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Review Article

A DETAILED REVIEW ON THE TYPES AND APPLICATIONS OF NANOPARTICLES OR NANOMEDICINE

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ABSTRACT

Nanoparticles are an emerging field of modern science. It is solid colloidal particles. They consist of micro molecular materials in which the active ingredients is dissolved, entrapped or encapsulated or adsorbed or attached. The size of nanoparticles ranges from 1 to 100 nm. It can be synthesized chemically or biologically. Nanoparticles are used in various purposes like in drug delivery, in food, in medicine, in cosmetics etc. There are lots of advantages of nanomedicine over other dosage form. Nanoparticles show high solubility as well as higher bioavailability on site of action. This review focuses on synthesis, biosynthesis, types, application, advantage, disadvantage, limitation of nanoparticle.

Keywords:- Nanoparticles, Synthesis, Nanomedicine

INTRODUCTION

Nanotechnology refers to an modern field of science which plays an important role in our daily life[1].The prefix ‘nano' comes from the ancient Greek vavoc through the Latin nanus which means dwarf. It is the science of the small; the very small. At this size, atoms and molecules work differently, and provide a variety of interesting uses. It provides various opportunities for the development of materials, especially for medical applications, where conventional techniques may reach their limits. Nanotechnology referred to as the ‘tiny science’ but it does not simply mean very small structures and products. Nanoscale features are sometimes incorporated into bulk material and large surfaces. Nanotechnology simply represents the design, production and application of materials at atomic, molecular and macromolecular scales, in order to produce new nanosized materials[2].

Nanoparticle

Particles having diameter in range 10-100 nm are known as Nanoparticles[3]. The term Nanoparticle is composed of Nanospheres and Nanocapsules. Nanospheres refers to as matrix system in which drug is uniformly dispersed while Nanocapsules refers to as system in which the drug is surrounded by a unique polymeric membrane [4]. Generally, Nanosized word is measured in Nanometers 2.A nanometer (nm) is an international system of units, unit that represents 10-9 meter in length [5]. Nanosized particles can be designed to improve pharmacological and therapeutic effect of drug [6]. The first reported Nanoparticles were based on non-biodegradable polymeric system [7]. Presently Copper, Zinc, Titanium, Magnesium, Gold, Alginate and Silver are used to produce various metallic nanomaterials [8]. In this review, we discuss the synthesis, types, application, limitation, advantage, disadvantage of Nanoparticles [9].

Synthesis of Nanoparticles

Synthesis of nanoparticles takes place chemically, biological or physically. In chemical method, various adverse effects occur due to the presence of some toxic chemical absorbed on the surface. Apart from chemical and physical method, Eco friendly alternatives are biological way of nanoparticle synthesis by using microorganisms [10,11] enzymes [12] fungus [13] and plants or plant extracts [14, 15]. The development of these eco-friendly alternatives (Biological method) is evolving into and important branch of nanotechnology for the synthesis of nanoparticles especially silver nanoparticles [16,17,18].

Biosynthesis of Nanoparticles

The biosynthesis of nanoparticles by using microorganism is an eco-friendly technology. In these various microorganisms (prokaryotes and eukaryotes) are used for synthesis of metallic nanoparticles (silver, gold, metal oxides etc.). The microorganism used are- Bacteria, fungi, algae [19,20]. Now,

- Intracellular Synthesis of Nanoparticles by Fungi:

In this, Nanoparticles are formed by transporting ions into microbial cells in the presence of enzymes.

- Extracellular synthesis of nanoparticles by Fungi:

Mostly, fungi are known to produce nanoparticles extracellularly because of their enormous secretory components which are involved in the reduction and capping of nanoparticles [21].

- Microbes for production of nanoparticles

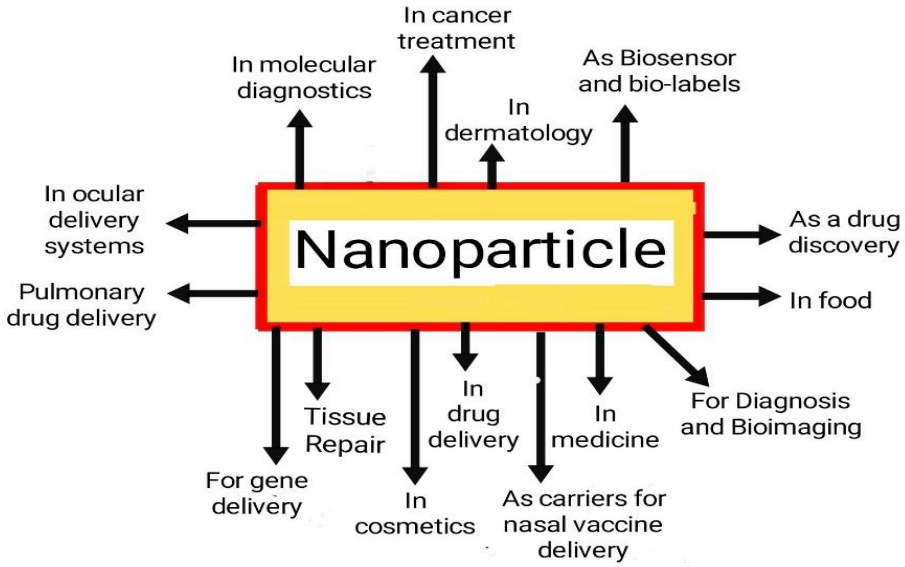
Inorganic materials are produced either extracellularly or intracellularly by using unicellular and multicellular organisms. The ability of microorganisms like bacteria and fungi to control the synthesis of metallic nanoparticles is employed in the search for new materials [22, 23].

