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REVIEW OF DRUG DELIVERY SYSTEM–NANO-MEDICINES

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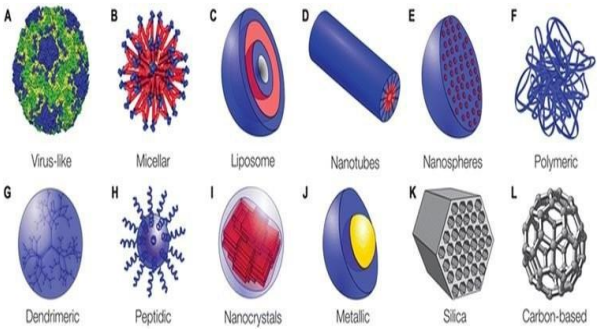
Abstract: Nano medicine has revolutionized drug delivery systems (DDS) by utilizing nano particle enhance therapeutic efficacy and targeted drug administration. Nano particles, due to their unique physicochemical properties at the nano scale, play a crucial role in overcoming limitations associated with conventional drug delivery, such as poor solubility, rapid clearance, and non-specific distribution. Various types of nano particles are employed in DDS, including liposomes, polymeric nano particles, dendrimers, solid lipid nano particles, metal-based nano particles (gold, silver, silica), and carbon-based nano particles (nano tubes, fullerenes, graphene oxide). These nano particles facilitate different types of drug delivery systems, such as controlled release, targeted delivery, and stimuli-responsive systems. which ensure precise drug release at the intended site while minimizing systemic toxicity. The synthesis of nano particles can be achieved through multiple methods, including chemical synthesis (Precipitation, sol-gel and polymerization), physical methods (Ultra sonication) and biological approaches (green synthesis using plant or microbial extracts). Advancements in nano technology-driven drug delivery hold immense potential for improving therapeutic outcomes, particularly in cancer treatment, infectious diseases, and neurological disorders. Further research is required to optimize nano particle design, enhance biocompatibility, and develope scalable synthesis methods for clinical applications.

I.INTRODUCTION:

The term "nano" comes from the Latin word for "dwarf," and it refers to a unit of measurement that is one billionth of meter (1nm =10^-9 m). Nano technology is the branch of science that focuses on the processes and phenomena that occur at the molecular level and at the scale of nano meters. It has been used in fields such as electronics, physics, and engineering for many years, and more recently it has been applied to biomedical and pharmaceutical research resulting in advancement in drug delivery systems. It has a significant impact in various fields of medicine, such as immunology, cardiology, endocrinology, ophthalmology, oncology, pulmonology and in specialized areas like brain targeting, tumor targeting, and gene delivery. Additionally, nano technology provides new systems, devices, and materials for improved pharmaceutical applications. (Bhatia, 2016). The key breakthrough in pharmaceutical applications of nano particles lies in their ability to overcome previous limitations (Couvreur,2013).

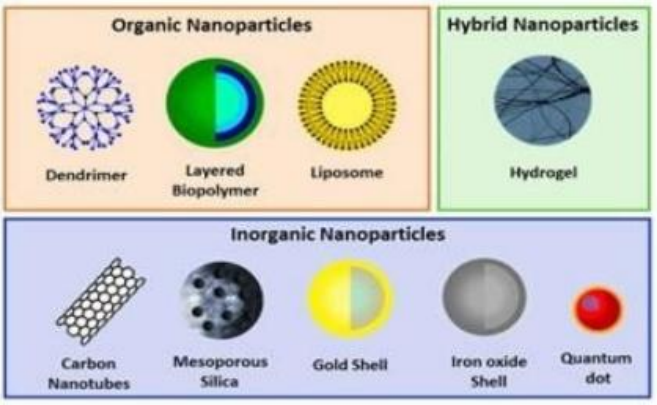
Nano particulate drug delivery systems (NDDSs) enhance drug effectiveness in clinical and research settings. They utilize various nano carriers, such as liposomes, polymeric nano particles, and metal-based nano particles, to improve drug solubility, bioavailability, and targeted distribution, overcoming limitations of traditional pharmaceuticals. (Torchilin, 2014). Nano particles are tiny particles, typically between 10and1000nm in size.

The method used to create the nano particles can result indifferent types, such as nano spheres or nano capsules. It can be designed with specific particle size and surface properties to target drugs passively or actively after administering them via injection. The primary objective in designing nano particles as a drug delivery system is to optimize particle size, surface characteristics, and drug release for targeted and controlled therapeutic effects (Mohanraj,n.d.).



