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Nanocarriers As Drug Delivery System

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Abstract

Nanocarriers are the tremendous advancement as diagnostic tool. Functionalisation of nanomaterials by assembling of nanomoeities has been the area of wide interest to acuire site specificity and stimuli sensitivity. The effort has been made to review various nanocarrier system for targeted drug delivery system.They are useful carrier systems due to small size and modified physical characteristics.

Introduction

Nano medicine and nano delivery systems are new and rapidly rising science in which nanoscale substances acts as diagnostic tools or deliver therapeutic agents in a controlled manner to specific targeted locations. Nanotechnology, as applied to medicine, is increasingly optimistic that it will bring remarkable advances in disease diagnosis and treatment. Developing novel approaches to building nanoformulations (nanocarriers) to efficiently transport drug molecules offers a broad range of applications in biotechnology.

Such nanostructured prototypes also allowed the successful delivery of active drugs to diseased tissues. The overall goal for nanocarrier jobs in drug delivery system is to treat the disease successfully with minimal adverse effects, thus striving at a critical increase in medical results by leveraging the (patho-) biology of the diseased tissue microenvironment.

Products with proteins need a more advanced form of carrier mechanism to increase their effectiveness and shield them from unintended degradation. It is interesting that the effectiveness of most drug delivery mechanisms is directly related to particle size. Due to their small size and huge surface region, medication nanoparticles depicts increased solubility and strengthened bioavailability, additional ability to cross the blood brain barrier (BBB) and be absorbed through the close junctions of the endothelial cells of the body.

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Nanoparticles made from natural and synthetic polymers have received more consideration as they can be optimized for selective drug targeting, boost bioavailability and enhance controlled release of drugs at a single dose; modification of the process will prevent endogenous enzymes from deteoriating the product. Also, the development of new drug delivery systems provides advantage for pharmaceutical sales. Novel drug delivery helps medical companies to develop novel versions for existing drugs. While these novel formulas will be useful for clinicians, they will also be created.

Literature review

Nano Technology

Nanotechnology is the science and technology conducted at the nanoscale, which is about 1 to 100 nanometers in size. There is unknown growth in research and application of nano technology in the recent years. There is increasing optimism that nanotechnology, as applied to medicine, will bring significant advancement in diagnose and treatment of disease. Except application in the science, the nano technology has application in drug delivery system, neutraceuticals, both in-vitro and in-vivo diagnose of the disease, and production of incompatible material.

Nanoparticles and drug delivery

Nanoparticles are sub-nanosized colloidal structures composed of synthetic or semi synthetic polymers. The polymeric nanoparticles can carry drug or protein. Thus they could be nanosphere, nanocapsules, nanocrystals, or nanoparticulates. Nanosphere are defined as solid core spherical particulates, whose size is nanomeric.

Nanocarriers drug delivery system

The challenge in the drug delivery system is that drug should reach at the site of action especially in cancer treatment. Nanocarriers are colloidal drug carrier systems having submicron particle size,>500 nm. [3] This carries the drug particles to the site of action. It is also used in the diagnose purpose for the detection of tumor cells or disease. Nanocarriers include benefits such as their small size which help in easy penetration of cell membrane, binding and stabilization of protein, and lysosomel escape after endocytosis.[2]

There are various nanocarriers which are used in treatment and diagnose of the disease.

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Organic and polymer based nanocarriers

These are carbon-based nonmaterial characterized by high biocompatibility and better drug loading capacity.[2]

1. Carbon nano tubes
2. Nano wires
3. Dendrimers
4. Liposomes
5. Niosomes

Inorganic and metallic nanocarriers

A core with inorganic component and a shell region of organic polymers that provide substrate for the conjugation of bio macromolecules or protect the core region from undesirable physicochemical interactions with the external biological micro environment are the two regions in inorganic nanocarriers.[1]

1. Silica gold nanoshell
2. Gold nanoparticles
3. Quantum dots
4. Mesoporous silica nanoparticles
5. Spion

Carbon nano tubes

Carbon nano tubes are new technology with novel and useful properties. It belongs to the class of a third allotropic form of carbon and contains one or more graphene sheets rolled up into single cylindrical tube or multiwall tube.

Single sheet cylindrical carbon nano tube:- In this graphene single layer is folded into cylinder to form nanotube which is measured on the nanoscale.

