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Nanocarrier Mediated Drug Delivery

Prashanthi Gummadi*

Department of Pharmacy, SSJ College of Pharmacy, Hyderabad, Telangana, India

Review Article

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***For Correspondence**

Prashanthi G, Department of Pharmacy, SSJ College of Pharmacy, Vattinagulapally, Rajendranagar mandal, Hyderabad, Telangana 500075, India.

E-mail:
prashanthi.cvk67@gmail.com

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ABSTRACT

Nanomedicine is the medical application of nanotechnology which made it new with greatly increased possibilities in the field of medicine. Nanomedicine aims in delivering a set of clinical devices, research tools ranging from the applications of nanomaterials in medicine to Nanoelectronics. Nanotechnology has improved the chances of delivering drug to specific site in the biological system thereby improving the bioavailability of the drug and reducing the side-effects, they have improved pharmacological and therapeutic properties of drugs. These nano-sized objects called nanoparticles has typical properties and functions, their small size, improved surface and solubility will continue to create new biomedical applications. This rapidly growing field requires interdisciplinary research to design and develop devices that can target and treat chronic diseases such as cancer. This article presents an overview of Nanomedicine, Nano carriers in drug delivery and types of Nanomedicine systems and their application.

INTRODUCTION

Nanotechnology is the manipulation of functional systems at the molecular level that are characterized by distinctive physical, optical and electronic properties extending from materials science to biomedicine [1-3]. One of the debut research areas of nanotechnology is Nanomedicine which uses nanotechnology to specific medical discoveries for the prevention, diagnosis and treatment of diseases [4,5].

Nanomedicine aims in delivering a set of clinical devices, research tools ranging from the applications of nanomaterials in medicine to Nanoelectronics. Nanoparticles have high surface area, containing encapsulated, absorbed, dispersed drugs with unique characteristics that can help in enhancing the performance in a various dosage forms thereby providing rapid onset of action and improved bioavailability. Nanotechnology can be implemented in interventions of new drug delivery systems that can expand highly in drug markets. The new drug delivery procedures should enable pharma companies to reformulate present drugs, thereby increasing the shelf life of products and improving the performance of drugs by increasing efficacy, safety and bioavailability and ultimately reducing healthcare expenses [6-8].

TYPES OF NANO CARRIERS IN DRUG DELIVERY

A nanocarrier is material size ranging from diameter 1–1000 nm which is used as a transport medium for drug. Some of the commonly used nanocarriers are micelles, carbon-based materials, polymers, liposomes. Nanocarriers are currently being investigated for their potential use in drug delivery and their role in chemotherapy. Types of nanocarrier systems are listed and some are described below [9-12].

- polymer conjugates
- polymeric nanoparticles
- lipid-based carriers
- dendrimers
- carbon nanotubes

- gold nanoparticles
- Nanorods

Liposomes

Liposomes drug delivery system can enhance the bio distribution and pharmacokinetic properties of the drug. Liposome is a phospholipid bilayer filled with internal aqueous core of drug. The use of internal aqueous core is ideal as it helps in delivery of hydrophilic drugs;the phospholipid bilayer allows the hydrophobic drug encapsulation [13-17]. Encapsulation of the drug helps to reduce the unintended side effects of commonly used drugs in liposomal formulations like cardiotoxicity and peripheral neurotoxicity. Above all liposomes used in cancer therapy are 100 nm in diameter and this size aids them to explode from circulation through the vascular tumor sites there by exerting effective therapy. Liposomes help in slow and sustained release of drug and they are able to reduce unintended side effects of chemotherapeutic agents by changing the distribution of entrapped drug [18-22].

Dendrimer

Dendrimer are nanosized repetitively branched structures which are also called as Cascade molecules or arborols. These molecules are characterized by structural perfection 9 [23-31]. Dendrimers provide higher bioavailability and biocompatibility;it is easy to predict the pharmacokinetic parameters of dendrimer. Hence, dendrimers can be potential and unique carrier system for anticancer drug. Dendrimers have varied applications in gene delivery, Blood substitution [32-38]. The three methods used for delivering drugs by dendrimers are the drug can be covalently attached to the peripheral layer of the dendrimer to form prodrugs of dendrimer, in second method the active drug is coordinated to the functional groups peripherally via ionic interactions, in third method the dendrimer is made as unimolecular micelle [39-43].

Carbon Nanotubes

Carbon nanotubes are cylindrical allotropes of carbon with unique properties that are important for nanotechnology, material science, optics and electronics. They belong to fullerene structural family [44-46]. Carbon nanotubes provides variety of potential applications in Nanomedicine, they have unusual biological and chemical properties monothilic structures and property to coordinate with any functional group [47-51]. They are divided in to two categories, single walled carbon nanotubes and multi walled carbon nanotubes [52-55].

Micelles

Micelles are colloidal dispersions with particle size ranging from 5 to 100 nm of diameter. They consists of amphiphiles or surfactants which are made of hydrophilic head and hydrophobic tail, they exists as monomers in true solutions at low concentration [56-61]. By increasing the amphiphiles concentration aggregated particles are formed which are called as micelle, the concentration above which micelle formation occurs is called as critical micelle concentration. Polymer micelles are in smaller size and provide excellent advantage compared to liposomes [62-77]. Polymeric micelles are used widely for targeted drug delivery in chronic diseases like cancer which showed less chemo toxic effects [78-80].

Polymer-drug conjugates

Polymer-drug conjugates are used in diagnosis and treatment of various diseases, they involves the use of both liposomes and micelles in drug delivery system. Polymer drug molecules have been resulted in excellent bioavailablility and improved efficacy of the drug at targeted site [81-88]. They have been extensively used in can cancer therapy due to their unique property of multidrug resistance **(Table 1)** [89-93].

Table 1: Examples of Drugs delivered using Nanocarriers

Types of nanocarrier systems	Example of Drugs
Liposomes	Pegylated liposomal of doxorubicin, Daunorubicin,Irinotecan
Dendrimers	polyamidoamines, Amino-terminated PAMAM
Carbon nanotubes	cisplatin, Doxorubicin
Polymeric micelles	Curcumin micelles, Cisplatin, Paclitaxel, Doxorubicin

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CONCLUSION

The clinical accomplishment and drug delivery efficacy of various nanocarrier in various treatment and therapies of chronic diseases have made them promising drug delivery systems. Nanocarriers improve the lolocalization of drug thereby providing targeted drug delivery between the drug and biological system. In cancer therapy nanocarriers help in offering advanced methods of tumor recognition with high efficacy and decreased side effects. On-going research by scientists and medical personnel in nanotechnology will produce new inventions in the field of nanocarriers. In the near future, nanotechnology will show a greater result in biomedicine. The great advantage of Nanomedicine is use of distinctive properties of nanosized materials in addressing most of the challenging clinical diagnosis and therapy [94-100].

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