TYPES OF NANO PARTICLES

Therapeutic and diagnostic nano particles can be divided into two types: inorganic and organic. Inorganic nano particles, such as gold and silica, have been successful in preclinical studies and have been approved for medical applications such as imaging and anemia treatment Organic nano particles, like polymeric particles and liposomes have also had success in clinical trials and are being developed for various uses, including vaccination, long-term drug delivery and topical treatments. Of particular relevance are organic nano particles that are delivered intravenously,

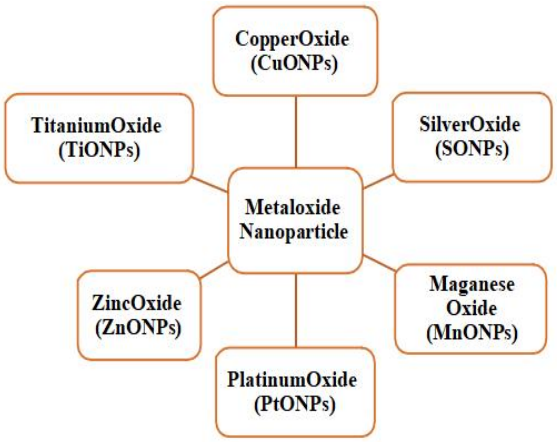


Which are being developed for gene therapy and the delivery of small molecule drugs for cancer treatment as shown in fig.02.

Other applications for organic nano particles, such as fungal treatments and vaccines, are also being researched. (Anselmo & Mitragotri, 2016)

lver nano particles are highly effective due to their strong antimicrobial properties against a variety of microorganisms, such as bacteria and viruses. They are among the most widely used nano materials and are used as antimicrobial agents in various industries including textiles water treatment and sunscreen products Studies have shown that silver nano particles can be successfully synthesized by using plants such as Azadirachtaindica Capsicumannuum and Carica papaya. (Hasan, 2015)

Gold nano particles (AuNPs) have various applications in research, such as in the identification of protein interactions and DNA fingerprinting, as well as in the detection of certain antibiotics. Gold nano rods are being explored as a tool for detecting cancer stem cells, which could aid in cancer diagnosis and in identifying different types of bacteria (Hasan,2015)



Metal oxide nano particles

Nano particles are composed of different materials and exist in diverse sizes and shapes, with arrange of synthetic surface molecules, which distinguishes them from naturally occurring materials. The physiochemical properties of metal and metal oxide nano particles are unique compared to their bulk counter parts, including their surface, optical, thermal, and electrical properties were mentioned in fig.03. They are produced through the addition of reducing or oxidizing/precipitating agents during synthesis. The reactivity of nano particles with biomolecules is dependent on various factors, such as size, core composition, shape, surface properties, purity, stability, and method of production. (Rastogi et al., 2017)

Recently, there has been significant attention given to nanostructured materials like silver, copper, ZnO, MgO, TiO2, CuO, and their composites due to their antibacterial properties. The US Environmental Protection Agency (EPA) recognizes elemental copper and its compounds as antimicrobial materials. Copper (I and II) oxides in their nano form (<100 nm) exhibit enhanced antimicrobial activity against pathogenic microorganisms, making them commercially useful in paints, fabrics, agriculture, and hospitals in the form of constituent powders or coated films. Numerous studies have explored the antibacterial activities of elemental Cu, CuO, and Cu2O, including the impact of particle size, morphology, and dissolution of copper ions in different media. antibacterial action of CuO has been linked to a sudden decrease in cell membrane integrity and the production of reactive oxygen species (ROS).

SYNTHESIS OF NANO PARTICLES

Physical methods

Physical methods, such as ball milling and laser ablation are used to reduce the size of larger particles into nano particles.

Chemical-methods

Chemical methods, such as co-precipitation, sol-gel, and hydrothermal synthesis, use chemical reactions to form nano particles. These methods often involve the use of stabilizing agents, such as surfactants, to prevent the particles from aggregating.

Biological methods

In biological methods, nano particles are synthesized using biological systems, such as bacteria or yeast, which produce nano particles with specific properties

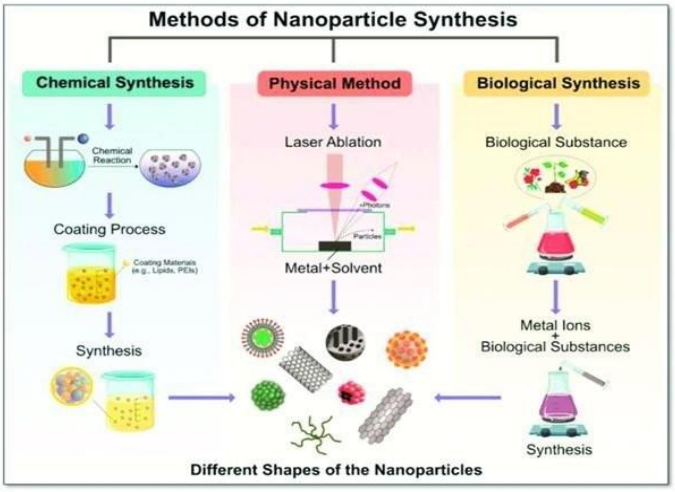
Inorganic-methods

Inorganic methods such as thermal decomposition are used to synthesize nano particles from inorganic precursors, such as metal oxidesormetal-salts.
The choice of synthesis method depends on the desired properties of the nano particles.