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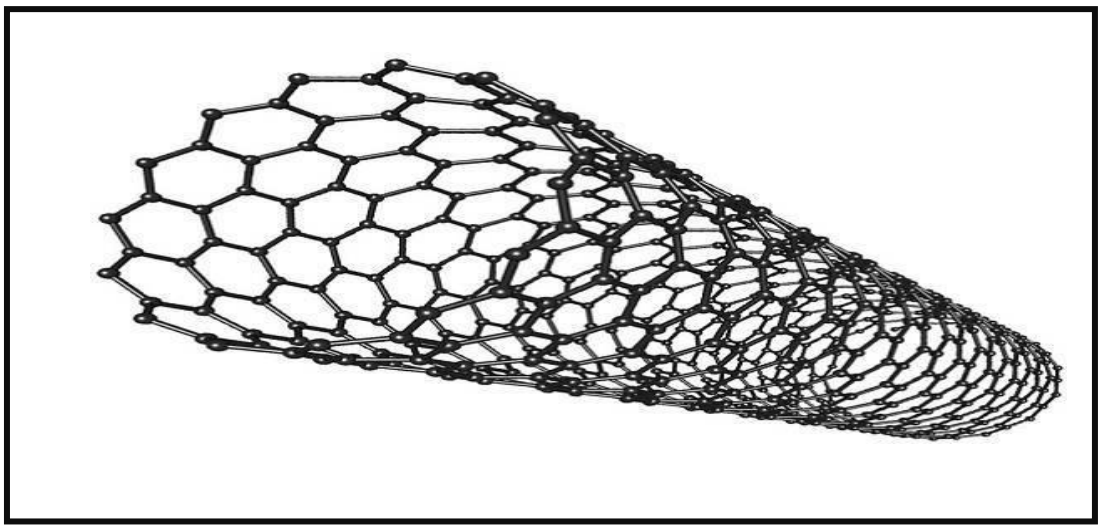

Figure 1: Single sheet of cylindrical carbon nano tube

Multi sheet carbon tube:- In this multi layer of graphene is folded into cylinder to form multilayered nanotubes.

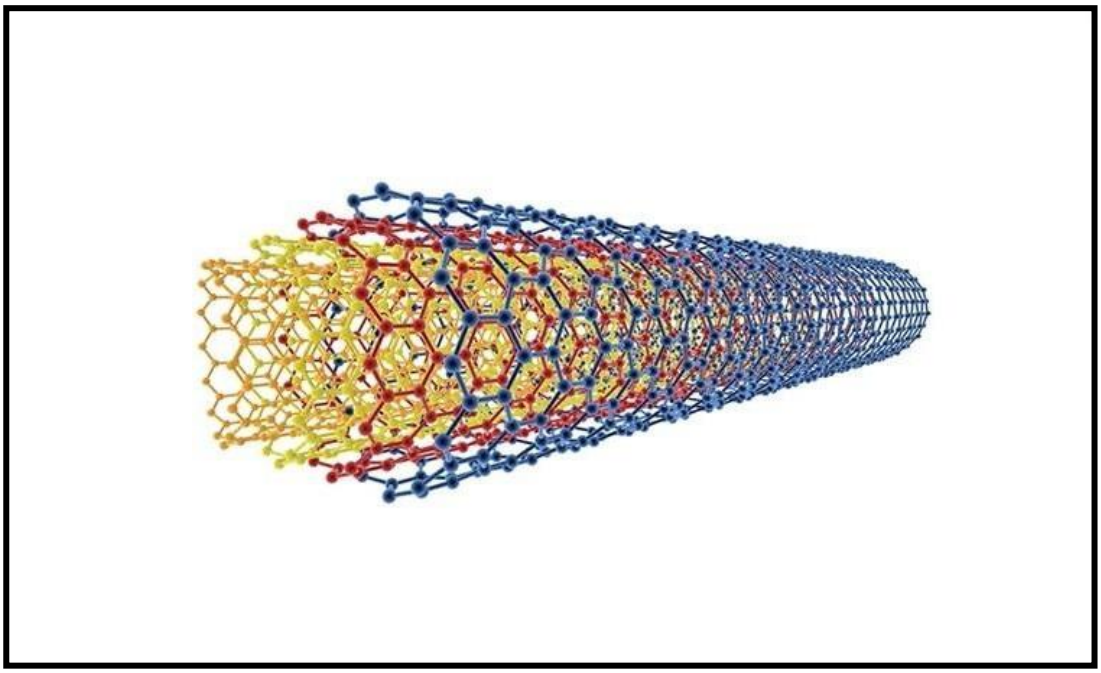

Figure 2: Multi layer carbon nano tube

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Application of carbon nanotubes [6]

1. Carbon nano tubes are used in drug delivery system carriers for cancer treatment and used in targeting of amphotericin B to cells.
2. Carbon nanotubes are antioxidant in nature so they are used to preserve drugs that are easily oxidized.
3. Carbon nanotubes are used as energy storage devices.
4. Carbon nanotubes are used in generation of tissues.
5. Carbon nanotubes are used as artificial implants. As they are having high tensile strength so they are filled with calcium and arranged like bone, which act as bone substituent.
6. Carbon nano tubes are used in gene therapy by DNA delivery.

