*Review Article*

# "A review of revolutionizing green synthesis of nanoparticles inpharmacy and healthcare"


## Abstract:

Science's newest and fastest-growing field is nanotechnology. The foundation of nanotechnology is made up of nanoparticles. The sizes of nanoparticles range from 1 to 100 nm. A variety of classes, including inorganic, organic, ceramic, and carbon-based nanoparticles, are used tocategorise the nanoparticles. Nanoparticles are becoming a more widely used material like electronic devices to medicine in industries. Green synthesis is a feasible and environmentally acceptable alternative that produces nanoparticles using natural resources and biological processes. In addition to using environmentally friendlyreducingand stabilising agents, the green synthesis approach makes use of a variety of biologicalresources, including bacteria, fungus, plants, and algae. These natural resources guarantee thebiocompatibility and stability of the final nanoparticles by acting as capping agents inaddition to reducing agents. Two additional categories of inorganic nanoparticles are metaland metal oxide nanoparticles and the organic nanoparticles includes ferritin, micelles, dendrimers and liposomes.Additionally, nanoparticles can becategorised into one, two, or three dimensions. Two methods, namely the top-down methodand the bottom-up method, are used to create the nanoparticles.The synthesis of nanoparticles using chemical, physical, and environmentally friendly methods is covered in this review. To make the nanoparticles, a variety of qualitative and quantitative techniques are applied.FTIR, SEM, and TEM are examples of qualitative techniques. The green synthesis methodoffers an environmentally friendly, straightforward, cost-effective, and repeatable process that speeds up the production of metallic nanoparticles.



**Keywords:** Nanoparticle, green synthesis, plants, metallic, organic and inorganic.


## 1. INTRODUCTION:

"Green synthesis," or the synthesis of nanoparticles usingnon-toxic and sustainable processes, has emerged as a revolutionary method. This new approach represents a departure from conventional nanoparticle synthesis techniquesare frequently energy-intensive procedures and the use of hazardous chemicals. The shift towards green synthesis is being driven by the need to reduce the impact on the environment, reduce the use of hazardous chemicals, and promote sustainable practices in the manufacturing of nanomaterials. Utilising the unique properties of natural sources, including microorganisms, plants, and various types of biomaterials, green synthesis techniques aid in the production and stabilisation of nanoparticles. The compatibility of green synthesis is one of its advantages.By avoiding the problems with conventional techniques, these approaches present a viable path towards the creation of nanomaterials with improved biocompatibility and a smaller environmental impact (1,2). Green synthesis's compatibility with green chemistry principles which emphasize waste reduction, energy efficiency, and the use of renewable resources is one of its main advantages. In addition to giving the process a greener reputation, use of plant extracts, microbial cultures, or waste biomasses as reducing and stabilizing agents also adds a level of biocompatibility that is essential for applications in environmental remediation, agriculture, and medicine.The context for investigating the varied and dynamic field of green synthesis methods for nanoparticles is established by this introduction. In keeping with the worldwide movement towards sustainable and eco-friendly technologies, the field of green synthesis provides a variety of options. These include plant-mediated techniques that leverage the bioactive compounds found in botanical extracts and microorganism-assisted techniques that harness the unique properties of bacteria and fungi. In order to reach the rising levels of demand for nanoparticles, thevarious industries are implementing green synthesis techniques. This strategy not only addresses environmental problems but also opens up new avenues for the economical, socially conscious, and scalable production of nanomaterials. This introduction aims to lay the groundwork for a more thorough investigation of the applications, outcomes, and techniques of green synthesis in the fascinating field of nanoparticle production. (3,4)

