time, target a specific organ, act as carriers of DNA in gene therapy, and deliver proteins, peptones, and other bioactive compounds.The main goals of nanoparticle design as a delivery system are to manage particle size, surface characteristics, & release of pharmacologically active substances in order to produce site-specific drug activity at the therapeutically appropriate rate & dose regimen. Despite the fact that liposomes have been used as potential carriers with unique advantages such as protecting drugs from degradation, targeting to site of action, & reducing toxicity or side effects, their applications are limited due to inherent problems such as low encapsulation efficiency, rapid leakage of water-soluble drugs in the presence of blood components, & poor storage stability, their applications are limited.Polymeric nanoparticles, on the other hand, have several distinct advantages over liposomes. For example, they can assist enhance drug/protein stability and have valuable controlled release features [28,29].

The advantages of nanoparticles

The particle size and surface properties of nanoparticles can be easily modified after parenteral delivery to accomplish both passive and active medication targeting. To achieve high medication therapeutic efficacy with fewer side effects, they control and sustain drug release during transit as well as at the site of localisation, modifying drug distribution and subsequent clearance. Site-specific targeting can be

accomplished by adding targeting ligands to the surface of particles or using magnetic guiding. The system can be utilised for a variety of administration routes, including oral, intraocular, parenteral, and nasal.Drug distribution to small locations within the body might be improved by nanoparticles. Engineers can now exert exact control over biomaterials & polymer physical properties on a large scale, something they couldn't do before. By overcoming the resistance imposed by biological membrane in the body, which is directly impacted by particle size, nanoparticles enable effective medication delivery to diverse areas of the body. Nanoparticles can help with drug delivery by increasing water solubility of poorly soluble medicines and increasing availability for structured release of drug & precise drug targeting.Proteins, tiny molecules, peptides, and nucleic acids can all have their surface characteristics altered for targeted medication delivery. The immune system does not identify the loaded nanoparticles, therefore they can be efficiently targeted to certain tissue types. Medication toxicity can be decreased and drug distribution can be made more efficient by focusing on nano drug carriers. Nano carriers have the ability to distribute biotech medications across many anatomical extremities of the body, such as the blood brain barrier (BBB).

After parenteral delivery, nanoparticle size and surface properties can be easily modified to accomplish both passive and active medication targeting. They manage and maintain drug release during transportation and at the site of localisation, modifying drug organ distribution and subsequent clearance in order to obtain increased medication therapeutic efficacy and reduced side effects. The choice of matrix ingredients can easily alter controlled release and particle decay characteristics.Drug loading is high, and pharmaceuticals can be absorbed into systems without undergoing any chemical reactions; this is an essential element in maintaining drug activity. Targeting ligands can be attached to the surface of particles or magnetic guiding can be used to accomplish site-specific targeting. The method can be employed for oral, nasal, parenteral, intra-ocular, and other routes of administration [30,31].

Nanoparticles, while their benefits, have limitations. Nanoparticles' small size & huge surface area, for example, can cause particle aggregation, making physical handling problematic in both liquid & dry forms. Furthermore, due to the small particle size and vast surface area, drug loading & burst release are easily achieved. Before nanoparticles may be used in therapeutic settings or made available commercially, these practical issues must be resolved.The various types of nanoparticle platforms have been explored in this review. The general approaches to the creation of nanoparticles employing biological processes, as well as the implications of nanoparticles in pharmaceutical & everyday life, been addressed.

Platforms of Nanoparticles

There are many different sorts of NPs platforms, each with its own size, shape, composition, & functionality. The following platforms for nanoparticles are addressed:

Liposomes

Liposomes will be the first nanoparticle technology. Liposomes were first described as a model for biological membranes in 1965 [32]. Liposomes were then employed to carry genetic and pharmacological information. Liposomes are spherical vesicles that contain lipids in a single or multiple bilayer structure and can self-assemble in aqueous environments [33]. Liposomes can be utilised to target ligands in order to increase the accumulation of diagnostic and therapeutic substances within cells. There are now 12 clinically approved liposome-based medicinal medicines.