Types of Nanoparticles

1) Silver Nanoparticles: - Silver nanoparticles have good antimicrobial efficacy and that's why they are used in textile industries for sunscreen creams and water treatment [24, 25]. Silver nanoparticles are obtained by the following process:- Silver ions are reduced by ethanol at 800°c to 1000°c under atmospheric condition [26].
2) Gold Nanoparticles: -Gold nanoparticles are produced by using liquid chemical method Chloroauric acid reduction [27].Gold nanoparticles are used for identification of protein interaction, detection of aminoglycoside, antibiotics (streptomycin and neomycin).They are also used for detecting the presence of DNA in a fingerprint sample [28,29].
3) Copper Nanoparticles:- It is also used as antifungal or antibacterial agents [30]. Copper nanoparticles are prepared under microwave irradiation. Under this, reduction of copper sulphate with hydrazine in ethylene glycol takes place to prepare this [31].
4) Magnetic Nanoparticles: -Fe_3O_4 (magnetite) &Fe_2O_3 (maghemite) both are magnetic nanoparticles which are known to be biocompatible. It is used in cancer treatment, gene therapy, DNA analysis [32].

Application of Nanoparticle
In Drug Delivery

The main advantages of nanoparticle used on drug carrier are high stability high, carrier capacity [33]. Some drugs cannot pass the first pass metabolism. The nanoparticles can be modified to overcome this and they also allow controlled sustained drug release from the matrix. This attribute can help in enhance the bioavailability of the drug and also in the reduction of the dosing frequency[34].



In Food

In the food sector, the area where nanotechnology has potential utility and emulsion formation, sensor development, encapsulation [35,36].

In Medicine

Nanomedicine are used in early detection, prevention and diagnosis of disease. Nanodevices like gold nanoparticles has made sequencing less difficult. By the help of nanotechnology, damaged tissue can be repaired or reproduced. Organ transplantation for artificial implantation can be revolutionised by using nanotechnology[37].

In Cosmetics

Sunscreens: - UV filters (Titanium dioxide and zinc oxide) are used in Nano form rather than bulk form to make the sunscreen transparent [38].
Hair Care: - RBC life sciences Nanoceuticals CitrusMint shampoo and conditioner are made with Nano clusters TM, ‘’nanoclusters to give hair a healthy shine” [39].

Tissue Repair

The nanoparticles are coated onto the surfaces of two pieces of tissue at the site where joining was desired. This technique helps to minimise tissue damage by using the least harmful wavelengths of light and/or lower powered light sources [40].

Advantage of Nanoparticle

- Smaller particle size have large surface area which results in a faster dissolution of the active agent in an aqueous environment, such as the human body. And faster dissolution generally results in greater absorption and bioavailability.
- Smaller drug doses causes less toxicity.
- Help in increasing bioavailability.
- Liposomes and polymer based nanoparticulates are biodegradable hence they do not accumulate in the body and are risk free.
- Different routes of administration and available including oral, nasal, parenteral etc. [41].

Disadvantage of Nanoparticle

- The manufacturing costs of nanoparticle are very high.
- Allergic reactions, immune response can start in body due to the use of solvents which are toxic in nature.

- Particle-particle aggregation occurs in physical form as its size is small and large surface area so it is difficult to handle[42, 43, 44].

Limitation of Nanoparticle

- After releasing nanoparticle into the environment, it might be undetectable whereby can cause problem if remediation is needed. So, different analytical techniques should be improved to detect nanoparticle in the environment.
- Novel nanoparticles elicit a risk of exposure during manufacture or usage. So, complete risk assessment have to be taken into consideration[45].
- As the particle size decreases, surface area increases and this property makes nanoparticle very reactive in the cellular environment.
- As the particle size is small it results in limited drug loading and burst release. This problem have to be sorted out before nanoparticles can be used clinically [46].

Nanomedicine

It can be defined as the monitoring, repair, construction and control of human biological systems at the molecular level by using engineered nanodevices and Nano structures [47]. The overall goal of nanomedicine is to diagnose accurately and early to treat as effectively as possible with minimum side effects [48].

CONCLUSION

Nanoparticles have become a highly attractive platform for a diverse way of biological application. It became significant in many fields such as energy, healthcare etc. and this is because of their incredible properties. Nano-particulates systems have potentials and are being able to convert into promising deliverable drugs from poorly soluble, poor absorbed and labile biologically active substances. Further advancement in nanotechnology can made our life more comfortable.

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