## 1.1) Nanoparticles and their properties:

To remove hazardous and waste metals from the environment and preserve microbes, plants, and other biological organisms, metallic nanoparticles can be used to oxidise, reduce, or catalyse metals. Since biologically produced metallic nanoparticle have special qualities like insulating, optics, antimicrobial, antioxidant, anti-metasis, biocompatibility and manipulability of applications such as drug delivery are made of them in the biomedical fieldcancer treatment, bio- imaging and protection against harmful microorganisms (5). These days metallic nanoparticles are quite important because of their catalytic activity, which makes them useful in the industrial area. Figure 1 delineates the specific applications of metallic nanoparticles derived from biological processes. Based on their source, nanomaterials are divided into primary categories: artificial nanomaterials, which produced through specific methods andminerals, proteins, viruses, and enzymes that are not found in nature. (6) Nanoscale, nanocrystals also referred to as zero, dimensions, - comprising semiconductor and metallic nanoparticles. Nanowires, nanobots and nanotubes are examples of one-dimensional nanomaterials. Three dimensional nanomaterials, bulkers- such as nanocomposite and nanoplates.

Based on their structural configurations, nanomaterials are divided into four main categories: metallic nanomaterials, carbon-based nanomaterials, dendrimers, and composites. (7,8)

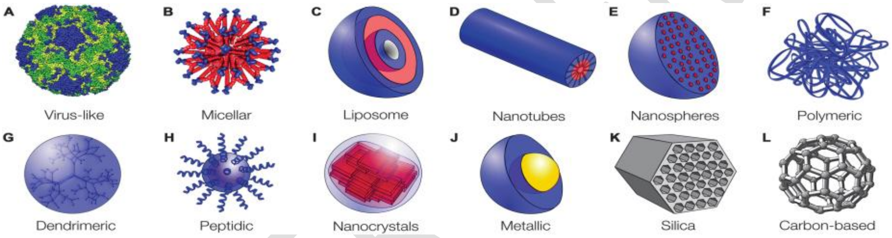


**Fig no1 : Types of nanoparticles**

## METHODOLOGY:

## 2) Synthesis method ofnanoparticle:

Two fundamental approaches that comprise a variety of preparation techniques and have been known since ancient times areused to create nanoparticles, which can originate from natural sources or be artificially created and have unique properties at the nanoscale. It includes two types, they are:

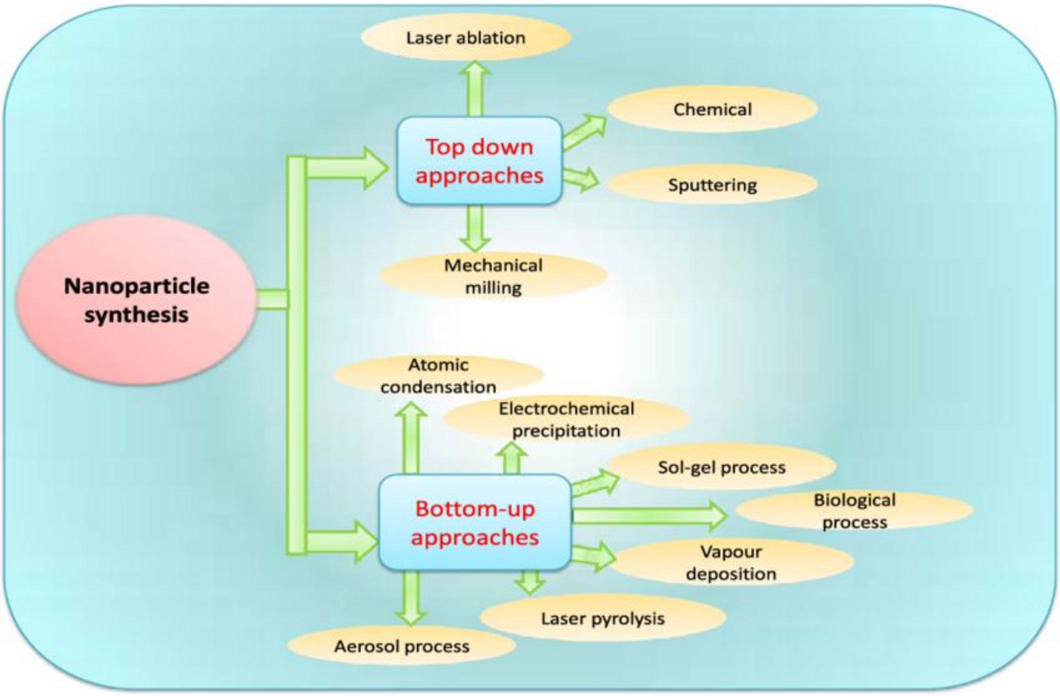


**Fig no 2 :Nanoparticle synthesis**

## 3) METHODS:

- Top-down method.
- Bottom-up method.