Albumin-bound

The endogenous albumin trails, which transport hydrophobic molecules in the bloodstream, are used by Albumin-Bound Nanoparticles (NAB). It struggles with non-covalent reversible binding of hydrophobic compounds and avoiding solvent-based toxicities for therapies [35]. As a result, this platform has been modified to transport drugs.

Polymeric

Biocompatible and biodegradable polymers are employed to make polymeric nanoparticles, which are exploited as medicinal carriers [36]. Block-copolymers of various hydrophobicity are used to produce polymeric nanoparticles [37]. The gradual and controlled release of medications at needed places makes these nanoparticle designs valuable.

Quantum dots

QDs are semiconductor particles with a diameter of less than 10 nm. The electrical and optical characteristics of QDs are size-dependent [38]. Cadmium selenide (CdSe) is used as the core, and zinc selenide (ZnS) is used as the cap (or shell) in most quantum dots [39]. Fluorescence imaging cell labelling and biomolecule tracking

are examples of how they are utilised in biological research.

Iron oxide

Because iron oxide NPs are superparamagnetic, they are being investigated as a passive and active targeted imaging agent. To boost their stability, they have an iron oxide core with a hydrophilic covering of dextran or another biocompatible substance [39,40]. They're typically employed in magnetic resonance imaging (MRI). MRI has only been clinically approved for two SPIO agents: ferumoxides (120-180 nm) and ferucarbotran (60 nm).

Nanoparticles: Types

Silver: These have been shown to be the most efficient antimicrobials against bacteria, viruses, and other eukaryotic microbes. [41, 42], They are the most frequently utilised nanomaterials as antibacterial agents, sunscreen lotions, water treatment, and textile industries, among other applications. The effective manufacture of silver nanoparticles has been reported using the plants Capsicum annuum [45], Azadirachta indica [46], and Carica papaya [47].

Gold nanoparticles (AuNPs) are utilised to identify protein interactions in immunochemical research. They are employed as a lab tracer in DNA fingerprinting to detect the presence of DNA in a sample. These nanoparticles may also detect aminoglycoside drugs including streptomycin, gentamycin, and neomycin. Gold nano rods were used to detect cancer stem cells, diagnose cancer, and identify different kinds of bacteria. [48-50]

Alloy nanoparticles have structural characteristics that differ from bulk samples. [51] Silver flakes are the most often used metal filler because they have the highest electrical conductivity of all metal fillers, and their oxides have a similar conductivity. [52] The properties of bimetallic alloy nanoparticles are influenced by both metals and regular metallic NPs, resulting in greater advantages. [53]

Magnetic nanoparticles, such as maghemite and magnetite, are known to be biocompatible. They have been actively considered for magnetic resonance imaging (MRI), guided drug delivery, targeted cancer treatment (magnetic hyperthermia), gene therapy, stem cell sorting and manipulation, and DNA analysis. [54]

Preparation of Nanoparticles

Proteins, polysaccharides, and synthetic polymers are among the materials that can be used to make nanoparticles. Many factors influence the choice of matrix materials, including [55]: (a) required nanoparticle size; (b) inherent drug properties, such as aqueous solubility and stability; (c) surface characteristics, such as charge and permeability; (d) desired biodegradability, biocompatibility, and toxicity; (e) desired drug release profile; and (f) antigenicity of the final product

Three processes have been used to make nanoparticles: (1) dispersion of preformed polymers, (2) monomer polymerization, and (3) ionic gelation or coacervation of hydrophilic polymers. Other approaches for producing nanoparticles, such as supercritical fluid technology [56] and particle replication in non-wetting templates (PRINT) [57], have been described in the literature. The latter claimed to have complete control over particle size, shape, and content, which could pave the way for future industrial nanoparticle mass manufacturing.Dispersion of premade polymers is a typical process for making biodegradable nanoparticles from poly (lactic acid); poly (D,L-glycolide), PLG; poly (D, L-lactide-co-glycolide) (PLGA); and poly (cyanoacrylate) (PCA) [58-60].