For example, some methods are better suited for producing highly uniform nano particles, while others are better for synthesizing nano particles with specific chemical or biological properties. ***(Ealia & Saravana kumar, 2017)***

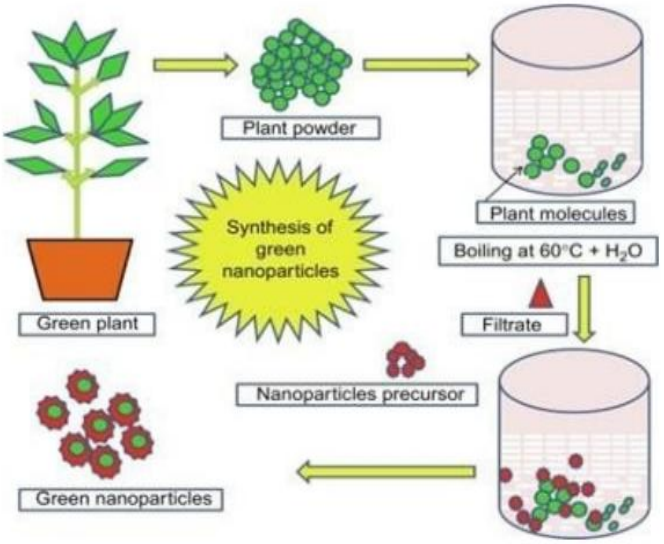
Green synthesis of nano particles

Green synthesis of nano particles refers to the environmentally friendly and cost- effective method of producing nano particles



using natural sources such as plants, bacteria and fungi. The process uses biogenic materials, reducing agents, and

stabilizing agents to produce nano particles without the use of harmful chemicals. Green synthesis is a sustainable alternative to traditional methods that use toxic chemicals and high energy consumption. It has applications in various fields, including medicine, electronics, and environmental science.



TYPES OF DRUG DELIVERY SYSTEM

The process of administering a pharmaceutical compound to achieve a therapeutic effect in the body. It involves selecting the appropriate route (oral, intravenous, topical etc.) to ensure the drug reach target site efficiently. A specialized system or technology designed to improve the efficiency, targeting, and controlled release of a drug. It includes various formulations, carriers, and mechanisms to enhance drug absorption, reduce side effects, and optimize therapeutic outcomes. Examples include nano particles, liposomes, and controlled- release tablets.

Type of Drug Delivery System	Description	Examples
Conventional Drug Delivery	Traditional methods where the drug is released immediately or gradually without specific targeting.	Oral tablets, capsules, syrups, injections, topical creams, ointments.
Controlled & Sustained Release Systems	Releases the drug at a controlled rate to maintain a steady concentration for a prolonged period.	Extended-release tablets, micro encapsulation, osmotic pumps.
Targeted Drug Delivery	Delivers the drug specifically to the affected tissues or organs to reduce side effects.	Liposomes, nano particles monoclonal antibodies.
Transdermal Drug Delivery	Administers drugs through the skin for systemic effects.	Patches (nicotine patch fentanyl patch).
Pulmonary Drug Delivery	Drug is inhaled into the lungs for direct respiratory treatment or systemic absorption.	Inhaler, nebulizers.
Ocular Drug Delivery	Targets drug release in to the eye for treating eye diseases.	Eyedrops, intraocular implants.
Intravenous (IV) and Injectable Drug Delivery	Directly injects drugs into the bloodstream or tissues for rapid effect.	IV infusions, subcutaneous, and intramuscular injections.
Biodegradable Implants	Drug is incorporated into a biodegradable polymer, releasing the drug over time as it degrades.	Drug-eluting stents, hormone implants.
Gene Therapy-Based Drug Delivery	Uses genetic material to treat or prevent diseases at the DNA or RNA level.	Viral and non- viral vectors for gene therapy.
Smart Drug Delivery Systems	Uses stimuli-responsive carriers to release drugs based on specific biological conditions.	pH-sensitive nanoparticles, temperature- sensitive hydrogels.

II..CONCLUSION

Nano technology, particularly nano particles, has revolutionized drug delivery by introducing materials with distinct properties at the nano scale. Unlike traditional bulk materials, these nano materials exhibit unique characteristics that enable new medical applications. A major advancement in this field was overcoming the historical belief that intravenous pharmaceutical suspensions were unsafe due to embolism risks. Nano particulate drug delivery systems (NDDSs) enhance drug effectiveness in clinical and research settings. They utilize various nano carriers, such as liposomes, polymeric nano particles, and metal-based nano particles, to improve drug solubility, bioavailability, and targeted distribution, overcoming limitations of traditional pharmaceuticals.

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