### 3.1) Top-down method:

The first strategy is known as the "top-down" method, and it involves using an external force to break solid materials into tiny bits. This method uses a variety of thermal, chemical, and physical processes to supply the energy required to produce nanoparticles. (9)

#### 3.1.1) Technique of thermal degradation:

Heat is the source of chemical breakdown in this endothermic process. This heat breaks the compound's chemical bond.The precise temperature at which an element undergoes chemical breakdown is known as the decomposition temperature. The formation of nanoparticles results from the breakdown of meta at a particular temperature. Heat decomposition is used to functionalize synthesised gadolinium oxide nanoparticles with paramagnetic polyethylene glycol.(10)

#### 3.1.2) Lithographic technique:

Lithographic techniques are top-down techniques that can produce most part micron size features, but they are expensive to use and energy intensive. For the past few decades,lithography has been utilised in the production of computers and printed circuit boards.One type of lithography that differs from conventional lithography is nanoimprint lithography. It is comparable to the synthesis of templates. Nanosphere lithography forms templated matrices using latex spheres. There are various kinds of lithography techniques, such as dip pin lithography, photolithographyelectron beam lithography, soft lithography, and focused ion lithography.(11)

## 2) Bottom- Up method:

The "bottom-up" strategy, which is the second method, involves assembling and merging atoms or molecules of gas or liquid. The bottom-up strategy yields good results in nanoparticle synthesis, but the top-down approach, which is more expensive to apply, cannot produce the possibility of cavities and roughness in nanoparticles, making them the perfect surfaces and edges. In addition, the bottom-up approach produces no waste materials that need to be removed and permits the creation of smaller nanoparticles due to its improved control over nanoparticle sizes. (12)

### 3.2.1) Chemicalvapour deposition (CVD):

The process that deposits agaseous reactant thin layer on the substrate. The thin-film depositing procedure takes place in reaction chamber. When a substrate gets heated, a chemical reaction takes placeand a combining gas come into contact. Thin layer of product that this reaction produces on the substrate's surface. The CVD method produces hard, strong, uniform, and incredibly pure nanoparticles. The disadvantages of the CVD technique involves the requirement for specialised toolsand the production of extremely toxic gaseous byproducts. It is coated and synthesised Titanium oxide ($TiO_2$) through the use of chemical method of vapour deposition Titanium tetra iso-peroxide (TTIP) was the precursor they employed. The outcomes of dip-coated, chemical method of vapour deposition-coated, and non-coated beads are shown in a SEM micrograph. Whereas the surface of the chemical method of vapour deposition-coated bead was uniform and regular, the dip-coated bead had areas that were partially coated and uncoated (13)

### 3.2.2) Sol - gel method:

The terms "sol" and "gel" combine to form the term "sol-gel method." Sol is a colloid that is made up of suspended solid particles in a liquid that is continuous. Gel is a macromolecule that is solid and dissolves in a solvent.The sol–gel method is the most widely used bottom-up technique for producing nanoparticles because of its ease of use. This process uses an appropriate chemical solution as a precursor. Inmetal oxide and chloride are frequently used as precursors in the sol-gel process. The precursor is distributed throughout the host liquid by employing a variety of techniques, including stirring, sonicating, shaking. Various techniques such as centrifugation, sedimentation, and filtration are employed to separate the resultant solution into a liquid and a solid phase with the aim of retrieving the nanoparticles. (14,15)