Method of solvent evaporation: The polymer is dissolved in an organic solvent such as dichloromethane, chloroform, or ethyl acetate, which is also used to dissolve the hydrophobic medicament. The oil in water (o/w) emulsion is formed by emulsifying the polymer and drug solution in an aqueous solution including a surfactant or emulsifying agent. The organic solvent is evaporated either by reducing the pressure or by continuous stirring after the development of a stable emulsion.The kind and concentrations of stabiliser, homogenizer speed, and polymer concentration were all found to influence particle size [61]. High-speed homogenization or ultrasonication are frequently used to achieve tiny particle sizes [62].

Solvent diffusion method or spontaneous emulsification: This is a modified version of the solvent evaporation method [63]. The oil phase in this approach is made up of the water miscible solvent and a little amount of the water immiscible organic solvent. Interfacial turbulence is formed between the two phases due to spontaneous diffusion of solvents, resulting in the production of tiny particles. The size of the particle can be reduced as the concentration of water miscible solvent increases.

For hydrophobic or hydrophilic medicines, both solvent evaporation and solvent diffusion procedures can be applied. A multiple w/o/w emulsion with the medicine dispersed in the

internal aqueous phase is required for hydrophilic drugs.

Method of polymerization Monomers are polymerized to create nanoparticles in an aqueous solution in this process. The drug is included either by dissolving it in the polymerization liquid or by adsorption onto the nanoparticles after the polymerization process is finished. By ultra centrifugation, the nanoparticle suspension is purified to remove various stabilisers and surfactants used in polymerization, and the particles are then re-suspended in an isotonic surfactant-free medium.Polybutylcyanoacrylate or poly (alkylcyanoacrylate) nanoparticles have been made using this method [64, 65]. The concentration of surfactants and stabilisersutilised determines the production of nanocapsules and their particle size [66].

Methods of coacervation and ionic gelation The creation of nanoparticles with biodegradable hydrophilic polymers including chitosan, gelatin, and sodium alginate has received a lot of attention. Calvo and colleagues devised an ionic gelation method for producing hydrophilic chitosan nanoparticles [67, 68]. The approach uses a mixture of two aqueous phases, one of which is chitosan, a di-block co-polymer of ethylene oxide or propylene oxide (PEO-PPO), and the other of which is a polyanion sodium tripolyphosphate.The positively charged amino group of chitosan combines with the negatively charged tripolyphosphate to generate nanometer-sized coacervates in this approach. Coacervates are generated when two aqueous phases interact electrostatically, whereas ionic gelation occurs when a substance transitions from liquid to gel under ionic interaction circumstances at ambient temperature.

Supercritical fluid technique is used to make nanoparticles. Organic solvents are used in traditional processes such as solvent extraction-evaporation, solvent diffusion, and organic phase separation, which are toxic to the environment and physiological systems. As a result, because supercritical fluids are environmentally friendly, they have been examined as an option to manufacture biodegradable micro- and nanoparticles [69].A supercritical fluid is a solvent that stays a single phase regardless of pressure at a temperature above its critical temperature. Because of its moderate critical conditions (Tc = 31.1 °C, Pc = 73.8 bars), nontoxicity, flammability, and low price, supercritical CO2 (SC CO2) is the most often used supercritical fluid. Supercritical anti-solvent (SAS) and fast expansion of critical solution are two of the most prevalent supercritical fluid processing processes (RESS).Because the solute is insoluble in the supercritical fluid (SC CO2), the SAS process uses a liquid solvent, such as methanol, to dissolve the solute to be micronized. Because the solute is insoluble in the supercritical fluid, the extraction of the liquid solvent by supercritical fluid results in the instantaneous precipitation of the solute, resulting in the formation of nanoparticles. Thote and Gupta (2005) used a modified SAS approach to make hydrophilic drug dexamethasone phosphate drug nanoparticles for microencapsulation [70].

