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Mini Review

An Overview of Nanotechnology and Nanoparticles: A Review

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ABSTRACT

One of the major concerns of this era of medicine is the specific and fast treatment without harming the organism. It is now possible with the new technology of nanoparticles. Nanoparticles are molecules of extremely small size range up to nanometers. These particles can be of different type and characteristics and on its basis different uses. These particles have its significance in medicine as it can be used as drugs. These drugs are most advanced and efficient. But due to its small size there are various limitations.

Keywords: Nanoparticles; Drugs; Electron microscopy; Emulsion; Diffusion; Nanoparticle drugs

INTRODUCTION

Nanotechnology as it names suggests, is the technology deals with the extremely small sized subjects of nano meter size, like our body cells. It deals with the nana subjects designs, productions, and characterization. They can be manipulated to our requirements; in medicine it is used by pharmaceutical industries for making nanoparticle medicines and therapeutic use. Now days it uses in medicine is replacing chemotherapy and radiations therapy. It has been successfully used today due to modern technology and knowledge of nanoparticle for treatment of cancer like diseases. Nanoparticles like any metal, semiconductor; polymeric particle is used in imaging and delivery of drug into body specific regions [1].

As a carrier system it is on top of all the carriers' systems used till today. It cans easily pass through different cells and vessels. If high density is required, it can be encapsulated and used. Liposome has been used frequently so far. But with its advantages it has some limitations like we cannot control the leakage of encapsulated liposome. On the other hand, polymeric nanoparticles offer specific advantages. The release of drug can be controlled efficiently by changing the amount of polymer and types. With all these advantages some minor pros include the faster absorption rate in epithelial cells, and have various routes for administration.

LITERATURE REVIEW

Types of nanoparticles

Different types of nanoparticles can be found based on composition; some of them are discussed below:

Inorganic nanoparticles: Inorganic molecules have special size, physical and catalytically properties, making them unique and mostly used in biotechnology. These nanoparticles are gold, silver, quantum dots. Their size also approached to nanometers so are our subject.

Polymeric nanoparticles: Solid particles of size ranging from 10 nm-1000 nm, build from polymerization of different monomers into it polymeric forms can be used as our carrier of drug, and various other activities. More research work is being done on it and its potential is considers more than any other nanoparticles [2].

Solid liquid nanoparticles: These particles have vital role in controlled drug delivery. These act as colloidal carrier system. Some of them are given below,

Liposomes: These are usually carrier of various different nanoparticles. These are single layered or multilayered lipid bilayer membrane vesicles. Inside it we can insert our compound of interest. Liposomes are being used today almost in every field and is emerging nanotechnology.

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Dendrimers: These are synthetic polymers, having definite structure, 3-dimensional shape, and its unique property which is hyper branching. Its features are more or like dendrites.

Nano tube and crystals: Extremely small sized, mostly of nanometer range scale tube like structures known as nanotube, which structural member of fullerene family. It contains sheets suspended at certain angle, and sheet of carbon called graphene. Its radius and angle define its properties. It can be of two types *i.e.*, one walled, or multiwall.

A nano crystal is a crystal having at least one side smaller than 100 nm. Its atoms are usually arranged in poly-crystalline form [3].

Characterization of nanoparticles

The nanoparticles can be differentiated by their respective size, shape, morphology and surface charge. All these physical characteristics cannot be seen by naked eyes for its techniques for microscopy are used. Scanning electron microscopy, transmission electron microscopy, and dynamic light scattering are one of these techniques.

Particle size: Size of nanoparticles affects its functions greatly. As we know major role of nanoparticle is to control the release and targeting of drugs. Size play's role in drug release, smaller size offers large surface area, and hence faster release of drug. But smaller size nanoparticles are not much stable and can be degraded during storage and transportation [4].

Surface charge: Interactions between molecules are due to charge differences, and so does the interactions of nanoparticles. An indirect method to measure the charge of it is zeta potential. The potential help us to find stability of particles and how long can we store them. For best use zeta potential should be high either negative or positive. It also helps us to know about the encapsulated material of nanoparticle.

Dynamic Light Scattering (DLS): Also known as photon correlation spectroscopy, is one of the best and mostly used because of its fast procedure and detection of nanoparticle in motions. A ray is bombarded from one side and nanoparticle from other, both collides and Doppler effect is observed due to change in wavelength and its measurement (*i.e.*, Diffusion coefficient, auto correlation) can tell us about size of the nanoparticle [5,6].

Scanning electron microscopy

The final diagnosis and examination, with visualization of nanoparticles can be obtained by SEM. Although, it far more advance and better, but it cost and handling is not much reliable. To check the characteristic of nanoparticle through it, the nanoparticle first converted into dry powder, coated with conducting metal, and then bombarded with electrons whose emission tells use about our particle.