## 4) GREEN SYNTHESIS METHOD:

An environmentally friendly way to synthesisethe biological approach, which is provided as an alternative to chemical and physical methods, is how nanoparticles are made. Furthermore, expensive, hazardous, or toxic chemicals are not needed for this process. Recently, a lot of work has been done using the biological approach to create metallic nanoparticles with a variety of contents, sizes, forms, and physicochemical properties. Synthesis can be finished in a single step using biological entities such as bacteria, actinobacteria, yeasts, moulds, algae, and plants, or their byproducts. Alkaloids, pigments, proteins, enzymes, amines, phenolic compounds, and microorganisms are among the molecules that carry out the reduction process that produces nanoparticles.(16-20)

When used in conventional chemical and physical methods, the reducing agents used in the reduction of metal ions and the stabilising agents used to prevent the unwanted agglomeration of the generated nanoparticles carry a risk of toxicity to the environment and the cell. Furthermore, the generated nanoparticles' size, shape, and surface chemistry are thought to be toxic. The biological organisms employed in the green synthesis method, which produces biocompatible nanoparticles, contain the agents. Because of their rapid growth, low cost of culture, and ease of control and manipulation of the growth environment, bacteria are a prime candidate for the synthesis of nanoparticles. At the same time, it is known that some species of bacteria have special defences against the metals.(21to 25)

## 4.1) GREEN SYNTHESIS PRODUCED METALS:

### 4.1.1) Copper (Cu) and copper oxide (CuO):

Many plant extracts have been used to create copper oxide nanoparticles.Copper salts are reduced by the electrons produced by the plant extract. Reduction occurs when phytochemicals react with copper ions to form copper oxide nanoparticles.Toobtain copper oxide nanomaterials, the colloidal heat combination process is employed. Utilising carboxy methyl cellulose a highly stable and sensitive Cu nanocomposite as a substrate was created by decontaminating and drying the incorporated cuo to produce distinct sizes of the Cuo nanoparticles.Copper oxide (CuO) nanoparticles are the focus of attention among all other nanoparticles due to their numerous applications.The term "green synthesis" describes the use of environmentally friendly techniques to create copper oxide nanoparticles without the need of harsh conditions or toxic chemicals.

**Advantages**:

- Green synthesis techniques typically involve lower operating temperatures and pressures, which results in a lower energy consumption when compared to conventional synthesis routes.
- Green synthesis techniques frequently produce biocompatible nanoparticles, which can be used in biology and medicine without endangering living things.
- Certain green synthesis methods reduce process costs by using readily available and reasonably priced raw materials.

**Disadvantages**:.

- The performance of nanoparticles produced by green synthesis methods may be impacted by their variable stability and size distribution.
- The overall production efficiency may be impacted by certain green synthesis techniques that call for longer reaction times than traditional techniques.
- It may be difficult to optimise and troubleshoot green synthesis methods due to incomplete understanding of the underlying mechanisms. (26,27)

### 4.1.2) Zinc Oxide (ZnO):

Zinc oxide (ZnO) nanoparticles are made using environmentally friendly processes that frequently use natural resources rather than dangerous chemicals. This process is known as "green synthesis."One class of inorganic metal oxides that is readily available is zinc oxide (ZnO), which comes in a variety of nanostructures.ZnO nanoparticles have a potent antibacterial effect on spores that can withstand high temperatures and pressure.ZnS NPs were synthesised in an aqueous rough concentrate of Stevia rebaudiana using a characteristic sweetener glycoside (250–300 times sweeter than sucrose), which worked well being an excellent bio- ZnO nanoparticles have a broad range of uses across all industries. The antimicrobial activity of ZnO nanoparticles is particularly noteworthy.

**Advantages**:.

- Green synthesisedZnO nanoparticles are frequently more biocompatible, which qualifies them for use in biotechnology and medicine.
- By avoiding using potentially harmful substances, green synthesis techniques generally support ecologically friendly practices
- When compared to traditional synthesis routes, green synthesis methods save energy by operating at lower temperatures and pressures.
- ZnO nanoparticle size and morphology can be more precisely controlled using green synthesis techniques, which can enhance their performance in a range of applications.