Synthesis of Nanoparticles from biological sources

Synthesis of Nanoparticles from Algae

Polysaccharide reduces and stabilises metal nanoparticles in algae. Polysaccharide stabilisation relies on several binding sites along the polysaccharide chain to promote attachment to the metal's surface, thereby encapsulating the metal nanoparticle and imparting strong protection against aggregation and chemical alteration. Different polysaccharides, such as starch [71-73], chitosan [74], natural gums [75-77], marine polysaccharides [78], and hyaluronan [79], have been used to make silver nanoparticles.Polymer acts as a stabiliser and a reducing agent in all of these circumstances. Seaweeds and microalgae like diatoms (Naviculaatomus and Diadesmis gallica) can be used to make gold nanoparticles, gold and silicagoldbionanocomposites [80]. Spirulina platensis (also known as edible blue-green alga) can be used to make gold, silver, and Au/Ag bimetallic nanoparticles [81].

Synthesis of Nanoparticles from Fungi

Enzymes and proteins found in fungi have the ability to reduce metal ions into nanoparticles and then act as a nanoparticle stabiliser. Fungi create a significant amount of proteins, which allows metal salts to be converted into metal nanoparticles quickly. Extracellular production of silver nanoparticles can be done with A. fumigates [82] and Phoma sp. [83]. At around 27°C, polydispersed silver nanoparticles of 5 to 40 nm were generated from the fungus Trichoderma viride, which has a UV-visible absorption band at 420 nm [84]. In the presence of the fungus Cylindrocladiumfloridanum, gold nanoparticles have been produced.The fungi collected face-centered cubic (FCC) (111)-oriented crystalline gold nanoparticles on the mycelia's surface in just 7 days. The characteristic peak on the Uv-Vis

spectrum, which emerges at 540 nm in the Uv-Vis region [85], validated the production of gold nanoparticles. Gold nanoparticles were also produced from Aspergillus niger, and their adsorption band at 530 nm [86] was used to prove their existence. F. oxysporum and Verticillium sp. were used to make magnetite, Fe3O4 magnetite nanoparticles [87].Schizosaccharomyces pombe and Candida glabrata have been shown to convert cadmium salt into CdS nanoparticles in solution [88].

Synthesis of Nanoparticles from Yeast

Because of their large production of NPs and ease of control in laboratory conditions, the synthesis of multiple enzymes, and quick growth with the use of simple nutrients, yeast strains have an advantage over bacteria [89]. It was also reported that hexagonal silver nanoparticles (2-5 nm) were formed extracellularly using the silver tolerant yeast strain MKY3 [90]. Yarrowialipolytica cells were incubated with various doses of chloroauric acid, resulting in cell-related gold NPs and nanoplates.Furthermore, the size of NPs is influenced by the number of cells and the salt concentrations used [91]. Similarly, zirconium phosphate with a manufactured mesoporous figuration and yeast as a bio template were used to create an air electrode with remarkable electro catalytic activity for oxygen decrease (ORR) [92].

Synthesis of Nanoparticles from Bacteria

Bacteria are one of the greatest choices for nanoparticle manufacturing because of their exceptional capacity to decrease heavy metal ions. When Thiobacillus ferrooxidans, T.thiooxidans, and Sulfolobusacidocaldarius thrive on elemental sulphur as an energy source, ferric ion can be reduced to ferrous state [93]. The bacteria Delftiaacidovorans produced pure gold nanoparticles in a recent study, in which the creation of a tiny non-ribosomal peptide called delftibactin was responsible for the gold nanoparticles [94]. The bacteria Rhodo Pseudomonas capsulate produced gold nanoparticles with a diameter of 10-20 nm that were formed extracellularly.An NADH-Dependent Reductase [95] was used to make these nanoparticles. Bacteria identified at Alpine locales have been shown to be capable of producing zero valent palladium (Pd0) nanoparticles. Pseudomonas cells were discovered to be involved in the production of catalytically active nanoparticles [96]. Copper nanoparticles were difficult to make because copper is unstable at the nanoscale. Morganella Morganii was used to make pure and stable copper nanoparticles in 2013.The Cu nanoparticles are synthesised intracellularly by M. Morganii by absorption of Cu ions and subsequent binding of the ions to either a metal ion reductase or a related protein. After being effluxed out of the cell, the metallic ion is reduced to metallic CuO, which subsequently aggregates extracellularly as nanoparticles [97].