Transmission electron microscope

Result might be same as SEM, but the principle is different. Here the electron beam passed through the ultra-thin sheet and the sample of our nanoparticle after various preparations is held between the sheets which bales use to understand morphology of our particle. Atomic force microscopy is used which is know because of it one advantage, the nanoparticle needs no special treatment and does not depend on its conducting or not. Accurate size and, size distribution can be found also with real pictures.

Methods of preparations

Different methods are available to make nanoparticle drugs, and are divided into to two groups one in which polymerization is done, while in other already made polymers are used. Choice of nanoparticle depends on, size, surface properties, stability, rate of biodegradation, drug release, and antigenicity of final product. Some of common method used these days is given bellow:

Emulsion/evaporation

In this method, organic solution and drug is emulsified in an aqueous solution, which is then reduce by using high energy and evaporation in vacuum to get a thin layer of nanoparticle which is then frizzed for storage. This method is used for lipophilic drugs, of nanoparticles mostly of size range from nanometers to micro. Due to poor entrapment with hydrophilic drugs, a variant of this method "double emulsion" is preferred. Bovine serum albumin was produced by it. High encapsulation is achieved by it.

Salting out

Its best method for polar solvent polymers A salting our solution with stabilizer in solution of polymer and drug is used under stirring. Nano-precipitation technique differs from salting out technique. In it, miscibility of both the phases is prevented by saturation of external aqueous phase with PVA.

Emulsification-diffusion

In it water miscible solvent with water immiscible solvent is mixed, and diffusion of both create disturbance leading to formation of small particles. Size can be changed with conc. of water miscible solvent changes. One of the cons of it is that it has low efficient of entrapment with hydrophilic drugs in nanoparticles. It can be modified with different particle requirement; one of the modified methods is "emulsion-diffusion-evaporation". Here with diffusion, evaporation is also done to obtain nanoparticles. The basic step involves dispersion of organic phase as globules in equilibrium with external aqueous phase due to continuous stirring; the globule size is reduced further by homogenization. To remove the organic layer for obtaining pure nanoparticles, solution is passed through high temperature.

Nano precipitation

In this method, semi miscible water solvent solution containing drug, surfactant, and polymer is added into the solution containing stabilized under stirring. Nanoparticles are formed

when rapid diffusion occurs. Nanoparticle drug efficiency is based on the selection of drug, solution, solvent and other reagents.

Ionic gelation method

Chitosan or gelatin like material are now on being researched and used. These are hydrophilic biodegradable polymers. This method involves mixing of two aqueous phases, one of the polymers discussed above *i.e.*, chitosan, other the poly anion-sodium triphosphate. Coacervates with a size in the range on nanometer are formed, when negative charge of triphosphate interacts with positive amino group of chitosan. Whereas, ionic gelation involves the material undergoing from lipid to gel due to ionic interaction conditions at temperature room.

Spray drying

Till now it has been one of the best methods for it fast and efficient results. It is used to form particle of size range micrometers. One step process involves drying/evaporation of solution droplet without mixing into another phase. Proteins and enzymes are successfully nanoparticulated through this method.

Advantages

Nanoparticles can be easily modified as our interests, for both passive and active drug targeting maximum efficiency with minimum side effect of the drugs. No chemical reaction by host system. Can detect specific targets. Easily go through our body, and doesn't accumulate because of the biodegradability. Looking into these advantages over normal drugs, it can be used in various different fields not only in medicine.

Applications

Nanoparticles, in spite of their small size are used by modern technology helping out in many different fields not only medicine, but also fields like chemicals cosmetics, food, agriculture electronics, environment and energy. This entire field has utilized nanoparticles for their benefit. Today, very few people know about nanoparticles and how to use them, but with time its importance will be recognized all around the world.

Limitations

Every single thing may have some of the limitations which are not in our control. As we are dealing with subatomic level, we do not know what exactly is going to happen nor is it going as we have imagined it would. Some of the limitations, like smaller surface area make them very reactive and if not build properly can reactive to different areas and chemicals. Due to its small size, it is needed in large amount. Handling of nanoparticles is very difficult in liquid or dry forms.

DISCUSSION

With time everything changes, and adopts the way that requires to be with time especially technology. Now days, technology is in another level. By using it for the welfare of mankind we can create numerous drugs and can be helpful to treat various diseases which are untreatable by the day. The antibiotics will have to be replaced with is. But nanoparticles are not cheap, or can be obtained easily.

CONCLUSION

One should know different methods, how to use and handle it. These are very delicate and if not handle correctly may cause harm. Nanoparticle technology will emerge soon and recognized by all, as its importance cannot be neglected.

COMPETING INTERESTS

The author and the co-authors have no competing interests.

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