**Disadvantages**:

- These traits can vary, which may have an impact on their uses and qualities.The synthesis process may become more complex and variable when biological or natural components are used.
- The final zinc oxide nanoparticles' size and shape might not always be precisely controlled by green synthesis techniques
- Utilising biological entities, such as microorganisms or plant extracts, could contaminate or introduce impurities that compromise the stability and purity of the ZnO nanoparticles. (28to30)

### 4.1.3) Cerium Oxide ($CeO_2$):

Cerium Oxide NPs' antioxidant properties as a possible medication strategy for treating obesity. In addition, CNP has quick electron transfer kinetics and works well as a co-immobilization material for many different enzymes, including horseradish peroxidase, glucose oxidase, and cholesterol oxidase. Excellent antibacterial qualities were demonstrated by the Gloriosa superba leaf extract; $CeO_2$ NPs had a spherical shape and an average size of 5 nm.The green synthesis of cerium oxide ($CeO_2$) nanoparticles uses energy-efficient techniques to reduce the usage of dangerous chemicals and other environmental pollutants.

The following are some benefits and drawbacks related to the environmentally friendly synthesis of cerium oxide.

**Advantages**:

- Greater control over the shape and size of CeO2 nanoparticles can be achieved through green synthesis techniques, which will enhance their performance in a range of applications.
- Green-synthesized CeO2 nanoparticles may have a range of useful characteristics, such as antioxidant, antibacterial, and catalytic effects, which would make them appropriate for a number of uses.
- The overall cost-effectiveness of the process is increased by using inexpensive and readily available raw materials in some green synthesis techniques.

**Disadvantages**:

- Green synthesis techniques could produce nanoparticles with a range of properties, such as stability and size distribution.
- It can be difficult to comprehend and regulate the reaction mechanisms involved in green synthesis. When natural or biological components are used, the synthesis process may become more variable.
- In comparison to traditional methods, some green synthesis techniques might call for longer reaction times. This might have an effect on the synthesis process's overall effectiveness. (31,32)

### 4.1.4) Cadmium sulphide (CdS):

Due to its numerous applications in nonlinear optical materials, photodetectors, solar cells, photo-catalysts, and antimicrobial activities, cadmium sulphide (CdS) is one of the most promising direct bandgap semiconductors. CdS nanoparticles were created using a variety of techniques, including chemical synthesis, laser ablation, hydrothermal processing, and sol–gel templates. Obtaining CdS nanoparticles can be done easily, affordably, and cleanly using the chemical method. The process of thermally breaking down thioacetamide (TA) in an acidic solution of cadmium nitrate yields nanoparticles and produces the supersaturating conditions required for the homogenous precipitation of CdS. In this study, we examine the optoelectronic characteristics of CdS nanoparticles made by thermally breaking down thioacetamide (TA).

### Advantages:

- When compared to conventional methods, green synthesis techniques are more environmentally friendly because they generally avoid or use fewer hazardous chemicals.
- In comparison to traditional synthesis methods, green synthesis frequently uses lower temperatures and pressures, which results in less energy being used.
- To cut costs, some green synthesis techniques make use of cheap raw materials, waste products, or readily available natural sources.
- Green synthesis techniques give CdS nanoparticles more control over their shape and size, enabling customisation for particular uses.
- Potential uses for green-synthesized CdS nanoparticles may be increased by their adaptable qualities, which include photocatalytic, antimicrobial, and sensing capabilities.