Synthesis of Nanoparticles from Plants

Plant-based nanoparticle syntheses are advantageous because they yield a large number of nanoparticles. Natural reducing and stabilisingsubstances are found in plants. Citrus limon, Murrayakoenigii Linn. leaves, and Canna indica (red), Quisqualis indica pink owers have all been used to make polymorphic gold nanoparticles. These nanoparticles were stable and ranged in size from 30-130 nm [98]. Lonicera japonica plant leaf extract was used to make gold and silver nanoparticles. Silver nanoparticles were 36-72 nm in size and had a spherical to plate-like poly-shaped shape, whereas gold nanoparticles were poly-shaped nanoplates with a size of 40-92 nm.The reduction of metal ions into nanoparticles was discovered to be caused by carbs, polyphenols, and protein [99]. Copper ions were reduced to nanoparticles using Magnolia kobus leaf extract as a reducing agent, and their antibacterial activity was tested against [100]. Gum kondagogu can be used to make Ag, Au, and Pt nanoparticles (Cochlospermumgossypium). Silver nanoparticles were found to have substantial antibacterial activity against bacteria from both Gram classes [101].

APPLICATIONS OF NANOPARTICLES

In drug delivery

To begin, excellent stability, large carrier capacity, ease of accommodating both hydrophilic and hydrophobic compounds, and multiple modes of administration, including oral application and inhalation, are the most significant advantages of nanoparticles utilised on drug carriers [102]. Certain medicines are not metabolised in the first pass. To overcome this, nanoparticles can be changed, and they also allow for regulated, long-term medication release from the matrix. These characteristics can improve the drug's bioavailability while simultaneously reducing dose frequency [103]. Quantum dots are tiny semiconductor particles with a diameter of a few nanometers.Artificial atoms with distinct electronic states are another name for them. They emit light of varying frequencies when exposed to

light or electricity. Changing the sizes, forms, and materials of the dots can change the frequencies, resulting in a variety of applications [104, 105]. ZnQ Quantum dots are the most advanced quantum dots technology connected with anticancer medication therapy. The quantum dots are loaded with anti-cancer medicines and enclosed in biocompatible polymers, which is the essence of this method. This is one of the most essential applications of Quantum dots technology [106], as it is how tumor-targeted medications are given.Verdun et colleagues found that mice treated with doxorubicin embedded in isohexylcyanoacrylate nanospheres had higher doxorubicin concentrations in their liver, spleen, and lungs than mice treated with free doxorubicin [107]. The most serious drawback of employing nanoparticles for tumour targeting is that they prevent particle uptake by the liver and spleen's mononuclear phagocytic systems. The biodistribution and pharmacokinetics of a cyclic doxorubicin-nanoparticle formulation in tumor-bearing mice were established by Bibby et al.These nanoparticles have been developed to serve as delivery vehicles for a variety of medicinal medications, including liposomal nanoparticles, layered double hydroxide, and water soluble polymeric drug conjugates [108-112]. Drug distribution to the central nervous system and brain is more difficult, however nanoparticles can overcome these challenges, guaranteeing that drug administration to the brain is successful.

In Food

Encapsulation and emulsion formation, food contact materials, and sensor development are three important areas where nanotechnology could be used in the food industry. Garber demonstrates the cultivation, production, packaging, and processing of food using nanoparticles as nanofood.Sensory enhancements (flavor/color enhancement and texture modification), increased absorption, targeted delivery of nutrition bioactive compounds, stabilisation of active ingredients such as nutraceuticals in food sources, packaging and product improvement to extend shell life, sensors for food safety, and antimicrobials to eradicate pathogenic microbes in food are some of the applications of nanofood identified by FSAI [113, 114]. Bionanocomposites are nanoparticle hybrids that have improved mechanical, thermal, and gas properties.They are used in food packaging to extend the shelf life. This is good for the environment because it reduces the reliance on plastics for packaging. Zein, a prolamin and a major component of corn protein, can produce a biodegradable zein film with improved tensile and water barrier properties when dissolved in ethanol or acetone [115]. Nanocapsules are used in Australia to add omega-3 fatty acids to white bread. In Asia, non-toxic nanoscale pesticides are being developed to interfere with weed seed coating and hinder germination [116].So, the application of nanotechnology in food is emerging rapidly and is involved in all areas of food chain.