Nano Wires

Nanowires are the one dimensional nanostructure used in the diagnose of biomolecule and pathogens. Polymeric nano wires are easy in formulation, biocompatibility and suitability with biomolecule. Field effect transistor nanosensors are three-electrode systems including source, drain and gate electrodes where memristor based sensor has source and drain electrodes.[7]

Application of nano wire [7]

1. Nano wires are used in detection of protein and DNA, such as nucleic acid.
2. Nano wires are used in drug discovery.
3. Nano wires sensor are used in detection of viruses in the solution.

Dendrimers

Dendrimers are the tree like structured macromolecules. They are hyper branched synthetic polymer system. This can be conjugated to various chemical species such as detection agent, targeting agent, and diagnostic agent, imaging agent, radio ligands and affinity ligands.[9] The structures of dendrimer consist of three components; multifunctional central core moiety, branched units and external capping groups. Due to its small size it has advantages like easy uptake by cells. [8]

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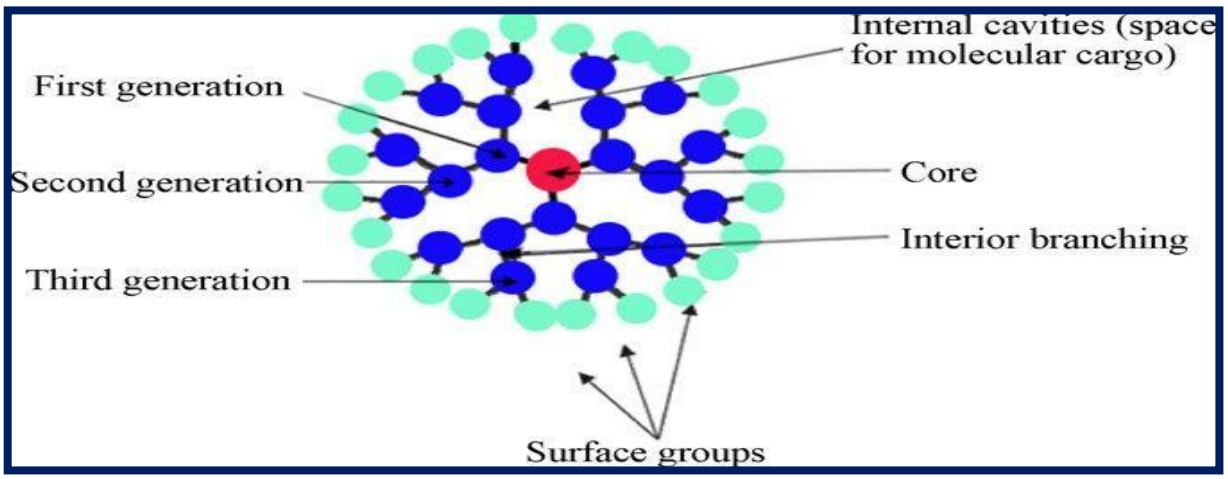

Figure 3: Structure of Dendrimer

Due to the 3D structure of dendrimer the drug loading is easier on surface, drug loaded can be on both interior and outer surface of the dendrimer. Encapsulation of drug and dendrimer-drug conjugates can be done in two methods i.e. non covalent encapsulation of drug/host guest relation and covalent dendrimer-drug conjugates.

Application of dendrimer[12]

1) Dendrimers are use in various drug deliveries like: -
   - CNS delivery
   - Ocular delivery
   - Transdermal delivery
   - Intravenous delivery
   - Vaccines delivery
   - Oral delivery
   - Nasal delivery
   - Gene delivery
   - Pulmonary delivery
   - Cellular delivery
   - Solubility enhancer
   - Targeted delivery
2) Dendrimer are used in site specific drug delivery.

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Liposome

Liposomes are vesicular-colloidal structures that consists of one or more lipid bilayers which surrounds an equal number of aqueous compartments. The shell-like sphere encapsulated an interior liquid containing substances like peptides and protein, hormones, enzymes, antibiotics, antifungal and anticancer agents. A free drug injected into the bloodstream, due to metabolism & excretion, typically achieves therapeutic level for a short time[3]