### Disadvantages:

- Because natural sources and plant extracts vary so much, standardising green synthesis methods can be difficult. T.
- There may be difficulties when moving production from the laboratory to the industrial scale. At larger scales, it can be challenging to maintain reproducibility and consistency.
- Because of the complexity of the biological or natural components involved, characterising nanoparticles synthesised using green methods may require advanced techniques. This may raise the price and lengthen the characterization process.
- Plant extracts and microorganisms are examples of biological entities that may introduce contaminants or impurities that could compromise the stability and purity of the CdS nanoparticles. (33,34,35)

## 4.1.5) Silver(ag) and gold(au) nanoparticles:

According to several studies, a wide range of plants are utilised to create gold and silver nanoparticles. For readers to gain a comprehensive understanding of methodology, reaction conditioning, and optimisation in a condensed manner, a literature review on the green synthesis of nanoparticles will be beneficial.By giving the metal ions an electron, these phytochemicals can reduce the metal ions and cause metallic particles to form. Temperature, pH, and the presence of other compounds are examples of reaction conditions that are favourable to this reduction process. As the concentration of nanoparticles in the solution increases, honey can speed up the reduction process. Nanoparticles formed through honey mediation have unique properties like biosensing, anticorrosive, catalytic, and antimicrobial activity. Produced au and ag nanoparticles by extracting leaf from the corresponding metal salt precursors. (36,37)

## Advantages:

- It contributes to environmental sustainability by avoiding the use of hazardous chemicals that are frequently used in conventional methods.
- Uses less energy than conventional synthesis methods because it works at lower pressures and temperatures.
- Cost savings can be achieved by using cheap raw materials or plant extracts in certain green synthesis techniques. (38)

## Disadvantages:

- Standardising the synthesis process may be difficult due to variations in plant extracts or natural sources.
- The shift from laboratory-to-industrial-scale production can pose difficulties and compromise reproducibility.
- When dealing with biological or natural components, characterization may call for sophisticated techniques.
- It can be difficult to precisely control the characteristics of silver nanoparticles made using green synthesis. (39)

## 5) EVALUATION TESTS:

### 5.1) Fourier Transmission Infrared Ray(FTIR):

FTIR is a method for obtaining an infrared spectrum of a solid, liquid, or gas's absorption or emission. High-resolution spectral data over a broad spectral range are simultaneously collected by an FTIR spectrometer. Additionally, different nanomaterials and proteins in hydrophobic membrane environments are studied using FTIR. Research indicates that FTIR can be used to directly ascertain the polarity of a transmembrane protein at a specific location along its backbone. FTIR can be used to quantitatively analyse the bond characteristics of different organic and inorganic nanomaterials. FTIR is used to identify biomolecules that are in charge of stabilization, reduction, and capping. (40)


**Fig no.3 Fourier Transform Infrared Rays (FTIR)**

## 5.2) UV – visible spectrophometric:

Using Uv-visible, the nanoparticles of different metals with sizes ranging from 2 to 100 nm are characterized. typically, a wavelength between 300 and 800 nm is employed. this method determines the stability and formation of nanoparticles in aqueous solution. Using the Beer-Lambert law, this qualitative, quantitative, and analytical method determines how much discrete ultraviolet and visible light is absorbed or transmitted through a given sample by comparing it to a blank or reference sample. It conducts research in a vacuum. (41)


**Fig no.4: Ultra -Violet Visible Spectrophotometric**

## 5.3) Scanning electron microscopy (SEM):

a focused electron beam is used to scan a sample's surface in a scanning electron microscope (SEM), creating images of the sample. the sample's atoms and electrons interact to produce a variety of signals that reveal details about the sample's composition and surface topography. an image is created by combining the intensity of the detected signal with the position of the electron beam as it scans in a raster scan pattern. in the most popular SEM mode, a secondary electron detector (everhart–thornley detector) is used to detect secondary electrons released by atoms excited by the electron beam.Using SEM, an output image is created by using electrons rather than light. SEM is used to characterize the morphology, size, shape, and distribution of synthesised nanoparticles. (42)