In Medicine

Nanomedicine aids in illness detection and prevention, as well as improved diagnosis and follow-up. The development of nanotechnology, such as gold nanoparticles, has made gene sequencing easier. When they are attached to small DNA segments, they can also be employed to detect genetic sequences. Nanotechnology can be used to heal or replicate damaged tissue. Nanotechnology has the potential to revolutionise organ transplantation and prosthetic implantation. Magnetic nanoparticles have been shown to be effective in isolating and aggregating stem cells.Quantum dots, on the other hand, have been employed in molecular imaging and stem cell tracing, among other applications. Designing distinct nano particles allows for controlled regulation of stem cell growth and differentiation [117]. The regeneration and neuroprotection of the Central Nervous System is another advantage of nanotechnology. One of the most well-known neurodegenerative diseases is Parkinson's disease. The intracranial nano-enabled scaffold device (NESD) is a great way for reducing the peripheral side effects of Parkinson's disease medication by delivering dopamine to the brain in a site-specific manner.Peptides and peptidic nanoparticles as novel tools for different Central Nervous System diseases include activation of signalling cues for regulated axon growth and peptides and peptidic nanoparticles as novel instruments for numerous Central Nervous System diseases. They can also restore function to injured neurons, providing neuroprotection and facilitating medication and chemical distribution across the blood-brain barrier. Amyloid beta plaques are usually observed in Alzheimer's patients' brains. Because these nanoparticles have a high affinity for plaques, they may suppress them, hence alleviating Alzheimer's disease symptoms.Tuberculosis is a life-threatening infection. Recent advances in nano-based drug delivery methods for encapsulation and release of antiTB medicines have enabled more effective and inexpensive TB pharmacotherapy [118]. Nano filled composite resin materials, like operational dentistry, provide effective wear

resistance, tenacity, and great aesthetic attributes because to their unique lustre retention and polishability.In operative dentistry, spherical silicon dioxide nano fillers elicit the possibility of altering the load of inorganic phase. Extreme hardness, exceptional bend strength, good elasticity, and low polymerization shrinkage characterise these nano composites. [120, 119]

Therapy of oxidative stress, intraocular pressure measurement, treatment of choroidal new vessels, scar avoidance after glaucoma surgery, and prosthetics are some of the applications of nanotechnology in ophthalmology [121]. In recent years, nanotechnology dispersed eye ointment (NDEO) has been used to treat severe evaporative dry eye. The normal corneal and conjunctival morphology was restored by NDEO, according to histological analysis [122]. Antibiotic resistance can be reduced by utilising Zinc Oxide nanoparticles, which boost Ciprofloxacin's antibacterial efficacy against microorganisms.The interaction of these nano particles with the proteins involved in antibiotic resistance causes this [123]. By blocking the release of histamine from mast cells into the blood and tissues, the nano device buckminsterfullerenes (bucky balls) can alter the immune response [124]. To some extent, nanopharmaceuticals reduce hazardous systemic side effects, leading in improved patient compliance. They are critical in recognising the failure of traditional treatments that target active molecules to specific sites. Thrmbocytic treatments based on nanoparticles have the ability to speed up the clot clearance process.Nanotechnology-assisted dentition renaturalization, a permanent cure for hypersensitivity, comprehensive orthodontic realignments, and other treatments are all possible in nanodentistry. The use of nanorobots in conjunction with a computer to manage them allows for the eradication of caries-causing bacteria and the repair of tooth flaws where decay has attached [125].

CONCLUSION

Nanotechnology has enabled the re-modification of poorly soluble, poorly absorbed, and labile physiologically active compounds into promising deliverable pharmaceuticals. Nanotechnology's ability to engineer matter at the atomic level is reshaping fields like information technology, cognitive science, and medicine. Nanotechnology research studies can be beneficial to all aspects of human life.

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