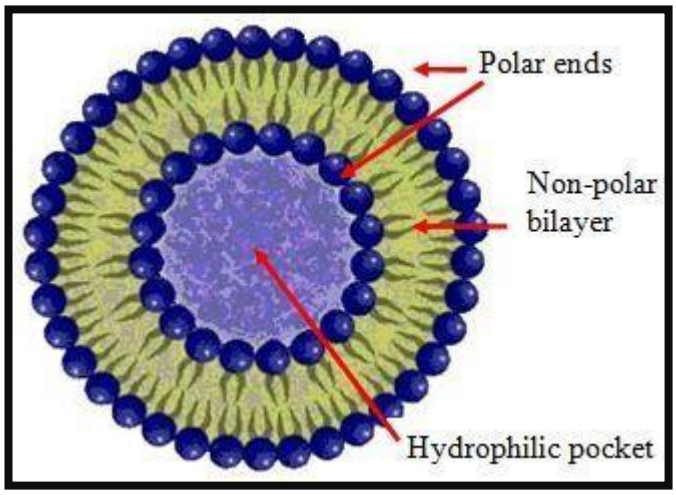

Figure 4 General structure of liposomes

Types of liposomes: -

A) Based on structural parameters

a) Unilamellar vesicles

In this three type of size are present i.e. small Unilamellar vesicles (size varying from 20-40nm), medium Unilamellar vesicles (size varying from 40-80nm), large Unilamellar vesicles (size varying from 100-1000nm).

b) Oligomellar vesicles

They are composed of bilayers of lipids surrounding a large volume.

c) Multilamellar vesicles

These have multiple bilayers. The arrangement of multilamellar is onion like.

B) Based on the method of preparation

a) Single or oligomellar
b) Multilayer lamaller
c) Stable plurilemellar vesicles
d) Frozen and thawed MLV

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e) Vesicle using extrusion technique
f) Dehydration- rehydration method

C) Based on the composition and application

a) Conventional liposomes
b) Fusogenisc liposomes
c) ph sensitive liposomes
d) cationic liposomes
e) long circulatory liposomes
f) immune liposomes

Targeting of liposomes

1) Passive targeting
   In this technique drug targeting takes place due to body's responsive system to physiochemical characteristics of the drug.
2) Active targeting
   In this targeting takes place by specific target agents which are positioned on the liposomal surface so that they can interact with the target i.e. receptor.

Application of liposomes

1) Liposome is used in the cancer chemotherapy.
2) Liposome is used in gene therapy.
3) Liposome is act as carrier of drug into oral treatment.
4) Liposome is used in the topical delivery.
5) Liposome is used in leishmaniasis.
6) Liposome is used in lysosomel storage disease.
7) These are used in metal storage disease.

Niosomes

Niosomes are the bilayered spherical structure consists of microscopic lamellar structure. Niosomes are formed from nonionic surfactant with or without cholesterol and a charge inducer.[10]

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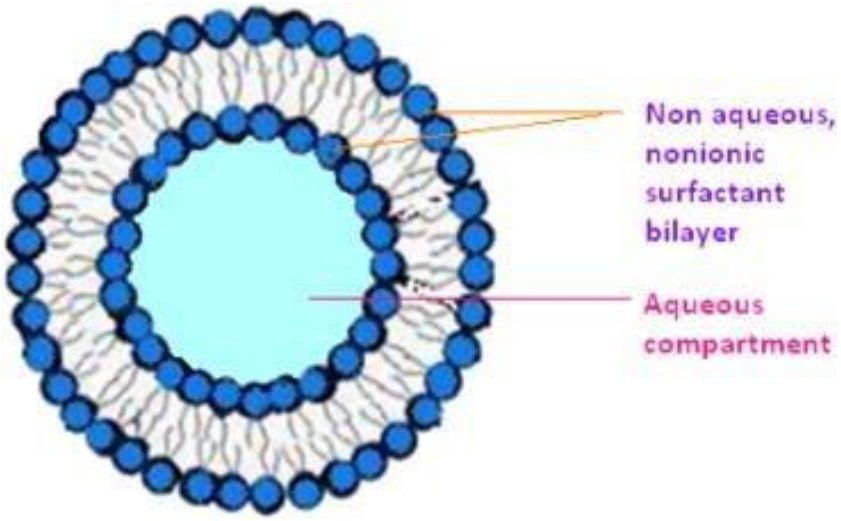

Figure 5 general structure of Niosomes

Niosomes are prepared by the hydration of surfactants and lipid mixture at increased temperature and then size reduction is done to form a desired colloidal emulsion.

Application of Niosomes[10]

1) Niosomes drug delivery system are used in delivery of drug through various routes like Transdermal, paranteral and ophthalmic.
2) Bioavailability of drugs like diclofenac, nimusulide and flurbiprofin are increased by niosomal formulation.
3) Chitosin coated formulation of timolol maleate has reduced intraocular pressure.
4) Niosomes are used in drug delivery in leishmaniasis, neoplasia, inflammation, lung disease.

Conclusion

The nanocarriers have tremendous potential in the drug delivery application than the conventional treatment. The use of nanopharmaceutical carriers is to enhance the *in vivo* efficiency of drugs in field of pharmaceutical research and clinical testing.

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