**Fig no. 5: Scanning Electron Microscope**

## 5.4) X ray diffraction (XRD):

X ray diffraction is used to determine a material's atomic structure. both qualitative and quantitative analysis employ it. it is employed in the computation of crystalline nanoparticle size, the determination of crystal structure, and the verification of nanoparticles. The basis of X-ray diffraction is the constructive interference of a crystalline sample with monochromatic X-rays. A cathode ray tube produces these X-rays, which are then collimated to concentrate them, filtered to produce monochromatic radiation, and directed towards the sample. When an incident of monochromatic x-rays happens on a crystal. The Crystal causes the atomic electrons to vibrate. They accelerate at the same frequency as the incident ray's frequency. The radiation that these accelerated electrons then release is directed in all directions at the same frequency as the incident x-rays. (43)

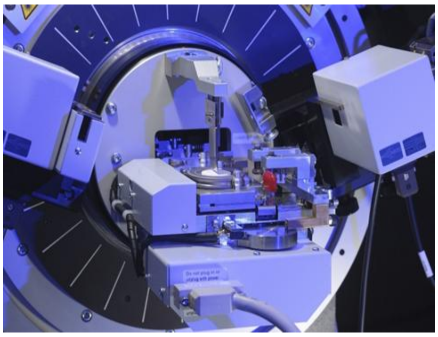

**Fig no.6: X-Ray Diffraction**

## 5.5) Transmission Electron Microscopy(TEM):

A beam of electrons is passed through a specimen to create an image in a process known as transmission electron microscopy (TEM). most frequently, the specimen is a suspension on a grid or an ultrathin section that is less than 100 nm thick. as the beam passes through the specimen, the interaction of the electrons with the sample creates an image. after that, the image is enlarged and focused onto an imaging medium, like a charge-coupled device connected to a scintillator sensor, a photographic film layer, or a fluorescent screen.It is employed in the study of crystal structure and material particle size at the nanoscale. (44)

**Fig no.7: Transmission Electron Microscope**

# 6) ADVANTAGES OF NANOPARTICLES:

- **Environmentallyfriendly**: The fact that green synthesis methods are environmentally sustainable is one of their main benefits. These methods reduce the use of hazardous chemicals and their overall impact on the environment by making use of natural sources and bio-friendly materials.
- **Reduced toxicity:** Typically, biocompatible substances like microbial agents or plant extracts are used in green synthesis. Because of this, the nanoparticles that are created are frequently less hazardous than those that are created through traditional means, making them safer for use in a variety of applications.

- **Energy efficiency:** Green synthesis techniques frequently use less energy and operate at lower temperatures than conventional chemical techniques. This improved energy efficiency makes the production process more economical and sustainable.
- **Biomedical application:** Because they are frequently biocompatible, green-synthesized nanoparticles can be used in a variety of biomedical applications. These include the administration of drugs, imaging, and other therapeutic applications where it is essential to reduce toxicity and guarantee compatibility with biological systems.
- **Versatility of source materials:** Numerous source materials, such as plant extracts, bacteria, fungi, and other bio-friendly substances, can be used with green synthesis techniques. Because of their adaptability, manufacturers and researchers have a wide range of options when creating nanoparticles that are suited for particular uses.

## DISADVANTAGES OF NANOPARTICLES:

- **Variable Product Quality:** The inherent variability in natural sources may lead to variable product quality when using green synthesis methods. Variations in the composition of microbial cultures or plant extracts can result in variations in the properties of the synthesised nanoparticles.
- **Limited control over particle size and shape:**It can be difficult to precisely control the size and shape of nanoparticles using green synthesis techniques. For some applications, more precisecontrol over these characteristics can be obtained through conventional chemical methods**.**
- **Biological contaminants:** It is possible to introduce contaminants like proteins, nucleic acids, or other cellular components when using biologicalmaterials in green synthesis. These impurities may need further purification procedures and have an impact on the stability and functionality of the nanoparticles.
- **Storage and stability issues:** When it comes to storage stability, nanoparticles made with green methods might not be as stable as those made with traditional methods. Over time, stability problems may have an impact on the nanoparticles' effectiveness and shelf life.
- **Cost of purification:**Depending on the source material used, additional purification steps may be required to remove impurities. The cost and complexity of purification processes can impact the overall economic feasibility of green synthesis methods.

## 7) APPLICATIONS OF NANOPARTICLES:

- In the past ten years, the number of scientific publications in the field of nanotechnology has dramatically increased.
- Nanomaterials produced using green synthesis are important for applying nanotechnology to a variety of fields.
- In order to achieve sustainable development, green nanotechnology refers to the creation of green nanoproducts and their application.
- Green synthetic nanoparticles (NPs) are important in medicine, clinical settings, and in vitro diagnostic applications.
- Nanoparticles made using environmentally friendly processes have strong antibacterial properties, antifungal effects anti-parasitic activity.
- To extend shelf life and guard against microbial contamination, food packaging materials can employ green-synthesized nanoparticles.
- Certain nanoparticles' antimicrobial qualities can improve food safety.
- Textiles can be given special qualities like improved mechanical strength, UV resistance, and antimicrobial activity by incorporating nanoparticles. The textile industry's increasing interest in environmentally friendly and sustainable practises is in line with green synthesis methods. (36-40)
- In recent times, noble nanoparticles have garnered significant interest due to their remarkable applications in the fields of electronics, medicine, and biology.
- The biological method has gained widespread acceptance among synthesis techniques, including physical and chemical methods, due to its simplicity, dependability, lack of toxicity, and environmentally friendly nature.
- The various possibilities for metallic nanoparticles that are compatible with biology and cytology were made possible by the fusion of green chemistry and nanotechnology.
- The medicinal properties of different metals are detailed in detail in the ancient Indian Ayurvedic medicine book "Charak Samhita," which mentions the use of silver as early as 300 BC.
- Silver nanoparticles (Ag) or AgNPs, are one of the many types of nanoparticles that are commonly used in biomedical, drug delivery, water treatment, agricultural, electronic devices, adhesives, and other applications.
- AgNPs have many uses as anti-microbial, anti-parasitic, and anti-fouling agents due to their unique properties. They can also be employed as an agent for water purification systems and medication tailored to a specific location.

- The complex and little-studied mechanism by which AgNPs affect bacteria is best described theoretically. AgNPs have two different ways of acting on microorganisms: bactericidal action and inhibitory action.
- AgNPs have antibacterial activity against both gram-positive and gram-negative bacteria, however conflicting reports from various researchers have not yet been verified.
- Nanotechnology is also thought to be important in the early detection of cancer by enabling the molecular level visualisation of cancer cells.
- The exact location of the tumor can also be determined, and the expression and activity of particular molecules that affect tumor behaviour and its response to therapy can be ruled out.
- In biomedical applications, pure platinum nanoparticles or those alloyed with other nanoparticles have found widespread use. Palladium nanoparticles find application in chemical sensors, optoelectronics, biological sensors, and antibacterial applications.
- Antibacterial applications, cosmetic formulations, and medical treatments have also made use of other non-noble metallic nanoparticles, including iron, copper, zinc oxide, and selenium. (45)

## CONCLUSION:

Green nanoparticles (nanoparticles) find wide-ranging applications in various fields, including biosensing, dentistry, and pharmaceuticals. in developing nations where such material may be found only in their native resources, the majority of plant-based products can be produced locally. Metal nanoparticles for green synthesis have recently been produced with efficiency using a range of microorganisms and plant extracts. green synthesis is the most practical, straightforward, environmentally friendly method for creating nanoparticles. it reduces the negative effects of chemical and physical methods by avoiding the use of toxic chemicals and the creation of hazardous byproducts.due to their superior properties, nanoparticles are widely used and have been the subject of extensive research in recent years. green synthesis produces antimicrobial, antioxidant, and non-toxic nanoparticles, and these properties are becoming more and more significant in terms of their physical and therapeutic effects.For green synthesised nanomaterials to be produced and used in practical applications, a number of obstacles and drawbacks must be addressed, including low yield, non-uniform particle sizes, intricate extraction processes, seasonal and regional raw material availability, and other issue.

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